Technical Proceedings of the Fifth International Marine Debris Conference

NOAA Marine Debris Program
National Oceanic and Atmospheric Administration
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March 20–25, 2011
Honolulu, Hawai'i, USA

Ben Carswell, Kris McElwee, and Sarah Morison (eds.)

United States Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service
Office of Response and Restoration
Marine Debris Program
Silver Spring, MD 30910

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Preface

This Technical Proceedings provides a record of the Fifth International Marine Debris Conference, a multi-disciplinary meeting that convened a global community of marine debris researchers, policy makers, advocates for ocean health, industry innovators, and artists in Honolulu, Hawai‘i, March 20–25, 2011. Included within this document is summary material, extended abstracts for all presentations and posters, a detailed conference agenda, a complete list of participants, and other conference highlights. Readers seeking knowledge about the status of marine debris in the world's oceans, approaches to measuring, managing, and mitigating its impacts, and strategies for its prevention are invited to use this resource. In addition, a separate document, the Summary Proceedings of the Fifth International Marine Debris Conference will be available from our conference partners, the United Nations Environment Programme, that will provide a concise, printed overview. The conference organizers wish to extend a heartfelt *mahalo* to all the participants of the conference for their commitment and invaluable contributions to the success of this event and, more importantly, for their dedication to understanding and solving the problems associated with marine debris.

Executive Summary

The Fifth International Marine Debris Conference (5IMDC) was the first international conference on marine debris in over a decade and the largest gathering devoted to the subject yet convened. The US Government's National Oceanic and Atmospheric Administration (NOAA) and the United Nations Environment Programme (UNEP) partnered to organize the conference. The organizers envisioned the 5IMDC as an inclusive, multidisciplinary event that would heighten global appreciation of threats posed by marine debris, highlight advances in research, and encourage sharing of strategies and best practices leading to collaborative solutions. The conference brought together an international group of marine debris researchers, natural resource managers, policy makers, industry representatives, the non-governmental community, artists, filmmakers, and students. Over 450 participants traveled from 38 nations to attend the 5IMDC, where they learned from the original research, unique experiences, and diverse perspectives of over 170 conference presenters.

The 5IMDC was a watershed event in the global effort to prevent, reduce, and understand the impacts of marine debris. Together, participants forged strong relationships and exchanged vital knowledge and perspectives within the rapidly growing marine debris community. This document provides a record of the events that took place at the conference, the participants involved, and a window into the information that was shared.

Marine debris is maturing and gaining stature as an environmental topic. The size of the 5IMDC and high profile of the attendees, along with steadily growing interest and specialization within the research community and increasing media attention, attest to that. Greater stature speaks to the efficacy of preceding efforts, but 27 years have now passed since the first Workshop on the Fates and Impact of Marine Debris was convened in Honolulu in 1984. It is indeed time for solutions and bold, science-based action. Two unique outcomes of the 5IMDC, the Honolulu Commitment and the Honolulu Strategy, will now serve to unite and guide international efforts to reduce and prevent marine debris.

The extended abstracts included in this document provide many examples of management-focused research and solution-oriented work. 5IMDC participants are driving change around the world, from highly effective, community-based waste management projects to far-reaching regional and international agreements. This combination of bottom-up and top-down approaches has led to progress across the board in reducing the impacts of marine debris. Still, the notion that marine debris is a solvable problem is yet to be realized. A lasting, global solution will require integration across spatial scales, partnerships that cross traditional institutional divides, and ultimately, a cultural shift in patterns of consumption and disposal that changes the way industries, individuals, and institutions make decisions. Though the challenges presented by marine debris are great, the 5IMDC participants demonstrated determination and ingenuity in the face of these challenges.

Moving forward, actions should be bold, yet their bases must be justifiable, their targets directed, and their outcomes measurable. Thus, it is essential that researchers across disciplines, including the social sciences, continue to advance the scientific understanding of marine debris in all forms and the impacts it has on marine ecosystems and coastal communities. Long-term monitoring, standardized techniques, statistically defensible conclusions, and accessible venues for data sharing are essential elements of success.

The pervasive presence of marine debris in our oceans and along our coasts is a highly visible reminder that the by-products of human civilization are now shaping the ecological systems that support our well-being. This message, and the evidence to support it, must be conveyed clearly, accurately, and frequently to those outside the marine debris community, especially to young people, some of whom were among the most important participants at the 5IMDC. They warmed our hearts with their artwork, candor, and remarkable insights, yet, sadly, it would be naive to expect that they will not encounter and be forced to reckon with marine debris in their lives. Our collective efforts should therefore be focused on providing them with healthier marine ecosystems that are less stressed by the cumulative impacts of marine debris, a responsible populace that understands the marine debris problem, and a refined set of tools for marine debris prevention, assessment, and reduction. The material contained herein documents a significant step towards achieving those goals.

Session Summaries

The following summaries were developed with invaluable input from the Session Chairs and Panel Moderators. The *Highlights* and *Implications* presented here are, with the exception of minor editorial corrections, their words. The conference organizers are grateful to these individuals for graciously providing their expertise and unique perspectives. Any opinions, positions, or conclusions expressed in these materials do not necessarily reflect the position of the National Oceanic and Atmospheric Administration, the Department of Commerce, the government of the United States, or the United Nations Environment Programme.

The session summaries are organized according to the same reference system that was used for the conference schedule, for easy cross referencing. Mutli-part sessions have been combined to provide a single comprehensive summary of each topic. References to web content have been hyperlinked, and the session #'s are linked to the abstract for the first presentation in each session.

Stories of success: place-based partnerships to prevent land-based sources of marine debris

Session: 1.a., Chair: Chris Corbin, on behalf of Mushtaq Memon

Description
The focus of this session was prevention of land-based sources of marine debris. Marine debris efforts often involve collaborations among many different organizations and disciplines. As the NOAA Marine Debris Program states, "Marine debris is everyone's problem." This session explored case studies that tell an interesting, holistic marine debris "story." Regional successes and challenges were highlighted as were projects that utilized partnerships among varied stakeholders.

Highlights

The session included presentations and active discussions on how collaboration among several different sectors, including the private sector and the non-governmental (NGO) community, can be used to reduce the impacts of land-based sources of marine debris. Peter Murphy from the NOAA Marine Debris Program outlined the importance of proactive collaboration in reducing the impact of storm related debris. Dr. Sue Kinsey, Litter Policy Officer with the Marine Conservation Society emphasized how positive working relationships can be established between private industry and the NGO community provided that common interests are identified. Amelia Montjoy, Vice President of Resource Development and Operations at the Ocean Conservancy, reiterated the importance of engaging the corporate and industry sectors through extended producer responsibility, life cycle analysis, and removal of accumulated debris.

Implications
Key messages from the session included the importance of partnerships and collaboration among all sectors; the need for expanded targeted outreach and public education as a means of fostering change in attitudes, values, behavior, and practices; and the need to enhance data collection, information dissemination and technology transfer.

Stemming the tide of trash: model education and outreach programs to prevent marine debris

Sessions: 1.b. and 2.b., Chair: Sarah Sikich

Description
Effective education and outreach efforts targeted at marine debris pollution prevention and reduction are needed to influence individual behavior change. This session focused on education and outreach programs designed to inform the general public about the impacts associated with marine debris and simple steps that can be taken to help prevent their contribution to the problem. Essential elements, creative approaches, and effective partnerships needed to implement effective marine debris education and outreach programs were discussed, as well as lessons learned to apply to the future development of marine debris educational efforts.

Highlights

- The importance of minimizing individual use of single-use plastics was a recurring theme in discussion of land-based sources of marine debris. Education efforts directed at changing individual behavior or policies were highlighted as ways to help achieve this goal.
- Many presentations in this session recommended tying education and outreach efforts about marine debris prevention and reduction to citizen science. This is a great way to build awareness, inspire action, and generate data regarding marine debris.
- Social media gets people excited about marine debris, as well as actions to prevent and reduce it. Social media and other internet outlets help communicate the global nature of the problem.
- When working on prevention of derelict fishing gear, it is best to engage the fishing community to identify practical solutions and educate about the problems and solutions.

Implications

Consistent priority actions included making education and outreach fun, providing practical solutions, and partnering with diverse groups to reach a broad audience about the problems and solutions associated with marine debris. Also, there was a theme of identifying individuals that are passionate about the issue and training them to be educators to help inspire change amongst their community members and networks.

Wildlife entanglement in marine debris: assessment and response

Session: 1. c., Chairs: Michael Williams, David Schofield

Description
This session focused on measuring the rates of marine animal entanglement and detecting changes in the rates of marine animal entanglement as they relate to efforts to remove marine debris from the environment. It brought together responders from the marine animal health and stranding network with marine debris prevention, removal, and detection experts. The session participants shared experiences, tools, methods, and strategies for responding to marine animal entanglement.

Highlights

- Derelict fishing gear (DFG) continues to cause direct mortality on target and non-target species for years after its loss or disposal. Some types of DFG investigated may continue to cause mortality for its entire life cycle (decades), rather than becoming fouled and tangled at the seafloor.
- Steller sea lion entanglement can be categorized as active or passive. Passive entanglement is encountering marine debris at sea. Active entanglement occurs with fishing gear that is being fished (i.e., ingestion of bait or hooked fish and then being hooked or in the case of large whales running into buoy lines or nets while this gear is being fished).
- There is a need to develop successful messages and partnerships to reduce the sources of marine debris.
- There has been an increase in seabird (including seaduck) entanglement since 1997.
- Northern fur seal entanglement may be higher in pre-weaned pups and females than previously estimated due to sampling bias related to swimming behavior and timing of arrival, respectively, in these segments of the population.

Implications
Marine debris continues to cause mortality and serious injury in marine mammals, seabirds, fish and invertebrates. Previous estimates of the rates of entanglement were either low or have become outdated as rates have increased.

Rates of entanglement in most species appear to be higher than previously thought. Whether the apparent increase is due to more debris, more sampling effort, or more interactions between marine animals and debris is unknown.

We defined active entanglement as marine mammals actively pursuing a hooked fish or bait and ingesting the hook. A subgroup of the presenters and audience met on March 23rd to discuss a variety of topics, including an update to Laist 1997 (presentation 12.c.1. by Cornish et al. may have accomplished this), better coordination among the National Stranding Response Program and the NOAA Marine Debris Program, and better messaging of the need to reduce marine debris for the protection and conservation of marine animals. The group agreed that an outreach campaign starting with the reduction of entangling debris like derelict fishing gear and packing bands would provide the most immediate benefit to marine mammals.

Innovative disposal options for difficult situations

Session: 1.d., Chair: Christine Laporte

Description

This session highlighted innovative and cutting edge technologies for debris management, including mobile treatment of waste through gasification, pyrolysis, and plasma vitrification. In many locations, landfill disposal is not feasible and so alternatives must be explored. In other cases, landfill disposal is undesirable. When energy can be produced from the debris or the debris may be recycled, there are synergistic benefits to its collection and waste management. This session presented the available information on the cost of facility construction and operation as well as waste throughput costs. Special issues related to derelict vessel deconstruction and disposal and new technologies that address concerns about the difficulty of collection and disposal in unique situations were also covered.

Highlights and Implications

- Private sector-public partnerships usually work well when all are committed to some similar values and goals, perhaps even better than public sector actions alone.
- Landfills are NOT a solution. Conversion of waste back in to energy is a critical next step.
- Specific solutions should be culturally and geographically relevant and utilize methodology that accounts for these considerations.
- Shipboard garbage/debris management can be improved with design approaches, such as convenient port-reception facilities.
- It is critical to maintain positive one-on-one relationships with stakeholders and to craft compelling stories that encourage investment in improved disposal options.

Reducing marine debris from shipping: the reality of regulation beyond the horizon

Session: 2.a., Chair: Allison Lane

Description

This session examined the development of international and national regulation aimed at preventing garbage pollution from ships and explored the feasibility of making regulation effective in an environment that relies on voluntary compliance. It is clear from both the international and individual state experiences that regulations to prevent garbage from vessels of all sizes may not be a comprehensive solution to the problem. While regulation is essential, enforcement of regulations becomes extremely difficult when vessels are routinely out of sight of enforcement agencies and, in the case of smaller vessels, are not even required to keep records of garbage management practices on board. This session covered the role of regulation and considered how this may be enforced and what is needed to ensure voluntary compliance in the case that enforcement is not a realistic option.

Highlights

- Developing countries struggle with land-based infrastructure, adding to the challenge of managing ship-based waste.
- Partnerships are needed with industry and require a foundation of mutual trust.
- Challenges arise in obtaining international agreement to change conventions due to differences in priorities and ability to implement changes.
- Changes to MARPOL Annex V are significant and should begin to shift culture and increase ocean protection.
- Incentives to discharge offshore are important.
- Inspection data should be incorporated in to the International Maritime Organization's Global Integrated Shipping Information System (GISIS).

Implications

A collaborative approach between industry and governments, with a focus on early facilitation of regional cooperation, will achieve the best results.

Addressing abandoned and derelict vessels

Session: 2.c., Chairs: Margaret Wright, Neal Parry

Description

This session focused on abandoned and derelict vessels (ADVs) and covered various aspects of response, removal, impacts, and policy. ADVs are a distinct form of marine debris that often demand innovative and alternative approaches to response and removal.

Highlights

- ADVs can present unique problems when being removed and the process can be costly.
- Proper planning and communication can help prevent costly problems during the removal of a vessel.
- The importance of obtaining the proper permits and permissions was discussed. It was noted that this can sometimes become a lengthy process.
- Community-based education is very important in helping to eliminate marine debris.
- Presentation 2.c.2. by Amber Von Harten provides several helpful websites that would be beneficial to anyone wanting to begin a community-based education program.

Implications

- Careful planning and preparation are essential to ADV response and removal operations.
- Thorough communication efforts should be employed to keep communities and partners informed.
- Targeted education campaigns are needed to help prevent ADVs.

Panel: waste reduction and recycling for a zero-waste future

Session: 2.d., Moderator: Betsy Dorn

Description
Waste reduction is integral to reducing and preventing land-based sources of marine debris. In this session, panelists discussed current methodologies for obtaining the goal of waste reduction and/or zero waste and efforts to recycle and reuse plastic packaging materials. The panel covered best practices designed to minimize waste in urban and coastal areas and focused on identifying the common elements of successful actions that can be replicated nationally and globally.

Highlights

- The first panelist and moderator, Betsy Dorn from StewardEdge, gave an overview of zero waste.
- The second panelist, Saskia Van Gendt from the US Environmental Protection Agency, discussed federal strategies and projects.
- The third panelist, Monika Thiele representing Mushtaq Memon, presented more global tactics and programs related to UNEP's work on striving for zero waste.
- Lastly, Peter Jones, with his vast experience in industry in the United Kingdom, represented both a European view to attaining zero waste and also provided an industry perspective.

Implications
The primary driver for extended producer responsibility going forward will be a lack of critical resources to produce industrial goods. Therefore resource efficiency is an argument to be used when trying to convince companies that a zero waste goal is in their best interest.

Outreach and education techniques and approaches

Sessions: 3.a. and 4.a., Chairs: Elisabeth Guilbaud-Cox, Monica Thiele

Description
The goal of this session was to present outreach options for a variety of audiences and locations. This session included approaches to outreach and education through artwork, classroom activities, and community involvement. Presenters shared stories of successful formal and informal education for many audiences.

Highlights and Implications

- Dr. Karla McDermid at the University of Hawaii-Hilo has developed a comprehensive undergraduate course focusing on marine debris and its impacts.
- The US Environmental Protection Agency is working to engage and inform urban communities, particularly groups that are not typically involved.
- Over communicating about an event is critical to getting good turnout, as well as identifying accessible clean-up-sites while keeping the event itself flexible so volunteers can come and go as they wish.
- Economic issues are critical with regard to an on-going dialogue and finding solutions.
- NOAA is combining data from drifter buoys, available free online, with wind and current data to generate visualizations that increase understanding and awareness of marine debris movement and accumulation patterns.

Modeling marine debris movement and transport

Session 3.b., Chair: Nikolai Maximenko

Description

This session focused on marine debris movement and transport in aquatic environments. Presentations covered a variety of topics linked in the common discussion of the fate and transport of different types of marine debris.

Highlights

The session included presentations on a variety of aspects of monitoring, quantification, and modeling of marine debris. Alexander Turra (University of Sant Paulo, Brazil) with co-authors and also Nikolai Maximenko and James Potemra (both from the University of Hawaii) discussed simulations of debris in ocean models of various complexity. They emphasized that modeling the dynamics of marine debris on local, regional, and global scales are tremendously difficult tasks. Many processes need to be studied much better in order to improve the models. Interaction between modelers and observational scientists should be developed by gathering all the data from marine debris observations in a single public domain, and also by making model outputs more readily available to the public.

Chris Pallister (Gulf of Alaska Keeper) and Scott Wilson (Centre for Environmental Management, Australia) overviewed results of their coastal debris monitoring programs and discussed the roles that storms and tides are playing in debris deposition on the coastline. They suggested that advanced research can lead to new engineering solutions that will efficiently catch debris near shore.

Doug Woodring (Ocean Recovery Alliance) pointed out the tremendously important roles played by rivers that are both the main source of debris and the best site to monitor and to cut this flux. He argued that awareness, involvement, and two-way communication should be developed on all levels, from the general public to government, from local levels to international levels. He also proposed an Internet-based system, allowing reporting of debris via cell phones, summarizing the data in a form of online map, and automatically notifying corresponding authorities.

Implications

Participants of the session unanimously expressed that increased funding for marine debris research is the key for future progress.

Designing meaningful protocols for monitoring marine debris

Sessions: 3.c., 4.c., and 6.c., Chairs: Ellik Adler, Francois Galgani, Christine Ribic

Description

This session focused on developing scientific monitoring programs to assess the distribution, amount, types, and impacts of marine debris. Environments considered included shorelines, wetlands, watersheds, surface waters, the water column, and the benthos. Emphasis was placed on statistical rigor, determination of environmental covariates that may affect debris movement and breakdown, development of standard procedures and sampling schemes, and methods of reporting results to appropriate audiences. This session also emphasized the need to determine the questions that will guide a monitoring program as the first step in the experimental design process.

Highlights and Implications

3.c. The overall objectives of modern and effective monitoring programs are to obtain reliable information to make good policy decisions, to generate awareness and support measures taken, and to obtain reliable information on the effects of the measures taken. The marine debris scientific and management community is moving towards the understanding that monitoring is an integral component of a larger assessment program. A program where stakeholders, such as end users and managers, are involved in defining the questions they need answered. The science-based answers to these questions will form the basis for a credible decision and policy-making process, which in turn will be reassessed to determine if the management decisions and policies taken have made a positive impact and achieved their goals. This circular, adaptive process serves as a base for developing and implementing various monitoring programs.

Monitoring programs have to challenge criticism for being too expensive, not useful, and not scientifically credible. In order to design and implement successful monitoring programs the following criteria and objectives must be designed and addressed: good base questions, appropriate and practical design, high-quality data, sound analysis to provide reliable assessments, usable and well communicated results, and long-term personal and institutional commitments. Presentations during this session demonstrated how new bio-monitoring and more traditional pollutants monitoring programs (in the US, the UK, the North Sea and the Arctic) are using and implementing these key principles.

4.c. M. Goldstein assessed the ability of the human eye to sort micro-plastic compared to a digital scanner. She found that results were comparable except for the very smallest pieces where the digital scanner outperformed the human eye. M. Crowley presented information on Project Kaisei and how they were interested in using the plastic debris they collected, not just cleaning up the ocean; she invited scientists to get involved in the project. E. Nakashima presented a method for estimating weight of debris on beaches by combining balloon-based photos with quadrats sampled to estimate debris weight; she also presented information concerning heavy metals associated with the plastic debris. There was some discussion concerning the influence of bio-films on the heavy metal results. K. Weiler presented information on different U.S. Environmental Protection Agency programs, highlighting the volunteer aspect of the National Marine Debris Monitoring Program. F. Galgani discussed the European Union’s program on marine litter, emphasizing the benthic debris problem. Key messages from the session included the need to establish protocols for debris measurement and evaluation as well as highlighting the diversity of programs and research being done to evaluate different aspects of the marine debris problem.

6.c. The session was focused on research related to monitoring programs assessing the distribution, amount, types, and impacts of marine debris. Currently, regular monitoring is limited to a few areas, but the concern is now worldwide. Presentations focused on shorelines including microplastics, but also considered benthic marine debris. Guidelines from UNEP and the Intergovernmental Oceanographic Commission were presented in support of litter monitoring on beaches. A commonality in the monitoring research efforts in Korea, Brazil, China, Hawaii and England was the need for the development of simple, standard procedures, sampling schemes, and reporting mechanisms available to appropriate audiences.

Panel: At-sea detection of marine debris: capturing local ecological knowledge and observations

Session: 3.d., Moderator: Kalani Souza

Description
Fields from climate change to fishery management have taken advantage of observational knowledge held by individuals with expertise outside the sciences. The vast expanses of the ocean pose an observing challenge to academic and government researchers, and access to those who hold this knowledge is sometimes difficult. Mining the experiences of those who spend much of their time at sea is a valuable way to gain knowledge. This experiential knowledge, while not collected using the scientific method, may illustrate trends only now being detected by science, cover a timeline longer than any research project, and lead to new and better management actions. Panelists discussed the frequency of marine debris sightings and encounters at sea, debris types encountered, geographic and temporal distribution of debris encounters, and insights into debris behavior and movement. This discussion captured observational knowledge based on panelists' experiences and observations as well as actions the panelists felt could lead to solutions.

Highlights
Panelists Capt. Robert Lamb, Matson's Manager of Marine Operations for Hawaii; LT Kelley Sage, NOAA Commissioned Officer Corps; and CDR Derek Trinque, US Navy, shared their experiences observing marine debris from aboard ships. All ocean-going panelists and audience members remarked that marine debris is frequently spotted at sea, that larger items are more easily spotted, particularly from large vessels, and that impacts to navigation, while uncommon, do occur.

Implications
Panelists and audience members noted the value of gathering information from ships of opportunity, the importance of a convenient way to report that information, and the need to gather it and make it accessible by agencies, organizations, and communities. General consensus was that the lack of scientific rigor in such observations (e.g., lack of a sampling plan, secondary or tertiary importance of observing mission) would be balanced by the value of the reported information. A simple but standardized reporting mechanism could partially overcome the inherent variability in platforms, observing protocols, and observer training.

Risk analysis: using predictions of the source and distribution of marine debris to assess their impacts

Session: 4.b., Chairs: Britta Denise Hardesty, Chris Wilcox

Description

Understanding the impact of marine debris is fundamental to the development of appropriate management responses to the problem. A risk analysis perspective provides a useful and cost-effective approach. Combining the likelihood that species interact with debris with a prediction or assumption about the likely impact of the interactions yields an expectation of the magnitude of the biodiversity risk posed by marine debris. This session covered the following topics: applying novel approaches to predict sources of marine debris, identifying the distribution and fate of marine debris, and performing risk analysis for marine debris impacts. This session examined different approaches to estimating the at-sea distribution of marine debris and evaluated how such estimates might be combined with predictions of impacts on marine biota to develop large-scale risk analyses for particular species or taxonomic groups.

Highlights
In this well-attended session, five speakers presented their findings on marine debris impacts in different systems. Hardesty described a preliminary audit of marine debris sources and sinks across Australia with results pointing to seasonality and population center differences in marine debris. Townsend discussed the impacts of marine debris, particularly plastics, on different life history stages of sea turtles near urban areas. Nevins presented her work on Northern Fulmars and the approach of using these plastic-ingesting seabirds as bioindicators of plastic in marine environments. Titmus reported on research into interactions of seabirds and marine debris conducted through visual observations from vessels in the Northeast Pacific Ocean. Wilcox concluded the session by describing a risk-assessment approach that combines modeling and empirical data to understand where marine turtles are likely to encounter derelict fishing nets. Discussion was lively and involved questions about community-level impacts for species with different life history traits and opportunities for combining empirical and model-based approaches to understanding marine debris impacts.

Implications
Key priority actions included targeting or identifying thresholds for acceptable levels of plastics in the marine environment, similar to the system adopted by the European Union. Common goals identified included establishing mitigation measures, focusing cleanup efforts on identified high-risk areas, conducting experiments to determine why and how marine species interact with marine debris, identifying fine-scale aggregations of marine species and marine debris likely to interact, and developing drift models to determine overlap of marine debris distributions with affected species populations.

In-water technology to detect derelict fishing gear in marine/estuarine ecosystems

Session: 5.a., Chair: Peter Murphy

Description
Derelict fishing gear (DFG) is an ongoing problem in most marine and estuarine ecosystems. DFG can have serious impacts to habitats and may potentially lead to significant losses of living marine resources from ghost fishing. This session focused on technological capabilities to detect derelict fishing gear in marine and estuarine waters. Presenters highlighted successes and challenges of varying technological approaches, capability sharing, and collaboration. The ability

to spatially map and quantify DFG will help determine the extent of impact and is valuable to establish targeted areas for gear removal.

Highlights

This session featured presentations from five different groups, each approaching the issue in a different way and in a different environment. Work in the U.S. Virgin Islands leveraged data from multiple sources to identify areas for investigation through side scan sonar. This sonar was deployed from an Unmanned Underwater Vehicle (UUV) through a partnership with the U.S. Navy. The data and lessons learned from this project emphasized the importance of making consistent disposal alternatives available to fishermen, as well as improved and clear delineations of fishing areas to prevent gear conflict and loss.

Amy Uhrin, of NOAA, presented her group's work in the Florida Keys National Marine Sanctuary, which utilized diver tows to examine concentrations and conditions of debris with special emphasis on derelict traps. This technique was found to be highly effective for both debris identification and contextual data collection on surrounding habitat based on the added degree of information that human observation can capture. Kyle Antonelis, of Natural Resource Consultants in Seattle, WA, presented on ongoing work in Puget Sound utilizing towed side scan sonar to identify derelict crab pots as well as fishing nets. This second capability is a cutting-edge development in the field of DFG detection that spurred questions and interest from the audience and presenters alike. Rachael Miller, of the Rozalia Project, presented on their ongoing efforts to utilize side scan sonar paired with ROV-deployed high-frequency sonar systems to detect DFG in the U.S. Northeast. Rozalia is actively working to engage fishermen and the public in the issue of DFG through hands-on demonstrations and presentations. Peter Murphy, with the NOAA Marine Debris Program, presented on the challenges of identifying and deploying the appropriate detection technology using a recent project on derelict crab pots in Alaska as a case study.

Implications

Several key commonalities emerged through the presentations and subsequent discussions. The first of these was that technology and techniques must be selected to fit project research questions. For example, a project seeking to measure only abundance can utilize random transects without the need for GPS tagging. Conversely, a project that seeks to remove targets at a later time needs to capture and catalogue highly accurate locations. While many of the projects discussed utilized side-scan sonar, each project had tailored their approach to fit their needs. This adaptability is critical for successful detection of derelict fishing gear. Lastly, presenters agreed that the data they provide must be communicated to others to drive heightened awareness that can lead to change of policies, management approaches, and/or consumer behaviors.

Panel: plastic recovery for a trash free ocean

Session: 5.b., Moderator: Katherine Weiler

Description

The problem of marine debris can be tackled at various points throughout the supply chain to help ensure that products are properly stewarded and do not end up in the ocean. This panel investigated the need for and benefits of product design improvements, supply chain logistics (i.e. utilization of sustainable packaging of products, source reduction), and highlighted international plastic producer and stakeholder efforts to reduce litter and to increase plastic recovery, renewable energy production, and greenhouse gas mitigation.

Highlights and Implications

- The helpfulness of a life-cycle study is seen in the example of global warming potential of a HDPE plastic bag versus a variety of other bag materials. In 2011 the UK government's Environment Agency commissioned a study that assesses the life-cycle environmental impacts of the production, use, and disposal of different carrier bags for the UK. The report found that paper, LDPE, non-woven PP and cotton bags should be reused at least 3, 4, 11 and 131 times respectively to ensure that they have lower global warming potential than conventional HDPE carrier bags that are not reused. (http://www.environment-agency.gov.uk/static/documents/Research/Carrier_Bags_final_18-02-11.pdf)
- "Plastics reduce energy use by 61% and greenhouse gas emissions by 57% across a variety of applications compared to alternatives." (Denkstatt, "The impact of plastics on life cycle energy consumption and greenhouse gas emissions in Europe," June 2010)
- Plastics help keep food fresh, reduce waste and protect products from farms to grocery shelves to kitchen tables. For example, "1.5g of plastic wrap extends a cucumber's shelf life from 3 to 14 days…Apples packed in a shrink-wrapped tray cut fruit damage (and discard) by 27 percent…Consumers toss out vastly more food than we do packaging" (http://freakonomics.blogs.nytimes.com/2010/02/08/how-about-them-wrapped-apples , http://www.siwi.org/documents/Resources/Policy_Briefs/PB_From_Filed_to_Fork_2008.pdf)
- In South Africa, the Industry Waste Management Plan was developed in accordance with the National Environmental Management Act.
- In 2009, nearly 480 million pounds of post-consumer rigid plastics were recycled, up 47% since 2007. (2009 National Post Consumer Report on Non-Bottle Rigid Plastics Recycling, published 2011)
- In 2008, the amount of energy saved by recycling PET and HDPE containers, including bottles, was the equivalent to the annual energy use of 750,000 U.S. homes. The corresponding savings in greenhouse gas emissions was an amount comparable to taking 360,000 cars off the road (Final Report—Life Cycle Inventory of 100% Postconsumer HDPE and PET Recycled Resin from Postconsumer Containers and Packaging, published 2010.)
- Operation Clean Sweep (OCS), a voluntary, industry effort to reduce pre-production pellet loss, is beginning to be implemented globally. In 2010 the British Plastics Federation signed on to OCS. Through the newly announced Marine Debris Declaration, the plastics industry aims to further expand the implementation of OCS.

Results and synthesis of marine debris monitoring projects

Session: 5.c., Chair: Thomas Maes

Description

The presenters in this session reported on the results of marine debris monitoring surveys. Participants discussed these results, including the major types of debris, spatial variation, oceanographic and environmental parameters, and temporal trends in debris concentrations.

Highlights

- Monitoring sites facing gyres have higher densities of marine debris.
- Monthly variability is commonly observed at monitoring sites due to weather, waves, and winds.
- Regional differences are observed in debris categories due to social and cultural differences.
- Restrictions on plastic use and compulsory trash sorting actions are producing measurable results.
- Persistent organic pollutants have been documented on microplastics in Portugal.

Implications

- There is a need for consistent but flexible monitoring protocols.
- More monitoring and research is needed in order to define effective and locally appropriate measures.
- The outcome of recycling and local initiatives showed the power of many small actions leading to a solution for a universal problem.
- Small-scale studies that attract and educate people on the marine litter issue encourage and inform larger efforts. Integration of monitoring efforts across scales is important.

Microplastic in the environment: causes and consequences

Sessions: 5.d. and 6.d., Chairs: Mark Browne, Richard Thompson

Description

Plastic debris is common in most marine habitats. In addition to conspicuous items of debris such as packaging, rope, and netting, fragments and pieces of microplastic have also accumulated in the marine environment from the poles to the equator. These fragments appear to have formed from the breakdown of larger items of debris, from the direct release of small pieces used in a range of cleaning processes, and from the release of pre-production pellets and powders. This session examined the scale of the problem in terms of its spatial extent and considered temporal trends in the abundance of microplastic debris. Approaches to quantify microplastic debris were examined together with assessments of the potential environmental consequences, both physical and toxicological, for marine life. The session also considered potential solutions together with directions for future research and policy.

Highlights

- Sewage is implicated as a potential source of microplastic.
- The marine debris community needs to be better informed on definitions relating to bioplastics, biodegradables and compostable plastics.
- The greatest concentration of plastic particles in the mid-Atlantic was measured far from land.

- A significant increase has been detected in the number of sea surface tows containing plastic (1972 versus 2010).
- Evidence was presented describing a decrease in the quantity of plastic pellets within sea surface debris.
- There is no evidence for a relationship between microplastic in surface waters and either plankton or *Sargassum.*
- Plastics can constitute up to 10% by mass of solid material sampled at the sea surface.
- Cumulative frequency of items in surface tows indicates that a substantial proportion of the sampled marine debris is microplastic (< 5 mm).

Implications

- A robust, scientific framework for managing microplastic is required. This must have standardized methodologies to enable us to identify and quantify microplastics and to fill knowledge gaps about sources, sinks and consequences.
- Information should be used to define environmental-quality standards and to test effectiveness of management actions.
- Information should also be used to educate consumers, industry, scientists and policy-makers so that they can make informed decisions.
- Use of microplastic in cleaning products is unnecessary and needs regulation.
- Uncertainty about potential hazards of microplastics points to a need to clarify risk-assessment, accounting for spatial variability.
- Microplastics represent an emerging issue that still needs further research to establish environmental impacts. This lack of knowledge should not be used to delay actions required to reduce marine debris.
- Solutions for the problems associated with marine litter need to have a much stronger emphasis on prevention rather than merely removal. This must embrace partnerships that consider solution strategies along the whole supply chain including production, use and disposal.

Managing marine debris in marine protected areas

Session 6.a., Chair: Scott Godwin

Description

This session was devoted to experiences in assessment and management for marine protected areas on a variety of aspects concerning debris, such as survey and removal, transport of non-native organisms, and effects on protected species. Protected areas in the marine environment often face challenges when assessing and managing marine debris due to remote or inaccessible habitats and the presence of protected species. Presenters discussed the challenges of dealing with baseline assessment in unique habitats and steps taken to achieve debris removal and threat abatement for protected species.

Highlights

This session presented the challenges of logistics, funding, and best management practices needed to minimize unintentional damage to protected marine resources through mitigation activities. Mark Chiappone, from the Florida Keys, presented on the use of design-based surveys to identify marine debris hot-spots, quantify magnitude of accumulations, and help strategize clean-up efforts. Scott Morrison, representing GhostNets Australia, presented efforts within Indigenous Protected Areas of the Bay of Carpentaria involving survey, debris removal and community collaboration within a remote area being influenced by regional fishing activities. Session chair, Scott Godwin, gave an overview of the permitting steps leading up to, and field efforts involved in, a partnership with the US Navy to remove a derelict vessel from a remote coral reef atoll in Hawai'i. David Johnson, Executive Secretary of The Convention for the Protection of the Marine Environment of the North-East Atlantic, presented on the challenges facing remote Macaronesian islands concerning marine debris due to regional sociological issues and local oceanographic and meteorological conditions.

Implications
A synopsis of the overall priority actions in the session reveals the need for involvement by both public and private sector entities to provide guidance on permitting issues, funding instruments and outreach at local and regional scales.

Preventing land-based sources of debris through solid waste management

Session: 6.b., Chair: David Osborn, on behalf of Mushtaq Memon

Description
Absent or poorly implemented solid waste management frameworks, coupled with careless consumer behavior, are at the heart of the marine debris problem. This session identified ways that solid waste management frameworks can be improved to prevent waste transfer from land to coastal waters and the open ocean. Presenters highlighted success stories in solid waste management at various levels and identified critical or determining features of those successes.

Highlights
The session included presentations and lively dialogue on proactive initiatives to improve solid waste management through community-based initiatives, legislative reforms and global partnerships. Sam Judd, co-founder of the New Zealand charity, Sustainable Coastlines, highlighted a community-driven waste management initiative in Tonga and emphasized the need to develop localized leadership around integrated solutions. Leila Monroe, a staff attorney with the Natural Resources Defense Council (NRDC) in the USA, recommended incremental improvements in legislative frameworks, including new laws to control high-priority marine plastics and requirements for Extended Producer Responsibility.

Irma Larrea, a Senior Programme Officer with the World Wildlife Fund (WWF), highlighted an NGO and industry-led partnership for waste management and recycling in the Galapagos Islands. She emphasized the need to provide sustained, on-site, technical assistance to develop lasting and transferable local knowledge. She also highlighted the need to develop long term education campaigns focused on the prevention principle. David Osborn of UNEP, on behalf Mushtaq Memon, provided a brief overview of the Global Partnership on Waste Management (GPWM), a new open-ended partnership for international agencies, governments, businesses, academia, local authorities and NGOs. The GPWM will facilitate the implementation of integrated solid waste management at national and local levels, and will support policy dialogues and other activities to exchange experiences and practices.

Implications
Key messages from the session included the need to empower communities, do more with existing laws and institutions, and to share resources and build leadership on integrated solutions. It is also important to collect lessons learned, educate the public and decision-makers, and demonstrate to the world that looking after the coast is fun.

Monitoring and reducing the impact of 'ghost' fishing by derelict fishing traps

Session: 7.a., Chair: Kirk Havens

Description
Lost or abandoned (derelict) commercial fishing traps can present safety, nuisance, and environmental impacts in estuarine and marine waters. Various shellfish and finfish species that become entrapped and die in derelict traps can act as attractants resulting in a self-baiting effect and a continual impact. Derelict fishing traps can damage sensitive habitats and can continue to capture both target and by-catch species. This session examined various programs that are addressing derelict trap loss and subsequent by-catch issues and explored options to minimize the overall adverse impact of lost traps.

Highlights
- Fishing pressure is directly related to the presence of lost traps.
- Movement of lobster traps has major habitat impacts on coral reef habitat.
- 5,000 miles of rope has been lost from lobster traps in the Florida Keys.
- 25,000 lost and abandoned blue crab traps have been removed from the Virginia portion of Chesapeake Bay.
- Lost and abandoned blue crab traps capture about 50 crabs per trap per season.
- Mortality of captured blue crabs is approximately 90%.
- 20% of deployed blue crab traps are lost annually.
- Fully biodegradable PHA polymer is effective in escape panels for blue crab traps.
- 80% of recovered Dungeness crab traps were rigged illegally with non-biodegradable components.
- 100,000 Dungeness crab traps are lost annually.
- 20% of Dungeness crab traps more than 7 years old were found to be still fishing.

Implications
There is significant annual loss of all gear types considered in this session, including blue crab, Dungeness crab, and lobster gear. Priority actions focused on continuing targeted removal efforts, development of biodegradable escape panels, and education programs to reduce user conflicts leading to lost gear.

Many hands make light work: global and regional partnerships to prevent, mitigate and remove marine debris

Session: 7.b., Chair: Daniella Russo

Description

Marine debris is a global challenge that cannot be resolved without sustained cooperation at regional and global scales. This session addressed the role of regional and global partnerships in promoting and supporting innovative mechanisms to prevent, mitigate, and remove marine debris. Presenters identified global actors and highlighted specific regional examples of cooperation. New partnerships to accelerate regional and global initiatives were also introduced.

Environmental impacts of chemicals in marine plastics

Sessions: 7.c. and 8.c., Chairs: Hideshige Takada, Hrissi Karapanagioti

Description

In this session, researchers provided an overview of the latest work on chemicals in marine plastics and their potential biological effects. Topics covered included uptake of plastics by marine organisms, characterization of chemicals in marine plastics, sorption and desorption processes of chemicals from marine plastics, and adverse effects of plastic-derived chemicals on marine biota.

Highlights and Implications

Sorption and desorption mechanisms of organic and inorganic pollutants have been studied. Slow sorption and desorption and large variability in pollutant concentrations in marine plastics were observed in the field. Plastic's capacity to sorb lipophilic pollutants is similar to the capacity of natural organic matter. Concentrations of pollutants in plastics can reflect local-scale pollution status. However, sorption patterns among polymer type and compounds are variable. More studies are needed to clarify general trends. The detailed biological nature of biofilm was demonstrated but its connection with sorption of pollutants has not yet been addressed.

Several field observations suggest transfer of toxic chemicals (PCBs, BPA, and phthalates) from marine plastics to biota that ingest plastics. Relationships between seabird behavior, related to endocrine system disruption, and their ingestion of plastics were examined. More studies are necessary to assess whether plastic-associated chemicals cause endocrine disruption in natural environments.

Shoreline marine debris: Removal and disposal methods

Sessions: 7.d. and 10.d., Chairs: Marie Ferguson, Max Sudnovsky

Description

This session explored the various methods and tools for removal and disposal of marine debris from shoreline environments including utilization of different mechanisms, special equipment and training needs, hazards associated with removing debris, solutions for disposal of collected debris as well as special considerations for removal in remote areas. Presenters shared different methods of removing marine debris from shoreline environments and discussed ways to improve and expand current removal methodologies.

Highlights

One of the main themes brought up in this session was the need for more and better options for disposing of marine debris. Individual groups in their respective regions have been successful and capable of maintaining marine debris removal efforts but the bottleneck occurs when it comes to the disposal of marine debris. The only viable option in certain regions is to dispose of it in a landfill which is a short-term solution. Small groups do not have the power or means necessary to dispose of debris in a responsible manner (e.g. incineration facility that can burn debris and turn it into energy for the community). It seems that collaboration is needed from local governments to incorporate a solution for this problem. This is obviously much more difficult to achieve when dealing with legislation and governmental bodies but still a necessary issue to examine. Additionally, providing sufficient and consistent funding for expensive removal efforts is also an issue and raises questions about the relative responsibilities of local governing bodies and manufacturing industries in accounting for externalized costs.

One conversation sparked by presenters and guests during the session was the notion that most marine debris is created locally. Many of the clean-up groups indicated that the marine debris they were removing in their respective regions was not generated locally and arrived from thousands of miles away via oceanographic processes, storms, currents, etc. (environmental factors). Groups cleaning their communities are spending thousands of dollars each year to clean-up debris that was generated elsewhere. This again emphasized the question of whether the responsibility should lie with the consumer or the manufacturer of the debris.

Implications

Marine debris removal efforts should utilize both volunteers and paid-personnel to minimize cost and maximize data integrity. Most groups are unable to hire full-time personnel to staff consistent, large-scale clean-up efforts so reliance on volunteers is necessary. On the other hand, if data is collected by unsupervised volunteers, it has the potential to be inconsistent and therefore compromised, so care must be taken to maximize data quality. The need for longer-term disposal solutions was stressed amongst presenters and during discussions. For some regions, there is an option of recycling some types of debris (e.g. nets to energy program on Oahu) but in many cases this option is unavailable, leaving the landfill as the only recourse.

Talking trash: Successes and challenges associated with policies to prevent plastic marine pollution

Session: 7.e., Chair: Kirsten James

Description

Plastic pollution, the largest component of marine debris, is a global problem that threatens marine life, ocean environments, and local economies. In response there have been a wide range of policies implemented to reduce plastic pollution. This session focused on case studies of local, state, and national policy and regulatory approaches that have been pursued to curb plastic pollution (especially concerning plastic bag legislation) and associated lessons learned. Presenters informed stakeholders about the last decade of successes and challenges in stemming plastic pollution in the marine environment, and shed light on model regulatory and legislative efforts.

Highlights

- Nine municipalities in California have banned single-use plastic shopping bags, including San Francisco, which has seen a 20% reduction in bag litter.
- Washington D.C. has seen an 86% decrease in single-use plastic shopping bag use since a 5-cent bag fee was established.
- San Francisco has experienced nearly 100% compliance with a ban on single-use expanded-polystyrene food containers.
- California State Trash Policy (currently in development) presents leveraging opportunities for achieving target trash reductions.

Implications

- Target trash reductions are critical to tackling marine debris problems.
- Bans and fee policies can be effective tools to address priority problems, such as single use plastic pollution from bags and food containers.

Engaging fishermen to address derelict fishing gear

Session: 8.a., Chair: Sarah Morison

Description

Providing fishermen with the means to get involved in derelict fishing gear (DFG) removal (potentially recovering their own lost gear) and working with them to identify ways to prevent gear loss are key avenues to reducing the overall amount of DFG. This session highlighted a number of efforts around the United States in which fishermen engagement has been integral to success.

Highlights

- Attracting and maintaining fishermen's interest in DFG can be difficult but is extremely valuable.
- Fishermen can be motivated to remove DFG, particularly when they perceive that debris removal can have a positive impact on the fishery.
- Economic impact data can justify contracting fishermen to remove DFG.
- Fishermen can be impacted by DFG created by fisheries other than their own.

Implications

Fishermen are generally considered the source of DFG, and may therefore be left out of attempts to address it. This is counterproductive. To prevent, reduce and remove DFG, fishermen must be engaged; they are willing when presented with reliable information describing negative impacts on their fishery.

Coastal cleanup programs - A solution to the problem or just to the symptom?

Session: 8.b., Chairs: Ronen Alkalay, Galia Pasternak

Description
Routine coastal cleanups and enforcement actions can create a visible improvement in coastal cleanliness. But is there a significant change in public awareness of the need to reduce plastic usage and waste production? Are we really dealing with the problem, or just the consequences? This session addressed the following question: is keeping the coast clean solving the problem of littering, or do we need to start at the source?

Highlights and Implications
There was broad agreement in this session that coastal cleanups are a key element to overcome the problem of beach litter. A holistic approach can yield profound improvement of beach cleanliness by combining measures such as:

- routine cleanup activities.
- information and public relations activities.
- educational activities and youth movements.
- enforcement targeting coastal polluters.

Panel: Building on maritime industry best practices to catalyze action

Session: 8.d., Moderator: Terry O'Halloran

Description
Preventing marine debris from ocean based sources requires the commitment and efforts of companies operating in the marine environment. This includes corporate culture, policies, protocols, and practices to ensure that company activities at sea do not generate marine debris. This panel brought together representatives from shipping and cruise industries that have been proactive in preventing marine debris to present case studies on their programs. The panelists shared best practices and lessons learned in order to inspire and inform other companies in undertaking their own efforts.

Highlights

- Matson is the only commercial container operator that has a zero solid waste program. The "Greentainer" Program with Zero Solid Waste was developed in 1993 through collaboration with the Center for Marine Conservation (now Ocean Conservancy).
  - All waste is recycled at sea, only food scraps are disposed overboard.
  - $224K was spent to replace existing containers.
  - Space is a premium on container ships and represents revenue. Matson puts the "green" containers on their ships replacing cargo slots on board.
  - Since 1994 approximately 12,000 tons of material has been kept on board rather than going into the ocean.

Implications
Regulating the maritime shipping industry is difficult as no one owns the high seas. The conscience of operators and companies must take over if the effort to prevent marine debris from

vessels is to be successful. The needs of the marine transportation system and protecting the marine environment are not mutually exclusive and do NOT represent irresolvable conflict.

- Port reception facilities are needed globally.
- Better understanding of waste streams and appropriate segregation is needed.
- Specific performance standards should be developed on established principles of integrated solid waste management systems ashore.
- These standards should be integrated into national laws and international instruments (MARPOL Annex V).
- Ships will favor ports with good services at reasonable costs.
- Good practices need to include ship masters and port reception facility operators.

To provide "operational adequacy", port reception facilities must:

- conform with national and local permitting and licensing requirements.
- be arranged so as not to interfere with port or terminal operations.
- be conveniently located to encourage use.
- be located so that wastes or residue cannot reenter water.

Panel: Secrets of Success: using film to increase public awareness

Session: 9.a., Moderator: Justine Schmidt

Description

Several notable ocean advocates are currently using film and media to increase the public's attention to the threats of marine debris. This panel explored the trends behind successful films and media campaigns and engaged in an insightful and candid dialogue about what drives some films to produce tangible results and create positive social change. Influential and inspirational environmentalists and filmmakers commented on their campaigns centering on plastics and marine debris. They showcased clips from their respective advocacy films and provide personal insight on what it takes to create an effective cross-media campaign.

Highlights

Presenters of this special panel included Dianna Cohen of Plastic Pollution Coalition, Stuart Coleman of Surfrider Foundation, Sarah Sikich of Heal the Bay, and Stiv Wilson from the 5Gyres Project.

- Dianna Cohen shared clips of the following marine debris films and public service advertisements (PSAs): Bag It! (film), Plastic State of Mind (PSA), Buried in Plastics (PSA) and premiered the latest PSA by Kate Miller (Wilhem - Think About it). Dianna discussed the important use of film in campaigns and some of the common successful ingredients such as using celebrities and talented ad agencies.

- Stuart Coleman shared a few Surfrider PSAs including Butts at the Beach, Not the Answer (with Laird Hamilton), and Rise Above Plastics. He also shared a few radio and print ad campaigns and discussed their impact on increasing public awareness about marine debris. Stuart believes that successful film campaigns share common threads such as use of celebrities, humor, enlisting talented ad/creative agencies, and short format films/ PSAs.

- Stiv Wilson from 5gyres echoed all of the above when describing his film campaigns documenting marine debris during his ocean sails aboard the 5gyres ships. He discussed the challenges of capturing compelling footage about marine debris and talked about providing honest, simple messaging. Stiv believes the best way to spread the word is through short web videos and a strong social media networking campaigns.

- Sarah Sikich from Heal the Bay showcased the successful film, "The Majestic Plastic Bag", narrated by Jeremy Irons and used in various "Ban the Bag" campaigns in CA. She agreed that the use of celebrities and humor is a successful tool in film media campaigns, in addition to enlisting the help of creative and talented ad agencies pro bono, as in the case of the "The Majestic Plastic Bag". Their ingenious writing and shooting skills are invaluable.

- Most presenters believed that the most impactful media campaigns were those that were web based with many short videos and associated social networking content, while others believed that the traditional storytelling method through long format film still proved most effective in communicating messages to large audiences.

Implications

- When presenting information to audiences using film or other visual media, the message must be presented simply and honestly.
- The best way to increase public awareness through film is to have a multi faceted media campaign that includes long or short format films, PSAs, web media, and social networking campaigns (facebook, twitter, etc).
- Other common elements of successful films and media campaigns include:
    - the use of celebrities.
    - the use of humor.
    - enlisting talented advertising or creative agencies when possible.
    - using appealing species as mascots or “spokes-animals” for the cause.
    - providing take-away actions or solutions.

Citizen scientists and marine debris monitoring: standardizing methods and establishing a database

Sessions: 9.b. and 10.b., Chair: Joel Paschal

Description
This session addressed the significance of standardizing and simplifying marine debris monitoring and analysis methods to allow for volunteer citizen scientists to participate in data collection for long-term monitoring. The focus was on ways to design methodology and sampling equipment in such a manner that they are accessible and safe for a wide user-base while still producing data that is valuable to governments and the scientific community. The

conversation considered all aspects of marine debris monitoring (near-shore monitoring, benthic sampling, monitoring of beach debris, pelagic sampling, etc.). Presenters shared desired data streams, gave input on how to obtain them, and demonstrated how citizen scientists can be most helpful to marine debris research efforts.

Law, policy, and economic considerations for successful governance

Sessions: 9.c. and 10.c., Chairs: Jamon Bollock, Stephanie Werner, Claude Rouam

Description

This session included discussions of law, policy, and economic instruments to address marine debris. The goal of this session was to learn from case studies that lay out the components necessary for successful governance, as defined by reduced marine debris impacts to the marine environment.

Highlights

- An in-depth analysis of the existing international regulatory framework applicable to derelict fishing gear (DFG) was presented.
- There is a lack of clear legal jurisdiction and enforcement capability concerning DFG, including lost, discarded, or abandoned fish aggregation devices (FADs).
- FAD's are involved in half of all tuna catches, but their use has little regulation.
- It is crucial to consider enforcement, operational, and spatial pressures that motivate fishers to dispose of or abandon gear at sea.
- There is a clear need to work strategically with regional fisheries management organizations to influence how their mandates can be most effectively applied to DFG.

Implications

Key messages from the session included the need to share law, policy, and economic experiences concerning the issue of marine debris governance implemented on national, regional, and international levels; to ensure effective participation of stakeholders in development and implementation of measures developed at different legislative levels; and to develop integrated management schemes for marine debris which can be applied in diverse geographies. Other suggestions included investing in harmonized monitoring, research, education, recycling, and recovery activities with neighboring countries, targeting zero land-filling in cooperation with industry, and designating competent entities to lead the development of DFG frameworks.

Ocean voyages to study and quantify pelagic debris

Sessions: 9.d. and 10.e., Chairs: Nicholas Mallos, Georg Hanke

Description

This session focused on the many ocean voyages that have documented marine debris across the global oceans. This included voyages specifically meant to study and quantify pelagic debris, as well as investigations that opportunistically study debris from "ships of opportunity." This session provided a framework for potentially disparate observations from all across the globe, and brought together researchers and marine debris observers to discuss the best way to utilize these voyages to study and quantify the marine debris problem.

Highlights and Implications

- High concentrations of plastic debris in the North Pacific Subtropical Gyre have been investigated since 1999.
- There is a need to channel data from NGOs and private initiatives into assessments by ensuring the compatibility of monitored parameters and appropriate data quality.
- There is a need to use all available platforms and opportunities for data collection in order to increase spatial and time coverage.
- Innovative and sophisticated methodologies for investigating microplastic and its impacts should be explored.
- Research and analysis is needed to compare methodologies for clean-up activities and promote resource efficient approaches.
- Marine debris reduction needs to start with individual responsibility and changes in consumer behavior and societal attitudes.
- Education is at the basis of societal changes necessary for long term marine debris reduction.
- Data from different sources needs to be comparable in order to allow time trend assessments and analysis of global distributions.

The role of ocean filmmaking in educating the public about marine debris

Session: 10.a., Chair: Justine Schmidt

Description

Utilizing modern-day filmmaking tools and messaging opportunities, how can films influence public attitudes toward conservation and protection of our ocean resources and especially highlight the issue of marine debris? This session covered the role of film in marine debris education and outreach campaigns to influence behavior change.

Highlights and Implications

Scott Elliott presented a web-based media campaign documenting a 35-day Sea Education Association (SEA) voyage that mapped 400,000 square miles of the North Atlantic Gyre. He discussed the challenges of visually documenting marine debris and effectively messaging the issue. As part of SEA's mission to promote and expand education about the state of the oceans, biweekly videos taken by two filmmakers aboard the sailing research vessel were posted to an educational website about oceanic plastic debris. The website now has over 10,000 hits and entices people to step aboard and experience the gyre while educating them on the many facets of marine debris research.

Jo Ruxton discussed her upcoming 90-minute documentary, filmed in full HD, for global cinematic distribution and TV release through National Geographic International. The multi award-winning 'Plastic Oceans' production team has assembled the world's top ocean and plastics scientists. Together in 2011 they will embark on an epic voyage of discovery around our oceans. From the frozen poles, to the dark abyss of the ocean floor, their stories will be brought to life by leading media personalities, who each have a passion for highlighting and combating one of the most insidious environmental problems of the 21st century. Ultimately, the 'Plastic Oceans' film will illuminate the positive steps we can take to change the way we use and discard plastic. The producers are using a multi-platform, multi-media approach to empower people to become part of the solution. The documentary provides the main tool for this, while the plasticoceans.org website offers an international audience a greater network of contacts, opportunities to get involved, and ways to find out more about the issue.

Andreja Palatinus discussed her upcoming project to produce a short film documenting an EU-USA multidisciplinary collaboration investigating coastal waters in the Adriatic Sea and the Hawaiian Islands, showcasing a pilot campaign to diminish sources of debris and clean coastal and marine waters. The project was initiated among a team of marine scientists, videographers, and environmental activists in coastal waters off Slovenia in 2008. The next phase of the project aims to produce a 50 minute non-commercial film that emphasizes pollution prevention in order to raise awareness and inform the public of behavioral shifts that can lead to sustainable lifestyles and enhanced enhancing ecosystem services for coastal communities and adjacent watersheds.

Public/private partnerships for reducing and preventing marine debris through education and outreach

Sessions: 11.a. and 12.a., Chairs: Keith Christman, Seba Sheavly

Description

This session focused on collaborative success stories and opportunities for improvement and innovative educational and technological activities that can be implemented nationally and disseminated on a global scale. The essential building blocks for successful marine debris prevention initiatives include education and outreach programs, effective laws and policies, fair and vigilant enforcement, and sound waste management infrastructure. The most successful programs take integrated approaches to changing the behaviors and practices of civil society, as well as those of industry and government. This session examined a number of public/private partnerships and similar programs already in place as a means of identifying best practices. Presenters highlighted innovative strategies being developed within the private sector and through partnerships to make sure that material innovations and product design breakthroughs are helping to reduce environmental impacts.

Highlights

- Coca-Cola has developed a recyclable PET plastic bottle that is made partially from plants, which is an important first step towards a longer term goal to produce a recyclable plastic bottle made entirely from renewable resources.
- Plastics makers and recyclers have spent more than $2 billion over the years to help develop technologies, build infrastructure and educate consumers in communities across the nation to recycle more plastics.
- As part of a "Plastics. Too Valuable to Waste. Recycle.™" campaign with American Chemistry Council (ACC), Keep California Beautiful and other partners, nearly 700 away-from-home recycle bins have been installed in more than 30 locations in California.

- In the first California K-12 Recycling Challenge, over 45,500 students and 2,100 teachers collected 74 tons of materials, including 4,317 lbs. of CRV beverage containers and 68,628 lbs. of mixed recyclables.
- The Marine Debris Declaration of PlasticsEurope and ACC was discussed and viewed favorably by session attendees. Several attendees commented at the end of the session that they were pleased to see industry representatives at this meeting, as it was an indication that they want to work more effectively on the marine debris issue.
- CPIA believes that there is substantial opportunity for Canada to increase plastic waste diversion through both mechanical recycling and energy recovery from waste.
- There is a growing demand for post-consumer resins. Plastic recyclers continue to face shortages of material to reprocess due to the exportation of materials to Asia, which continues to absorb more than 50% of the PET bottles and 30% of the HDPE bottles collected in the US.
- APR has released a position statement indicating plastic reclaimers are prepared to accept and reprocess closures included with containers, thereby creating a positive reduction in marine debris.
- From 2008 to 2011, the "Fishing for Energy" partnership has successfully expanded to eight coastal states and 24 participating ports. More than 500 tons of gear has been collected by providing commercial fishermen with accessible locations to dispose of damaged or worn out gear.
- In three Caribbean SIDS marine litter programs, projects have identified the need to better understand marine litter sources; to better understand marine litter impacts (beyond the aesthetic ones); to adopt a multi-stakeholder approach in marine litter interventions; for data acquisition as metric for progress in cleanup assessments; to separate recyclable materials for recycling activities; and to provide direct technical support based on the MARPOL Conventions and LBS Protocol.

Implications

- Presenters advocated for an expansion of partnerships related to recycling education programs.
- Presenters supported increased recycling and efforts to recover energy from plastics.
- Presenters encouraged expansion of the Operation Clean Sweep program to control pellet loss.
- Effective stakeholder engagement was noted by all presenters as an essential element for successful program implementation.
- The challenge of managing partners effectively was mentioned by several presenters as was the need to find the appropriate roles for partners in marine debris programs.

Diving for debris: methods and approaches for human-powered in-water marine debris removal

Session 11.b., Chairs: Mark Manuel, Kyle Koyanagi

Description

This session explored the use of different diving methodologies for marine debris removal, including safety precautions, specific trainings, and debris handling techniques. Topics included scuba diving, hookah, and snorkeling operations. Presenters explained safety practices and precautions taken for particular operations. Discussions included the need for specific trainings such as small boat operations, debris handling methods, and proper rescue certifications. Specific case studies were utilized to provide examples of both successful and flawed approaches.

Highlights
The session provided insight into the various human-powered methods and approaches utilized to remove marine debris, particularly derelict fishing gear, from different regions of the world. Presentations were informative and highlighted potentially valuable tools for future marine debris removal efforts.

Ania Budziak, Science Policy Officer with Project AWARE Foundation, discussed her experience organizing thousands of volunteer scuba divers from over 100 countries, and encouraged the use of volunteer divers, both professional and recreational, as a tool for marine debris removal and data collection efforts. Jennifer Renzullo, Project Assistant for California Lost Fishing Gear Recovery Project, highlighted the significant connection of local knowledge and techniques utilized by California urchin divers to the successful removal of 11 tons of fishing gear from California's Channel Islands. Kyle Koyanagi, Marine Debris Operations Manager of the Coral Reef Ecosystems Division (CRED), explained the unique method of tow boarding, a useful tool that led to the removal of 689 metric tons of derelict fishing gear within the Papahanaumokuakea Marine National Monument from 1999 to the present. Mark Manuel of CRED provided an overview of the marine debris relief effort in American Samoa following the fatal tsunami of September 2009, and discussed the use of adaptive methods for successful survey and removal of marine debris.

Implications
Consensus from the session included the definite need for marine debris outreach and education in schools and for the general public. No single method for marine debris removal will work for every situation. Thus, it is imperative to employ adaptive, creative, and flexible methodology for marine debris removal to continue to address this growing issue.

Using social marketing to cause a sea change on marine debris pollution

Session: 11.c., Chair: Scott Radway

Description
This session explored how comprehensive social marketing campaigns can address the challenges faced in reducing or eliminating marine debris and its effects on wildlife. Presenters discussed campaigns centered on changing individual and industry behavior concerning trash disposal and reducing or eliminating marine debris.

Highlights and Implications
All presenters discussed the need to deal with underlying behavioral barriers to change. Information is not enough. There is a need to go beyond the message that litter is bad. Addressing social norms and infrastructure is critical. In addition, presenters saw an important

opportunity in dealing with plastics upstream and working with manufacturers and industry to adopt better practices. Policy is another area that needs attention and social marketing is a key to fostering policy change in a competitive environment where many environmental issues are before policy makers as well as prominent economic issues.

Don't fill our landfills: alternative disposal methods for marine debris and derelict fishing gear

Session: 11.d., Chair: Christine Laporte

Description

This session highlighted successful alternative marine debris waste management scenarios, including waste-to-energy and recycling, and explored the innovative practices of gasification and pyrolysis (uncommon for marine debris yet proven for other materials). Logistics of collection and costs were covered. For innovative technologies, facility construction, operation, and waste throughput costs were presented. This session attracted participants conducting or planning marine debris and derelict gear cleanups and considering alternative disposal options rather than landfills.

Highlights and Implications

- Identify ways to retrieve derelict fishing gear (DFG) legally and efficiently throughout the year, not just at one cleanup.
- Determine a more permanent mechanism for funding DFG bins and annual trap cleanup.
- Continue shoreline cleanups and establish protocols for reducing the waste generated at cleanups thereby encouraging alternatives to land-filling.
- Establish a sustainable management structure for debris found onshore.
- Encourage community clean up events and litter reduction campaigns.
- Study the relative effectiveness of disposal technologies available in the market and evaluate relative ability to:
  - physically process marine debris materials.
  - process marine debris waste effectively while minimizing environmental impact.
  - process marine debris waste while maximizing its beneficial use locally.

Assessing the dangers and removal of sea-dumped munitions and other hazardous debris

Session: 12.b., Chair: Paul Walker

Description

This session considered the hazard posed by toxic underwater munitions and other hazardous marine debris materials, including efforts to prioritize risks among sites by developing a comprehensive database, bringing these threats to light in a series of meetings and international dialogues, and finally, examining clean-up strategies. Key points included the need for international agreement to tackle the issue, the need for a coordinated global database, awareness to raise political will, policy alternatives, dangers to human health and the environment, and the need for new technology to mitigate impacts of hazardous debris. Though some research has been conducted into the broader environmental consequences on the marine habitat, for example on coral and fish stocks, it has not yet been coordinated or reported globally and databases are still dismally patchy. In other words, the situation, which has received very limited attention to date, could be a serious sleeper ready to cause severe damage in the future if disregarded now.

Highlights

- NOAA has developed new technology for the removal of underwater military munitions.
- It was discovered that an active firing range off Waianae, Hawaii, would have led to a risk of unexploded ordinance in addition to discarded munitions.
- The location of sea-dumped munitions off Japan coincides with the location of the recent major earthquake and ensuing tsunami, raising concerns about the potential dislocation of these munitions and disbursement of munitions-related ecosystem and human-health effects.

Implications

- There is an awareness deficit, even within the marine debris community, about the issues surrounding sea-dumped munitions.
- There is a need for a global database of sea-dumped munitions.
- Partners should work together to advocate for international legislation addressing all sea-dumped munitions.

Biological impacts of marine debris

Session: 12.c., Chair: David Johnson

Description

This session covered the interaction of marine debris with the biological aspects of marine ecosystems. The goal of this session was to better understand the interactions of debris with marine species and to elucidate the broader impacts of debris on marine communities. Presentations covered a host of topics but shared a common focus on specific biological impacts.

Highlights and Implications

- International monitoring guidelines are needed to better understand broad scale impacts of marine debris on biological communities.
- Population-based assessments of marine debris effects are needed.
- Pathogens and microbes that populate marine debris need to be identified.
- Researchers should take care not to contribute to the problem through loss or improper disposal of research materials.

Aerial remote sensing of marine debris

Session: 12.d., Chair: William Pichel

Description

This session focused on remote sensing of marine debris, particularly at-sea but also on beaches. The goals of marine debris remote sensing are locating areas where marine debris is likely to be found, detection prior to removal, debris census/mapping, and technology development. This session addressed technology and procedures for remote sensing of marine debris using in-air platforms such as satellites, aircraft, and Unmanned Aerial Systems. Remote sensing instruments include visible, infrared, LIDAR, sonar, and radar – single channel, multi-channel, or hyper-spectral. Session presentations provided information on such topics as: a survey of the state-of-the-art technology for the remote sensing of marine debris, results of past marine debris surveys, problems yet to be solved before operational marine debris detection and removal is feasible and cost-effective, and successes and challenges in the use of various pertinent technologies. The presentations and resulting discussion in this session clarified the road ahead in regard to development of technology and procedures for operational detection and removal of marine debris at sea.

Highlights and Implications

- An automated camera system, Sea Litter Cam, was successful in identifying and recording marine debris from a cruise ship underway.
- Surface current maps for the world's ocean basins show major convergence regions in both the Northern and Southern Hemispheres.

Outcome Summary

The 5IMDC was designed to exceed the usual conference services of sharing research results and providing opportunities to network by encouraging discussion and requesting input on multi-faceted solutions that can be used to adaptively address marine debris problems long after the conference. Three conference outcomes provide the foundation for this approach, a commitment statement agreed to by participants, a strategic framework for focusing on results and harmonizing efforts around the globe, and a platform to facilitate continued relationship building and information sharing after the conference.

1. **The Honolulu Commitment**, a multi-stakeholder pledge to address marine debris, was prepared by a representative drafting committee reflecting key principles, messages, and commitments stemming from the conference. It was adopted by acclamation in the closing plenary session and is included below.
2. **The Honolulu Strategy**: A global framework for the prevention and management of marine debris. Prior to the conference, recommendations generated from the four previous international marine debris conferences were compiled and analyzed to identify common and recurring themes. An expert working group was formed to develop the structure and draft content of the Honolulu Strategy by incorporating these recommendations with their own professional knowledge and by reaching out to colleagues throughout the world to identify ongoing initiatives and future plans. The draft elements of the Honolulu Strategy were developed and distributed to conference attendees prior to the conference. A number of mechanisms were provided during and immediately following the conference to build support for and provide input on the draft elements. The final Honolulu Strategy will reflect participant input and information from the conference and will serve two main purposes:
    - To describe and catalyze the multi-pronged and holistic response required to solve the problem of marine debris

- To guide monitoring and evaluation of global progress on specific strategies at different levels of implementation, including local, country, regional, and international efforts and achievements

3. **Platform for New Partnerships and Alliances –** Multi-stakeholder partnerships, large and small, were announced or initiated at the conference. These focused on advancing global awareness, stakeholder involvement, research and development, policy development and enforcement, waste prevention and management, debris removal and cleanup initiatives. Conference attendees supported the formation of a global marine debris network to build on these partnerships.

The Honolulu Commitment

Participants attending the 5th International Marine Debris Conference held in Honolulu, Hawaii, 20-25 March 2011:

Considered marine debris to include any anthropogenic, manufactured or processed solid material, irrespective of its size, discarded, disposed of or abandoned in the environment, including all materials discarded into the sea, on the shore, or brought indirectly to the sea by rivers, sewage, storm water or winds;

Expressed concern at the growing presence of plastic debris in the marine environment and acknowledged the plastic associations' Global Declaration on Marine Litter, while recognising other materials also constitute marine debris;

Welcomed the ongoing work of scientists, research organisations and other citizens to better and more accurately understand the sources, nature and extent of marine debris, including the effects of micro-plastics, heavy metals, persistent organic pollutants, endocrine disruptors and other chemicals on marine biodiversity and public health;

Expressed concern at the continued threat and economic costs from marine debris to human health and safety; biodiversity and ecosystem services; sustainable livelihoods; and the boating, shipping, tourism and fishing sectors;

Noted that these issues are compounded by accelerating pressures associated with pollution and climate change, as well as human uses of oceans and coasts, such as fisheries, urban and industrial development, tourism and shipping;

Acknowledged the importance of international mechanisms, such as MARPOL, the Regional Seas Conventions and Action Plans and other regional mechanisms, in preventing and reducing marine debris;

Recognised the opportunities for addressing marine debris through linkages to sustainable development goals that promote resource efficiency and the principles of a green economy, such as improved life-cycle design and sustainable packaging; extended producer responsibility; safe and efficient fishing and maritime transport practices; and the development of integrated waste management infrastructure that supports recycling and energy recovery programmes and zero-waste strategies;

Recognised the roles of governments, international organisations, industry and civil society in sharing best practices and facilitating the transfer of knowledge;

Recognised the need to address the special requirements of developing countries, in particular the Least Developed Countries and Small Island Developing States, and their need for financial and technical assistance, technology transfer, training and scientific cooperation to enhance their ability to prevent, reduce and manage marine debris as well as to implement this commitment and the Honolulu Strategy;

Emphasised the importance of collaborative partnerships, including industry and grass-roots initiatives, and acknowledged the recent creation of the Global Partnership on Waste Management;

Celebrated the increasing level of public interest in finding solutions to the marine debris challenge;

Welcomed the opportunity to contribute to the development of the Honolulu Strategy – a framework for the prevention, reduction and management of marine debris; and

***Hereby* invite international organizations, governments at national and sub-national levels, industry, non-governmental organizations, citizens and other stakeholders, to commit to:**

1. **Make** choices that reduce waste in order to halt and reverse the occurrence of marine debris.
2. **Encourage** all citizens, industry and governments to take responsibility for their contribution and find solutions to the marine debris problem;
3. **Share** openly and freely technical, legal, policy**,** community-based and economic / market-based solutions that will help prevent, reduce and manage marine debris;
4. **Advocate** mechanisms that emphasise the prevention or minimisation of waste;
5. **Facilitate** initiatives that turn waste into a resource in an environmentally sustainable manner;
6. **Develop** global, regional, national and local targets to reduce marine debris;
7. **Improve** global knowledge, understanding and monitoring of the scale, nature**,** source and impact of marine debris, and raise awareness of its impact on public health, biodiversity and economic development;
8. **Collaborate** with global, regional and sub-regional organisations, to enhance the effectiveness of multi-lateral initiatives aimed at preventing, reducing and managing marine debris;
9. **Encourage** financial support for global, regional, national and local actions that contribute to the implementation of the Honolulu Strategy;

10. **Encourage** relevant intergovernmental fora, including those at global and regional scales, to express support for the Honolulu Commitment and encourage governments to take action consistent with the objectives and strategic activities outlined in the Honolulu Strategy; and

11. **Participate** in a global network of stakeholders committed to understanding, preventing, reducing and managing marine debris in an environmentally sustainable manner;

12. **Contribute** to the development and successful implementation of the Honolulu Strategy – a framework for the prevention, reduction and management of marine debris – and its periodic review.

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Oral Presentations

1.a.1. Proactive collaboration to storm debris – cyclone debris case study

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KEYWORDS
Hurricane, Cyclone, Katrina, Planning, Preparedness, Partnership, Collaboration, Framework

BACKGROUND
Cyclones, commonly known as hurricanes in the Gulf of Mexico region, pose a significant and persistent threat to valuable coastlines around the world. Their destructive power can threaten rich commercial and cultural resources. This destruction can also lead to the creation and wide dispersion of huge quantities of debris, both on land and in the marine environment. This marine debris can negatively affect commerce, commercial and recreational fishing, tourism and transit. In order to effectively respond to storm events and their impacts pre-planning and preparedness are vital. That necessity is intensified by the response to storm events, where multiple responsibilities and missions exist and can even overlap under current response frameworks. These facts were underscored through experiences gained during the long term response to impacts of Hurricanes Katrina and Rita in the Gulf of Mexico region from 2006-2009.

METHODOLOGY
Over the course of 3 years, NOAA worked with multiple partners to conduct a survey of near-shore waters in Alabama, Mississippi and Louisiana. This survey resulted in the discovery of over 6,000 individual debris items spread over 1,500 square nautical miles. To accomplish project goals, the team collaborated closely with stakeholders at the Federal, State and Local levels, gaining an understanding of the roles and responsibilities each held in the response frameworks that were in play. This led to the recognition of a need for a plan targeted specifically to create preparedness for future storm events.

OUTCOMES
NOAA worked with partners throughout the gulf region to gather key lessons learned and identify data gaps to be filled. The goal of these steps was to create a practical and useful tool for local, state and Federal staff to enhance preparedness. Once assembled, this information was codified and synthesized into the Emergency Response Plan, which defines the marine debris response into three phases: Planning, Assessment and Removal, Recycling and Disposal. One of the key identified areas of focus across these phases is the need for increased collaboration across all levels of government. This collaboration should be started before a significant incident

in order to make linkages and create understandings that can be called upon in the event of a need.

PRIORITY ACTIONS

Pre-identify key relationships and stakeholders for potential emergency events. This allows for the building of relationships and consensus in an open environment rather than the high-pressure environment of an emergency response.

FIGURES AND TABLES

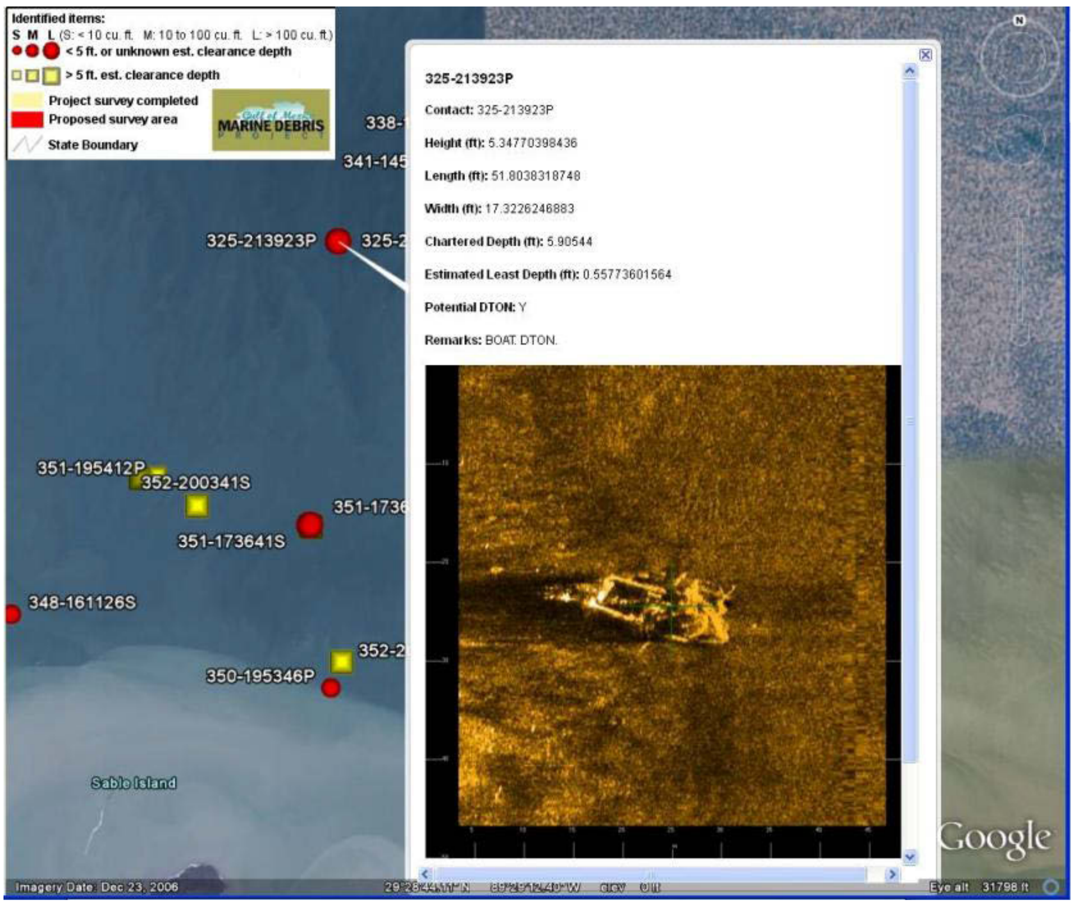

Figure 1: A side scan sonar image of a sunken vessel in a target review file. Image: NOAA

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1.a.2. Sleeping with the enemy! Can an environmental NGO and the plastics industry work together to prevent marine litter?

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KEYWORDS
Marine Conservation Society, Plastics2020, Beach litter, Education, Recycling, UK

BACKGROUND
The Marine Conservation Society (MCS) coordinates the only national beach litter survey around the UK coastline and our data has been acknowledged by the UK Government as the best long-term data set on UK marine litter. Our data is also used at OSPAR level and we coordinate the UK part of the International Coastal Cleanup. MCS Beachwatch Big Weekend is the biggest volunteer beach clean-up in the UK. Last year over the third weekend of September 2010, 376 beaches were cleaned and almost 5,000 volunteers took part. They collected over 330,000 items of rubbish equating to almost 2,000 items of litter per km. Plastic items accounted for almost 70% of total items.

For too long the plastics industry and environmentalists have been seen as opposite ends of the spectrum when it comes to environmental issues. This situation has, not surprisingly, resulted in little being done for the environment and has given rise to a great deal of mutual misunderstanding.

METHODOLOGY
At MCS we strive to maintain a pragmatic, evidence-based approach that involves being open to the ideas of those apparently opposed to our own positions.

In 2009 MCS produced a short series of actions that we thought could be easily taken to start actually solving the problems of marine litter. After publication in the journal of the Chartered Institute of Waste Management we were approached by the group, Plastics2020 – an umbrella group of plastics concerns around Europe as much to their own surprise they found that they agreed to most of the actions listed.

Initial meetings between MCS and the plastics industry were of help in determining that from the MCS side of things the plastics ‘people’ were not all devils with horns and from the plastics industry side that MCS were not a bunch of tree-hugging, sandal wearing hippies!

We believe that the plastics industry has reached a position where they are no longer (or less!) worried about the finger being pointed at them as producers of plastic items and would seem to be genuinely concerned to do something about the problems that plastic in the marine environment causes. On the MCS side we believe that we can work with the plastics industry as together we have a greater voice than alone or fighting with each other.

One of the first steps was to really drill down into what each side really believed. There are certain things on which we have agreed to disagree – the continued reliance on plastic bags for one! However we have also agreed that this does not stop us working together and we have both maintained our positions on these issues.

OUTCOMES

1) We agreed that education was a vital step in preventing litter in general and marine litter in particular. MCS runs an already successful schools education programme – the 'Cool Seas Roadshow' (CSR) - which tours UK schools to educate children in the amazing wildlife in our seas and the dangers that face them. Plastic bottles are found in great numbers on our beaches – last year during the MCS annual clean up weekend over 18,000 bottles and 21,000 bottle tops were found on 397 beaches.

As an initial project and following on from the soccer world cup where several teams wore official team strips made out of recycled plastic bottles, it was decided to incorporate into the CSR the 'Bottle Top Champions' scheme in which children would recycle plastic bottle tops at their school (with the actual bottles being recycled at home) If the school as a whole brought in enough bottle tops they would get a free strip for the one of the school's sports team. Plastics2020 organised the recycling of the bottle tops and the production of the sports kits

We were unsure of the interest of schools at the beginning, but the response was phenomenal! Every school contacted wanted to take part and in the process, 1000s of bottles and tops have been recycled and children have been able to see a direct link to the benefits of recycling. As this pilot project was so successful we are now in the planning stages of rolling it out to more UK schools.

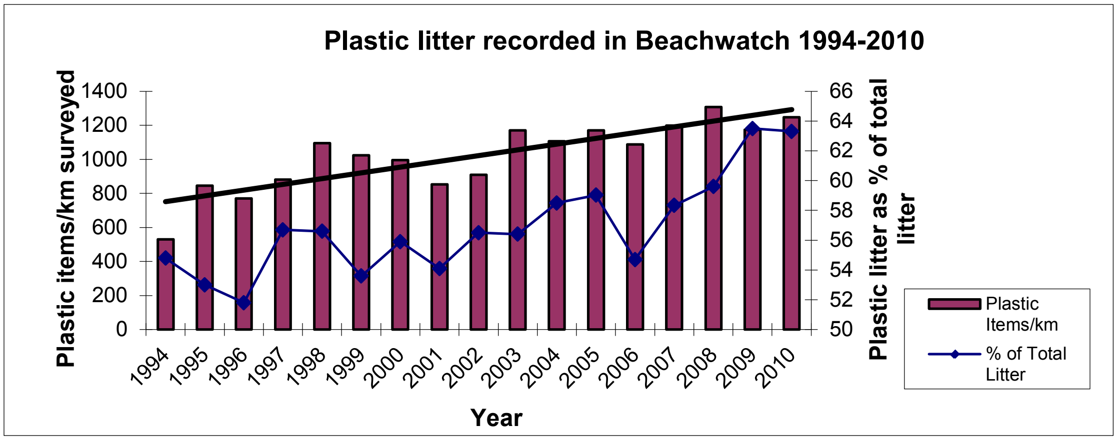
2) Going forward we have jointly put in a bid for EU money to develop a much larger education and public information campaign.

3) As the problem of microplastics and the potential this has for moving toxins up the food chain. Many parties around the world are understandably keen to know if this is happening. Plastics2020 have been involved in commissioning a project with the University of Ghent to try and further explore the uptake on microplastics by various organisms around the European coast. MCS sits on the steering group of the project.

PRIORITY ACTIONS

- Acceptance that litter is a pollutant on a par with oil and chemicals
- Action must start now
- Improve education, infrastructure, design of goods, enforcement of existing laws

FIGURES AND TABLES



Top ten litter items found during Beachwatch Big Weekend 2009 and 2010

2009	2010	Item	% of Total Litter	Items/km
1	1	**Plastic pieces < 2.5 cm**	11.7	231.3
2	2	**Plastic pieces > 2.5 cm**	10.4	204.0
4	3	**Plastic rope/cord/string**	7.1	140.2
5	4	**Plastic caps/lids**	6.4	126.5
3	5	**Crisp/sweet/lolly wrappers**	6.0	119.0
6	6	**Polystyrene pieces**	5.8	114.6
9	7	**Cotton bud sticks**	4.8	95.1
8	8	**Fishing net and net pieces < 50cm**	4.4	87.1
7	9	Plastic drinks bottles	4.1	80.6
11	10	**Glass pieces**	3.3	64.4
		TOP 10 ITEMS	**64.1**	**1262.8**

Cool Seas Roadshow in action with life-size marine models

1.a.3. Harnessing resources for a clean and healthy planet: a look at what industry is doing to end marine debris

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ABSTRACT
Industry examples abound to address marine debris. Hearing from industry will bring another voice to the mix at 5IMDC and serve both an evangelistic and educational purpose in urging other corporations to follow suit. This presentation will share stories of how a variety of large corporations have committed funds, inspired employee engagement, and changed production practices with the goal of reducing trash in the oceans. The presentation will discuss examples such as: Owens-Illinois, Inc.: While many life cycle analyses exist, to date there is no unified way to compare impact across the broad spectrum of products. O-I is producing a life cycle protocol to do this. Solo Cup Company: Solo Cup has launched a Go BARE™ Colleges and Universities awareness-building/activism program highlighting its new eco-forward™ compostable convenience tableware line. Bank of America Charitable Foundation: promotes annually a multi-staged engagement /activation program that involves employees individually and collectively to help solve marine debris problems. The Coca-Cola Company: Coke plays a leadership role on sustainable product development, recycling and water resource issues. Walt Disney Parks and Resorts: Disney goes to great strides to reduce waste, change behavior, encourage cleanups and adopt more sustainable actions in its global properties and cruise line. The Center for Responsible Business, Haas School of Business, University of California, Berkeley, and Dow Chemical Company have created the Sustainable Products & Solutions Program at UC Berkeley and lead Dow's Breakthrough to World Challenges 2015 Corporate Sustainability Goal, The session presenter, Amelia Montjoy, Vice President, Resource Development and Operations, Ocean Conservancy, has worked with each of these companies to identify how best to harness their dollars and resources towards a healthy ocean.

1.a.4. Preventing debris at the water's edge: working with marinas and boaters

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KEYWORDS
Boaters, marinas, anglers, cigarettes, fishing line, monofilament, recycling, prevention

BACKGROUND

Marinas by their very nature are located at the water's edge making their operations particularly sensitive and prone to impacting marine habitats. By design, marinas unlike other private businesses have an unprecedented amount of public access to their private property. This public access can make preventing marine debris a challenge. Boaters too, recreate directly on the water so as a group they are intimately connected to water quality and the negative impacts of marine debris. The BoatU.S. Foundation for Boating Safety and Clean Water works with boaters and marinas around the country to help promote clean boating and clean marinas.

In partnership with federal, state and local governments, other NGOs, the boating industry and the private sector, the BoatU.S. Foundation has developed two programs specifically aimed at preventing marine debris at marinas: the Reel In and Recycle Program, funded in part by NOAA's Marine Debris Program, and the Cigarette Litter Prevention Program, in partnership with Keep America Beautiful. These voluntary programs both aim to prevent debris where it can be most dangerous, right at the water's edge. Through these voluntary initiatives, together with the use of broad partnerships and incentives both programs have demonstrated concrete results preventing marine debris.

METHODOLOGY

Reel In and Recycle fishing line recycling program

This program aims to get fishing line recycling bins at popular fishing spots around the country. The BoatU.S. Foundation builds the PVC recycling containers and provides them to waterfront businesses, parks and volunteer groups to install and maintain. Groups that receive bins commit to install and maintain the bins and report the amount of line they collect in an online database. The groups install the bins along with UV resistant signage at waterfront locations. The bins are emptied and the collected line is sent for recycling. In most cases Berkley Conservation Institute is the recipient of the collected line. This line is melted down into consumer products and artificial reef ball material. Once the line has been shipped, the volunteer groups enter the shipment date, weight and any comments into an online data tracking website. As an incentive for reporting, each time a group reports line collection they are entered into a monthly drawing for a gift card. Groups can view the amount of line collected over the life of their bins through this website to allow them to quantitatively measure the impact of their efforts.

Cigarette Litter Prevention Program for marinas

Keep American Beautiful (KAB), a recognized nonprofit leader in community improvement through litter prevention, beautification and waste reduction, partners with communities around the country to help reduce cigarette litter through their Cigarette Litter Prevention Program. Recognizing that marinas are situated at the water's edge, KAB approached the BoatU.S. Foundation in 2009 about implementing their proven Cigarette Litter Prevention Program at marinas.

In 2009 the BoatU.S. Foundation used it's network of cooperating marinas and selected 31 marinas from 14 states to participate in the program. In 2010 the program was expanded with an additional 40 marinas from around the country. Each participating marina received a grant of $500 along with 300 portable ashtrays to distribute to boaters. Before initiating any program activities the marinas conduct a preliminary cigarette scan where they collect and count the number of cigarette butts found littered on their property. Then with the grant funding they purchase ash receptacles of their choice and install them at litter prone areas, install educational signage, and distribute the portable ashtrays to customers and boaters. Six to eight weeks after the start of program activities and the installation of the cigarette receptacles, marina staff conduct a second litter scan to count the number of cigarette butts littered on the property after commencing the program. These pre and post program litter counts are reported to BoatU.S. Foundation and Keep America Beautiful.

OUTCOMES

Reel In and Recycle fishing line recycling program

To date the demand for fishing line recycling bins has outpaced the program's ability to build and ship them. It is clear that there is an active demand for the program. In three years the program has built and distributed nearly 1,200 bins that have been installed at popular fishing spots in coastal and Great Lakes states. Demand is starting to shift away from groups needing bins to be provided, to groups now building their own bins and getting free decals and signs. This helps keep the branding of the program intact, while lower program costs.

In 2010 over 2,700 miles of fishing line was reported as recycled through the online data tracking system. While there are many bins still not reporting their activity, reports have increased with the use of reporting incentives. This 2010 number serves as a baseline and with the continued use of outreach to volunteer groups and incentives the program will continue to monitor these line total amounts.

In focus groups conducted by the program, most anglers seemed very interested in the idea of keeping used fishing line out of the water and recycling, but many were unaware of such programs or where they could go to recycle their line. This indicates that more outreach can be done to help make anglers aware of the availability of line recycling.

Perhaps the greatest success of the program is the broad range of entities involved in the partnership. The program is funded by NOAA, a federal agency through the National Fish and Wildlife Foundation, individual contributions from boaters and anglers to the BoatU.S. Foundation, and the private sector with support of inland bin construction and distribution from the Brunswick Public Foundation. Bin hosts run the gamut from federal land and water management agencies including the Bureau of Land Management, the U.S. Fish and Wildlife

Service, and the Army Corp of Engineers, to state agencies including the California Department of Boating and Waterways, the California Coastal Commission, the New Jersey Clean Marinas Program, the Virginia Marine Resources Commission and the Oregon State Marine Board, to numerous environmental and boating non profit organizations as well as private businesses and marinas.

Cigarette Litter Prevention Program

In 2009 of the 23 marinas that completed the program, all but one saw a reduction in the amount of cigarette litter at their marinas. One marina in Vermont saw a remarkable 100 percent reduction in cigarette litter. Their initial scans found 55 butts. After installing six new ash receptacles near the bathrooms, storefront, picnic and barbeque areas and distributing the portable ashtrays, zero cigarette butts were found in the scan areas during the follow up scan. Another marina in Connecticut who saw a 95 percent reduction in cigarette litter said, "the placing of cigarette disposal receptacles definitely helped with the litter. I also handed out the handheld ash receptacle to customers." The one marina that saw an increase in cigarette litter had a very low initial scan of only 3 butts. They installed 5 ash receptacles with their CLPP grant funds and have indicated that they will be purchasing more receptacles with their own funds. On average marinas who fully implemented the program saw a 70 percent reduction in cigarette litter at their marinas.

In 2010 of the 37 marinas who fully implemented the program, on average they saw a 63% decrease in cigarette litter at their marina from the preliminary scan to the follow-up scan. Two marinas saw an increase in cigarette butts, but one did not fully implement the program before conducting the follow-up scan. More than half of the participating marinas saw substantial reductions of 70% or greater. The Smoker's Outpost receptacles were the most popular choice, but marinas appreciated the flexibility to purchase receptacles of their choosing to match existing receptacles and decor.

The data from the cigarette litter scans show that the CLPP methodology delivers results. Those marinas who placed ash receptacles in targeted areas, distributed portable ash receptacles to boaters and placed signage and other educational materials educing boaters about cigarette litter prevention saw reductions in the amount of cigarette litter. The comments from the participating marinas identify a secondary benefit to the program. As one manager stated, "YUCK! I didn't realize what my crew had to clean up! We don't allow smoking on the docks, so the dog park, walking paths and parking lots get it." By involving the top level marina management in the CLPP and providing the financial grant incentive, the problem of cigarette litter is elevated from the staff level, to the marina management level. It was clear that many managers did not realize the scope of the problem at their marina. As a result of the program many managers are now more committed to investing in the resources needed to continue to prevent cigarette litter and to educating their customers about the challenge.

PRIORITY ACTIONS

Programs and activities targeted towards the type of debris (cigarette and fishing line) as well as containing a geographic or sector focus (marinas) help to facilitate direct messaging and quantitative measurement.

Providing the infrastructure needed to help prevent debris, while not free, is an inexpensive means to get the buy-in from partners to help implement deris prevention measures. This investment in preventive infrastructure (line bins and cigarette receptacles) is affordable compared to debris removal costs and environmental impacts and can help get program partners started working on debris prevention.

Broad partnerships including multiple levels of government, the non profit community, the private sector as well as the industry that manufacturers the product of concern are best able to provide the insights and resources needed to address the problem.

1.a.5. Protecting the marine ecosystem and human health in the Gulf of Guinea from uncontrolled disposal of plastics and other municipal wastes

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KEYWORDS
Keith Chanon, International, waste management, fisheries, oceans, plastics, recycling

BACKGROUND
The large quantity of solid wastes on the coastline of Ghana has been identified as a significant problem creating potential risks to both human health and to the health of protected living marine resources, including nesting sea turtles and marine mammals. Plastics and other marine debris are known to cause death to these marine species through entanglement and by ingestion.

In the capital city of Accra, 2000 metric tons of solid waste is generated each day according to the Accra Metropolitan Authority (AMA). While a complex infrastructure exists to collect trash, there are no engineered landfills in the city. Like Accra, other municipalities and townships across the country confront similar challenges. Consequently, garbage is hauled to informal and designated dumpsites and may migrate into rivers and streams that flow into the ocean. In addition, a large amount of used plastic bags is discarded by individuals on the streets and directly into sewage drainage canals, ultimately finding their way into the sea. The large volumes of uncontrolled plastics in the waterways and on the beaches pose significant risks to human health and the marine environment.

OUTCOMES
Due to concerns regarding the threat to living marine resources from plastics and other land-based sources of marine pollution, NOAA initiated an effort to further assess the source of the wastes and facilitate a multistakeholder approach to address the problem. Building on partnerships with government agencies and organizations in Ghana, NOAA worked with the US Embassy in Accra and the US Navy Africa Partnership Station to engage experts and community groups. Following an exploratory assessment of the waste management system in Accra and its surroundings in March 2010, the port city of Tema was chosen as the site for a pilot program to increase the recycling of plastic water sachets, strengthen education and outreach activities, and collect data on the waste stream entering the Gulf of Guinea.

In September 2010, a multistakeholder meeting was convened in the City of Tema that brought together over 40 representatives from government, academia, the private sector, and non-governmental organizations. An important outcome was the prioritization of the three work areas and the establishment of a local Steering Committee. Plastic recycling was identified as the top priority. Outreach and education was identified as the second priority, including an assessment of ongoing educational activities, region-wide cleanups, and participation in the International Coastal Cleanup (ICC). And lifecycle analysis of the waste stream was identified as the third priority, including an analysis of the waste stream. The Steering Committee, comprised of the federal and municipal governments, the private sector, academia, and NGOs was established to further develop the program.

PRIORITY ACTIONS

Due to the complexity of the waste streams, cultural behaviors and attitudes, infrastructure capacity, and economic factors, it is essential to partner with a wide variety of institutions and tap into local expertise. In turn, strengthening collaboration with the private sector, and in this case, the recycling industry, can significantly reduce the amount of plastics that enter the waste stream. Lastly, a champion that leads the process in-country is needed to oversee and ensure continued progress toward meeting the goals of the program.

1.b.1. Measures implemented to reduce marine debris from New Zealand fishing vessels

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KEYWORDS
Marine debris, fishing, ships, garbage, management. education

BACKGROUND
During an extensive consultation and a survey of existing garbage management practices on commercial fishing vessels, a number of barriers to good practice were identified. These included limited understanding of relevant regulations and good practice, poor management of volumes and storage of garbage on board, and the perceptions that shore-side reception options were inadequate.

This paper reports on a project undertaken in New Zealand to address these barriers as a means to reduce the contribution from commercial fishing vessels to marine debris.

METHODOLOGY
A collaborative approach between government agencies, non-government organisations and industry allowed the issue of marine debris from commercial fishing to be tackled using a range of approaches. Strategies were particularly focused on education and the elimination of barriers and were reviewed in detail by practicing fishing operators to provide a reality check as to their relevance and usefulness.

OUTCOMES
Guidance on best practice and ideas to simplify garbage management on boats was developed, and presented as far as possible from an industry perspective. This material was published to be available to fishermen in a range of accessible formats, including a handbook, online resources, stickers, conference presentations and short articles in popular industry publications.

The Waste Management Handbook (full title) which included all kinds of waste including garbage, oil, sewage and chemicals, was designed to be user friendly with cartoon illustrations, plain English text, tips for good practice and written as though "by fishermen for fishermen". In addition, a simple template was provided to allow fishing operators to develop a waste management plan for their own vessel. The handbook can be downloaded from the Seafood Industry Council website at:

http://seafoodindustry.co.nz/f464,84718/84718_Waste_Management_Handbook.pdf

Copies of the handbook were distributed for free to a large number of fishing operators through the Seafood Industry Council and at industry conferences.

Stickers suitable for display on boats were produced providing a plain English explanation of the applicable rules for garbage disposal at sea. These were distributed for free at boat shows, through maritime advisors, the Seafood Industry Council and at industry conferences.

A series of short articles highlighting the issues of marine debris, and focussing not only on environmental harm but on the potential for lost time, repair costs to equipment and machinery and impacts on fisheries, were published in fishing and boating magazines.

In addition, the identification of perceived barriers to returning waste ashore has been used to develop a targeted campaign to work with local government authorities to improve waste reception facilities at marinas and boat ramps.

Lessons discussed in this paper will underpin the development of an upcoming campaign targeted at the substantial recreational boating sector in New Zealand.

PRIORITY ACTIONS

This project highlighted the value of a collaborative approach with government and industry in developing strategies and materials targeting at changing behavior in a specific industry sector. Direct consultation with the target audience to identify barriers to good practice was crucial in finding ways to communicate effectively with fishing operators and providing resources that would be genuinely useful to them.

1.b.2. Development and distribution of marine debris education kit for fishermen in Korea

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KEYWORDS
Marine Debris, Environmental Education, Education Kit, Fishermen, Awareness

BACKGROUND
Fishing-related debris occupies a relatively high fraction in the marine debris collected in Korea although fishermen population accounts for only 0.2% of the employed population. This justifies an urgent need for a marine debris education program for fishermen. The fishing community, however, is not well aware of how serious the debris problem is because of old age, low education level, and distrust on government policies. This has been one of the main reasons for their low participation in marine debris management efforts of the Korean government.

Marine debris education for fishermen has not been included in any program that targets them, such as educational or training programs provided by local governments, Fisheries Cooperatives, Korean Coast Guard, Korea Institute of Maritime and Fisheries Technology, etc.
An educational kit on marine debris for Korean fishermen has been developed with a support from the Korean government. Its primary target is people who closely work with fishermen, such as local officials, coast guards, and instructors in local educational institutions, leaders of fishery cooperatives.

METHODOLOGY
Socio-economic conditions of the fishing communities and recognition about education programs of Korean fishermen were examined before the educational material was developed. Characteristics of existing materials and cases on environmental education in general and marine debris in specific for fishermen were reviewed to derive effective educational strategies and contents. Educational programs and institutions to which marine debris education can be applied were also surveyed.

OUTCOMES
The educational kit is composed of an instructor's manual, booklets, a DVD, posters, and a briefcase (Fig. 1.). The manual provides detailed script of each material so that instructors can give lectures even without a special training. Supplementary information, references, a video, and photos are also included in the DVD for in-depth education.
The kit introduces the impacts of debris on marine life to fishermen and guides them how to participate in efforts to reduce marine debris (Table 1). Cartoons and photos were used for their easy understanding.

The first workshop was held on April 2010 to train about 170 potential educators. Most of participants were officials in charge of marine environment management of local governments. More training workshops are planned in several coastal areas.

PRIORITY ACTIONS

- Invest more for prevention than for cleanup of marine debris.
- 'Train One, Educate Many!'
- Develop method and index for the evaluation of education effects

FIGURES AND TABLES

Fig. 1. Marine Debris Education Kit for Fishermen of Korea

Table 1. Contents of the Marine Debris Education Kit for Fishermen of Korea

Policy	Project	How fishermen can participate
Reduce	Biodegradable fishing gears	Use biodegradable fishing gears
Reduce/Remove	Buyback Program	Active participation
Reduce/Remove	Reception barges	Voluntary collection on the barges
Reduce	Standard EPS buoys	Use standard EPS buoys
Reduce/Remove	EPS buoy compactor	Cooperation for the collection of used EPS buoys
Remove	Removal of sunken debris	Report locations of dangerous debris
Reduce	Community fishing management	Prevent gear conflicts

1.b.3. Plastic Free Hawaii: moving toward freedom from plastic… one community at a time

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KEYWORDS
Education, plastic-free, youth, community, single-use plastics, Hawaii, Haleiwa, Kailua, schools, businesses

BACKGROUND
Plastic Free Hawaii is a program of the Kokua Hawaii Foundation, a non-profit organization that supports environmental education in Hawaii's schools and communities. Inspired to preserve and protect our island home, the vision and goals of Plastic Free Hawaii were created to ultimately eliminate single-use plastics in our community.

METHODOLOGY
Plastic Free Hawaii Goals:

1. To minimize the consumption of single-use plastics. Single-use items include: plastic bags, food take-out containers, Styrofoam, plastic utensils, water bottles and more.
2. To promote the human and environmental health benefits of going plastic free.
3. To provide resources for alternatives to single-use plastics.
4. To support and assist local government in passing plastic free legislation.
5. To keep the campaign tone positive and looking towards a healthier future, rewarding those that participate without condemning those that do not.

Plastic Free Hale'iwa, the first Plastic Free community launched in 2007. The Kokua Hawaii Foundation partnered with Kanu Hawaii to launch the Plastic Free Commitment campaign as a way to elicit consumer activism. Five plastic free commitments were crafted to allow individuals to pledge their support of the plastic free message. Commitment cards and collection boxes were placed in Coalition member businesses to further educate and engage customers. A Plastic Free webpage and widget were added to tally Plastic Free supporters, their commitments and measures our collective impacts.

In 2009 the Coalition introduced the Plastic Free Haleiwa stainless steel water bottles and reusable shopping bags. The bottles and bags encourage people to break their single use plastic habits and switch to reusables. The bottles and bags became a huge hit with a variety of demographic groups, from school kids to visitors. Both the bags and bottles are available in Hale'iwa at several Plastic Free Hale'iwa businesses.

In 2010 Plastic Free Kailua joined Plastic Free Hawaii. Plastic Free Kailua has begun to build a coalition of businesses, schools and residents by hosting monthly meet-ups featuring film screenings and beach clean-ups while also engaging in community outreach and dissemination of state and county bag ban legislative initiatives. Both Plastic Free Kailua and Plastic Free Haleiwa have been initiated in partnership with volunteer community leaders who continue to network and campaign within their respective communities.

Kokua Hawaii Foundation recently launched Plastic Free Schools, a program that aims to reduce single use plastics on school campuses. The program encourages students, faculty, and parents to make plastic free commitments to use waste free lunches, reusable bottles and tote bags and provides educational resources to make these commitments come to life.

OUTCOMES

The Plastic Free Hawaii Coalition currently includes over 60 businesses from Haleiwa and Kailua towns and thousands of community supporters who have joined in the movement to minimize single use plastics. These loyal partners have been making great strides in becoming plastic free and have raised the bar for sustainable business practices in the state of Hawaii.

PRIORITY ACTIONS

Plastic Free Hawaii encourages people to think about plastic in their personal life with attention to reusable bottles, totes and foodwares. We also encourage business and community leaders to start similar projects with the eventual goal of elimination of single-use plastics.

REFERENCES

www.kokuahawaiifoundation.org/plasticfreehawaii
www.kokuahawaiifoundation.org/plsticfreeschools

1.b.4. Anthropogenic marine debris in the SE Pacific: Citizens discover the problem on their beaches

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KEYWORDS
beach litter; plastics; anthropogenic marine debris; beach survey; volunteer participation; beach user interviews; perception and disposition; environmental education.

BACKGROUND
As in all major oceans, anthropogenic marine debris (AMD) is a common problem in the SE Pacific. Several studies have suggested that most AMD in this region is of local origin, but the extent and causes of the problem are not well known. Environmental awareness is limited among the population of the countries in the SE Pacific. Therefore this study pursued two main objectives: (1) Determine the types and quantities of AMD on the beaches in the SE Pacific, and (2) Reach out to the general public and motivate people to take action. Getting the general public involved in the scientific process and learning through first-hand experience about the types, quantities and impacts of AMD was considered an ideal approach to raise public awareness.

METHODOLOGY
In order to combine the study of this problem with a search for solutions, we developed a model that integrates research and outreach. In two nationwide research projects (an AMD beach survey and a beach user survey) we invited schoolchildren from coastal communities on the Chilean coast to participate. At the beach, students followed a specific sampling scheme to identify and quantify the amounts of AMD on local beaches. At a later date, the students surveyed the inhabitants of their coastal cities about their environmental attitudes.
A package with survey forms and additional background information was sent to all participating schools. Guidance for a preparatory activity was provided to the school teachers. After completion of the field activity, all completed forms and interviews were sent to Universidad Catolica del Norte in Coquimbo, Chile) where we carefully revised all data before proceeding

with the evaluation. The instructions and forms for the beach survey and user interviews are available on www.cientificosdelabasura.cl.

OUTCOMES

A beach survey covering more than 40 beaches along the entire coastline (from 18°S to 53°S) confirmed that most AMD results from nearby human activities, i.e., the activities of local people (Figure 1). In northern and central Chile a large proportion of AMD was directly deposited by beach users, while in southern Chile aquaculture activities and fishermen were identified as the main sources of AMD (Bravo et al. 2009, Hinojosa & Thiel 2009). In a follow-up study, schoolchildren interviewed beach users about their perceptions of and attitudes towards AMD on the beach. The results confirmed that most beach users were aware of the local origin of AMD on Chilean beaches. The data also suggested an association of education level with slightly higher levels of environmental responsibility and knowledge. Interestingly, most respondents proposed educational activities in combination with fines for beach littering as one of the best solutions to solve this local problem.

PRIORITY ACTIONS

Both studies (the AMD beach survey and the user survey) were very well received by all volunteers, who freely gave their time to participate in this activity (Figure 2). We propose this form of citizen science as an important tool for examining the extent of the littering problem and searching for solutions.

FIGURES AND TABLES

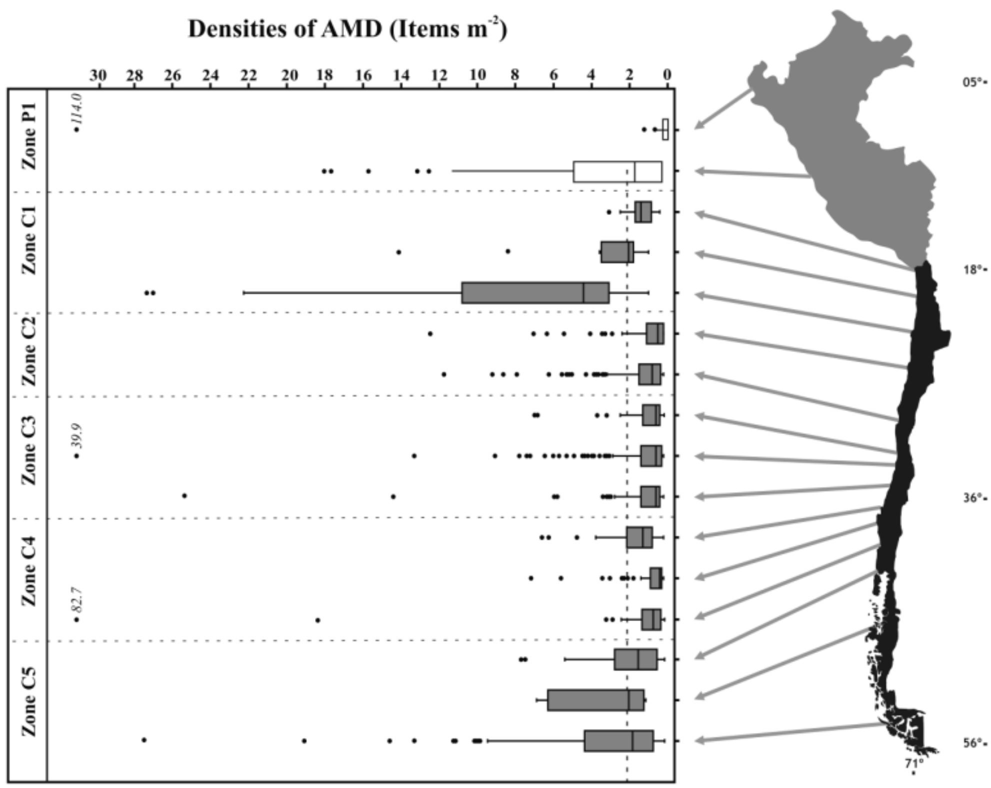

Figure 1. Average densities of anthropogenic litter on beaches along the coast of the SE Pacific (data from Bravo et al. 2009; A. Pacheco unpublished data).

Figure 2 (A) Group of volunteers that participated in the survey. (B) Volunteers surveying AMD at one of the stations. (C) Newspaper article reporting on the preliminary results of the survey. (D) Sorting the different categories of AMD found in a station.

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For survey instructions and forms see: http://www.cientificosdelabasura.cl/

1.b.5. Engaging communities and volunteers in ongoing partnerships to reduce marine debris in the Great Lakes region

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KEYWORDS
volunteer programs, marine debris, Adopt-a-Beach™, Great Lakes

BACKGROUND
The Great Lakes provide drinking water to 40 million people. They also provide countless jobs and unparalleled recreational opportunities through boating, swimming, and lakefront parks. Unfortunately, the Great Lakes face a host of very real and urgent threats including pharmaceutical pollution, water depletion, debris littering our beaches and invasive species—like Asian carp—that are having a devastating ecological impact. Through the Adopt-a-Beach™ program, the Alliance is improving water quality and coastal health for people and wildlife, while engaging and educating stewards.

Through the Alliance for the Great Lakes' Adopt-a-Beach™ program, more than 10,000 volunteers collected data and removed debris at more than 292 beaches in six states around the Great Lakes in 2010. Adopt-a-Beach™ teams use data collection forms aligned with the International Coastal Cleanup marine debris collection card and the U.S. EPA's beach sanitary survey form. Teams of volunteers participate from all walks of life including: businesses, community groups, schools, families and individuals. Information collected by volunteers is collected year-round and logged into an online data collection system and shared with the public, researchers and agencies. During the 2010 beach season, volunteers submitted 675 litter collection forms and 598 beach health assessment forms. The beach health form collects rain event information, current movement, condition of trash containers at beaches and potential point and non-point pollution sources that can contribute to debris problems at beaches.

The Adopt-a- Beach™ program is integral to the Alliance for the Great Lakes mission, which is to conserve and restore the world's largest freshwater resource using policy, education and local efforts, ensuring a healthy Great Lakes and clean water for generations of people and wildlife.

METHODOLOGY
The Adopt-a-Beach™ program offers formalized methods for data collection and opportunities for building community partnerships, as well as tools for taking action and engaging volunteers on an ongoing basis, as it pertains to marine debris and beach health issues. The program goals are not only to collect data but to utilize and share data to encourage action to make positive changes.

OUTCOMES
The following case studies illustrate how engaging volunteers in removing and cataloging debris promotes Great Lakes stewardship resulting in positive action to address marine debris issues. In an effort to reduce the amount of cigarette litter on beaches, an Adopt-a-Beach™ team in Muskegon, Michigan successfully persuaded local officials to restrict smoking on a section of their local beach. Their actions sparked the adjacent community to do the same on all of their county owned beaches which then spread to restrictions on smoking in the City of Chicago and Evanston, Illinois. Another example of action comes from the Friends of Sleeping Bear Dunes Adopt-a-Beach™ team consisting of over 30 individuals that regularly scour this remote section of national lakeshore. This corps of volunteers: located the owner of a commercial ice machine that then was held responsible for the removal of the object from the shoreline; convinced a local grief support group to find a friendly alternative to an annual balloon release; and responded to a mystery trash wash up by removing and monitoring debris as it washed ashore. An Ohio team, Baldwin-Wallace College, launched a fundraiser to pay for animal proof lids on trash containers at their adopted beach so the trash stays put no matter the weather or animals lurking about. This group also educates the local community marine debris issues through local media and events. This year they will be investigating the source of tampons and cigar tips that wash up along the shore in unusually high numbers.

Over the last couple of years, the Alliance has been working closely with beach health officials and others to share information gathered by volunteers. Some examples of data sharing include: identifying an illicit discharge to the beach; working with state park officials to provide and monitor assistance to gauge the impact of a local beach restoration project; and providing information to researchers and others types of debris to assist in source identification.

PRIORITY ACTIONS
The Alliance for the Great Lakes Adopt-a-Beach™ program will continue to: engage volunteers in year-round debris removal and beach monitoring; build and expand partnerships with agencies and others to work toward improvements for beaches; and educate people about actions they can take action to reduce debris.

1.c.1. Derelict fishing gear impacts on the marine fauna of Puget Sound and the Northwest Straits

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ABSTRACT
Derelict fishing gear can remain in the marine environment for years, trapping and killing many marine organisms. Our project has recovered over 3300 derelict fishing nets from areas throughout Puget Sound and the Northwest Straits, primarily from high-relief, rocky habitats in the San Juan Islands and in northern Puget Sound. Primarily gillnets from decades of salmon fishing, recovered gear was usually relatively small in size, in relatively good condition, and stretched open to some extent. Of the organisms documented, 195,000 were marine invertebrates (44% dead), 1,990 were fishes (81% dead), 790 were birds (100% dead), and 46 were mammals (100% dead). Invertebrate mortality was documented in ½ of recovered gillnets, while vertebrate mortality was documented in 1/3 of recovered derelict gillnets. We have documented at least 140 species of marine invertebrates, 41 species of marine fishes, 17 species of marine birds and 4 species of marine mammals during derelict gear recovery, some of which are species of commercial or conservation concern. The numbers of animals killed, and to a lesser extent the species impacted, documented during gear recovery are mere snapshots of the damage gear causes over its derelict lifetime. Estimates of mortality due to derelict fishing gear range from a minimum of documented carcasses and bones up to several thousands of animals annually using empirically-based catch rates and turnover rates from decomposition and scavenging. We continue to refine estimates of mortality from derelict fishing gear by modelling net fishing ability over time and varying degradation and drop-out rates. This information can help prioritize removal of derelict gear as well as put this mortality source in context for local and regional species of economic and conservation concern.

1.c.2. Northern fur seal entanglement on the Pribilof Islands

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KEYWORDS
Pribilof Islands, Alaska, northern fur seal, entanglement, marine debris, Unangan, entanglement rates.

BACKGROUND
On the Pribilof Islands in the Bering Sea, one of the most prominent local impacts of marine debris is the entanglement of northern fur seals or laqux (*Callorhinus ursinus*) in pieces of net, plastic bands and other synthetic debris. The Pribilof fur seal population is in the midst of a long-term decline, causing continued concern about the impact of mortality due to entanglement. Unangan (Aleuts) of the Pribilof Islands are working in collaboration with partners in the fishing industry, management agencies and environmental community, to mitigate the damaging effects of marine debris. In recent years Aleut community members have captured and released entangled northern fur seals and conducted beach clean-ups to remove marine debris from the environment. To evaluate the success of these efforts local programs have been implemented to monitor trends in the rate of entanglement and the composition of debris removed from fur seals. The ECO on St. Paul has tracked their capture effort and success rate since 1998 and identified the debris observed entangling seals. In all years, entangling debris observed on and removed from northern fur seals consisted primarily of net, plastic packing bands and line mostly related to the fishing Industry. From 2005-08 the St. George Island Institute monitored fur seal entanglement using observational surveys of females and pups at South rookery on St. George Island. These efforts demonstrate the ongoing commitment of the local communities to continue the longstanding effort to mitigate and monitor northern fur seal entanglement in the Pribilof Islands.

METHODOLOGY
During all field activities conducted on St. George Island, St. George Island Institute researchers recorded sightings of entangled fur seals. Sightings were also reported to the Island Sentinel Program on each island by other researchers, community members and visitors to the islands. During all field activities conducted on St. Paul and St. George Islands, ECO researchers recorded sightings of entangled fur seals. Sightings were also reported to the Island Sentinel Program on each island by other researchers, community members and visitors to the islands.

Captures were attempted in situations where entangled seals could be safely captured with minimal disturbance to the haulout or rookery area. When entangled seals could not be captured immediately, photographs were used to detect repeat sightings and track entangled seals until they could be captured or verified as a scarred seal (Figure 1). We conducted observational surveys of females and pups at South rookery, St. George Island recording the incidence of entangled seals among a sample of seals whose heads, necks and shoulders were visible. We used photo-documentation of individual sightings to track individual entangled seals over time. This allowed us detect repeat sightings of individual entangled seals over the course of the breeding season.

OUTCOMES

From 1998-2006 on St. Paul Island, ECO observers recorded 848 sightings of fur seals that were entangled or scarred from previous entanglement. Out of 349 attempted captures, debris was successfully removed from 292 fur seals, or approximately 34% of the potential entangled seals sighted. This is a minimum estimate because the number of seals sighted includes some repeat sightings and possible scars. The number of attempted captures and seals disentangled was lower than average during 2006 due to two factors: a) efforts to minimize disturbance to breeding fur seals in view of the population decline in recent years; and b) concentration of sighting effort at survey sites which reduced the coverage of other areas on the islands. Continuation of community-based efforts to capture and remove debris from Pribilof fur seals is listed as an annual priority in the Northern Fur Seal Conservation Plan (NMFS 2006).

During more than four decades of study, entangling debris observed on and removed from fur seals has consisted primarily of pieces of trawl net, plastic packing bands and line mostly related to the fishing industry (Figure 2). The size distribution of debris removed from 695 fur seals between 1985 and 2006 indicates that the most frequent debris diameter is consistently between 21-30 cm (8-12 inches) for the three major debris types; packing bands, trawl net and line (loops of twine, string and rope).

We recorded 278 sightings of 88 individual entangled fur seals during surveys at South Rookery on St. George Island over the course of the 2005-08 breeding seasons. Our data for four consecutive years on St. George Island show a mean entanglement rate of 0.06-0.08% for pups, with a potential maximum rate of up to 0.11% in October prior to weaning. The incidence of entanglement among females on St. George Island increased during the course of the breeding seasons during each year, coincident with the predicted arrival of progressively younger females on the rookery. The estimated entanglement rate reached 0.13% in October 2006, an order of magnitude higher than the average incidence in mid-July.

PRIORITY ACTIONS

Based on the results of these efforts, we recommend that that female and pup rookery surveys be continued in addition to roundup surveys during the subsistence harvest and counts of adult males. We do not recommend the continuation of observational surveys of male haulouts at this time. Additional time and effort should be allocated to locating and disentangling fur seals on both islands as a direct means to mitigate the effects of entanglement of fur seals in marine debris.

FIGURES AND TABLES

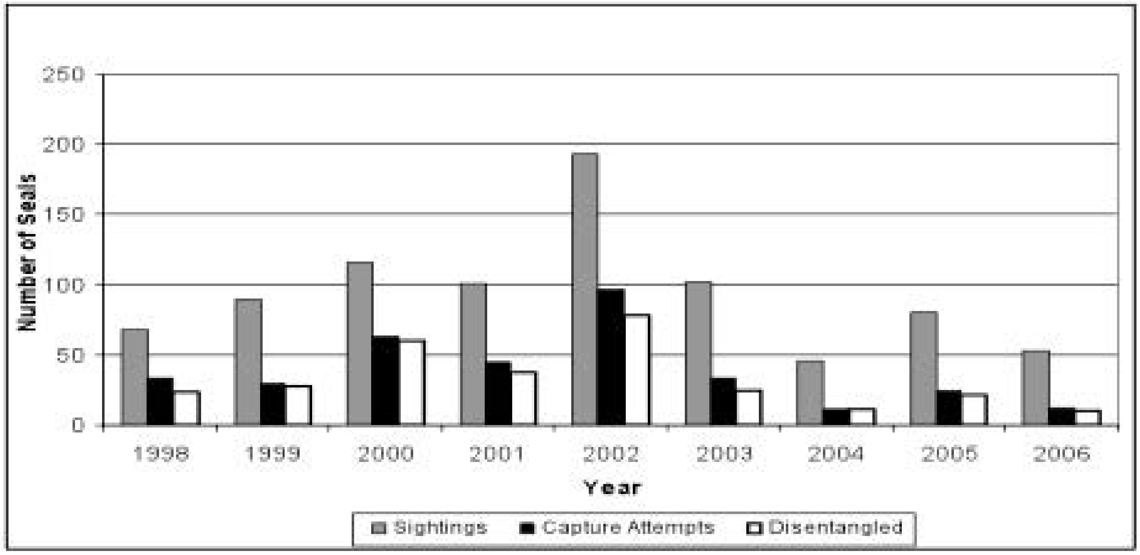

Figure 1. The number of sightings of entangled seals, capture attempts, and seals disentangled by ECO disentanglement teams on St. Paul Island from 1998-2006.

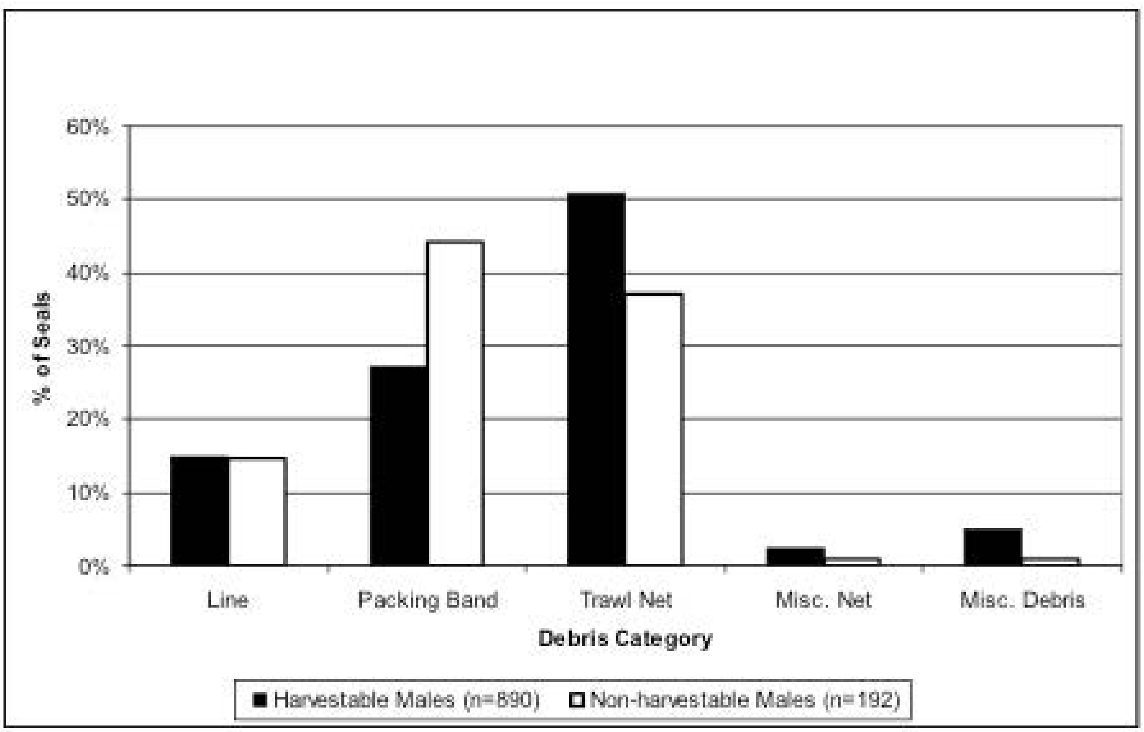

Figure 2. The distribution of major debris types among 1082 harvestable and non-harvestable male northern fur seals disentangled on the Pribilof Islands between 1985 and 2005.

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1.c.3. Steller sea lion (*Eumetopias jubatus*) entanglement in marine debris and ingestion of fishing gear in Alaska and British Columbia: identifying causes and finding solutions

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ABSTRACT
Entanglement in marine debris and ingestion of fishing gear contribute to Steller sea lion (SSL; *Eumetopias jubatus*) injury and mortality. From 2000 – 2010, we surveyed SSL haulouts and rookeries throughout Southeast Alaska and northern British Columbia and documented sex/age class of animals entangled or that had ingested gear, and described the type of entangling debris or ingested gear. We recorded a minimum of 501 individual SSLs that were entangled or had ingested gear; this included both males and females and all age classes. The most common neck entanglements were packing bands and black rubber bands. The most frequently ingested gear was salmon troll fishing gear, evidenced by flashers hanging from the corners of animals' mouths. We documented 18 permanently marked (branded) individuals that were entangled or had ingested gear; a disproportionately high number (16) were males. We are following the fate of these animals; to date, 1 is known dead, 5 have lost their neck entanglement or evidence of gear (though hooks may still be present internally), and 3 were suffering severe neck entanglements when last observed. Reducing the use of packing bands, cutting loops of synthetic material, and re-configuring gear that uses loops can prevent entanglements. We believe it will take a cooperative effort between commercial and sport salmon trollers and biologists to develop methods to reduce interactions between SSLs and salmon troll fisheries.

1.c.4. Lose the loop: Reducing Steller sea lion (*Eumetopias jubatus*) entanglements in marine debris

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KEYWORDS
Steller sea lion, *Eumetopias jubatus*, marine debris, entanglement, Lose the loop, Oregon, Sea Lion Caves, Cascade Head, Dungeness crab fisheries.

BACKGROUND
Over the past 30 years, Steller sea lions have declined by over 80% resulting in their threatened status in the eastern and endangered status in the western portion of their range (Loughlin et al., 1992; Trites and Larkin, 1996; Sease et al., 2001). While causes of the decline are unknown, entanglement in fishing gear and marine debris is known to contribute to Steller sea lion mortality (Perez, 2006; Angliss and Outlaw, 2007; Raum-Suryan et al., 2009). However, the extent that entanglement related mortality contributed to the decline is unknown. This study provides the first report of Steller sea lion entanglement incidence in Oregon.

The primary goal of this study was to provide baseline data on entanglements affecting Steller sea lions in Oregon. Our objectives were to 1) determine sources of marine debris entangling Steller sea lions; 2) estimate entanglement incidence; 3) determine if the incidence of entanglement varies by age or sex; and 4) find solutions to reduce entanglements.

METHODOLOGY
Entanglement data were collected during Steller sea lion studies at Sea Lion Caves (44.1167° N, 122.133° W) from 2005-2009 and at Cascade Head (45.072° N, 124.009° W) from 2005-2007. Observations were made in the field using binoculars, spotting scope, and digital camera, or via six remote video cameras installed at Sea Lion Caves. When an entangled individual was observed we recorded: type of entanglement (e.g., neck entanglement, hook and/or ingested fishing gear), description of entangling material (e.g., white plastic packing band, black rubber band, salmon flasher (lure)), severity of entanglement or ingested gear, age class (adult, subadult, juvenile), sex (if able to determine), and behavior (e.g., nursing pup, etc.). Additional data included: counts, date, location, observers, photographer, start and end times, and weather. Photographs of entangled individuals were entered into a database along with detailed information about each individual.

To determine entanglement incidence, we first divided the total number of entangled Steller sea lions counted on a haul-out by the total number of Steller sea lions counted on that haul-out. We then calculated a mean of means for each haul-out site then a grand mean for both sites.

OUTCOMES

From 2005-2009 we surveyed Sea Lion Caves and Cascade Heal haul-outs in central Oregon (n = 389 days) and recorded 72 individuals as being either entangled in marine debris or having ingested salmon troll fishing gear. Neck entanglements (n=70) were much more common than Steller sea lions interacting with salmon fishery troll gear (n=2). Although we observed 70 individuals with neck entanglements, we were unable to identify 29% (n = 21) of the entangling materials because the entangling material was either too deeply embedded in the neck or the quality of the video photo image was not clear enough to determine what the material was. Of the 49 identifiable neck entanglements, black rubber bands (used in commercial and recreational Dungeness crab fisheries) were the most common entangling material (62%; Fig. 1), followed by plastic packing bands (36%; Fig. 2), net (1.2%), yellow rubber bands (0.4%), and Frisbee (0.4%). Two individuals were observed with salmon troll gear (flashers or lures) hanging from their mouths, indicating a swallowed hook. The majority of the neck entanglements (71%) were severe (entangling material cutting through skin) and 5% were very severe (Table 1). Overall, entanglement incidence for Sea Lion Caves and Cascade Head was estimated as 0.34% (SE = 0.030). Juveniles were the most frequently entangled age class (60%), followed by adult females (28%), and subadult males (12%; Fig. 3).

PRIORITY ACTIONS

- "Lose the loop" - encourage cutting and proper discarding of entangling loops that could potentially end up as marine debris.
- Tie knots in rubber bands used on crab pots to reduce the diameter of loops or find alternative biodegradable materials to use in place of rubber bands.
- Reduce the loss of rubber bands from going overboard by using a retaining clip and keeping loose bands off the decks of boats.

FIGURES AND TABLES

Table 1. Codes used to depict entanglement or ingestion severity and percentage of the degree of entanglement severity of Steller sea lions observed from 2005-2009.

Degree of Severity	**Description**	**Degree of Steller sea lion neck entanglement severity (%)**
D1	**NIL:** Neck entanglement loose; exerting no pressure	**1%**
D2	**SLIGHT:** Neck entanglement tight but not breaking the skin	**23%**
D3	**SEVERE:** Neck entanglement material cutting through skin; swallowed hook or hook with flasher attached	**71%**
D4	**VERY SEVERE:** Neck entanglement material cutting through skin, blubber, and at times muscle; fluids from swallowed hook visible from mouth; likely to cause death	**5%**

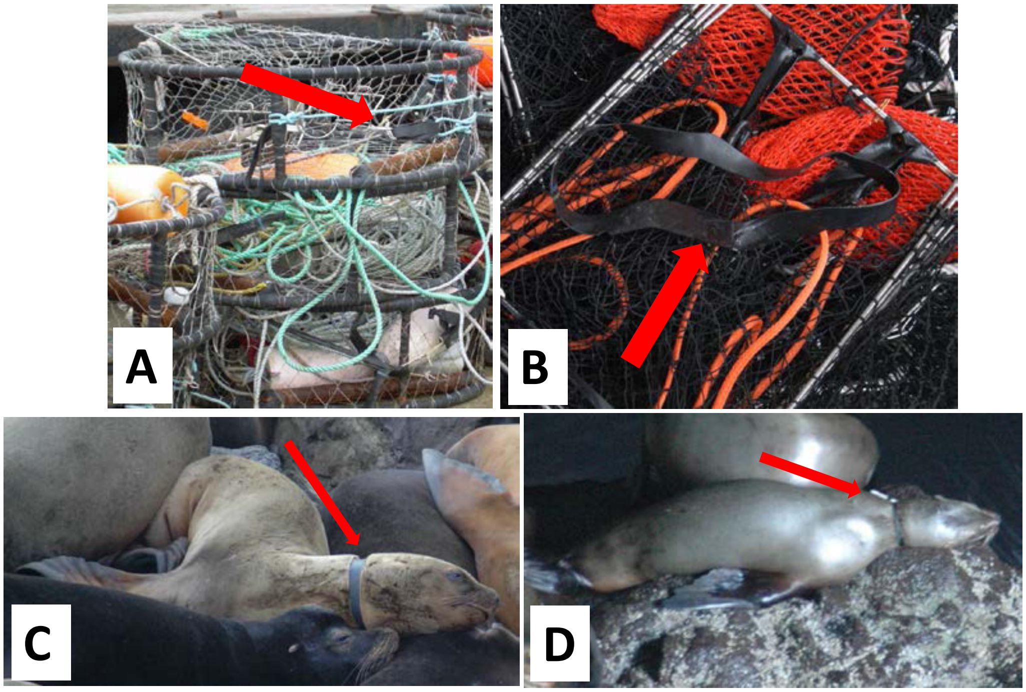

Figure 1. Examples of A) commercial Dungeness crab pot with attached black rubber band, B) loose rubber band lying on top of recreational crab pot aboard vessel underway, C) juvenile Steller sea lion with black rubber band neck entanglement at Cascade Head, Oregon, and D) juvenile Steller sea lion with black rubber band and attached white plastic hook neck entanglement at Sea Lion Caves, Oregon.

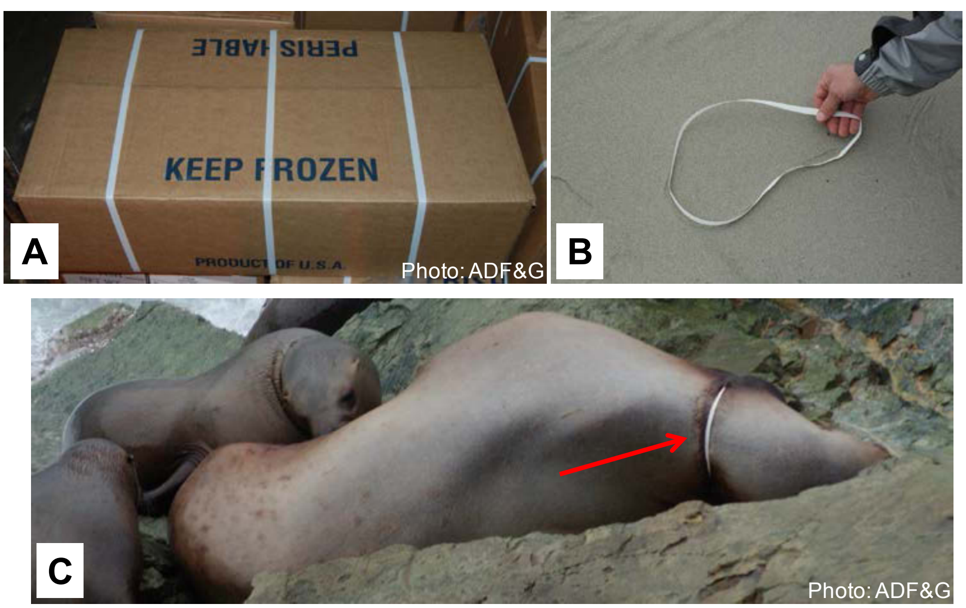

Figure 2. Examples of A) plastic packing bands on fish bait box, B) plastic packing band washed up on Newport, Oregon beach, and C) Adult female Steller sea lion with plastic packing band around neck.

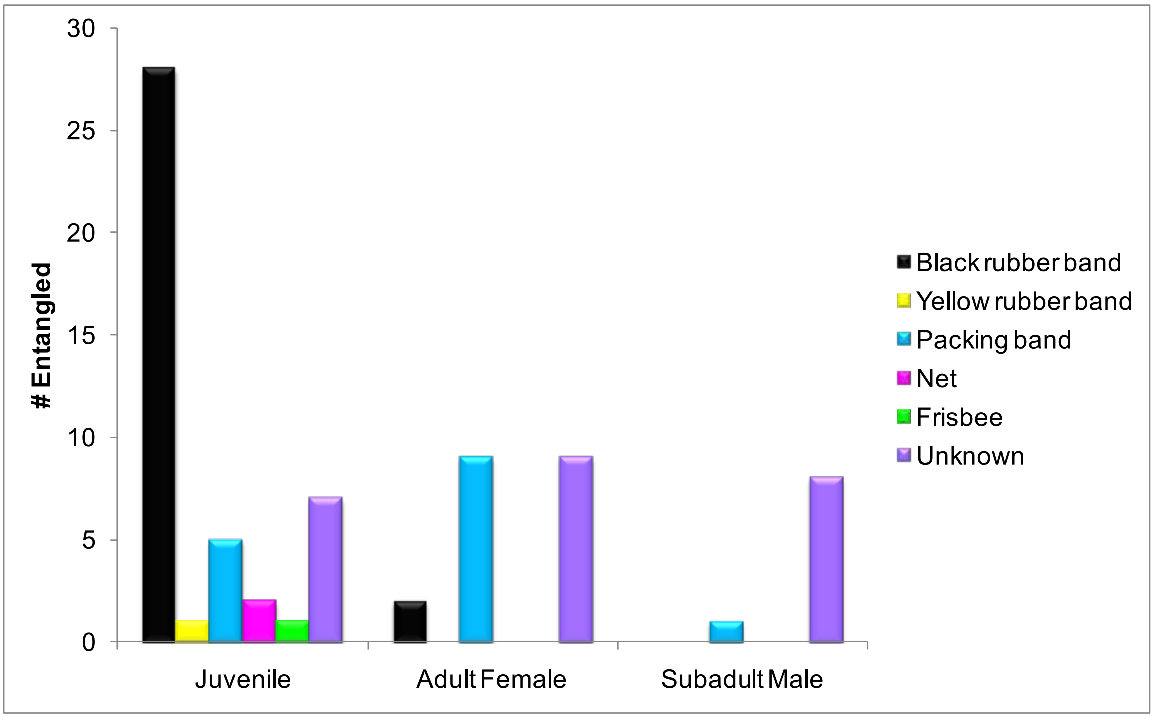

Figure 3. Number of juvenile, adult female, and subadult male Steller sea lions entangled by entanglement material observed during surveys in Oregon during 2005-2009.

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1.c.5. Marine debris entanglements of birds: global patterns, impacts, and solutions

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ABSTRACT
Marine debris affects seabirds via ingestion of anthropogenic materials (*e.g.*, pellets, fish hooks, other plastics) and entanglement in derelict fishing gear (recreational or commercial fishing nets, lines) and other entangling plastic debris that is lost or abandoned in the marine environment. A 2009 report of the United Nations Food and Agriculture Organization and Environment Programme reported that approximately 640,000 tons of discarded fishing gear enters the oceans yearly, accounting for nearly 10% of the world total of marine debris. Since the 1950s, most of the world's fishing industries replaced nets composed of natural fibre with those made from synthetic material, resulting in lost or abandoned fishing gear remaining in the marine environment for decades. Derelict fishing gear has been implicated in the entanglement and death of marine birds since the 1970s, and entanglement and ingestion impacts were reviewed in the 1990s. Since then, there has been an increase in gear retrieval programs and explicit studies on the fate and biological impacts of derelict gear, including impacts on marine birds. We reviewed published and unpublished reports of seabird entanglement and mortality to summarize geographical, taxonomic, and fishery patterns worldwide. For birds, monofilament line is the most common entangling gear, with monofilament gillnets causing the greatest per capita mortality. Almost 100 species of birds (primarily marine birds) have been documented entangled; however, the demographic effects of this mortality are not well understood. United Nations resolutions now require reducing derelict fishing gear and marine debris in general, and cutting edge technologies are assisting in detection of marine fishing debris. Clean-up efforts underway worldwide should reduce associated risk for all marine birds.

1.d.1. Waste conversion technology options for marine debris

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KEYWORDS
Waste conversion; Waste-to-energy; Waste-to-fuel; Gasification; Thermal depolymerization; Department of Defense (DoD)

BACKGROUND
One of today's biggest challenges for the Department of Defense (DoD) is how best to implement integrated solid waste management. Regardless of whether the military installation is on the United States mainland or at a Forward Operating Base, the basic challenge is the same. One option that is receiving significant attention is *waste conversion*. This approach not only provides the alternative for producing energy as a direct product, but it can also provide for by-products such as transportation fuels. This same approach can be used for marine debris and will be examined in this session from two viewpoints. First, technology options for the conversion of waste marine debris will be explored. Included in this analysis will be technologies such as gasification, plasma arc, and thermal depolymerization with applications such as waste-to-energy and waste-to-fuel conversion. Various factors such as the waste characterization, feedstock and product output will be considered. And, an approximate cost estimate will be included as well as an overview of the logistics required for implementation.

Second, two actual case studies will be summarized focused on Oahu, Hawaii and the State of Alaska. These case studies originated from projects funded by the U.S. Department of Defense. In these studies, a regional waste conversion scenario was developed in conjunction with various stakeholders and partners that presented the most effective way to deal with regional waste. This discussion will identify the various organizations involved and the role they played in developing this plan.

METHODOLOGY
When assessing the viability of any waste conversion process, there are three key factors; the characterization or content of the waste stream, the typical feedstock anticipated from the waste stream and the end product or output desired. These factors form the basis for conducting any technology feasibility assessment. The most important factor, however, and sometimes the most difficult to obtain is the waste characterization. The waste stream must be understood in terms of content and categories of waste as well as the quantity for each category even if it is estimated. Without this information, an analysis of the most applicable technologies cannot be developed effectively.

OUTCOMES
When assessing a technology solution for waste conversion, the three most critical factors include the waste characterization, available feedstock and product output desired. These factors

provide an overall picture of the technology needed to achieve the results and a baseline for the path forward.

The projects conducted in Hawaii and Alaska utilized this approach to determine if either was viable. It became quite evident that although a DoD-only approach could be adequately justified, the more cost effective approach was to regionalize the solution and encompass the largest waste stream possible.

A summary level cost benefit analysis and implementation plan were developed for both Hawaii and Alaska. An oil commodities market price of $70 per barrel was used, and the return-on-investment for both locations was calculated to be less than five years.

PRIORITY ACTIONS

- Establish a public-private partnership based upon the current stakeholders and other interested parties or organizations.
- Develop the implementation plan and identify the management team for the project start-up.
- Develop the funding profile needed to support implementation/operation and identify potential funding sources.

1.d.2. Hawaii's successful approach to marine debris disposal

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KEYWORDS
Waste conversion; Waste-to-fuel; Waste-to-energy; debris to energy; debris disposal; marine debris

BACKGROUND
Marine debris of all types accumulates in and around the islands of Hawaii due to their location in the middle of the North Pacific Subtropical Gyre. Much of the debris is made up of derelict fishing nets. Derelict fishing nets and other fishing gear from domestic and foreign sources in the greater Pacific are safety and navigation hazards and can damage vessels. Carried by currents, the nets wash ashore and snag on the coral reefs of the Northwestern and Main Hawaiian Islands, causing extensive damage and entangling marine mammals, turtles, and other wildlife each year.

Historically, collected derelict nets would be disposed of in landfills where they not only take up space, but also break down (fragment) very slowly. These plastic nets (mainly nylon) do not biodegrade or mineralize (break down into inorganic components), but simply break down into smaller and smaller pieces. Therefore, a better disposal method for these nets was needed.
Two very different approaches and alternatives to marine debris disposal are presented herein. The first is the successful Hawaii Nets to Energy Program that takes derelict net, rope, and line and uses it to create electricity. This partnership is and has been successful mainly due to the support and participation of private sector businesses. A second approach seeks to transform waste, more specifically plastic waste, and debris to a transportation fuel such as gasoline and diesel. This can be achieved by implementing one of various technologies such as thermal depolymerization. Through the use of these two approaches, an effective waste and marine debris disposal and diversion strategy can be implemented at many locations and will contribute to a more sustainable community overall.

METHODOLOGY
<u>Hawaii Nets to Energy Program</u>
Since 1996, the National Oceanic and Atmospheric Administration (NOAA) has led a marine debris removal effort in the Northwestern Hawaiian Islands (NWHI). Since then, over 670 metric tons of derelict nets, line, and rope have been removed by NOAA and the US Coast Guard. Instead of adding this debris to already congested landfills, in 2002, the Northwestern Hawaiian Islands multi-agency marine debris group devised a unique program to turn this marine debris into usable electricity.

The collected derelict fishing gear, mainly nets, is transported to the facility of Schnitzer Steel Hawaii Corporation, a mainland-based scrap metal recycler (Figure 1). There the nets are chopped into small pieces suitable for combustion at the City and County of Honolulu's H-Power waste-to-energy facility run by Covanta Energy. Schnitzer Steel Hawaii Corporation transports the chopped net pieces to the H-Power facility. There the nets are burned, producing steam that drives a turbine to create usable electricity. All services (transport included) are donated free of charge. According to the Hawaii State Department of Business, Economic Development and Tourism, 100 tons of derelict net provides enough electricity to power 43 Oahu homes for a year! This program is possible only through the partnership and support of Hawaii's multi-organizational marine debris group including the businesses listed above, as well as Matson Navigation Company and Alliance Trucking.

Today, all NOAA-funded marine debris removal projects in Hawaii incorporate this program as a component for success. Derelict net from the Pier 38 port reception facility, local beach cleanups, and organizations such as the Hawaii Wildlife Fund and Surfrider Foundation's Kauai Chapter also go into the Hawaii Nets to Energy Program (Figure 1).

Debris to Fuel

A second approach to alternative marine debris disposal is currently in the evaluation phase. The U.S. Department of Defense (DoD) installations on the Island of Oahu have undertaken an initiative to transform as much waste as possible into useable products. In addition to the energy that can be directly generated by waste conversion, another potential alternative product is transportation fuel in the form of gasoline, diesel, or jet fuel. By understanding the content of the waste stream and utilizing the latest available technology, highly efficient waste conversion can be implemented to achieve the greatest result possible.

OUTCOMES

Hawaii Nets to Energy Program

Hawaii's Nets to Energy program was the first of its kind in the United States. It has been, since its beginning, a very successful program that has facilitated and fostered numerous partnerships in marine debris across the state of Hawaii. The program runs today through the no-cost support and work of Hawaii's marine debris partners, mainly within the private sector. This program has been so successful that it was used as the model for the "Fishing for Energy" program, which was implemented in sites along the northeastern coast of the US beginning in 2008.
Since the start of Hawaii's Nets to Energy program in 2002, over 670 metric tons of derelict net, line, and rope debris have been used to create electricity (an average of about 82 metric tons per year) – enough to power over 340 homes for a year each!

Debris to Fuel

A detailed waste characterization for all of Oahu including the DoD installations was completed. This data showed that there was sufficient waste, including marine debris, available to make the implementation of a waste conversion process viable. Two types of waste conversion technologies have been identified based upon the available waste stream; gasification for waste-to-energy and waste-to-fuel focused upon plastic waste. A business case has been completed for both technology scenarios, and the decision-making process has begun.

PRIORITY ACTIONS

- Engaging the private sector (e.g., for-profit businesses) in marine debris efforts is important in moving towards the ultimate goal of reducing the amount and impacts of marine debris.
- To the extent feasible, the most pro-active marine debris disposal method should be considered for every removal effort.
- The marine debris community should continue to be involved in any waste conversion project on Oahu and provide input to achieve the greatest return possible.

FIGURES AND TABLES

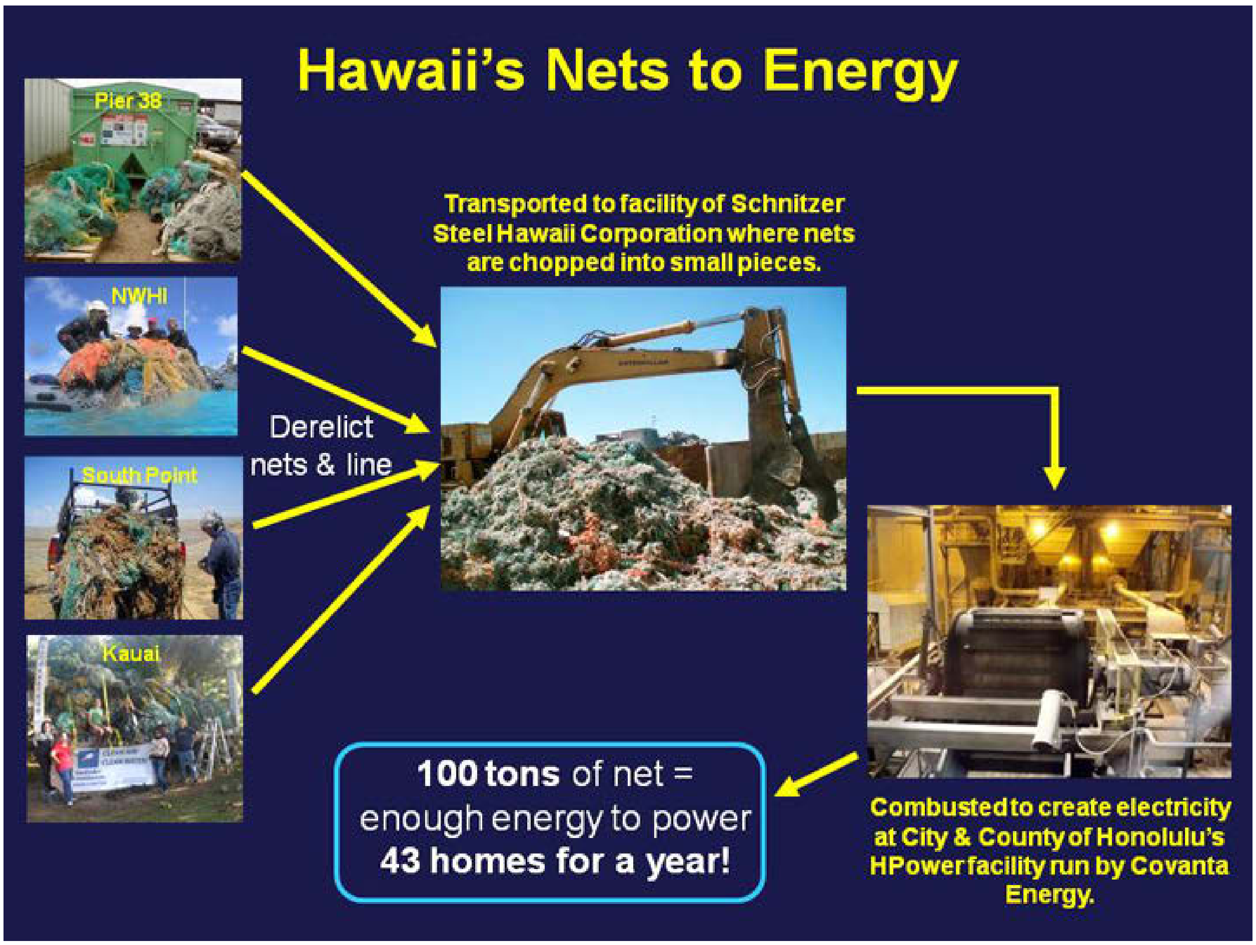

Figure 1. Visual depiction of the Hawaii Nets to Energy Program

1.d.3. Waste management practices on Pacific islands and opportunities for marine debris reduction

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ABSTRACT
Island nations often have waste management constraints due to the amount of land available for waste storage, or technology available for recycling or remediation. As a result, waste often reaches the ocean, impacting the local ecosystems as well as contributing to the broader issue of marine debris.

This study is conducted by graduate students from Yale University's environmental sciences department on behalf of Covanta Energy (www.covantaenergy.com) and Project Kaisei (www.projectkaisei.org), who have together made a commitment at the Clinton Global Initiative in September 2010 to capture marine debris and use new waste-to-fuel technologies to show that a secondary product can be made from the waste stream. The focus will be on three island nations of the Pacific to characterize their waste streams and waste management systems. Based on available information, this will give a basic outline of the waste generated on the islands and how it is disposed. This data will be used to assess project economics for a waste-to-fuel (WtF) system in these locations using system cost data provided by Covanta.

BACKGROUND
The objective of this project is to assess the viability of different waste management technologies or processes that could be introduced to island nations in order to help them with their waste management issues. By learning more about the waste streams and processing, we will better be able to bring about preventative measures that can be long term and community oriented, helping to keep waste from the island's waters. Specific areas of interest include:

- The quantity and type of plastic waste that the islands generate and what kind of waste management infrastructure is already in place
- The viability of plastic waste as primary feedstock for new technology and processing with other separated waste streams such as biomass being secondary feedstock materials.
- The characteristics of the market for diesel fuel in these islands at present (e.g. prices, demand, types of use and availability)
- Other factors that solutions may need to take into consideration (e.g. informal waste economy and cultural / political factors)

The presentation will discuss the findings of the report, and suggestions that can be made for not only the three island nations being studied, but how other island communities may be able to benefit from the knowledge and focus brought to waste management issues vis-à-vis new technologies that are available in the market today.

1.d.4. Hydrothermal carbonization of marine debris: a novel waste management technique

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ABSTRACT
Hydrothermal carbonization (HTC) is an innovative thermochemical treatment technique that may be used to sustainably manage marine debris. HTC is a wet, relatively low temperature (180 – 350 ^{o}C) conversion process that, under autogenous pressures, converts biomass into a carbonaceous residue often referred to as hydrochar. Successful carbonization of marine debris via HTC could substantially reduce fugitive greenhouse gas emissions from current waste management practices. Another significant advantage is the potential to use carbonized wastes (hydrochar) for applications such as environmental remediation (e.g., like activated carbon), feedstock for energy generation (via co-combustion or use in carbon fuel cells), and soil augmentation.

HTC of waste materials (e.g., paper, organic waste, plastic) was conducted at 250 ^{o}C for 20 hours. Carbon content of the solid, liquid and gas-phases was measured to determine the mass of carbon sequestered within the hydrochar. Results indicate the solid phase retains a significant fraction of carbon. The energy content of the hydrochar was measured and is equivalent to that of lignite coal. These results suggest carbonization of wastes is a feasible alternative waste management technique. Experimental results, as well as implications associated with scale-up of this process, will be presented.

1.d.5. Garbage management on fishing boats – lessons from the New Zealand industry

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KEYWORDS
marine debris, fishing, ships, garbage, management.

BACKGROUND
While much research has been done on marine debris found on shore, almost no published data are available on the relative contribution of waste sourced from ships compared to debris that enters the oceans from land-based sources. The fishing industry is often cited as a significant contributor to marine debris, at least partly because fishing related debris is easily attributed to a specific source. However debris could equally be sourced from land or from other ships and result in unidentifiable waste, such as plastic fragments.

As a first step to developing policies and management strategies to minimize the contribution of fishing operators to marine debris, it is necessary first to profile the amount and type of garbage produced on fishing boats. It is also necessary to understand existing garbage management practices and barriers fishing operators face in returning garbage to land. This paper describes the results of a study of garbage production and management on over 300 New Zealand fishing vessels.

METHODOLOGY
The issue of marine debris was discussed with fishing operators at the annual industry conference in 2009, and the garbage management study was outlined in a widely read industry publication. Contact information was obtained for the owners of all New Zealand registered commercial fishing vessels and 1200 survey forms were sent to the owners of vessels ranging in length from 3 meters to over 60 meters. As far as possible the surveys were written in plain English and the majority of questions could be answered by marking check-boxes. To further encourage participation in the survey, respondents were invited to have their name entered into a prize draw.

Survey questions covered details of the vessel size and fishing methods, types of garbage produced onboard, what garbage was discarded intentionally at sea or accidentally lost overboard, onboard garbage management practices, understanding of relevant maritime regulations and observations of garbage at sea. Survey results were collated and analysed to identify trends and assess relationships between fishing activities and garbage generation. These data formed the basis of a progressive programme targeting improved garbage management practices at sea by fishing operators and for expansion into programmes targeting recreational vessel operators.

OUTCOMES

Over 300 surveys were returned, with respondents representing a total of 9 different fishing methods including trapping, line, netting and trawling methods. Approximately 30% of operators reported using more than one method at different times. Over half of the respondents worked on vessels between 12 and 24 meters in length. The majority of vessels were normally crewed by 2 or 3 people and were at sea for between 1 and 4 days on a typical trip.

However, despite the trends based on vessel size, crew and days at sea, there was a surprising variation in the amount of garbage produced on board per crew day (= total garbage/(number of crew x days at sea)). Not including vessels that stated they produced no garbage at all, the amount of 50 litre garbage bags per crew day ranged from 0.02 to 2.0, with an average of 0.3 garbage bags per crew day.

The most frequent types of garbage produced on vessels were food and bait scraps (74%), followed by plastic bags and wrapping (73%). Almost 70% of vessels had cardboard and paper and 62% had plastic bottles as garbage. Approximately 50% of the vessels produced cans and glass, strapping, bait packaging or fishing gear as garbage types during voyages. The items identified as making up the greatest volume of garbage were plastic bags, strapping and bait packaging.

The main garbage type that fishermen intentionally discharged at sea included food and bait scraps (approximately 60%) and cardboard and paper (approximately 30%). A small proportion stated that they discharged cans and glass at sea.

The most common method of stowing garbage on board fishing vessels was in plastic bags (70%) with 25% of fishermen stowing garbage in solid bins or buckets. Other methods of stowing garbage included placing it in sacks and in netting. Garbage was most commonly stowed on the deck (58% of vessels), with 19% of fishermen storing garbage in the living areas or galley and 7% of fishermen stowing garbage in the holds.

While the great majority of fishermen stated that they believed they had a good understanding of the garbage regulations, more than half did not consider that enough information was provided by the regulator, industry organisations, local authorities or during training. In addition, the answers provided in response to the questionnaire suggest that the regulations are not well understood by many fishermen.

When asked to identify barriers to bringing garbage ashore respondents cited problems with reception facilities (26%), space on the boat (22%) and concerns with the hygiene of storing garbage on board (8%). Following up on concerns about reception facilities, fishermen commented that rubbish bins are commonly unavailable, difficult to access or overfull.

There was a high incidence of lost fishing gear reported, with 15% of vessels reported that they experienced this. As the New Zealand fishing fleet does not use fish attraction devices, lost fishing gear from vessels consists of lines, nets, pots and associated ropes and buoys. Nearly all of these items are likely to persist in the marine environment and have the potential for significant environmental harm as well as posing a safety risk to vessels.

One of the most disturbing findings was the number of fishermen (71%) who reported observing garbage at sea, and the high proportion of this garbage that consisted of plastic. Of the observations of marine debris, 80% included plastics, while 26% of the observations included fishing related debris such as nets, fishing line, rope scraps and buoys.

The high frequency of reports of marine debris, particularly plastics, observed at sea was also concerning, as was the amount of fishing gear that fishermen reported encountering at sea. Interestingly, the reaction of many fishers to the high incidence of garbage found at sea was to attribute blame to foreign operated vessels, demonstrating the belief by local fishermen that they are environmentally aware and responsible.

PRIORITY ACTIONS

In working to reduce overboard disposal of garbage from fishing vessels it is necessary to first engage fishermen to effectively relate prevention strategies to the realities of working on board vessels, existing practices and attitudes. Most importantly any proposed solution must be practical and take account of realities of working on boats and the shore-side disposal issues.

FIGURES AND TABLES

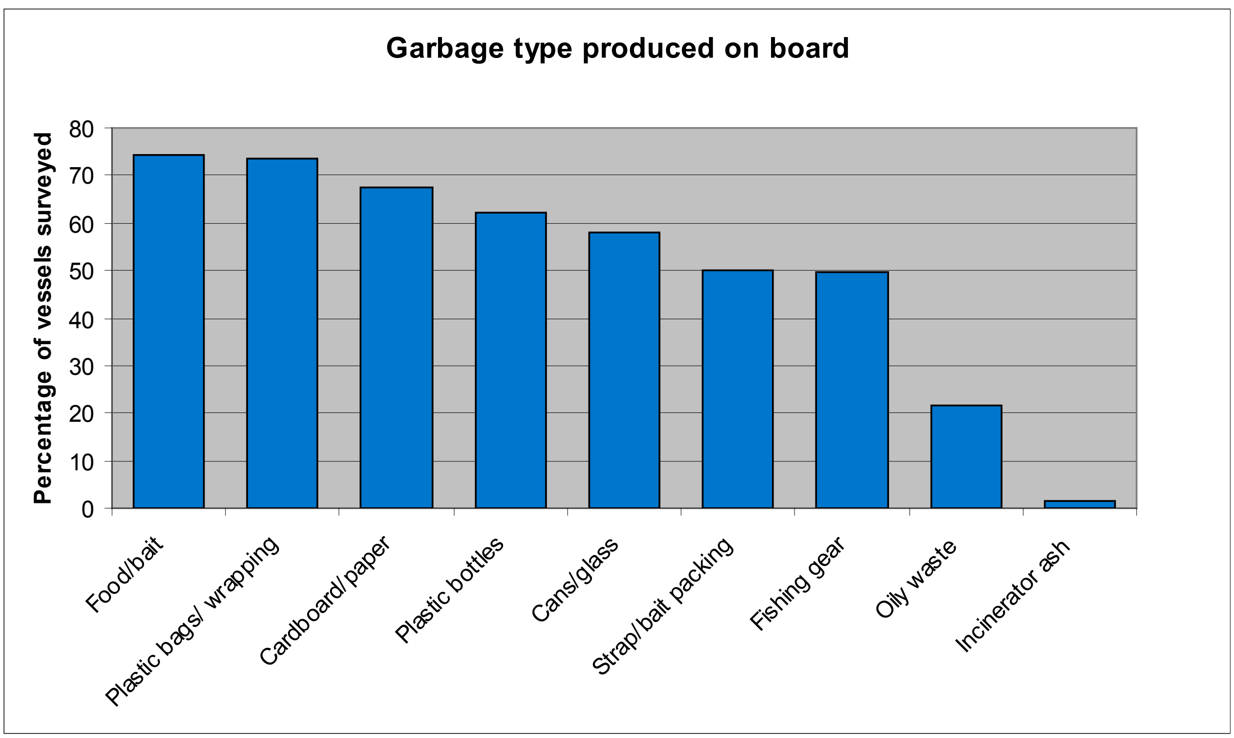

Figure 1. Garbage types produced on New Zealand fishing vessels

2.a.1. Protecting the Caribbean Sea from marine-based pollution: lessons from the MARPOL Annex V Special Area Designation.

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KEYWORDS
MARPOL, Ship Generated; Marine Litter, Solid Waste, Pollution, Caribbean Sea, SIDS, UNEP, IMO, Special Area

BACKGROUND
The Wider Caribbean Region contains 28 coastal and insular Countries that have coasts on the Caribbean Sea, the Gulf of Mexico and part of the Atlantic Ocean. It covers an area of more than 3.3 million km^2, from the United States of America to French Guiana. The region's highly productive but extremely sensitive ecosystems provide a livelihood for many coastal communities through tourism, artisanal and industrial fisheries and sea bed exploitation, and more than 41 million people live within 10 km of the coastline.

When the 60th Session of the Marine Environment Policy Committee (MEPC) of the International Maritime Organization (IMO) accepted the submission to put into effect the MARPOL Annex V Special Area Designation for the Caribbean Sea in March, 2010, it marked the culmination of a process that had spanned almost two decades.

The importance of the Caribbean Sea to the development of the Wider Caribbean Region had been recognized as early as 1981 with the establishment of the UNEP's Regional Seas Caribbean Environment Programme followed in 1983 by the adoption of the only regional legally binding framework for the Protection and Development of the Caribbean Sea – the Cartagena Convention.

In the 1980's and 90's there was growing concern of the negative impacts from the disposal of ship-generated waste at sea, polluting international waters and coastal zones (UNESCO 1994). Monitoring studies suggested the occurrence of marine-based litter on Caribbean Beaches polluting local waters and threatening the tourist trade (Corbin and Singh 1993). The request to IMO by Caribbean Governments for MARPOL Special Area Status under Annex V in 1993 emphasized the region's vulnerability to the discharge of garbage from ships.

Several capacity-building projects followed including the Global Environment Facility (GEF) funded Wider Caribbean Initiative for Ship Generated Solid Wastes Project (WCISW) (World Bank 1999), the Organization of Eastern Caribbean States (OECS) Solid and Ship Generated Waste Management Project (World Bank 2006), and IMO publications of guidelines on ship-reception facilities in ports and marinas. Why did the process take 17 years to complete and what challenges now face Caribbean countries in implementing MARPOL Annex V when the Special Area designation becomes effective in May 2011?

METHODOLOGY

This paper discusses some of the initial social, economic and cultural barriers for receiving ship-generated solid wastes. It evaluates the state of existing reception-facilities and enforcement mechanisms. It further considers the unique challenges facing the smallest tourism-dependent islands where garbage generated from a one-week cruise could overwhelm national waste management capacity and where increases in shipping bring increased risks to human health and agriculture from invasive species.

OUTCOMES

A study conducted by UNEP assessed that litter from ocean-based sources of pollution (such as fishing nets, gear and supplies, ropes, etc.) accounted for at least 11 per cent of all marine litter in the Caribbean region (UNEP CAR/RCU 2008). This does not even include garbage that could have been disposed of from ships but was considered to originate from land-based sources, such as glass, metal, and paper.

Most developed nations ratified the MARPOL Convention soon after it entered into force, but there was initial slow ratification by developing countries in the Wider Caribbean region (See Table 1 for current ratification status). This was attributed to the convention's requirements that countries provide adequate port reception facilities for receiving ship-generated waste and implement national legislation to enable enforcement of the convention. There were also concerns of the risks posed to human health and agriculture from invasive species and diseases, cultural barriers to accepting wastes which were viewed as "imported wastes" as well as weaknesses in domestic waste management services including inadequate solid waste disposal sites.

When some of the projects in support of MARPOL Annex V aimed to improve port reception facilities for ship-generated waste, it became evident during their implementation that the quantities of solid waste, especially from cruise ships, was not as significant as anticipated during project design. This was due to improvements in on-board waste management technologies and solid waste disposal practices.

The focus in many Caribbean countries became less on establishing port reception facilities including port incinerators but rather on implementing systems and procedures for the improved collection and transportation of ship-generated waste from ships to local sanitary landfills using licensed private operators and haulers. The management of ship-generated waste in many smaller islands thus moved from the port into the land-based system. This made it imperative that as these mechanisms were being established, parallel improvements in the domestic infrastructure for collection and disposal of all solid waste took place so that ship-generated waste were effectively managed as part of the domestic solid waste stream.

Many Caribbean governments still report that the management of ship-generated waste management is of much lower priority than solid waste management. In a few of the smaller islands, the quantity of solid waste generated from one large cruise ship could exceed local capacity for effective management. In these islands, receiving ship-generated wastes is not a viable option. This re-enforces the need for regional collaboration in the receipt of wastes especially from cruise ships as they sail from island to island on a typical 5-10 voyage. There are also growing concerns of the lack of effective management of solid and other wastes received from yachts and smaller recreational vessels visiting marinas and anchorages. While the quantities are not large, these wastes pose a significant potential threat to human health and agriculture in the absence of adequate control and monitoring mechanisms. There is a further need to strengthen the tracking system to monitor internal transport of all ship-generated waste from docks and ports to local landfills to ensure that such wastes are not scavenged en route. While this monitoring process has improved in some Caribbean countries through the support of regional projects, it remains a major challenge for the future implementation of MARPOL Annex V.

Although there have been significant improvements in domestic solid waste management policy, legislation and regulations, development of regulations for the management of ship-generated waste have lagged behind. Effective enforcement especially in smaller islands with limited human resource capacity remains a challenge.

One important lesson learnt from the implementation of regional projects in support of Global Environmental Agreements such as the MARPOL Convention was that establishing effective sub-regional and regional coordination mechanisms depend heavily on first having national-level coordination in place. Without this in-country support, regional based objectives often suffer. Other key lessons learned were:

Integrating Ship and Shore-Generated Waste Management
For many Caribbean countries especially the smaller SIDS, the effective management of litter generated from marine sources including ship-generated wastes depends heavily on having a well established and functioning domestic waste management programme. Understanding of the issues and the negative impacts of poor solid waste management on other aspects of economic and social development should provide the framework from dealing with marine litter.

Targeted and Sustained Promotional and Awareness Campaigns
Clean-up campaigns increase awareness of the issues of littering and waste disposal. They also facilitate the growth of stewardship for the communities and selected "public spaces". However, successful and sustainable campaigns must include information on compliance and law enforcement built into the messages. Waste reduction "demonstrations" must be part of any clean-up campaign activities.

Financial Sustainability
New mechanisms for the collection of revenue have to be explored given the difficulties experienced with collections through the Government Coffers. Government commitment is critical to the sustenance of the Solid Waste and Marine Litter Management Activities.

PRIORITY ACTIONS
While much of the shipping industry appears willing to accept their corporate responsibility for marine resource management, there remains a need to build closer linkages between marine and

land-based interests. Caribbean countries must ensure that are ready to take full advantage of the Special Area Designation when it comes into force on 1 May 2011. This is especially relevant considering that maritime traffic is expected to continue to dramatically increase in the Caribbean region with the expansion of the Panama Canal.
They need strengthened mechanisms for collaboration between all sectors, continued improvements in local solid waste management systems with a greater focus on reduction and recycling technologies, more effective enforcement of laws and regulations at national and regional levels, and a wider level of public awareness to ensure that marine-based wastes are addressed through an integrated pollution prevention approach.

FIGURES

STATUS OF CONVENTIONS
as of 31 January 2011

x = accession, ratification, etc s = signature	MARPOL 73/78 (Annex III)	MARPOL 73/78 (Annex II)	MARPOL 73/78 (Annex IV)	MARPOL 73/78 (Annex V)	MARPOL Protocol 97 (Annex VI)	CARTAGENA CONVENTION	Oil Spill Protocol	SPAW Protocol	LBS Protocol
Antigua & Barbuda	x	x	x	x	x	x	x	s	x
Bahamas	x	x		x	x	x	x		x
Barbados	x	x	x	x	x	x	x	x	
Belize	x	x	x	x	x	x	x	x	x
Colombia	x	x	x	x		x	x	x	s
Costa Rica						x	x		s
Cuba	x			x		x	x	x	
Dominica	x	x		x		x	x		
Dominican Republic	x	x	x	x		x	x	x	s
El Salvador	x	x	x	x		x			
France	x	x	x	x	x	x	x	x	x
Grenada						x	x		
Guatemala	x	x	x	x		x	x	s	
Guyana	x	x	x	x		x	x	x	x
Haiti									
Honduras	x			x		s	s		
Jamaica	x	x	x	x	x	x	x	s	
Mexico	x			x		x	x	s	
Netherlands	x	x	x	x	x	x	x	x	s
Nicaragua	x	x	x	x		s	s		
Panama	x	x	x	x	x	x	x	x	x
Saint Kitts and Nevis	x	x	x	x	x	x	x		
Saint Lucia	x	x	x	x		x	x	x	x
St. Vincent & Grenadines	x	x	x	x	x	x	x	x	
Suriname	x	x	x	x					
Trinidad & Tobago	x	x	x	x		x	x	x	x
United Kingdom	x	x	x	x	x	x	x	s	
United States	x	x		x	x	x	x	x	x
Venezuela	x	x	x	x		x	x	x	

Table 1: Status of Ratification of the MARPOL and Cartagena Conventions and its Protocols in the Wider Caribbean Region

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2.a.2. MARPOL Annex V – achieving consensus to change international law

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KEYWORDS
MARPOL Annex V, International law, International Maritime Organization, control of garbage/waste in marine environment, regulatory mechanism.

BACKGROUND

Annex V of the International Convention on the Prevention of Pollution from Ships is the primary legal instrument controlling the practices of garbage discharge from ships. With 140 contracting parties, the Convention applies to 97.5% of the world's registered shipping tonnage and the majority of its provisions also apply to smaller boats of all sizes. Annex V entered into force in 1988 and has not been significantly revised since that time. The provisions of the present Annex are very lenient and allow the discharge of nearly all garbage types (with the exception of plastics) from ships, legalising a potentially large source of marine debris. This is a dramatic contrast to modern domestic regulation for garbage discharge from land or in near-shore waters in most countries.

The challenge of the review and revision process was how to address a number of important environmental issues associated with garbage management on board of vessels, how to bring the old Annex V in line with modern waste management practices and regulations, and how to secure consensus between all involved parties.

METHODOLOGY

This paper describes the 5 year process by which the International Maritime Organization (IMO), through the work of its members and many associated organizations, has moved Annex V into the 21st Century. The international review group included representative from 22 countries (some with strong coastal protection priorities and others with a strong ship registration focus) and 16 other UN and private organizations representing interests from environmental protection, cargo terminals and shipping.

OUTCOMES

We will describe the mechanism for the review and update of the Annex, but also discuss the many challenges faced in trying to reconcile the diverse interests, philosophies and technical and operational needs represented by the international review group. The resulting amendments, approved in October 2010 by the IMO's Marine Environment Protection Committee, represent a massive philosophical shift and greatly enhanced protection of the marine environment from garbage sourced from ships.

The Annex is now based on general prohibition of discharge of any garbage into the ocean. The challenge of the international review group was to specifically identify all types of garbage generated on board ships and consider the environmental, operational, health and crew and vessel safety and economic issues associated with either prohibiting or permitting discharge of this waste as sea. This was made more challenging by the lack of published data on ship-sourced marine debris or scientific evidence of environmental harm resulting from some more inert garbage products. Based on these considerations, the group was required to identify any special circumstances in which the garbage could be discharged. The challenge of adequate land based reception facilities around the world, including in developing and small island nations, was also discussed and addressed when developing the final text of the revised Annex. The various requests and interests by all members of the international group – representatives from state administrations of the Annex and from shipping companies was discussed and reconciled to provide and workable and agreed upon text for the revised Annex.

PRIORITY ACTIONS

The process for updating Annex V has shown that shifts in the way various organizations think about their operations take time to implement on the international scene. It was very important that the co-ordinators of the international national review group were committed to bringing the Annex in line with other modern regulations addressing waste management while recognizing the reality of large- and small-scale shipping operations around the world. Negotiations and understanding of the various views of all of the participating parties was critical to the positive outcome of the review and updating process of the Annex.

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2.a.3. Open oceans and marine debris: reforms to the ineffective enforcement of MARPOL Annex V

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KEYWORDS
MARPOL, Annex V, Paris MOU, port reception facility, flags of convenience

BACKGROUND
The existing regulatory structure for marine debris does not comprehensively address the root causes of garbage discharge. With holes prevalent throughout the IMO legal framework, ships continue to discharge solid waste with impunity. The International Convention for the Prevention of Pollution of Ships (MARPOL) Annex V addresses the discharge of garbage from ships yet is ineffectively enforced by port and flag states. Although MARPOL recognizes the need to provide incentives for ships to discharge trash at port reception facilities, this crucial goal is not accomplished on a comprehensive international level. This presentation addresses the regulatory difficulties associated with MARPOL Annex V enforcement and seeks to provide a roadmap for several of its persistent deficiencies.

OUTCOMES
Port State Operators Lack a Comprehensive Information Source Detailing Past Violations of Noncompliant Flag States and Ships

Port operators do not have access to a reliable and comprehensive source for information on noncompliant ships and flag states. Regulating marine debris at a portside level involves checking that a garbage log is maintained and that ships carrying over 15 passengers follow a garbage management plan. Although inspection of these two documents rarely leads to direct evidence of dumping, the process demands procedural compliance, which requires ship operators to at minimum consider alternatives to discharging garbage into the ocean.

The goal of a centralized information clearinghouse is to name and shame flag states and ship operators into compliance with international treaty obligations. The Global Integrated Shipping System (GISS) is a database maintained by IMO. Member State officials can update the database with information about the adequacy of reception facilities at ports around the world. This presentation discusses the need for IMO to use its abilities to disseminate information to add to the GISS the past port state inspection records for all Member States and regional agreements. As a result of granting port reception facilities and ship operators access to the data, a real-time model of inspection records could be utilized, allowing port state inspectors to alter their inspection based on the entries of other ports

Lack of Standardized Port Reception Facilities

The dearth of standardized port reception facilities is a major contributor to the poor disposal behavior of the commercial shipping fleet. When the availability, functionality, and cost of garbage reception facilities are uncertain, ship operators are significantly more likely to discharge at sea. MARPOL requires ports to ensure adequate port reception facilities. Because no port state operator wants to be viewed as having expensive reception facilities, a race to the bottom currently exists. For example, a common perception among ship operators, that the United States' port reception facilities are too expensive, incentivize ship operators to either discharge their garbage at other ports or dump the waste into the ocean. To ameliorate the lack of standardized port facilities, IMO should more actively censure those facilities that are inadequate under MARPOL standards. By publicly denouncing states lacking adequate port reception facilities, neighboring ports will likely recognize the unfair burden of disposal and environmental degradation placed on them and pressure other states to meet their international obligations.

Lack of Enforcement by Flag States

MARPOL enforcement relies almost exclusively upon flag states to sanction and remedy the violations they receive from port states that document infringements. When a coastal state detects an alleged violation, it is required to either take action under its own laws or forward the case to the flag state for consideration. When an offense occurs in international waters, the responsibility for imposing the penalty lies with the flag state. Flags of convenience undermine the enforcement regime through their inability or unwillingness to pursue violators. In the case of garbage discharge, detecting violations while in international waters is not feasible. True enforcement lies in the regular maintenance of a garbage record book and in the construction of a viable garbage management plan, both of which are overseen by flag states.

PRIORITY ACTIONS

- Key suggestions to increase MARPOL compliance among shipping industry vessels:
- Compile information from regional MOUs about flag states and ship compliance records to increase the effectiveness of the GISS system
- IMO should encourage port state enforcement by further defining "undue delay" in MARPOL Article 7
- To standardize port discharge facility requirements, IMO should add binding, substantive requirements to the use of "adequate port reception facilities" in MARPOL Annex V
- Regional MOUs should standardize and enforce fines against ships that do not maintain a garbage log, garbage management plan or post placards when required
- To ensure member compliance to provide adequate garbage reception facilities, regional MOUs should place political and economic pressure on member states not in compliance
- Regional MOUs should standardize charges for garbage disposal to reduce uncertain costs and incentivize lawful garbage discharge

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2.b.1. Marine debris education in a non-formal educational setting

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KEYWORDS
Non-formal education, behavior change, outdoor education, empowerment, locus of control

BACKGROUND
Outdoor education is an important component of developing connections to our natural world, which we expect will translate to action in the form of environmental citizenship behaviors. However, specific actions need to be discussed and practiced if they are to translate to students lives after their visit to non-formal environmental education centers. The marine debris problem provides opportunities to influence students environmental behaviors if we intentionally craft non-formal education experiences to affect behavior change.

METHODOLOGY
The NorthBay program is a middle school focused 5 day residential non-formal environmental education program that combines character and environmental education. The Investigating and Evaluating Environmental Issues and Actions theory and curriculum is foundational to the NorthBay program and personal responsibility is a central theme. The week long program is focused on three guiding questions: how do your actions affect your future, how do your actions affect your community and how do your actions affect the environment. Specific environmental issues are investigated through the week in order to affect variables such as locus of control and success in action which are considered necessary precursors to behavior change and action.

OUTCOMES
The structure of the NorthBay marine debris program is embedded in the context of the NorthBay curriculum. Marine debris is investigated as an environmental issue. Ocean Conservancy International Coastal Cleanup data cards are used to record data. Students evaluate the data to determine the source of debris, and develop action plans to stop marine debris at its source. The week concludes with a multi-media assembly focused on marine debris and character choices. Students are encouraged to take action when they return to their schools and social media outlets are used to maintain contact with students. Ongoing action is encouraged and a mechanism is in place for students to report the marine debris related actions they take. Emphasis is placed on recognizing the effects of our actions and establishing personal responsibility for environmental and social problems.

A pre and post evaluation is conducted to measure shifts in students attitudes concerning environmental action, character choice, and academic intention to act. Littering behavior is specifically surveyed. In general, students are more likely to take environmental action, apply themselves in school and recognize that their choices affect their communities after their

NorthBay experience. The evaluation specifically reveals that students are much less likely to litter after their NorthBay visit than before.

Social media outlets are effective means to maintain contact with a large number of students after their non-formal visit. However, we are finding that students under report positive actions they take, unless directly asked. Anecdotally, students continue to take action upon their return to schools.

PRIORITY ACTIONS

To be effective, non-formal education programs need to be intentional in the outcomes they wish to achieve, and the mechanisms used to achieve those outcomes need to be relevant to the students they serve. Evaluation should be a part of any program to determine whether the program is achieving its goals. Social media can and should be used to maintain contact with non-formal education program participants to encourage continuing positive action and hold promise for encouraging environmental behavior change.

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2.b.2. Algalita Marine Research Foundation's Ship-2-Shore Education Program: connecting classrooms with plastic marine debris research

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KEYWORDS
Online education, plastic pollution, outreach, marine debris

BACKGROUND
Plastic marine debris is a global issue which has only recently gained significant attention from the research community and public. Due to the scope of the origin and impact of plastic marine debris, research and education must be coupled to investigate and communicate this issue, as well as to innovate diverse solutions to this problem. In 2007 the Algalita Marine Research Foundation launched the Ship-2-Shore Education Program to connect students from around the world with research teams conducting plastic marine debris research at sea.

METHODOLOGY
The Ship-2-Shore Education Program is an interactive, internet-based education program that allows researchers to share their daily observations and experiences with students in participating classrooms. The researchers strive to make students feel a part of the research team by answering student questions and encouraging students to share their insights and suggestions about research protocols and goals. Interactions with the at-sea research team are complemented by standards-based lessons utilizing interactive maps of past research voyages provided through Algalita Marine Research Foundation's "Mapping Plastic Marine Pollution Educator's Guide". Using these lessons, the information gained through interactions with the ship's research team, and guidance from a research mentor, students are encouraged to become part of the solution by designing and implementing locally-based projects to address the global problem of plastic marine debris.

OUTCOMES
Since its inception in 2007, the Ship-2-Shore Education Program has run in conjunction with extended marine debris research voyages in the North Pacific, North Atlantic, and Indian Oceans, and has reached thousands of students from around the world. During the initial program in 2007 over 1,000 students from 23 schools in 9 countries participated in a research voyage through the North Pacific Subtropical Gyre. Our most recent program, which ran in conjunction

with a plastic research voyage across the South Atlantic Ocean, was one of our most successful programs yet. We had over 3,000 registered participants from 68 schools and other organizations, from 18 states in the USA as well as from Australia, Canada, Chile, Columbia, Costa Rica, Guam, India, Mexico, Netherlands, Puerto Rico, Uruguay, and Venezuela.

We are encouraged by the international scope of the interest we have received in this program, as well as by the enthusiasm and commitment of the student participants. Not only have participants shown their growth in understanding the issue of plastic pollution through their excellent questions and comments throughout the Ship-2-Shore Program, they have also shown their commitment to take action on this issue. Student participants have worked on projects including efforts to: educate others through art and video, reduce the use of disposable plastics at school and home, clean local watersheds and beaches, and get involved in local policy decisions relating to plastic pollution.

PRIORITY ACTIONS

Research efforts in the field of marine debris must be coupled with education to disseminate up to date information in this field, resulting in an informed public, industry and government that is able to actively address this international issue in an informed and effective manner.

2.b.3. Ocean garbage beware: we have the technology and are inspiring people to clean you up

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KEYWORDS
Rozalia Project, ROV, remotely operated vehicle, sonar, VideoRay, Blueview, Lyyn, Tritech, marine debris programs,

BACKGROUND
Everyone knows that trash should not end up in the ocean, the challenge is in inspiring people to be a proactive part of the solution of marine debris day after day. Whether that is in prevention (changing of habits) or in action (taking part in clean ups), it is consistent behavior, and small steps by everyone that will truly make a difference.

Rozalia Project for a Clean Ocean is using high tech equipment to educate and involve people in the problem of marine debris through engaging dockside and shipboard programs. Our programs focus on action and connecting people with their underwater world through the use of ROV and sonar technology. Our trash-hunting technology includes: VideoRay micro-ROV, Tritech side scan sonar, Blueview imaging sonar and Lyyn image enhancement system. We integrate this equipment in order to achieve our goals of action (trash pick up from the surface to the sea floor) with research (video data collection) and outreach (we are there, on site with the participants who take an active role in retrieving trash from the water).

METHODOLOGY
Rozalia Project delivered dockside marine debris programs to 475 people (all ages) in Boston, MA on the Charles River; Providence, RI on the Providence River; and in Burlington, VT on Lake Champlain in 2010. The programs incorporated an interactive introduction to the problem of marine debris game-show style followed by an introduction to the underwater technology we use to locate and remove trash from the sea (turning the ROV's video camera on the class during the system check was always a hit).

Once the group learned about the volume and effects of marine debris, the group goal was to find and remove trash from their local venue. We deployed the ROV and participants took various roles from tether handler to watching the sonar screen, to watching the video screen. Everyone was considered a trash hunter and the search became very engaging. All of our locations were thick with trash (reflecting the Ocean Conservancy data in terms of types of marine trash) and finding debris targets to grab with the ROV's manipulator was both easy and exciting.

The ROV's manipulator was the primary tool we used to recover the trash, however, we also used a combination of the ROV and pool skimmer to pick up hard to grab objects in shallow water. All trash we recovered was either recycled or properly land-filled.

OUTCOMES
In terms of inspiration, we made a few discoveries. First, though most of our participants had been to a local aquarium, few had seen what is on the bottom of their body of water in real time. Second, though many had heard of ROV's very, very few had seen one 'in real-life' much less had the opportunity to handle it.

We found that seeing underwater in real-time and on site was very powerful to people. Seeing the sheer volume of trash on the bottom of the Charles River was an eye-opener and many participants said they would be more careful from now on making sure their trash was in (not on) river-side trash cans. In Providence, the children got to see the large number of crabs running around the bottom and sitting on the rocks which connected them to the creatures that may suffer because of carelessly placed trash.

In terms of the technology, we found it appealed to all ages. Children were mesmerized by the robot and 'live Playstation' factor and feedback from adults was that it was, "just cool". A comment we heard several times was that being able to be part of the process of using the ROV and sonar to find and remove trash was like, "living a Discovery Channel episode".

Feedback we received from all the programs we visited was that while we were there, the children were far more engaged than in a typical session and that instructors overheard participants, even weeks after our visit, telling each other to make sure they recycle, not to let trash get in the water and we even had reports of children using pool skimmers to remove floating trash on their own initiative, something that had not happened prior to our visit.

PRIORITY ACTIONS
- Involve as many people as possible in marine debris clean-ups.
- Incorporate engaging and hands-on education for all ages into clean up activities.
- Recognize all efforts, the solution to marine debris starts with individual people making a change.

2.b.4. Curbing plastic bag pollution: grassroots and viral efforts to bag the bag

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KEYWORDS
Plastic pollution, Plastic bags, California, A Day Without A Bag, The Majestic Plastic Bag, Trash Your Friends, Heal the Bay, Clean Seas Coalition

BACKGROUND
The vast majority of trash found in aquatic environments is comprised of plastic, which threatens wildlife, litters our communities, and is costly to clean-up. Plastic pollution in the ocean also attracts other oil-based pollutants, which may threaten wildlife when ingested. Single-use plastic products, such as plastic bags, polystyrene food take-out containers, plastic bottles and bottle caps are frequently found in community-based clean-up activities. The visible nature of trash helps make water pollution issues more easily understandable to the public.

With society faced by information overload in today's technology era, successful education and outreach campaigns tend to be distinct and targeted. This holds true for online social marketing efforts, as well as more traditional grassroots approaches. A major challenge associated with educational efforts surrounding plastic pollution is motivating individuals to take action and affect behavior change. Targeted education and outreach efforts need to go beyond simply raising awareness to help prevent and reduce plastic pollution. Personalizing the issue of plastic pollution and making the solutions easily understandable and accessible, while connecting educational efforts to distinct behavior changes and policy initiatives, can help link outreach to action. Education can be an effective tool to reduce and prevent plastic pollution prevention and reduction when connected to targeted individual, community and policy actions.

METHODOLOGY
Heal the Bay has implemented targeted grassroots and viral campaigns to raise awareness about plastic pollution, promote personal behavior change, and encourage individuals to get involved local and state policy efforts to prevent plastic bag pollution in California. Our grassroots efforts include A Day Without A Bag, which strives to educate December holiday shoppers by providing reusable shopping bags to use instead of the single-use alternatives for their holiday shopping. Online efforts include an April Fool's Day spoof to "trash" your friends and raise their awareness about plastic pollution, and a short "mocumentary," *The Majestic Plastic Bag,* on the life adventures a plastic bag. These viral and grassroots tools have been directly tied to behavior change and policy action to reduce plastic bag pollution.

OUTCOMES
Over the past five years, public understanding and concern about plastic pollution has grown greatly. Grassroots and online efforts have helped increase this awareness. Heal the Bay focuses

its outreach efforts on directly connecting people with ways to get involved and support policies to reduce and prevent plastic pollution. As a result, we have seen a growth in citizen involvement in our policy efforts. There has also been a recent increase in local and state government pursuit of plastic bag reduction ordinances in California.

Partnerships with government, creative agencies, and environmental organizations have greatly influenced the success of our plastic bag prevention campaigns. For example, in partnership with the County of Los Angeles, Heal the Bay launched its A Day Without A Bag event in 2007 with 17 reusable bag giveaway locations in Los Angeles County. By 2010, this event grew to 171 giveaway locations in southern California in 2010 with municipal and environmental partners throughout the region through the Clean Seas Coalition. Heal the Bay also partnered with the County of Los Angeles in 2010 to host a summit as part of A Day Without A Bag for to provide local governments tips and tools for pursuing plastic bag ban ordinances in their community. Representatives from over 50 different municipalities in California attended the event, and several are now developing plastic bag ban ordinances.

Viral efforts to educate the public about the proliferation of plastic bags have also helped raise awareness about the problem and related solutions. In 2010, in partnership with Heal the Bay creative agency, DDB Los Angeles developed an April Fool's Day spoof to "trash" your friends and well as a short "mocumentary," *The Majestic Plastic Bag,* to raise awareness about plastic bag pollution, as well as to drive individuals to support a bill being considered by the California legislature that would ban plastic bags. These efforts were successful in both raising awareness and inspiring action. *The Majestic Plastic* Bag has received over 1.3 million views on YouTube, and 13.3% of people that were "trashed" by their friends through the website prank also sent letters to the Governor supporting the legislation. This response rate is much higher than the typical 0.5%-6.5% response generated through most direct mail or online campaigns.

As awareness about plastic pollution problems grows, state and local governments are beginning to take action through establishing reduction and prevention policies. There has also been a recent groundswell of support from the general public for such policies. With opposition from groups like the American Chemistry Council and plastics industries to these regulatory and legislative efforts, it is critical that supportive individuals are educated on ways to support and engage in plastic pollution prevention and reduction efforts.

PRIORITY ACTIONS

Local and state government should adopt policies that ban or place a charge on single-use bags, and other single-use items commonly found as pollution. A portion of these funds should be directed towards local governments and community groups to assist with directed plastic pollution education efforts and providing reusable alternatives (e.g. reusable bags, water bottles, coffee mugs, etc) to the public.

Efforts to educate and raise awareness about plastic pollution should be directly tied to behavior change and ways to engage in or support policy action targeted at prevention and reduction. Local and state governments that pursue policies to ban or place a charge on single-use items should develop partnerships with environmental and community groups and business to help with successful adoption and implementation of plastic pollution prevention and reduction policies.

REFERENCES

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2.c.1. Derelict vessels as marine debris – environmental and administrative considerations

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KEYWORDS
abandoned, derelict, vessel, marine debris, salvage, wreck removal

BACKGROUND
Abandoned and derelict vessels (ADVs) comprise an obvious category of marine debris but are frequently excluded from the broader discussion of marine debris because of the unique and often costly legal and technical problems associated with their removal. While seaworthy vessels provide many services such as recreation and commerce, ADVs have numerous deleterious impacts—threat of oil or other pollutant spills, impediments to navigation, physical destruction of habitat, use as clandestine dump sites, nutrient enrichment, tourism reduction, and human health and safety hazards, to name a few. Storm events can move or break up vessels, spreading the damage over a greater area and often increasing the cost of addressing them.

A patchwork of U.S. Federal and state laws further complicates the issue. Part of the challenge in appropriately responding to ADVs is the sheer number of variables (e.g., ownership, jurisdiction, liability, appropriate legislation or regulations) possible per individual case. Some scenarios, such as if a vessel is leaking oil or if a vessel is located in a federally maintained navigation channel, are relatively clear in terms of responsibility and action required. However, there are significantly more scenarios with an unknown path to resolution. Of particular inerest at this conference are the international implications of ADVs, including releases of oil, jurisdictional issues on the high seas, and dedicated sources of funding.

METHODOLOGY
Despite increasing numbers, media coverage, and public interest in the topic, abandoned vessels continue to be a significant pollution concern. However, recent actions have been undertaken to identify select vessels, improve understanding of their impacts on natural resources, and strengthen awareness of relevant legal authorities.

From 2001-2005 NOAA created a comprehensive database of abandoned vessels that could potentially threaten coral ecosystems in U.S. waters. This Abandoned Vessel Program (AVP) database was combined with additional databases populated and maintained by NOAA, including the AWOIS and RUST databases. In 2009 the NOAA Marine Debris Division coordinated an ADV workshop to facilitate communication with other Federal agencies as well as state and territorial representatives (Parry and McElwee, 2010).

OUTCOMES

This paper highlights efforts by the U.S. National Oceanic and Atmospheric Administration (NOAA) to address abandoned and derelict vessels, including a summary of impacts, best practices, and state laws related to vessel removal. Effectively managing a national database of ADVs continues to prove challenging, and often of limited utility given the need for broad strategic efforts to address the issue. While certain efforts have been successfully conducted, a more coordinated and sustained effort is required to address ADVs.

In addition to the state-level guidance developed at the 2009 ADV workshop, the National Association of State Boating Law Administrators developed a document outlining Best Management Practices to address ADVs (NASBLA, 2009). Additionally, the Sea Grant Law Center produced updated guidance on select state laws governing ADVs (SGLC, 2009).

PRIORITY ACTIONS

Federal agency representatives acknowledge gaps in existing legislative mandates and authorities to respond to ADVs, and pragmatic approaches to ensuring the consistent application and interpretation of relevant federal ADV legislation could include, but not be limited to: the drafting and adoption of new Federal legislation; development of a unique Federal fund for addressing ADVs; and/or broadening international efforts through a relevant body such as the International Maritime Organization (IMO).

State and local bodies similarly have a significant responsibility in addressing ADV challenges, and may contribute through improved database coordination and information sharing, identifying appropriate and transferable financing mechanisms, as well as strengthened education and outreach programs to constituents.

REFERENCES

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2.c.2. Marine debris and abandoned vessels: identification, reduction and prevention through community-based education and action

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KEYWORDS

abandoned vessels, marine debris, community, volunteers, education, prevention, training, partnerships

BACKGROUND

South Carolina boasts 2,876 miles of coastal shoreline edging estuaries, tidal creeks, rivers and wetlands. South Carolina's coastal area is aptly called the *LowCountry,* based on its flat, low-lying mainland, bordered seaward by barrier islands and Sea Islands. The waterways provide ample opportunity for recreational boating and fishing as well as commercial shipping and fishing. Charleston, SC is a major port in the southeast. Public safety for navigation and environmental protection of public trust waters depend on multi-state and federal agency regulations/actions and citizen awareness/actions in regard to problems with large marine debris items, such as abandoned or derelict vessels, damaged dock or seawall structures, and commercial gear. However, the extent of marine debris issues and the specific educational needs of coastal communities are unknown. In order to identify the current state of marine debris issues and the future needs for monitoring and removal programs, the project aimed to develop a community based action network to promote prevention, identification and reduction of marine debris.

METHODOLOGY

Through a NOAA funded, stakeholder driven effort, a multiagency team has designed a three-tiered project: 1) to identify marine debris issues as perceived by coastal focus groups and develop appropriate educational campaigns and community partnerships for the prevention and reduction of marine debris; 2) to empower and train local citizens to report marine debris in their local waterways through implementation of a volunteer marine debris spotting network and web-based reporting system; and, 3) to support a community-wide debris removal event focusing on large items, unwanted boats, fishing gear and other debris that may end up in the marine environment.

OUTCOMES
Project partners conducted three focus groups with targeted stakeholders in key coastal communities to assess community perceptions about marine debris issues, causative factors and potential solutions, education and monitoring needs. In order to further engage coastal communities in the stewardship process, Results of the focus groups revealed specific issues and needs that varied by region of the coast and are being used to guide the development of future marine debris outreach materials and initiatives.

Following the focus groups, project partners worked to develop a training program, training manual, gridded maps and a web-based reporting form to assist with the implementation of a community based volunteer network to monitor waterways and report abandoned vessels and other large marine debris items. Six training workshops were held in key coastal communities training over 75 volunteers on the need for monitoring, marine debris issues in coastal South Carolina and how to monitor and report marine debris using a standardized reporting form. The form can be submitted via paper or on the newly created internet based form and records the latitude/longitude of the item and if the item is posing a navigational hazard or impact to marine habitats (such as salt marsh or oyster beds). The reports are being compiled into a GIS-based database to assess the extent of larger marine debris items, determine which items need priority for removal and to pursue funding for removal efforts.

Finally, the project is partnering with local government agencies, private marinas and waste removal companies to host a Clean Marine weekend April 8-10, 2011. The focus of the removal event is two-fold. First, the project will partner with six commercial marinas, one commercial seafood dock and five public boat landings to host drop-off sites for citizens to remove and dispose of solid waste that they own related to marine activities (fishing, boating, etc.). Second, the event will serve an educational purpose and will involve media relations on the project results to date as well as community outreach on how citizens can become coastal stewards by working on the prevention and reduction of marine debris in our coastal environment.

PRIORITY ACTIONS

- Priority actions for identifying, preventing and reducing marine debris in coastal South Carolina include:
- Create effective partnerships between agencies and organizations with marine debris interests that foster citizen involvement and community action at the grassroots level.
- Implement community-based volunteer monitoring networks to address specific marine debris issues.
- Establish clear lines of communication and collaboration between local citizens and agencies responsible for educating about and removing marine debris.

FIGURES AND TABLES

Table 1: Links to Marine Debris Volunteer Monitoring program & Internet Reporting Form

Volunteer Training Manual	http://www.scdhec.gov/environment/ocrm/docs/debris/MD_Monitor_Manual.pdf

Internet Reporting Form	http://www.scdhec.gov/environment/ocrm/D-0984.asp
Reporting Form	http://www.scdhec.gov/administration/library/D-0984.doc
Maps: Charleston	http://www.scdhec.gov/environment/ocrm/docs/debris/MD_Charleston_Maps.pdf
Maps: Beaufort	http://www.scdhec.gov/environment/ocrm/docs/debris/MD_Beaufort_Maps.pdf
Maps: ACE Basin	http://www.scdhec.gov/environment/ocrm/docs/debris/MD_ACE_Basin_Maps.pdf
Removal Flow Chart	http://www.scdhec.gov/environment/ocrm/docs/debris/vessel_flowchart.pdf
Summary of Focus Groups	http://www.scdhec.gov/environment/ocrm/docs/debris/MD_Focus_Groups_Summary.pdf

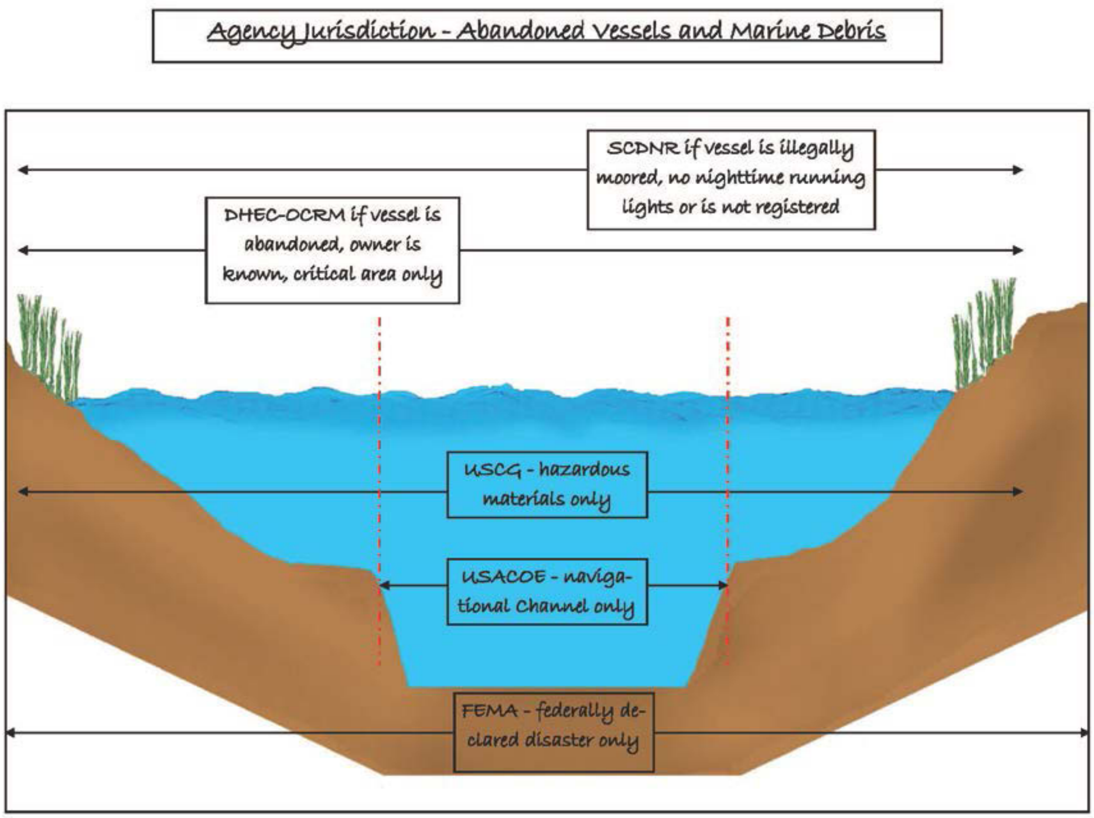

Figure 1: Educational handout from the project providing an overview of agency jurisdiction for handling abandoned vessels and marine debris.

2.c.3. Removal of the F/V Ocean Clipper on St. Paul Island

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ABSTRACT
In March, 1987 the 80 ft steel F/V Ocean Clipper grounded in an unoccupied northern fur seal breeding area on the Reef Peninsula on St. Paul Island in the Bering Sea. St. Paul is the largest of the remote Pribilof Islands and supports the world's largest northern fur seal population which is listed as depleted under the Marine Mammal Protection Act. Soon after the grounding, the owner abandoned responsibility for the vessel. The U.S. Coast Guard acted to remove fuel, oil and other pollutants from the abandoned vessel. After the immediate threat of hydrocarbon pollution was removed, a variety of roadblocks to the complete vessel removal inhibited further action. These roadblocks included: no viable responsible party either insurer or owner, severe weather, remote location, and heightened safety considerations. Faced with these obstacles no immediate attempt was made to remove the vessel or any of the supplies and commodities left on board. The vessel eventually became a hazard to the local fur seal population and federal land and wildlife managers, local residents and the village corporation leaders. Faced with this seemingly forgotten vessel aground in the rookery at a common fur seal viewing site the community tried different avenues for requesting removal of the vessel with no success. Unfortunately the vessel also became harder to remove due to degradation of the hull and a lack of "emergency" need for removal. Further complicating the effort was a seasonal restriction due to the presence of breeding, resting and nursing fur seals around the vessel combined with restrictive weather windows. The vessel would need to be removed following the breakup of ice on/near the beach, but before the arrival of the fur seals – a window likely less than 6 weeks. As the price tag for the removal grew, prospects looked dim until the NOAA Restoration Center ARRA funding opportunity. The Marine Conservation Alliance Foundation submitted a proposal for marine debris cleanups which included a project for the removal of the vessel. With adequate funding there were still many challenges to successful removal when it finally occurred in 2010. This talk will discuss challenges related to the costs, permitting, remote logistics, benefits of timely removal, vessel disposal options, public responses and media attention faced by the Ocean Clipper removal team.

2.c.4. Delivering disaster recovery through increased responsiveness, efficiency and effectiveness by a state agency

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KEYWORDS
Nancy Beward, Disaster recovery, Sidescan sonar, Historical sites, State of Texas, Program management, FEMA reimbursement, HNTB, Vessel removal

BACKGROUND
Hurricane Ike's landfall in September 2008 as a strong category 2 hurricane with a category 4 storm surge in the Galveston area had a devastating effect in a highly urbanized and tourist area of the state. Marine debris consisted of household material, vessels and petroleum processing infrastructure that was located in the four major bays and areas offshore in the Gulf of Mexico. Marine debris removal activities were contracted for over 350,000 acres of bays and 80 miles of coastline.

The presenter will discuss three major changes in processes and procedures on how the State of Texas responded to marine debris removal after the event. The three processes consisted of contracting for a Program Management Company who focused on results and timeliness while allowing agency personnel to continue with normal operations, use of new technology such as sidescan sonar which protected the historical artifacts located in the Gulf of Mexico and the use of a private company to develop due diligence procedures for the removal of private vessels. Included in the presentation will be the results of implementing these processes which allowed the State of Texas to receive reimbursement funding from FEMA for over 95% of the costs for hurricane recovery activities.

METHODOLOGY
Presenter will describe the use of new technologies such as sidescan sonar and GPS mapping. Through a coordinated use of these methods the State of Texas was able to identify and remove hazardous marine debris while protecting historical artifacts located in the Gulf of Mexico. GIS maps and pictures with descriptions will be shown along with challenges encountered.

Presenter will provide the structure and process of how the use of a private company to develop due diligence procedures for the removal of private vessels accelerated documentation and response processes to avoid lawsuits and protracted removal operations.

Presenter will describe the processes and procedures that were required in order for the State of Texas to receive reimbursement funding from FEMA for over 95% of the costs for hurricane related marine debris removal.

OUTCOMES

The planning, management and execution of the program ensured effective removal of marine debris hazards in a record amount of time. The State of Texas was required to expend funds for recovery and then gain reimbursement from FEMA through thorough documentation and adherence to NEPA and FEMA reimbursement standards. Lessons learned and/or results that will be highlighted during presentation.

Program Management Company –

- The effective use of a Program Management Company allowed the State of Texas employees to continue standard services with minimal interruption.
- Program Management Company costs were reimbursed through FEMA funding.

Effective application of Technology –

- Previous marine debris methods did not allow for the identification and review by resource agencies to prevent damage to sensitive environmental and historic sites.
- Use of high quality sidescan sonar coupled with GPS allowed that State of Texas to target debris collection.
- Use of these technologies allowed contractors to establish a unit price for debris removal based on estimated quantities.

Use of private company in handling abandon vessel disposal -

- Private company with pre-storm knowledge of vessel disposal facilitated the removal and disposal of abandon vessels.
- Removal of learning curve from a potentially sensitive legal subject.
- Provided the State of Texas with one point of accountability.

PRIORITY ACTIONS

- Experience gained in this successful program revealed a number of key lessons learned.
- Highly dynamic nature of the coastal environment immediately after a storm.
- Importance of coordination with FEMA during both the program planning stage and program execution stage.
- Regular effective communication with all program stake holders was a major contributing factor of its success.

3.a.1. MARE 410, marine debris in the Pacific: teaching undergraduates at the University of Hawaii-Hilo

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KEYWORDS
Marine debris, undergraduate education

BACKGROUND
Marine debris is a multi-disciplinary topic that integrates oceanography, chemistry, biology, ecology, and economics. How do you teach undergraduates about the scientific study of marine debris? How do you increase students' fluency with primary literature on marine debris? On completion of a marine debris course, successful students should be able to:

Discuss the dispersal and accumulation patterns for marine debris.
List and explain the environmental problems caused by marine debris.
Describe the sources, known effects on laboratory animals, wildlife, and human health; relevance to plastic marine debris; and potential impacts on marine ecosystems of Persistent Organic Pollutants (POPs), bisphenol A, and phthalates.
Compare and contrast the methods used by researchers to measure and quantify the amounts of plastic debris in the marine environment, and their results.
Identify the strengths and weaknesses of monitoring methodologies.
Apply biological and ecological concepts to marine debris.
Recognize the current knowledge gaps in marine debris studies, and prioritize areas of future research on marine debris issues.

METHODOLOGY
In 2007, 2009 and 2010, an experimental upper division elective course, "Marine Debris in the Pacific," was integrated into the UH Hilo Marine Science curriculum. MARE 410 is now a full-fledged part of the UH-Hilo Marine Science major. Enrollment is capped at 24. Student majors have included Marine Science, Biology, Environmental Science, Psychology, Anthropology, Natural Science and Tropical Conservation Biology. Developing this curriculum focus enables UH Hilo to train future scientists, policy makers, and advocates who can have a direct impact on a critical issue affecting our local and international communities.

OUTCOMES
The 2007 course included lectures by international experts, team marine debris research projects, field trips, discussions, quizzes and exams. There are no up-to-date textbooks with a focus on marine debris, so the students read 41 articles relevant to marine debris problems and solutions from scientific journals and other primary literature sources. Lectures and readings covered topics including distribution, abundance, dispersal, and accumulation patterns of marine debris;

the fate of plastics in the marine environment; impacts of marine debris on wildlife; persistent organic pollutants on marine debris; endocrine disrupting chemicals in plastics; survey and monitoring methods; and removal and mitigation efforts, including green plastics and removal of plastics from the waste stream. In 2009, the course was offered again with a revised reading list, more written assignments, more hands-on activities, local guest lecturers, and no exams! In Fall 2010, the course evolved to include FT-IR training, a class research project on micro-and meso-plastic impacts to beach sediment parameters, and student-led discussions of articles. The course continues to evolve, and will be offered in Fall 2011.

The major outcomes of this "experiment" in teaching are students aware of the issues and thinking about solutions. Some students have chosen to focus on an aspect of marine debris for their senior thesis research, Marine Option Program project, or master's thesis. Others have used marine debris as a theme for assignments in other courses. Some have designed curricula for elementary schools activities or Ocean Day presentations. Some graduates of the MARE 410 are attending this conference!

PRIORITY ACTIONS

More marine debris courses should be developed and taught at colleges and universities. More undergraduates should be involved in the science of marine debris.

3.a.2. Engaging urban communities to reduce litter and marine debris

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KEYWORDS
Urban, communities, waterways, diverse, partnership, litter, marine debris, engage, value, volunteers

BACKGROUND
Urban waters are especially important as they impact large populations and influence land-use decisions in an entire watershed. When urban rivers, lakes, streams or wetlands are inaccessible or degraded, the surrounding communities may not view them as valuable and worth restoring. Furthermore, urban areas are generally very densely populated, so the amount of trash and litter generated is often greater. These higher amounts of waste are more likely to be mismanaged and blown or washed into storm drains or directly into waterways; upon reaching the waterways trash and litter become marine debris.

In partnership with federal, state, tribal, and local partners, EPA is working to foster increased connection, understanding, and stewardship of local waterways. As a result, in 2010, EPA and Ocean Conservancy developed a partnership to integrate EPA's Urban Waters efforts and Ocean Conservancy's International Coastal Cleanup efforts. The goal of the new partnership is to promote urban waters protection and restoration by engaging communities in cleanup and demonstration activities that foster an increased community connection, an understanding of litter implications and the value of clean waterways, and a renewed ownership of their waters and surrounding land. The partnership will also expand the conversation by seeking to involve more diverse communities and volunteers who may not have participated in environmental efforts in the past. The focus of this presentation will be on the importance of and methods for engaging local communities to reduce litter and marine debris within their local urban waterways.

METHODOLOGY
As a component of the Urban Waters/International Coastal Cleanup (UW/ICC) partnership, EPA and Ocean Conservancy developed an electronic UW/ICC Toolkit designed to engage local urban communities in ICC events and call attention to the urban-coastal connection. The UW/ICC Toolkit, which was distributed to all ICC Coordinators, consisted of several resources including PowerPoint presentations, fact sheets, lesson plans, op-editorials, and other educational materials that provided information on the value of keeping urban waterways clean and litter free.

Another part of the partnership was the UW/ICC Events held in Washington, DC, and Bronx, NY. In order to develop these events, which included speakers, the cleanup, educational exhibits and demonstrations on the urban-coastal connection, entertainment, and refreshments, EPA and Ocean Conservancy worked very closely with many local partners from environmental organizations and governments. In trying to engage local community volunteers, particularly those who may not traditionally participate in cleanups or other environmental events, outreach was targeted at local schools, groups, and governments. While many of these groups were environmentally focused, there were also efforts to reach out to groups of specific community importance, such as crime and health organizations. Mechanisms for this outreach included distributing flyers, submitting newspaper op-editorials, and using online and social media resources, such as website postings, Facebook, and Twitter.

OUTCOMES

The two UW/ICC Events had over 300 participants from the local community, local environmental groups and organizations, and federal and local governments, many of whom had never attended a cleanup event. At the Events, over 200 bags of trash were collected at the parks, along the rivers, and even on the rivers. The educational exhibits also provided a key prevention component to the events by demonstrating and explaining the importance of keeping waterways clean which can ultimately help to promote the growth of local businesses, enhance educational, recreational, and social opportunities in nearby communities, and improve the long-term health of urban water bodies.

PRIORITY ACTIONS

Engage people that may not typically be involved in environmental efforts.

Target marine debris prevention, reduction, and cleanup efforts in high density urban areas where trash and litter is more prevalent.

During cleanup events, integrate a prevention component by educating participants on the implications of litter and the value of clean waterways.

3.a.3. Visualizing marine debris: using drifter buoys and debris tracking data to visualize marine debris movement and distribution

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KEYWORDS
Data visualization, drifter buoys, marine debris tracking, pelagic migration, wind stress, ocean currents

BACKGROUND

Problem Statement: Tracking the movement and accumulation of marine debris is difficult because even large quantities or large masses are not easily detectable. Small debris pieces are difficult to see due to their size, and many of these pieces may be suspended below the surface of the water, which makes them even harder to detect. For these reasons, debris is not visible with existing satellite technology. Even with larger debris like derelict fishing nets, detection is difficult requiring satellite image searches, instrumented aircraft searches or chance sightings. This hinders the ability to locate and remove drifting debris. Pelagic species are at a greater risk of entanglement and ingestion of marine debris when travelling though areas where debris concentrates. Floating debris also accumulates along shorelines where it becomes a land-based hazard for wildlife.

By tracking the movements of drifting buoys and satellite tagged derelict fishing nets we can get an indication of where floating marine debris is traveling and accumulating. To predict the pathways that marine debris might travel on a temporal scale, wind stress driven surface currents can be tracked over the course of a year. To determine where species are travelling in the Pacific, satellite tracking of individual animals can be used to visualize the pathways used by these species to give us a better indication of where species may encounter higher densities of marine debris. To locate and document marine debris accumulation on shorelines, aerial surveys can be used create debris maps and aid in targeting areas for debris removal efforts and lessen threats to wildlife on shore.

These data are incorporated into a visual education resource that can be used for formal and informal classroom settings and public outreach efforts to support environmental literacy. This resource can be incorporated into lesson plans and science center exhibits to enhance the learning experience and foster greater environmental understanding.

METHODOLOGY

With the goal of mapping the ocean's surface circulation, the Global Drifter Program (GDP) has deployed a global array of 1500 surface drifting buoys. These buoys are fitted with sensors that transmit sea surface temperature and position information to the ARGOS satellite-based data management system. Each buoy is tracked with 16-20 satellite fixes per day. This data is interpolated to regular 6 hour intervals to track the position of the buoy over time. Sub-surface drogues are tethered to buoys which measure mixed layer currents at a depth of 15 meters. Beginning and ending position data for the past ten years for each buoy in the North Pacific for all buoys transmitting data for one year or more were plotted using Geographic Information Systems (GIS). To look at longer term movement, 11 drifter buoy tracks active for 5 years were plotted first in GIS and then animated and visualized in ESRI Arc GIS and Adobe software.

To visualize subsurface movement, data was obtained from the High Seas Ghost Net Program which tracks lost fishing nets or ghostnets in the North Pacific. Ghostnets are tagged with satellite tracking devices to monitor their location. The data for 10 ghostnet tracks were plotted first in GIS and visualized in ESRI Arc GIS and Adobe software.

Remote sensing datasets obtained from the NOAA OceanWatch - Central Pacific show the location of convergent patterns of surface wind circulation along shorelines, the equator and high-latitude areas. The SeaWinds Scatterometer instrument on the QuikSCAT satellite system records oceanographic processes and conditions occurring within the Pacific Basin using microwave radar sensors to measure near-surface wind speed and direction. The wind stress curl data as well as QuickSCAT vector winds data is matched with 19 buoy tracks from the same time period (2004-2006) and animated in Adobe software.

Migration paths of satellite tagged pelagic species travelling through the North Pacific were obtained from the Tagging of Pacific Predators Project (TOPP). Satellite tracked positions for the Northern Elephant Seal, Black Foot Albatross, and Pacific Bluefin Tuna were plotted in GIS and later animated in Adobe software. This data is combined with the average speed and direction of wind stress compiled by month to visualize the correlation between animal migrations and seasonal changes in wind driven surface currents that bring nutrient rich waters to the surface and provide feeding grounds for these pelagic species.

To determine where marine debris accumulates along shorelines, data was obtained from the Pacific Islands Fisheries Science Center (PIFSC). The PIFSC uses aerial surveys to map the type, size and location of derelict fishing gear along Hawaiian shorelines. Also, the previously plotted end positions of free floating buoys illustrate common grounding points along shorelines.

OUTCOMES

Drifters: The 885 GDP drifter buoys that transmitted positions for at least one year since 2000, recorded a majority of end positions within the North Pacific Transition Zone or grounded on shorelines. The Transition Zone is bounded by strong frontal zones, the westerlies in the north and the subtropical easterly tradewinds to the south. The transition zone is an area of lower wind stress and greater oceanic convergence. The accumulation of buoys within the transition zone is not dependent upon buoy starting position or duration of float time. The 11 drifter buoys tracked for 5 years, move within the transition zone and remain there, also regardless of their starting point. The 10 ghostnets, tracked for varying lengths of time, have rotated clockwise in the Transition zone within the high pressure area of the North Pacific Subtropical High between Hawaii and California.

Winds and Currents: Global winds drag on the water's surface, causing it to move and build up in the direction that the wind is blowing. And just as the Coriolis Effect deflects winds to the right in the Northern Hemisphere, it also results in the deflection of major surface ocean currents to the right (in a clockwise spiral). This major spiral of ocean-circling currents are called "gyres" (Ross, 1995). The North Pacific Subtropical Gyre is created by the movements of four large, clockwise-rotating currents – North Pacific, California, North Equatorial, and Kuroshio. The 19 buoy tracks transmitting positions for the years 2004-2006 follow the surface wind patterns for the same time period.
The NOAA Ocean Watch wind stress curl data show the convergence pattern of circulation at the surface along shorelines, the equator and high-latitude areas. Along the edge of convergent areas, winds drive currents that bring nutrient rich water to the surface creating a rich feeding ground for migrating pelagic species. The convergent circulation areas move toward the equator during the northern hemisphere's winter and move north during the summer. Between the equatorial and high-latitude convergence zones, the North Pacific Subtropical Gyre circulates low-nutrient surface water.

Biological Concerns: The same forcing factors that create currents and concentrate debris may also concentrate biological productivity and activity. TOPP position tracks of satellite tagged animals travelling through the North Pacific Ocean, including the Northern Elephant Seal, Black Foot Albatross, and Pacific Bluefin Tuna show routes that traverse the North Pacific Subtropical Gyre where floating debris is accumulating. Pathways through areas of higher debris density increase the chances of ingestion or entanglement for these species.

Shoreline Debris: One of the reasons marine debris accumulates in the Hawaiian Islands is the movement of debris within the North Pacific Subtropical Convergence Zone at the southern edge of the North Pacific Subtropical Gyre. The accumulation pattern of marine debris along the shorelines of the main Hawaiian Islands illustrated in the PIFSC maps is facilitated by the Northeasterly trade winds that concentrate debris deposits along windward shores. Trade winds drive the Equatorial Currents westward, thus transporting warm ocean-surface waters in that direction. The accumulation of GDP drifter buoy end points in the Philippines may be a result of this forcing factor and indicate an area where marine debris is also accumulating. The Alaskan current moves counterclockwise along the northwestern Pacific coastline where another area of drifter buoys find their endpoints which may indicate another area of concentration of marine debris.

PRIORITY ACTIONS

Presenting scientific data in a visual format available to formal and informal educators facilitates the increased environmental understanding and awareness of marine debris movement. Public outreach efforts in formal and informal settings also benefit from presentations of scientifically based visual data, fostering an environmentally literate public.

Tracking of drifting buoys beyond the time span of 5 years will reveal long term patterns of travel paths and possibly predict where concentrations of marine debris may also travel and accumulate over long time spans. This information may assist in more effective and efficient targeting and removal of marine debris.

FIGURES AND TABLES

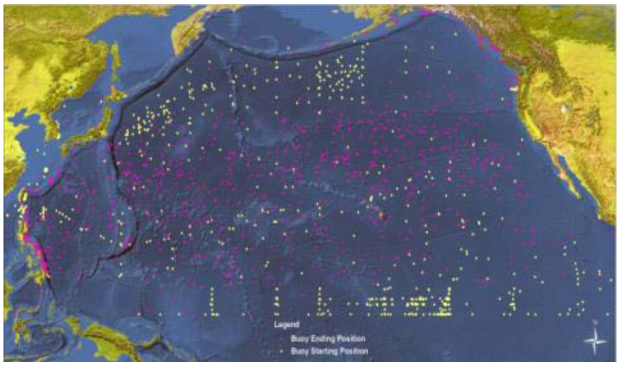

Image 1: Location of starting (yellow) and ending (magenta) positions of drifting buoys in the Pacific.

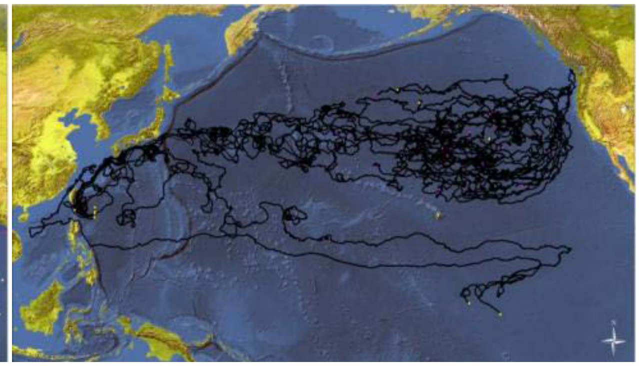

Image 2: Satellite tracks of buoys adrift for five years. Yellow dots represent beginning position, magenta dots are ending position.

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The High Seas Ghostnet Project http://highseasghost.net/overview.html Data managed by Airborne Technologies, Inc. (UAS research) https://atiak.com/data

NOAA Ocean Watch – Central Pacific with the support of the National Environmental Satellite, Data, and Information Service (NOAA-NESDIS) http://oceanwatch.pifsc.noaa.gov/index.html

Global Tagging of Pelagic Predators (GTOPP) Built upon the Tagging of Pacific Predators (TOPP) program, Census of Marine Life http://www.gtopp.org/

Pacific Island Fisheries Science Center (PIFSC) Coral Reef Ecosystem Division (CRED) http://www.pifsc.noaa.gov/cred/aerial_surveys.php

3.b.1. Numerical simulation of plastic pellets dispersal in coastal systems as a tool for the identification of potential sources

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KEYWORDS
dispersal, pellets, sources.

BACKGROUND
One of the major environmental concerns is about marine pollution. Among various pollutants that threaten this delicate environment are plastics, a material whose utilization at the modern society has increased and is harmful to the environment due their high strength to degradation and their potential to be vector to toxic chemicals. The prime resource is commercialized in the form of "pellets", 5mm granules that are being dumped in the marine environment during production, utilization, and transport stages (see EPA, 1992). In the environment, pellets can remain floating for long periods or accumulate in sandy beaches causing environmental, economics, and aesthetic impacts (see Thompson et al., 2009 for a recent review).

In this way, pellets may disperse passively for large areas and contaminate marine environments distant from their sources. Moreover, pellets can still function as a vehicle to some toxic hydrophobic compounds as DDTs, PCBs, and phenols (Mato et al., 2001; Endo et al, 2005; Teuten et al., 2009). Thus, the understanding of their sources and dispersal pattern may help to ascertain environmental risks.

Although the pathways of pellets to the sea are generically known (EPA, 1992), a local understanding of their behavior is lacking. Therefore, the present work proposed the identification of potential sources of pellets and their dispersal at Santos Bay considering both surveys of factories and transport facilities as well as using modeling techniques to forecast the dispersal of pellets in different climatic and oceanographic conditions.

METHODOLOGY
The study area comprises Santos Bay, which is located at Santos and São Vicente municipalities and estuary, central coast of Sao Paulo State, southeastern Brazil (Figure 1). A survey of companies that produce, transport, and process pellets at the estuarine region was realized and the type of polymer produced by industries was also evaluated.

Modeling techniques were also employed considering three probable points of emission of pellets chosen based on the results of the survey described above to simulate their dispersion over a year. Hourly, one particle of each of the three points were launched to the environment for a period of 12 months (for year 2008), in a total of 8.760 particles. This modeling was adapted from the numerical modeling developed by Harari and Gordon (2001) to evaluate the dispersion degree of substances and particles at Santos Bay. The hydrodynamic model generated currents for all months, thus covering all tide and wind conditions. As particles were launched each hour, all hydrodynamic situations through the 2008 year were covered.

OUTCOMES

Concerning the industries, the potential sources of pellets to Santos Estuary are the Santos Harbor area, mainly the back-harbor that includes Braskem terminal, as well as the industrial plant of the companies Pepasa and Polietilenos União. These potential emissions may be responsible for raising the concentration of pellets in interior parts of the estuary. The Harbor back area can be the source of the three types of polymers found at beaches (PP, PEAD, and PEBD), through handling pellets big-bags and containers between ships and trucks/terminals. Braskem terminal may possibly emit PP pellets, which are produced at interior of Sao Paulo and is exported by this terminal. Pepasa, that produces PP and PEAD, and Polietilenos União, that produces PEBD, can also be sources of the pellets found at Santos beaches (Manzano, 2009). There were not found polymers produced by Dow Quimica (PS) in the beaches and, so, this company cannot be a pellet source for the beaches in the region. Besides these possible inland sources, there are reports (three independent and spontaneous interviews; see also Pianowski, 1997) on the possibility of emissions off the bay derived from washing procedures of ship tanks, as pellets are considered better abrasives and absorbents then sand.

The modeling results complemented the information above and showed that, depending on the points of emission, pellets presented different behaviors (Figure 2). For releases inside the estuary, representing spills from harbor activities, they tended to become arrested inside the estuarine system. It was hypothesized that they may reach the bay in large quantities in intense runoff (rain) situations and ebb spring tide currents. Pellets released at the mouth of the estuarine channel, simulating those particles that are effectively leaving the estuary, presented a fast dispersion along the Bay and tended to concentrate at both of its extremes/sides. They will be probably rearranged by the combined effect of internal circulation and drift cells, formed by the influence of currents, tides, waves, and winds. Under this scenario, there is a prediction of a small offshore exportation of pellets that may contaminate other regions. In this way, Santos region is a possible source of pellets contamination for nearby areas, since they are not permanently arrested into the estuarine/bay system.

Pellets were also experimentally released off the bay, representing loss from ships arriving or leaving the harbor (load loss or improper practices of ship cleaning). The particles were exported to areas around the Bay and along the coast, but a considerable amount also reached the beaches inside the Bay, especially at winter conditions (cold fronts from south). Thus, pellets at the beaches of Santos Bay are hypothesized to be originated from both estuarine and offshore areas/activities, but internal sources are supposed to contribute with larger amounts since there are small quantities of pellets at the beaches of nearby municipalities (unpublished data), which are probably results of export from Santos Bay and offshore sources. On the other hand, offshore sources, especially from ship cleaning practices, may represent a more significant problem since pellets, even in smaller amount, may be more contaminated with chemical pollutants and have a stronger environmental impact.

PRIORITY ACTIONS

Combined field surveys of companies and modeling pellet dispersal can be used as a tool to help in the definition of sources and strategies to prevent or reduce the input of this material to the sea. In this way, we suggest that local efforts to address the processes of production and transportation of pellets and their actual risks to contaminate the sea as well as the hydrodynamic behavior of pellets should be employed aiming to develop good management practices in industries, harbor areas, and ships.

FIGURES AND TABLES

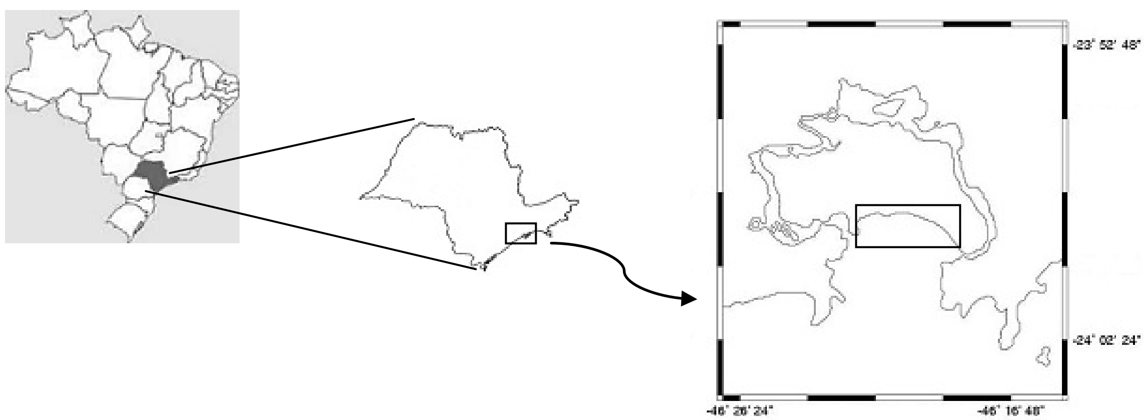

Figure 1 - Location of Santos Bay (Source, Cesar *et al.*, 2006)

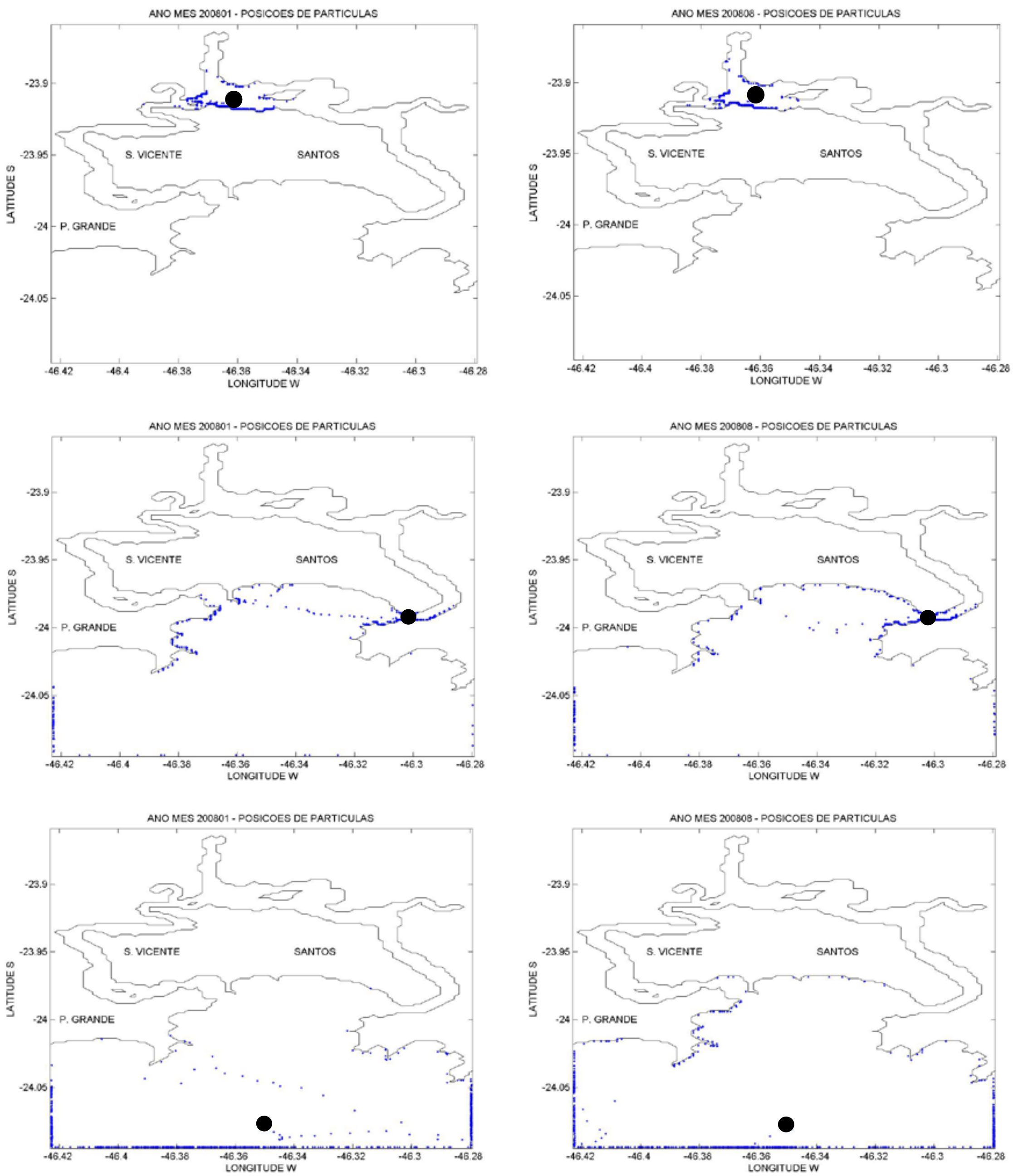

Figure 2. Pellet dispersal in 1º and 8º month released, respectively, in upper Santos estuary, at the mouth of estuarine channel and off the bay.

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3.b.2. Global Ocean Alert System: focusing on the world's river mouth outflows as a source of marine debris

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KEYWORDS
Ocean Alert System, River Mouth Outflow, Marine Debris, Plastic

BACKGROUND
The United Nations has estimated that up to 80% of the ocean plastic garbage is land-based in Source, and there are not many large scale attempts to prevent it across many international boundaries, all at once. The Global Ocean Alert System (GOAS) addresses a number of issues which include the following: A) A gap in awareness between those living "upriver" and the ocean, B) A lack of awareness, or focus on, rivers as a source of debris outflow, and the responsibility that local communities/governments have towards keeping this clean, C) A tool which can now be viewed by many, allowing them to gain knowledge of "hotspots" or bad areas, allowing for the potential for cleanup or capture of debris, particularly during high-water incidences. This is important knowledge to share if fisherman or others want to collect the debris for use in secondary products or fuel. The long term goal is to bring awareness to waste as a resource, and therefore to be able to use this platform to find those "resources" as, and if, they flow from the rivers.

Rivers are the best place to capture aggregated material before it becomes dispersed in the ocean by wind or currents (or sinks). When considering the length of a "coastline," and you bring a 1,000 mile river into an equation, then there are really 2,000 miles of "coastline," before the water even reaches the ocean. Therefore, and with the help of the GOAS platform, we will be able to draw awareness to the relationship between river outflows and the health of the ocean. Even if people live upstream, they can impact the ocean. By capturing it along the way, or at the mouth, we can create a large scale impact, without having to go to the middle of the ocean to gather it later.

METHODOLOGY
The GOAS takes advantage of the latest cloud-based technologies and open APIs available. The core application resides on Amazon's Web Services platform, combining user-inputted data with weather data pulled from various sources, and ultimately displaying the output on a custom Google Map. In later phases, more data-heavy, scientific functionality will be added to the platform through the incorporation of a professional GIS watershed solution, allowing for scientific and governmental use.

A mobile extension of the platform is essential to both data quality and robustness, especially if relying on user-generated data. Smartphone applications are expected to be the preferred mode of input in areas where the infrastructure supports this. Given the scarcity or even absence of mobile infrastructure in many developing countries, it is imperative to build an alternative in parallel, which operates on the SMS system rather than through a data connection.

OUTCOMES

The Global Ocean Alert System will be both an awareness platform and a management tool. It is meant to engage a broad aspect of the community, allowing them to become "neighborhood watchers" for their rivers, but also to increase basic awareness about the link between rivers and oceans. This platform will be open for all to use, including governments, schools, institutions, companies and NGOs. If plastic is shown to have value when collected, this tool can help alert the "fisherman" or others, to collect before it goes to sea. It can also be a sharing tool, to showcase best-of-practice examples of what other countries/river systems are using to collect or reduce debris outflows, either upriver, or at the mouths.

Right now, waste management is often a sideline issue to broader human and environmental issues in some countries. The GOAS platform will help to highlight the impacts of waste that flows to the ocean, impacting both river health, as well as the livelihoods of those along the ocean coastline. This will bring a wide variety of impacts on awareness, including personal/community experiences, university and NGO outreach potential, company involvement, fisherman involvement, and government response, either to solve a problem, or to showcase their good solutions.

The issue of plastic in the ocean is an international problem, yet when the material goes into international waters, it is hard to engage national governments on the issue of remediation. Article 207 of the Law of the Sea says "states shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from land-based sources, including rivers, estuaries, pipelines and outfall structures, taking into account internationally agreed rules, standards and recommended practices and procedures." This is hard to accomplish with multiple source pollution, such as plastic, and as a result, the GOAS offers a tool, and an opportunity, for communities to monitor and improve their local environments.

PRIORITY ACTIONS

With the introduction of the Global Ocean Alert System platform, the entire community will be able to participate in the reduction of plastic and other debris or pollution into the ocean. This system will allow for the incentivization of proper capture and flow prevention activities, as well as monitoring, sharing of best practices for river-sources of debris.

3.b.3. Plastic debris pathways and areas of accumulation in statistical Lagrangian model based on drifter trajectories

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KEYWORDS
drifter trajectories, marine debris, statistical model, deposition on shore

BACKGROUND
Problem statement: Distribution of long-living (such as plastic) marine debris, floating at the sea surface, is controlled by distribution of its sources (on land and at sea), by its motion under effects of ocean currents and winds, and by processes removing debris from the ocean by bringing it on shore; none of these three components are sufficiently studied.

METHODOLOGY
We use trajectories of more than 14,000 Lagrangian freely drifting surface buoys (drifters) to describe pathways of marine debris in a statistical manner. For this purpose, we calculate the probability for a drifter to excurse between pairs of 1/2-dergee geographical bins in five days [Maximenko et al., 2011]. These probabilities are then used to experiment with different scenarios of initial conditions and sources of debris. Drifter trajectories are also used to describe the events when buoys were running aground. In some cases, the drifters, gone aground, continued transmitting and were identified properly as their coordinates were not changing. However, in many other cases, as a result of contact with the shore, transmitters were damaged before the drifters could be identified as "gone aground". A new method has been developed and applied to discriminate statistically between such undetected drifters running aground, drifters that were picked up by the boaters, and drifters that terminated transmitting due to natural end of their lives (mostly due to the battery failure). Sources of plastic are parameterized using simple assumptions together with the data of the population density and economical indices.

OUTCOMES
Results of our modeling indicate that distribution of marine debris is sensitive to distribution of sources, rate of degradation, and rate of deposition on shores. While five main patches are formed in all numerical experiments, their relative "masses" vary between the model runs. Debris with shorter live span can also form additional patches closer to the sources. The set of our experiments also explains differences in the "age" of debris sometimes reported by the

observers from different off-shore areas. Our model reveals a complex pattern of locations, where model debris is deposited on shore. This pattern can be used to study coastlines, affected by marine debris.

PRIORITY ACTIONS

Validation and improvement of the model requires a unified global dataset of debris observations. Locations and intensity of main sources of various kinds of debris need to be identified, using observations as well as using socio-economical national parameters, characterizing production, consumption, and rate of deposition of debris into the ocean.

FIGURES AND TABLES

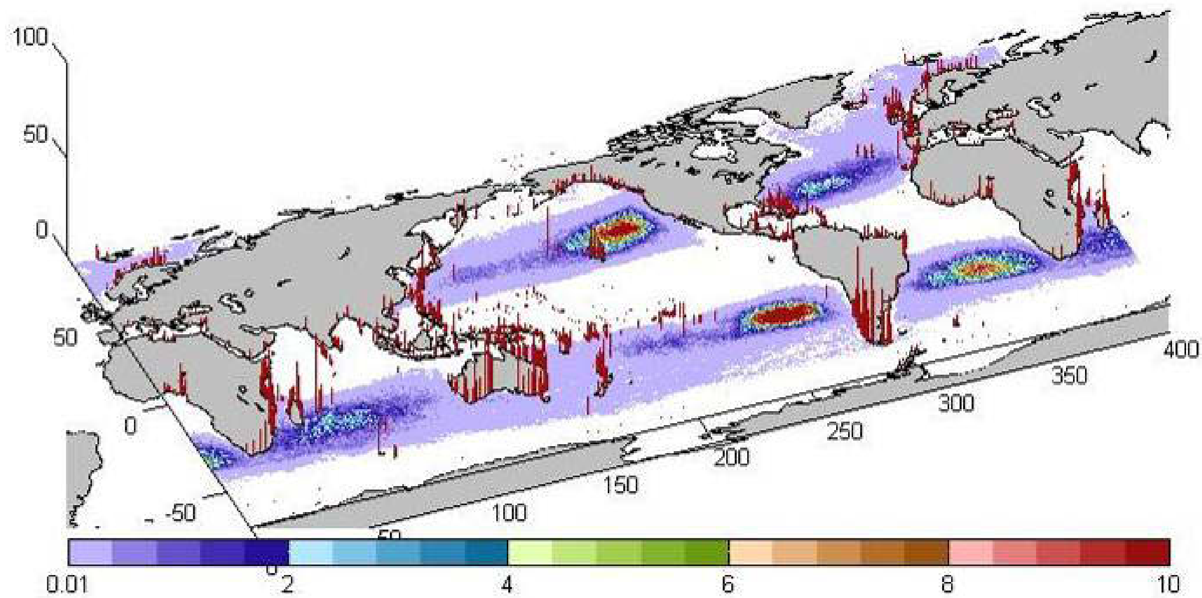

Figure 1. Density of model debris after 10 years of integration from initially homogeneous distribution without additional sources. Vertical bars show amount of debris deposited on shores. All units are conventional.

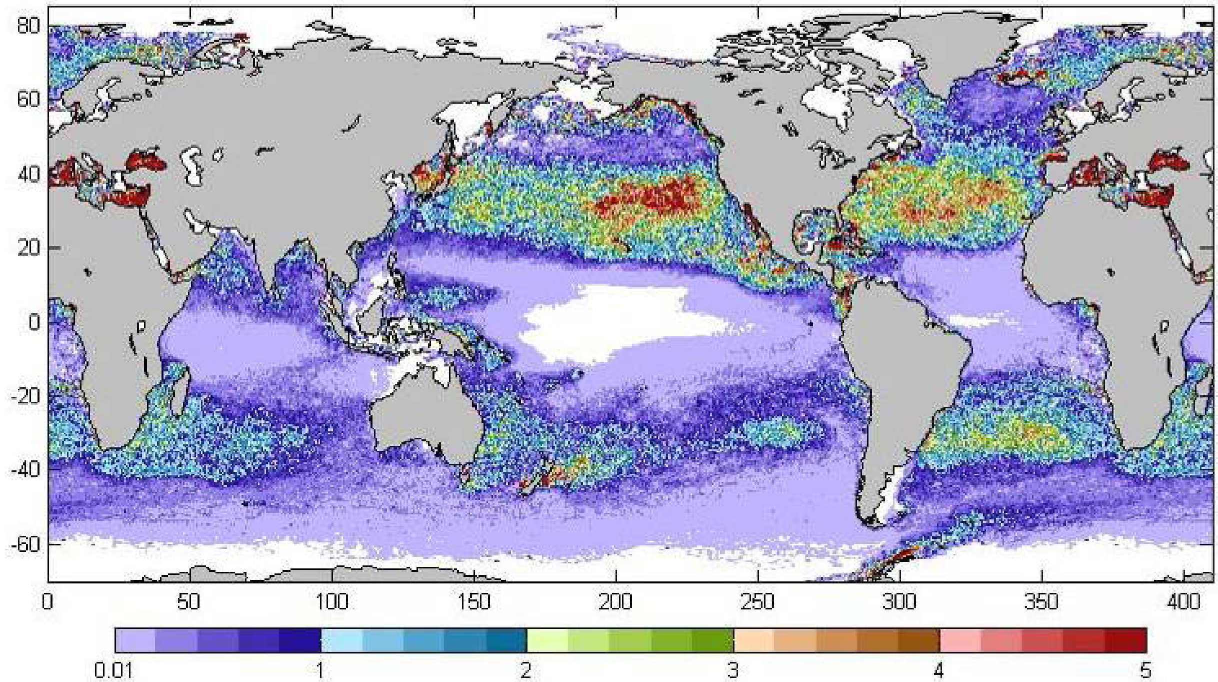

Figure 2. Density of model debris after 10 years of integration with sources of debris uniformly distributed along the coastline. Initial condition is "no debris" and debris is assumed degrading in time with the time life of 3 years. Units are conventional.

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3.b.4. Storm influenced marine debris movement into Prince William Sound, Alaska

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KEYWORDS
Gyre, ACC, Alaska Coastal Current, Pineapple Express, storm surge, storm track, current, wind profile, density, convergence

BACKGROUND
The problem statement for this presentation is: Winter storms and ocean currents combine to deposits tons of non-local MD upon Gulf of Alaska beaches each season. Most MD that accumulates on these beaches originates from offshore vessels or from countries on the western side of the Pacific Ocean.

This presentation explores the influences of gyres, prevailing storm tracks, storm surges and local currents upon the deposition of foreign MD along the shorelines of the northern Gulf of Alaska, particularly in Prince William Sound and along the Kenai Peninsula.

During the fall and winter, MD is deposited on northern Gulf of Alaska shorelines at a staggering rate. Gulf of Alaska Keeper tracks that deposition through the use of MD monitoring sites which are re-cleaned annually. After 4 years of data collection, it is apparent that the annual rate of deposition varies remarkably and appears to be directly correlated to the frequency, duration, and severity of fall and winter Pacific storms blowing onshore. The northern Gulf of Alaska experiences a strong winter weather phenomenon referred to locally as the Pineapple Express. It is a low pressure storm track originating in the vicinity of the Hawaiian Islands which blows for sustained periods across the northern Pacific straight into the very northernmost portion of the Gulf of Alaska. These ocean storms pile tons of foreign-origin MD upon local shorelines.

Using historical NOAA weather and current data, and local current data developed since the Exxon Valdez oil spill, this presentation will illustrate how MD drifts thousands of miles to these remote beaches. Annual deposition rates will be correlated to annual fall and winter storms tracking across debris-laden gyres, driving MD into the northern Gulf of Alaska with assistance from the Alaska Coastal Current. The presentation will explore how knowledge of MD drift patterns might help establish individual national or regional responsibility for the MD problem in remote, sparsely populated areas.

METHODOLOGY
Using historical NOAA weather and current data, and local current data developed since the Exxon Valdez oil spill, this presentation will illustrate how MD drifts thousands of miles to these remote beaches. Annual deposition rates will be correlated to annual fall and winter storms

tracking across debris-laden gyres, driving MD into the northern Gulf of Alaska with assistance from the Alaska Coastal Current.

OUTCOMES
Winter storms and prevailing ocean currents directly influence the amount of debris deposited upon Gulf of Alaska beaches each season.

PRIORITY ACTIONS
Methodology must be developed for assessing national and industry responsibility for the MD problem. The costs related to the MD environmental problem must be internalized if the issue is ever to be properly addressed. That will ultimately require an international treaty apportioning responsibility and cost.

3.b.5. Influences of weather and tidal patterns on beach debris accumulation

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ABSTRACT
Understanding factors that influence marine debris accumulation on shorelines is important to ascertain where debris might accumulate on a shore, when this may occur, how much is likely to accumulate and how often. This study aimed to examine the relationships of weather and tidal patterns to marine debris on beaches around Central Queensland, Australia. Surface debris was collected, sorted and categorised every 4-7 days from four beaches over several lunar cycles. Corresponding tidal heights, currents, wind direction, wind speed, rainfall data and beach morphology were also recorded. Results indicated that tidal height and wind direction were the most influential factors on debris accumulation rates. The greatest amount of debris was consistently collected on the higher astronomical tides in each lunar cycle across all beaches while the influence of wind direction was dependent on individual beach aspect and morphology. Plastics were the most common debris type collected, irrespective of weather or tidal patterns however a difference in subclasses was observed. The prevailing currents and winds, rather than proximity to source, significantly influenced where on the beach debris accumulated. The implications of these findings to monitoring protocols and management of marine debris from a source and sink control aspect will be discussed.

3.b.6. Numerical modeling with application to tracking marine debris

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KEYWORDS
Numerical modeling, ocean circulation

BACKGROUND
Estimates of near-surface ocean circulation are typically based on direct measurements (e.g., from drifting floats), from analyses of remotely-sensed data (e.g., depth-integrated velocity estimated from satellite-derived sea surface height), or from large-scale numerical models. At present, there are few data sets based on direct observations that could be used to provide estimates of ocean circulation that would be appropriate and sufficient for application to the issue of ocean-drifting debris. Results from ocean general circulation models (OGCM's), on the other hand, can provide a more comprehensive estimate of ocean circulation. This presentation will focus on a discussion of OGCM's from which output is freely available.

METHODOLOGY
The basic equations for passive advection of particles at a particular depth are straightforward and simply involve the integration of the appropriate velocity field. Velocities from several different large-scale general circulation models were used to compute particle trajectories. As an example, particles were released along a line from Seattle to Hawaii and from Seattle to Japan (simulating potential shipping routes) and then tracked for a total of four years. It is important to note that mean (not time-evolving) velocities were used, so the results are more statistical than actual. The procedure was done using surface currents (as a proxy for tracking floating debris) and on subsurface currents (nominally at 100 m) to track debris such as derelict fishing gear that might drift subsurface. The results from these calculations will be shown and discussed.

OUTCOMES
The requirements needed for model-derived ocean velocity as applied to tracking ocean debris are somewhat prohibitive. The model must be of sufficient horizontal resolution to permit eddies, have large enough domain to include the entire ocean basin, and have a sufficiently long run-time to resolve decadal transports. The resources required are non-trivial, so instead existing model runs whose output are freely available, are used in this analysis. Model resolution, both temporally and spatially, will have an influence on the trajectory calculations. At reduced resolution, nonlinear effects are reduced, and the flow is more idealized. To demonstrate these effects, the results from the 1/32-degree Navy Ocean Layered Model (NLOM) will be shown. The results highlight the dependence of subgrid-scale processes on model results. This is particularly notable with integrated quantities, where relatively small effects such as eddies can, over time, integrate to large differences. In most cases, the model resolution is coarse; horizontal

resolutions of a few kilometers such as NLOM are rare. Similarly, getting high temporal resolution output is usually impractical, given the significant amount of storage needed to archive such results.

PRIORITY ACTIONS

Can possibly overcome with passive trajectories released during the model run, or improved statistical methods for computing trajectories.

3.c.1. What makes a good marine debris monitoring program?

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KEYWORDS
monitoring, design, randomization, adaptive management

BACKGROUND
Marine debris, defined as "any manufactured or processed solid waste material (typically inert) that enters the ocean environment from any source," is one of the most pervasive and potentially solvable pollution problems plaguing the world's oceans and waterways. Marine debris monitoring programs can clarify the problem – e.g., what are the types, what are the possible sources, how widespread is the problem – and provide a framework for the formulation of management strategies for abatement and prevention. Ongoing monitoring activities can be used to assess the effectiveness of management strategies, and provide insight into when strategies need to be modified for changing conditions. Monitoring marine debris is not unique to science and we can improve our approach by putting marine debris monitoring in the framework of environmental monitoring.

OUTCOMES
The concept of monitoring a system is a sound one, which has been useful for addressing problems from quality assurance in manufacturing to maintaining human life in space. However, many environmental monitoring programs have been accused of being unscientific because questions are poorly specified and hypotheses are rarely tested, so that it becomes a 'fishing expedition'. Monitoring has been accused of being too expensive because many programs try to monitor everything rather than targeting the effort, leading to a lot of money being spent. Monitoring can also be wasteful because most monitoring data are never used and thus were collected for nothing. The monitoring community is finally listening to the approach recommended by the statistics community and adopting a new paradigm where monitoring is an integral part of an assessment program, a program where stakeholders are integrally involved in defining the questions they need answered to help move policy or assess management actions (Lovett et al. 2007).

This new paradigm, adaptive management, is where marine debris monitoring needs to move to be successful and effective (Figure 1). Under this new paradigm, environmental monitoring is a time series of measurements that is done to answer specific questions about environmental change. Monitoring has a clear role in the new paradigm. It provides the record of environmental change, it determines whether or not an event is unusual or extreme, and it helps put shorter-term observational studies in perspective. For marine debris, ENSO or storm events can increase the amount of debris on a beach but having a long-term monitoring record can help determine what is extreme and what is natural variability. Marine debris deposition patterns are highly nonlinear so knowing when the data were collected – on the upswing or a downswing - can provide context for short-term observations as to whether an increase or decrease will be sustained.

A key to a successful monitoring program is having personal or institutional commitment to carry the program out. Without this commitment, the program will fail. There are many examples of monitoring programs that were started and then died as the sponsoring institutions stopped supporting them.

There are four characteristics of good monitoring programs: good questions, appropriate design, high quality data, and the analysis and use of the data. Good questions are crucial. They determine the variables to be measured, the spatial extent of sampling, and the intensity and duration of the measurements. In other words, good questions determine the usefulness of the entire program. Figuring out the questions must involve the managers or policy makers who need the information. If you answer the wrong question, you are not helping the people who really need information. By making sure the managers/policy makers have a voice, you get stakeholder buy-in and allies who want the program to succeed.

And the questions can change. As part of the new paradigm we may have management actions/interventions so we need to keep asking "are the questions still relevant?" Use of statistical design principles are critical for producing data that can be used to answer the questions. Power analyses are important to help determine what questions have a reasonable chance of being answered given resource constraints (time, money, expertise, etc.).

Statistical designs can be complicated but a cornerstone of statistics is randomization; randomization ensures that the sites/samples are representative of the population of interest. And with the advances in statistics, spatial designs that include a randomization component are a necessity to make sure that the population of interest is sampled. These two principles allow you to generalize to the system as a whole. By choosing sites without randomization and a spatial design (for example, unrelated platforms of opportunity), the program loses the ability to reliably answer the questions.

Another part of an appropriate design is figuring out the core measurements that will be taken and the measurements that will not be taken – because you cannot measure everything. Core measurements should be indicators of change or variables of particular interest. They also should be as inexpensive as possible; otherwise the program may not be sustainable. For marine debris, you have to decide what the size range of the items will be, if pieces/fragments are important, if a suite of indicator items will work or even if a single item is what you need. You can also decide to focus on a specific type of debris material such as plastic. But what is measured must be tied directly to the questions being asked. Finally, with a solid statistical design, it is easier to change measurements as the questions change.

Making sure the data are of high quality means that a quality assurance program must be in place before data are collected. Sample collections and measurements must be well-documented and employ acceptable methods. This ensures that the methods are rigorous and repeatable. Archiving of the data, including all the metadata associated with the project, needs to be planned from the start. Remember that sharing well-documented data enhances the credibility of the monitoring program with the monitoring community and the public. Unfortunately the data analysis part of a monitoring program often receives low priority compared to actual data collection. This is why monitoring often has a bad name. But under an adaptive management framework, data analysis is where we answer our questions, which leads to re-evaluation and revision of the program (new questions, new variables).

Publication of results in peer-reviewed scientific journals is expected, but also bringing in the stakeholders to discuss what you are doing and getting their input/insights to make sure they are getting the information they need is critical in an assessment program. Using an adaptive management framework means we use the information to review the program – Is it on track? Do we need other questions? Data analysis is the key in the loop back to management priorities and actions. Information sharing and review also helps to retain institutional commitment. Thus, integrating monitoring into an adaptive management assessment framework that seeks to answer specific questions, having personal or institutional commitment, and applying the core principles will lead you to a successful marine debris monitoring program.

PRIORITY ACTIONS

Work with managers to develop relevant questions about marine debris.

Use monitoring as one part of an integrated assessment program.

Follow good design principles to produce meaningful data.

FIGURES

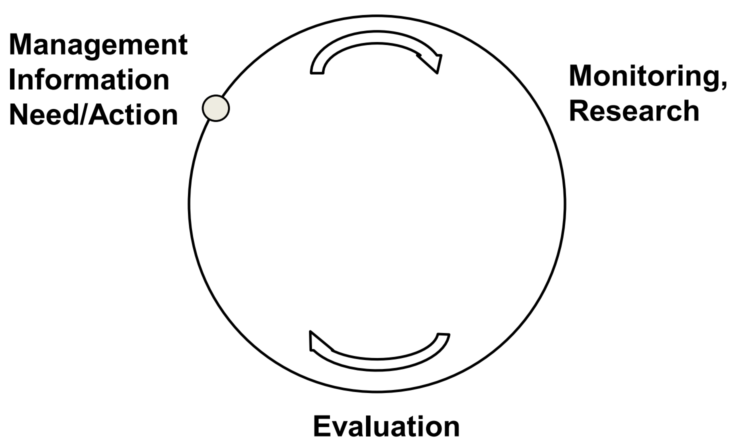

Figure 1. An integrated assessment program (adaptive management).

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3.c.2. A first UK marine litter assessment of northern European waters

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KEYWORDS
Marine litter, benthic surveys, opportunistic sampling, spatial distribution, categorization.

BACKGROUND
The spatial distribution of marine litter on the UK seafloor, including different types and quantities, were mapped by collecting additional data on the back of existing research cruises.

The initial results suggest wide spread distribution of marine litter on the seabed of the North Sea, dominated by plastics. The data shows detailed distribution and accumulation patterns in North European waters.

METHODOLOGY
Several surveys using only two types of trawls (4mbeam/GOV Otter trawl) gathered detailed information over a total time period of 18 years (1992 until 2010).

It started off with the ICES International Bottom Trawl Surveys (IBTS), followed by the UK Clean Seas Environmental Monitoring Programme (CSEMP) and recently was expanded with additional ICES stock assessment surveys (Quarter1 South West (Q1SW), Quarter4 South West (Q4SW), 7D Bottom Trawl Survey (7DBTS) and North West Ground Fish Survey (NWGFS)).

OUTCOMES
There is a considerable variation in geographical abundance between stations, ranging from 0 to 3224 pieces of debris per km^2. Plastic (mainly bags and bottles, 30%) accounted for a very high percentage, more than 70%.

Accumulation of specific debris at certain regions was commonly observed. Remarkably, the available trend data seems to indicate that quantities of macro marine litter remained relatively stable over the past two decades.

PRIORITY ACTIONS
The results will be used to efficiently inform policy makers about pressures when designing programmes of measures. This analysis is one of the first valuable contributions to assess the different types and quantities of offshore marine litter in North European waters and may eventually be used to determine Good Environmental Status (GES) as defined in the EU Marine Strategy Framework Directive, Descriptor 10: “Properties and quantities of marine litter do not cause harm to the coastal and marine environment”.

FIGURES AND TABLES

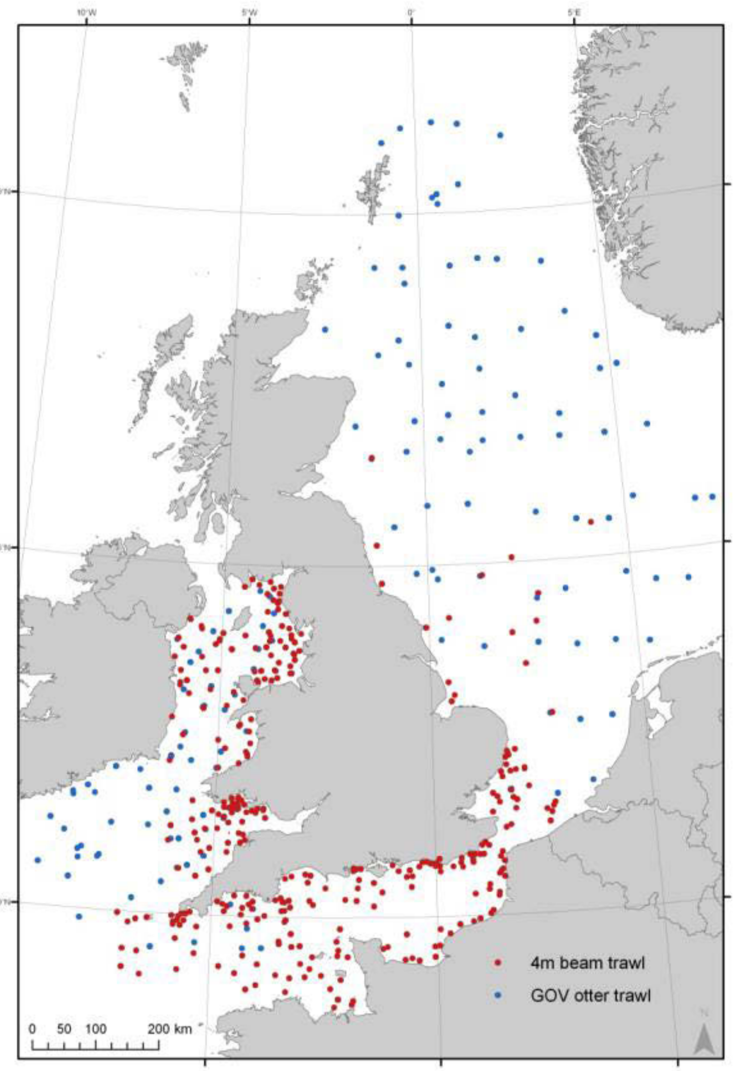

Fig. 1: UK Marine Litter Stations

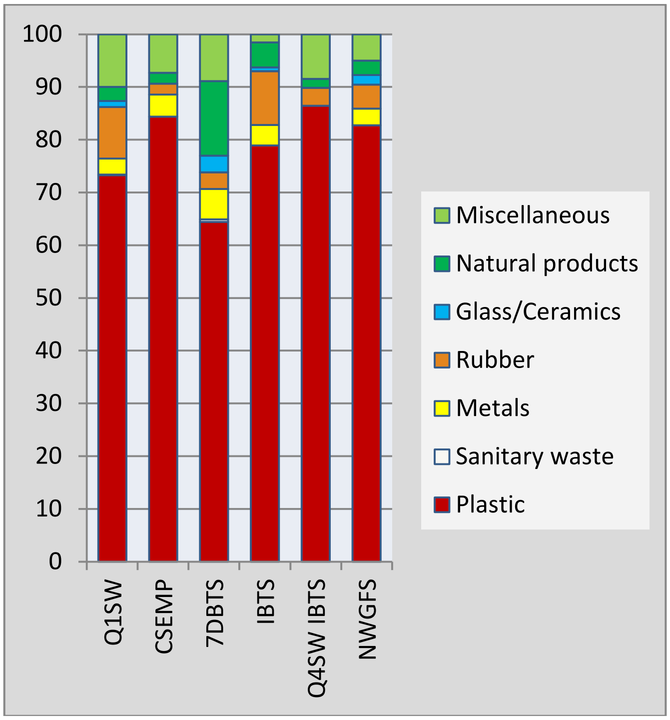

Fig. 2: Main marine litter categories found per survey (%)

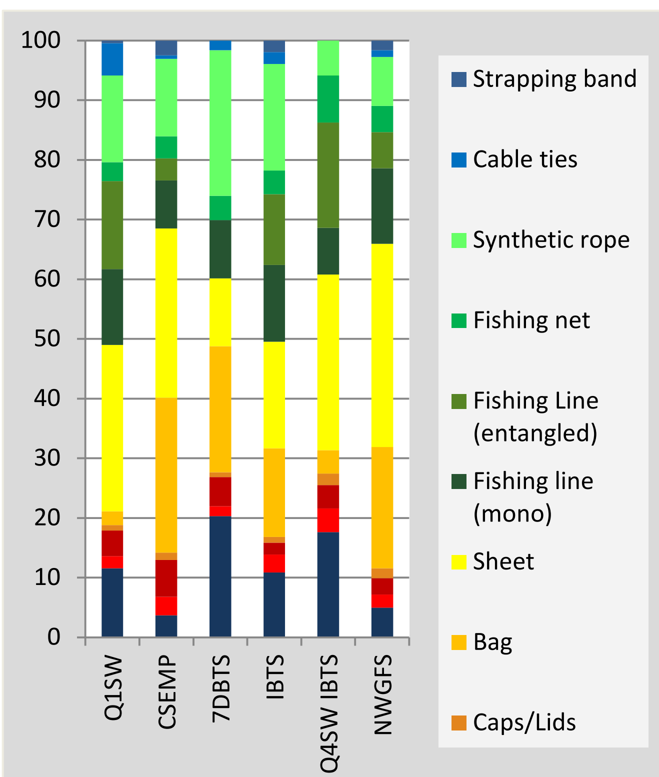

Fig. 3: Subcategories of plastic found per survey (%)

3.c.3. NOAA protocols for marine debris monitoring and assessment along shorelines and in coastal surface waters

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KEYWORDS
Monitoring, Shoreline, Pelagic, Assessment, Surface waters, Standardization

BACKGROUND
In recent years, research efforts in the marine debris field have significantly increased knowledge of the topic. However, significant gaps still remain in standardized monitoring procedures. While numerous past debris studies have been conducted, a single best method is not currently available to estimate total densities in the environment, including: water column, subsurface, and shoreline locations. As such, the NOAA Marine Debris Division (MDD) is in the process of establishing a long-term monitoring and assessment program with four main objectives:

- Assess the quantity of debris at an initial location then expand to regional characterization according to associated land use or other correlating parameter.
- Determine types and density of debris present by material category (plastic, metal, glass, rubber, paper/processed lumber, cloth/fabric, other).
- Examine spatial distribution and variability of debris.
- Investigate temporal trends in debris types and quantities.

Scientific monitoring of marine debris is necessary in order to understand the source, distribution, abundance, movement, and impact of debris on national and global scales. Standard monitoring methods allow for the comparison of the spatial distribution and temporal variability of debris at a given location as well as regional characterization according to land use.

METHODOLOGY
Shoreline surveys are conducted on 100m sections of shore. Before any debris surveys are completed, surveyors determine shoreline characterization. This includes identifying primary substrate type, the tidal range and distance, a description of the first barrier at the back of the shoreline section, aspect of the shoreline, and surrounding land-use characteristics (e.g. primary land use, nearest town, nearest river, etc.). Shoreline macro-debris density surveys are conducted at low tide within four randomly chosen transects in the 100m section (Figure 1). Debris is tallied by material type and category (plastic, metal, glass, etc.).

Coastal surface water trawls are conducted within two nautical miles of shoreline surveys (Figure 2). Three surface trawls are done using a 0.0333mm mesh manta net towed at 2-3 knots for 15 minutes. Collected debris is sifted into two size classes (macro-debris >5mm and microdebris <5mm). Similar to the shoreline survey, macro-debris is tallied by material type and category where possible. Micro-debris is returned to the lab for further analysis

The developed methodologies take into consideration lessons learned from numerous previous monitoring efforts. Additionally, these shoreline methods were developed with input from an established advisory group. The advisory group consisted of researchers in the debris monitoring field (including those studies mentioned above), other federal agencies involved in marine debris efforts, and internal MDD staff.

OUTCOMES

Results of this project are still preliminary, as the methods were first developed and then refined in the 2009 and 2010 field seasons. In fall 2010 a four-week shoreline assessment was completed in the Chesapeake Bay, Maryland, USA. The presentation will detail the temporal variability associated with this assessment, and will compare the debris densities obtained during that four-week sampling event to previously-collected sampling points at the same location. The presentation will also detail the composition and spatial distribution of debris collected from surface waters in three rivers that feed into the Chesapeake Bay, Maryland, USA.

Future directions for this project include an assessment of statistical rigor and sampling frequency to be conducted by a contracting company in 2011. This information will be valuable for determining necessary sampling schedules and statistical power of the data collected. Additionally, methodologies to determine debris densities in other environmental habitats (e.g., benthic monitoring, stratified water column monitoring) are of interest to develop to understand the holistic picture of the debris problem. Lastly, the NOAA MDD will share data and methods from this project with scientists and citizens interested in monitoring debris in local regions. This will be accomplished through the publication of a technical memorandum and distribution among interested regional partners and parties.

PRIORITY ACTIONS

Important actions that will help reduce marine debris in the next ten years include the following:

- Development of standard survey protocols that work well in varied environments.
- Discussion amongst global regions of how standard survey protocols can be integrated to share similar information and allow for global data sharing. This will help us understand where debris hotspots are located and will tell us more about marine debris movement.
- Implementation of standard protocols across the globe, with a way to share the data gleaned with a global audience after it has gone through a quality control process.
- Formation of a monitoring network.

FIGURES AND TABLES

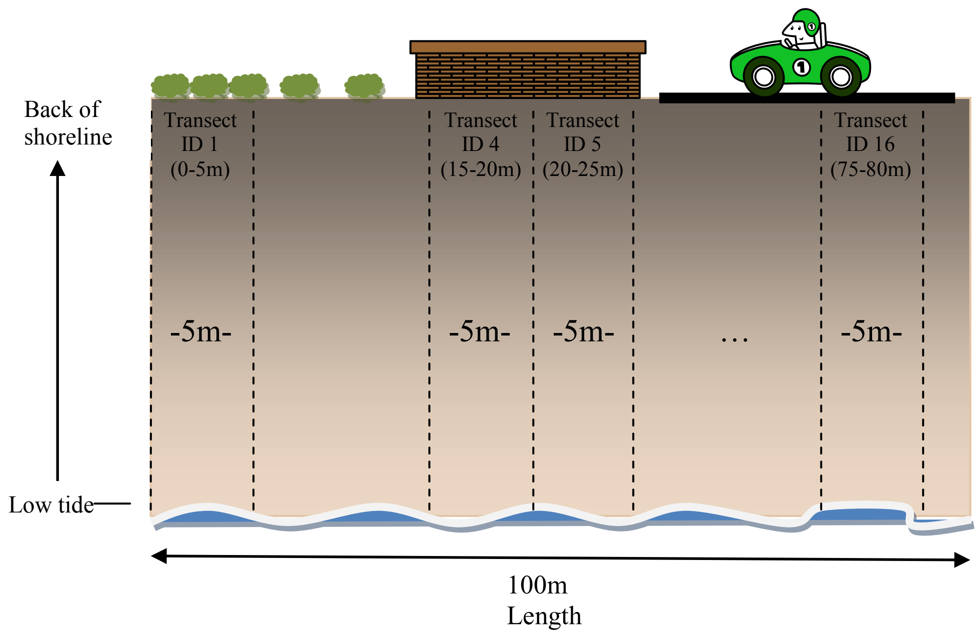

Figure 1. Shoreline section (100 m) displaying perpendicular transects from water's edge at low tide to the first barrier at the back of the shoreline section.

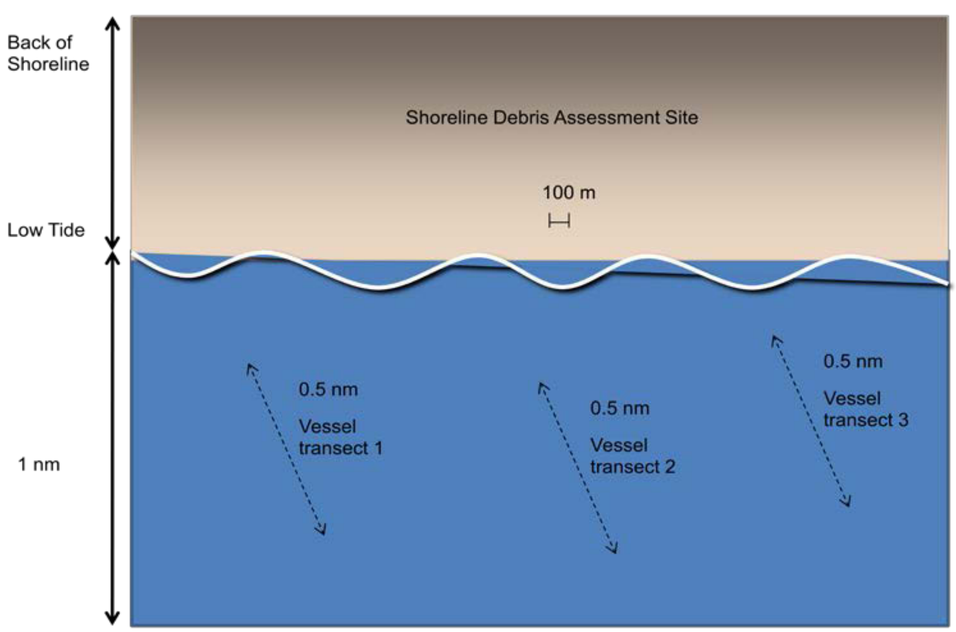

Figure 2. Shoreline and pelagic sampling will be coordinated so that the pelagic trawl transects occur within two nautical miles of the shoreline assessment sites (here, denoted as a single 100 m section of beach). Three trawls, each approximately 0.5 nm, will be conducted at each site. (For conversion purposes, 1 nm = 1.852 km = 1.1508 mi.)

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3.c.4. Characterization of individual marine debris items by mass

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KEYWORDS
Moisture content, sand content, debris characterization, average mass, weight

BACKGROUND
Currently, during beach cleanups, marine debris items are counted and gross quantities of marine debris (weight of all debris collected, plus water or sand attached) is often measured. This information is beneficial, providing an indication of the quantity of debris collected/removed. However, it is skewed by both water and sand content, and this information is not detailed enough to conduct an analysis of the mass characterization of debris. Typically in detailed solid waste characterization studies, the mass of the waste items themselves are used to provide an overall mass/category characterization (Tchobanoglous et al., 1993). For example, waste generated in the U.S. is quoted on a dry mass basis in terms of plastic, paper, wood, etc (US EPA, 2008). In addition, if marine debris is not physically collected (e.g., a scientific survey is completed for a beach, but the debris is unable to be removed), there is currently no methodology for estimating the mass of debris that was documented during the survey. The purpose of this research is to expand the characterization of marine debris to the level of characterization of typical solid waste analysis (e.g., moisture content, sand content, and individual item mass) so that total debris quantities can be estimated (not including sand and moisture) at beach cleanups and in surveys where debris is not collected.

METHODOLOGY
This research consists of characterizing marine debris items by mass in the laboratory. Items were voluntarily collected throughout the U.S. and shipped or brought to the Jambeck Research Laboratory at the University of Georgia (Table 1). Standard waste characterization protocols performed by a professional research engineer were used to characterize the debris. The moisture content of each sample was measured. The entire sample was placed in a metal pan and the weight of the pan plus the sample was documented. The pan containing the sample was then dried in a large oven at 105^{o}C for 12 hours. The moisture content of the sample was calculated as the weight of water initially in the sample (initial weight minus dry weight) divided by the initial wet weight of the sample. Sand was then removed from each item in the sample by a small brush and all sand was removed from the pan and the sample weighed again. The sand percentage is calculated as the difference in the sample weights (before and after sand removal) divided by the initial sample weight.

Next, each individual item in the bulk samples was identified, described, recorded and weighed. It was also noted if at least 50% of the item remained (to delineate between nearly full items and just item pieces). Approximate size of items (in categories) is also recorded, as well as, for example, when possible, if a bottle cap came from a water bottle, soda bottle or a larger mouth bottle (e.g., Powerade). While the database contains more detailed information than typ2ical beach cleanup volunteers or researchers will include in surveys, it is important to note this level of detail so that data is transparent when the items are aggregated together into an "average" mass of, for example, a bottle cap. To test the overall methodology and robustness of the database, eventually, the average mass of each item will be used to estimate the total mass of a sample and this will be compared to the actual mass of the sample. Further testing and refinement will continue as more debris is collected and submitted to become a part of the database.

While we are soliciting samples from the entire U.S. and would like to see a wide variety of samples from every coastal state, it is important to note that this research is not about characterizing a *specific beach* or *location* for marine debris, but about creating a large database of masses of individual debris items. Therefore, as long as products are standard throughout the U.S. (e.g., aluminum cans), and we don't aggregate items beyond this standardization, samples may come from any location. There will likely be items that are only aggregated regionally (e.g., some fishing gear) as it varies from region to region. However, the statistics performed will be based around the aggregate number of each item recorded, so, for example, the total number of cigarette butts in various categories (butt only or some tobacco left) will be important. Although we recognize that beach locations will influence the type of debris we receive to measure, we can then solicit specific debris items to fill in any gaps in the database later.

OUTCOMES

To date, a total of nine (9) samples have been received from four different states in the U.S. Eight (8) of these samples have been characterized for moisture, sand and item content (Table 1). Moisture content ranges from less than 1% to greater than 21%. Sand content ranges from 12% to 45%. The total number of items identified and recorded so far is 639. Table 2 contains an example of the data collected for each item in each sample (not a full sample, but a subset). Eventually data will be aggregated into average values for specific components. Table 2 also illustrates that items that repeat are similar in mass (e.g., straws, paper gum wrappers and cigarette foil packaging).

The level of detail of marine debris documented in this research could bring the characterization of marine debris to a new and important level. It will also provide percent by mass characterization, which will provide a different perspective on marine debris. The data will be posted publically, which will also provide education and outreach opportunities an expanded level of detail. This database will also allow for a greater characterization from beaches where scientific surveys do not always allow for collection and removal of debris.

PRIORITY ACTIONS

While we would like to gratefully acknowledge those that provided samples to us (six individuals), sample donations are desperately needed for this research. In order for this database to be robust and meaningful, multiple samples of debris are needed from every coastal state in the U.S. The database is going to be made publically available through a web portal so that it is available to the public and/or researchers in its most current and updated form. As long as funds are available the database will continue to expand.

FIGURES AND TABLES

Table 1. Marine Debris Sample Moisture and Sand Content and Number of Items

Sample ID	Date Sampled	Moisture Content	Sand Content	Debris Mass (g)	Number of Items in the sample
1	9/17/2010	0.58%	21%	400.29	144
2	12/30/2010	1.07%	N/A*	40.79	18
3	2/4/2011	5.99%	45%	183.3	62
4	1/30/2011	2.85%	39%	60.91	18
5	2/2/2011	0.27%	19%	9.33	2
6	1/31/2011	7.88%	32%	396.4	143
7	2/3/2011	21.4%	12%	718.53	127
8	11/27/2010	0.54%	14%	703.24	125

N/A = Not Available; Sand removed also included candle wax that melted in oven, so sand content not accurate

Table 2. Example of level of detail recorded for individual debris items (subset of Sample 3)

Item ID	Item Description	Mass (g)	50%?
1	Chip bag - individual	6.32	Yes
2	Grocery bag - large	5.35	Yes
3	Underwear - woman's size 8	16.2	Yes
4	Water bottle - plastic with label	9.8	Yes
5	Wet wipe	1.65	Yes
6	Wrapper - plastic	0.25	No
7	Can - aluminum, beer	16.14	Yes
8	Bottle cap - plastic water bottle	1.94	Yes
9	Receipt - paper	0.62	Yes
10	Receipt - paper	0.63	Yes
11	Plastic decking material - block	30.56	No
12	Wood block - half painted	44.16	No
13	Cat toy - plastic with metal bell	4.1	Yes
14	Styrofoam piece	1.1	No
15	Styrofoam piece	0.49	No
16	Bottle cap - plastic	2.61	Yes
17	Lipstick/Lip Balm (no cap, some balm) - plastic	6.26	Yes
18	Straw	0.93	Yes
19	Straw	0.84	Yes
20	Receipt - paper (parking)	0.75	Yes
21	Metal cap filled with grout (e.g., old fuse tip)	21.66	Yes
22	Marking tape - plastic, green - 4.5 inches	0.2	Yes
23	Wrapper - paper, gum	0.12	Yes
24	Wrapper - paper, gum	0.08	Yes
25	Cigarette packaging - foil wrapper	0.19	Yes
26	Cigarette packaging - foil wrapper	0.17	Yes

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3.c.5. A standard protocol for monitoring marine debris using seabird stomach contents: the Fulmar EcoQO approach from the North Sea.

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KEYWORDS
Monitoring; Litter; Plastic; Ingestion; *Fulmarus-glacialis*; Ecological-Quality-Objective; OSPAR; Europe

BACKGROUND
The ultimate fate and environmental impact of marine plastic debris is a major policy concern that requires reliable assessments of regional pollution levels and rates of change: such information is critical for efficient decision making and setting the right priorities of measures to be taken. Bio-monitoring can provide such assessments by integrating pollution levels over space and time with an immediate link to ecological impact. It is the ecological impact that generates public awareness of the urgency of the problem and the willingness to accept and support measures to deal with that problem.

METHODOLOGY
Seabirds that regularly ingest marine debris, like many tubenoses, are suitable bio-monitors of litter in the marine environment. In Europe, in the North Sea, regional differences and trends in marine litter are monitored by the abundance of plastics in stomachs of beached Fulmars (*Fulmarus glacialis*). Fulmars forage only out at sea and usually retain poorly digestible particles in their stomach. The accumulated plastics in their stomachs provide an integrated picture of litter abundance in their foraging area over a longer period of time.

In the 2002-2004 'Save the North Sea' campaign (www.savethenorthsea.com), a wide range of persons and organizations joined forces in a program collecting beached Fulmars for marine litter research. This group has been able to continue its work until present. Procedures for dissections, stomach analyses and data processing have been standardized as one of the Ecological Quality Objectives (EcoQO's) for the North Sea by OSPAR *(Convention for the protection of the marine environment of the North-East Atlantic*). The dissection protocol (van Franeker 2004) include details to assess age, sex, condition, origin, cause of death, etc. In a pilot study in the Netherlands (van Franeker & Meijboom 2002) only age was found to have an effect of the amount of litter in the stomach, with younger birds having more plastics. But for robustness of future analysis, records of potentially relevant other variables are maintained.

Contents of the complete stomach, that is the combination of the glandular proventriculus and the muscular gizzard, are rinsed over a 1mm sieve and then sorted under binocular microscope.

Remains are categorized into various plastic types (industrial pellets and various user categories), other rubbish types and natural components (see project reports for details). Plastic categories are counted for number of particles and weighed on an electronic mass balance with accuracy to 4th decimal of a gram. The OSPAR EcoQO mainly looks at a simplified overall figure related to the mass of all plastics in the stomachs, but details on sub-categories assist in data interpretation.. The following conventions and definitions apply:

- **'Incidence'** is the percentage of birds in a sample having plastic.
- **'Averages for the numbers or mass of plastics'** refer to 'population averages', so calculated over a sample including the birds that had no plastics at all.
- **'Current Situation'** = the situation over the most recent 5-year period, in which data are calculated from all individuals *(i.e. not from annual averages)*.
- **EcoQO Compliance or Performance** = the percentage of birds in a sample that have 0.1 g or more plastic mass in the stomach
- **EcoQO Target'** = the policy target set by OSPAR for 'acceptable environmental quality' is defined as the situation where less than 10% of beached Fulmars has more than 0.1g of plastic in the stomach over a continuous period of at least five years for all North Sea regions (OSPAR 2008)
- **Temporal Trends** are tested by linear regression fitting ln-transformed plastic mass values for individual birds on the year of collection over the past 10 years (='recent trend') or over a full dataset ('long-term trend'; for the Netherlands first individual 1979). Birds without any plastics are included in the analysis by addition of an imaginary 1 mg plastic to all stomach contents prior to logarithmic transformation.
- **Regional Differences** are evaluated by fitting data from individual birds in a negative binomial generalized linear model and tested by likelihood ratio test.

OUTCOMES

The dataset for the Netherlands starts with a good sample from the first half of the 1980s, then has few birds until about 1995, after which an unbroken series of good annual samples is available. Data on EcoQO performance over the full period are shown in figure 1. Being the defined time-frame for conclusions on environmental status and avoiding short term fluctuations, all data are presented on the basis of 5-year periods. Over the 2005-2009 period in a sample of 226 Northern Fulmars from the Dutch coast, 58% of the individuals had more than 0.1 gram of plastic in the stomach, which is strongly above the policy target of a maximum of 10% of such birds. More specifically, plastic incidence among Dutch Fulmars in this 5 year period was 95% with an average ± se number of 27.3±2.5 pieces per bird, and average mass of 0.28±0.03 gram. Between the 1980s and 1990s industrial plastics showed significant decreases, but user plastics very sharp increases. From the 1990s the trend for user plastics reversed and was significantly downward until 2006, after which the decrease came to a halt. Currently levels seem stable. The analyses do suggest some decrease for both industrial and user plastics but at an extremely low rate and not at a statistically relevant level. Measures like the European Directive on Port Reception facilities (EC 2000) may have assisted in stabilizing pollution levels, but have not reduced the amount of litter.

In the wider North Sea, current levels for EcoQO performance range between roughly 40% to 80% of Fulmars exceeding the 0.1g critical limit of plastic in the stomach. Heaviest pollution is found in the French-English Channel with gradually declining pollution levels when going further north (Figure 2). Shipping and fisheries are considered the main sources of plastics in the North Sea. In the North Atlantic, the OSPAR EcoQO target for acceptable ecological quality is probably only met in its high arctic regions. Fulmars are widely distributed and numerous over much of the North Atlantic and Pacific, making them very suitable for comparative monitoring over a wide area (e.g. Mallory 2008; Provencher et al 2009; Hyrenbach et al. 5IMDC abstract 204) In areas where Fulmars do not occur, feasibility of other species for bio-monitoring of marine litter should be tested. This needs for example to be done for implementation of the European Marine Strategy Framework Directive (EC 2008; Galgani et al. 5IMDCAbstract 20) where Fulmar monitoring can only cover part of the marine areas.

The Fulmar EcoQO approach has shown that monitoring litter abundance through marine animals can provide a reliable scientific tool for policy decisions and at the same time is an powerful instrument to increase awareness among public and stake-holders promoting the understanding for, and willingness to comply with measures.

PRIORITY ACTIONS
Governments should facilitate long term bio-monitoring of marine litter in order to:
Obtain reliable information to make the right policy decisions
Generate awareness and support for their policy decisions
obtain reliable information on the effects of policy decisions

FIGURES AND TABLES

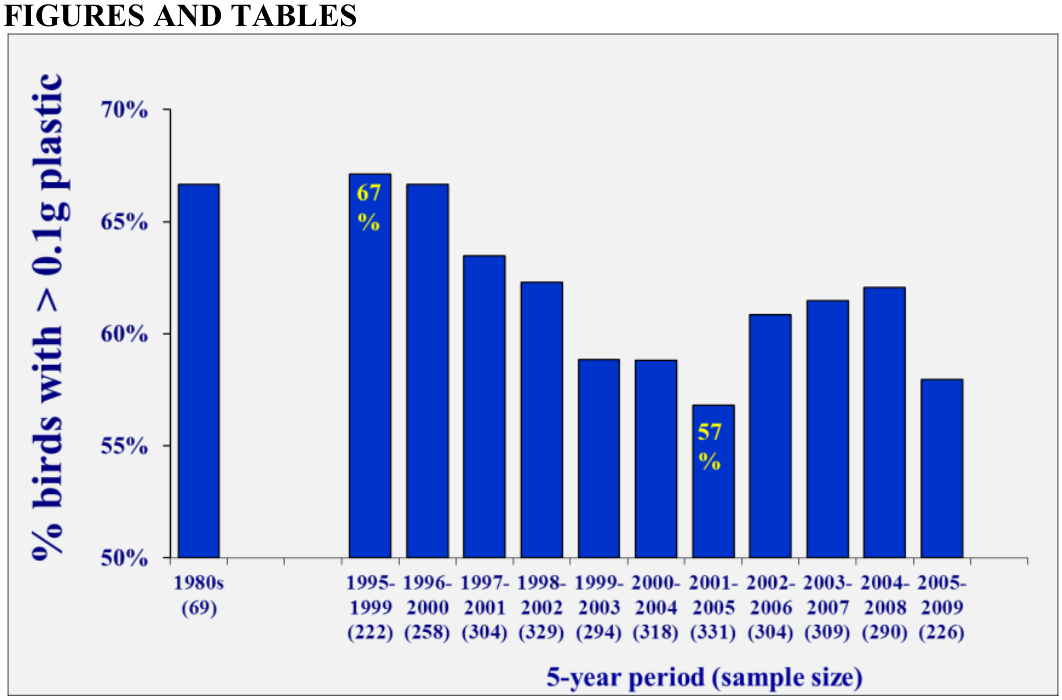

Figure 1. Trend in EcoQO performance in the Netherlands (% of beached fulmars having more than 0.1 gram of plastic in the stomach - *running 5-year arithmetic average for all ages, all plastics; note y-axis starts at 50% in this graph, where reduction target is below 10%).*

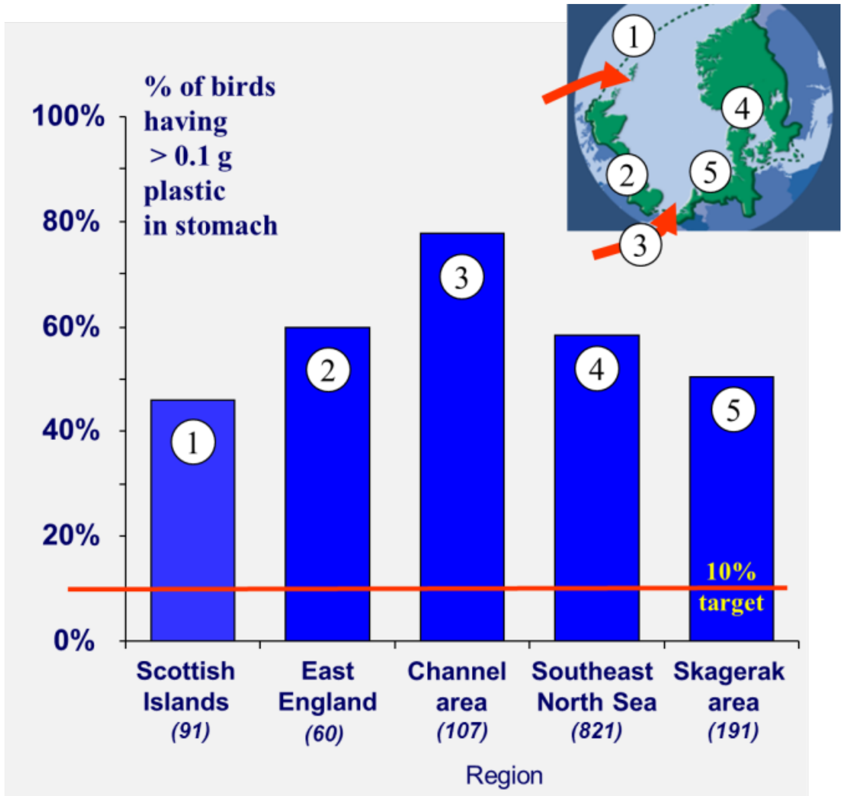

Figure 2. Regional pattern of EcoQO performance in the North Sea (% of beached fulmars having more than 0.1 gram of plastic in the stomach - *5-year arithmetic average 2003-2007 for all ages, all plastics)*

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3.c.6. Plastic ingestion by North Pacific seabirds: progress review and future directions

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ABSTRACT
Over 50 species of North Pacific seabirds have been documented to ingest plastic marine debris, with mounting evidence of higher incidence and larger loads over time. The widespread nature of this pollution warrants a review of progress to date and a discussion of the challenges facing this evolving research field. To this end, we compiled published and unpublished reports of seabird ingestion of marine debris, and critically evaluated the literature to assess progress in terms of: (1) study objectives and approach, (2) experimental design, and (3) reporting of results. We performed a meta-analysis of the resulting database (> 200 species records and 10,000 specimens) of incidence of plastic ingestion, spanning from 1969 to the present. These analyses revealed increases in the incidence of plastic ingestion, especially for surface-foraging species. Even though the taxonomic scope of the studies has narrowed over time to include fewer species, the sample sizes have increased to include specimens from different sources (bycatch, beach cast, collections) and stages of the life-cycle (breeding adults, non-breeding adults, chicks). Thus, we contend that three critical steps are needed: (1) continuation of standardized time series comparable to historical samples, (2) performance of comparative studies to assess potential biases across sample sources, and (3) development of non-lethal methods for monitoring plastic ingestion in seabirds. We finish by making a series of recommendations for developing standardized metrics of plastic ingestion, and present an initiative for the use of seabirds as biological sensors of marine debris in the North Pacific Ocean.

4.a.1. Expanding the reach of a one-day event: California Coastal Cleanup Day's year-round impact

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KEYWORDS
Coastal Cleanup, Education, Behavioral Change, Debris Reduction.

BACKGROUND
California Coastal Cleanup Day has long been California's biggest volunteer event, annually bringing more than 75,000 volunteers out to the shorelines of the state, and removing over 1 million pounds of debris each year. The Cleanup, which is the single largest contributor to the International Coastal Cleanup, organized by Ocean Conservancy, has even been cited by the Guinness Book of World Records as the "World's Largest Trash Pickup" (1993). But despite these enormous numbers, and the unquestionable impact of California Coastal Cleanup Day on that third Saturday of each September, what effect does this effort have during the other 364 days of the year? The California Coastal Commission, organizers of the Cleanup in California, has long wrestled with this question, and in recent years, has developed a number of innovations to lengthen the life of the Cleanup beyond what might normally be found associated with a one-day event.

METHODOLOGY
The Coastal Commission undertakes a number of outreach efforts to spread the reach of California Coastal Cleanup Day to new audiences, including significant media outreach through both paid and earned media. The Cleanup generally earns upwards of 400 print media articles each year, along with hundreds more in radio, television, and web outlets. The impressions left by these media hits help extend the reach of the Cleanup far beyond the thousands of volunteers who actually participate in the Cleanup. More recently, social networking sites have played an increasing role in the Commission's ability to build discussions and community around the issues the Cleanup tackles. Most importantly, these sites have allowed for the development of conversations around pressing environmental issues with new communities that would not otherwise be receiving these messages.

The Commission has also launched several educational efforts that have enabled year-round impact from the one-day event. The Commission's formal curriculum, *Waves, Wetlands, and Watersheds*, includes lessons focused on Coastal Cleanup Day. Directed at classroom teachers, these lessons help draw students and teachers into extended learning sessions that greatly increase the impact of the Cleanup. The Commission's most recent initiative, "BYO for CCD," marks our most ambitious campaign to date. It is an effort to help reduce the negative environmental impact of the Cleanup itself by encouraging volunteers to bring their own reusable cleanup supplies from home, rather than utilizing the single-use, disposable products that the Commission supplies for every Cleanup site. This new campaign not only promises to reduce the amount of waste created by the Cleanup itself, but also to demonstrate the simple behavioral changes that everyone can make that will significantly reduce the amount of potential marine debris we collectively generate.

OUTCOMES

One of the most significant measurements the Coastal Commission uses to validate its efforts in partnering with statewide media is the number of volunteers who turn out for California Coastal Cleanup Day each year, since we have seen over time that the Cleanup itself is one of the most effective educational endeavors we can undertake. By that simple measurement alone, the Commission's outreach efforts have been a phenomenal success: participation in the Cleanup has risen by 62 percent over the past fours year, from around 50,000 in 2007 to over 82,500 in 2010. Participation in the Cleanup alone, however, does not compel behavioral change, which is ultimately what the Cleanup seeks.

Through the development of curriculum lessons for formal educators and on-line conversations that promote informal exploration of the topic of marine debris, the Commission has sought to make California Coastal Cleanup Day an educational event, rather than only a volunteer event. Surveys of Cleanup participants show that the Commission has been successful in this effort: as one example, survey results show that 77.7 percent of Cleanup participants felt knowledgeable or very knowledgeable about the impacts of marine debris after taking part in the Cleanup, as opposed to 61.2 percent who felt that way before the Cleanup.

The Commission's goal is to impart the knowledge necessary to help Cleanup participants and others make small lifestyle changes that may lead to larger and more significant pro-environmental changes. Using the tools described above, and specifically the new "BYO for CCD" campaign, the Commission is providing the tools and incentives necessary for turning knowledge into significant changes in behaviors and attitudes. The BYO Campaign, only in its infancy, is already showing great potential: in 2010, over one quarter of all Cleanup participants brought at least one reusable cleanup supply from home, which helped reduce the demand for single-use plastic bags significantly (40,000 fewer than were used in 2009). These changes, and the long-term impacts of these changes, are what will ultimately be needed to bring the challenge of marine debris under control.

PRIORITY ACTIONS

The priority actions for local Cleanups to take in order to expand the reach and impact of their events are:

- Partner with both local media and formal educators to help develop compelling messages that will engage the general public and students in ongoing education about the sources and impacts of marine debris;
- Develop new initiatives that can increase interest in the Cleanup while also educating potential participants about the sources of the debris we are seeking to remove.

4.a.2. Scaling it up: advancing the environmental literacy of citizens through local, regional and global education and outreach efforts.

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ABSTRACT
Although the marine science community continues to investigate, understand, and predict changes in the earth's environment, the task of increasing the environmental literacy of the general public is an essential component to the overall health of the planet. Providing the public with accurate, reliable, relevant and accessible information about the environment has been challenging. We have developed an education and outreach strategy that bridges the gap between the scientific community and that of the general public. Our approach is to engage the public on local, regional and global marine debris issues in both formal and informal settings, inspire them to take action, realize the consequences of their actions, and assess the impact of our interaction by learning progressions based on formative assessment. Our new interactive web assisted virtual education sustainability (WAVES) website allows us to track the progress and impact of our efforts at local, regional and global scales.

4.a.3. Raising awareness: the ripple effect of acting local and thinking global

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KEYWORDS
Plastic pollution, education, outreach, Rise Above Plastics, bag bans, polystyrene

BACKGROUND
This presentation will focus on the education and outreach initiatives of Surfrider Foundation's Rise Above Plastics program, with the mission to reduce the impacts of plastics in the marine environment by raising awareness about the dangers of plastic pollution and by advocating for a reduction of single-use plastics and the recycling of all plastics.

The presentation will cover the success and challenges associated with grassroots outreach used to promote individual awareness of the marine debris problem and to spark behavior change. The foundation of awareness and creating change for the greater good is to first educate the public. Once people are educated about the harms of plastic to our oceans, they ask "What can I do?" Surfrider's RAP program is geared at grassroots and peer-to-peer education through local in-person meetings and online social media tools. By using these tools, the program works to reduce marine debris by the reduction in consumption of single-use plastics.

Some "Best Practices" that will be discussed during the presentation include the 1) Grassroots Chapter model, 2) Online Outreach, and 3) PSAs, Marketing and Media.

METHODOLOGY
Surfrider Foundation has a unique and effective grassroots chapter model, comprised of over 55,000 volunteers in various localities. Surfrider's Rise Above Plastic program has gained momentum from existing chapter beach clean-up activities. All 79 of Surfrider Foundation's domestic chapters and approximately 150 chapters worldwide engage in clean-up activities. Once the volunteers see the trash on the beach, they want to become more engaged in how to stop the proliferation of ocean litter and the harm to our beach and ocean environment. Because plastics comprise up to 90% of all floating marine debris and a large portion of what is picked up off of our beaches, Surfrider activists see first hand the problems of plastic pollution. (ENDNOTE 1) The grassroots, chapter-based Rise Above Plastics campaigns grow out of these experiences. The campaign goals vary from purely educational efforts to a focus on enacting local bans on plastic bags and/or polystyrene. Many chapters combine their outreach and awareness efforts with advocacy efforts, which, for example, encompass municipal ordinances to ban expanded polystyrene foodware packaging or support a better plastic bottle recycling law.

From Surfrider Foundation Headquarters, located in San Clemente, California, staff works to support and coordinate chapter campaigns. The strength behind the RAP program, however, lies in the chapter volunteers and the peer-to-peer information and strategy sharing that takes place. For instance, a Powerpoint presentation developed by an activist in Monterey, based on information from the Algalita Marine Research Foundation, was presented at state and region-wide chapter conferences and several local chapter meetings to educate people about the harms of plastic pollution on the ocean. This Powerpoint and several others were made available for Surfrider Foundation activists to share at community presentations to school groups, Rotary Clubs, other environmental group meetings and the like. Several other Chapters and volunteers have made their own presentations to cater to different age groups and local interests, which are constantly being shared and presented in local communities.

OUTCOMES

The RAP program has helped to effect local change by first raising awareness of the harms of marine debris on our ocean environment, and then supporting sound and balanced local policy efforts to address these harms.

Online Presence and Tech Tools

Surfrider Foundation's worldwide Web presence reaches over 22,000 people on Twitter, 107,000 via Facebook, and countless others through our social media channels and chapter online activities. Through these online channels, Surfrider has gathered support for our Rise Above Plastics program. Specifically, Surfrider Foundation has gathered approximately 200,000 views of our RAP Whale PSA, 80 unique visitors a day on our Rise Above Plastics Blog, and over 17,000 Rise Above Plastics pledge signatures. This RAP pledge states that the signatory will strive to reduce their plastic footprint by using reusable products such as bags and bottles. Surfrider Foundation is also engaging people through smart phone applications like "Extraordinaires" which allows you to take a picture of the pollution you see and report it to others via mobile phone.

Education and Community Presence

Surfrider Foundation's grassroots model leads to strong community and local ties, which allow for peer-to-peer education opportunities. Surfrider Foundation chapters organize school presentations on marine plastic pollution as well as presentations to other community groups. Within schools, we have a Youth Service Program that is thriving in High Schools and some Junior High Schools. These Youth Service Organizations under the Surfrider banner are focusing on increasing awareness of plastic pollution, advocating for local plastic bag and polystyrene bans or increasing recycling opportunities within schools. The High School Clubs are required to do at least one service project a year, many of which fall under Surfrider's RAP program. Additionally, Surfrider Foundation has encouraged the intersection of art and ocean awareness with projects like the Plastic Sea Monster, made by elementary school students; the Plastic Wave, made by a chapter activist and on tour at community events to raise awareness; and the Rise Above Plastics class at Otis School of Design in Los Angeles.

Through the RAP peer-to-peer presentations, where chapter activist leaders were taught about the plastic pollution problem and then equipped to teach others, Surfrider Foundation reached over 20,000 people in the Los Angeles area alone. Chapters are also engaged in community awareness activities through reusable bag giveaways. By way of example, our San Diego County Surfrider Foundation chapter has given away over 7,000 reusable bags in the past year. These bags were purchased with grant funding and were made in the United States from recycled cotton.

In order to improve education and outreach efforts, it is very important that research entities and governmental agencies offer and continue to make available reliable facts and figures about ocean pollution. Where there is a dearth of information, Surfrider Foundation relies upon these entities to engage in research to elucidate the problems of marine plastic pollution. Additionally, The coastal litter cleanup programs engaged in by every grassroots chapter could be made more effective by using a standardized data card for volunteers to record and collect data. These cleanup efforts help not only in protecting marine life that are endangered by trash pollution, but also help to keep a clean and beautiful coastline. In turn, the improved aesthetics of the beach help to improve coastal tourism revenues for the local communities.

Thriving Chapter Campaigns

Surfrider Foundation has over 30 individual chapters engaged in the RAP program with detailed chapter campaign activities and goals. In the past three years, the Rise Above Plastics Program has resulted in over 15 RAP victories (see www.surfrider.org/wins) in the form of plastic bag bans, polystyrene foodware bans or better recycling laws and availability. Two notable success stories are the 5-cent fee on single-use bags that was implemented in Washington, DC and a plastic bag ban on Kauai. In DC, initial results of the fee indicated that single-use bag usage was down 60% and the fee was put toward restoration of the local Anacostia River. The Surfrider Foundation DC Chapter garnered a major win in this case. Similarly, our Kauai Surfrider Chapter worked for two years on a campaign to ban single-use plastic bags on their island and were successful in October 2009.

This Rise Above Plastics outreach program is an experienced, effective and useful model for raising awareness of the problem of plastic pollution. Surfrider Foundation and other non-governmental organizations (NGOs) have been doing a very successful job of advancing education efforts in relation to marine debris. The NGOs should be supported in these efforts.

PRIORITY ACTIONS

To reduce the vast amount of land-based marine debris, implement bans and fees on easily littered items. Bans are more appropriate for items that are likely to become marine debris and have readily available alternatives (such as reusable bags). Fees are more appropriate for items that are likely to become marine debris and do not have readily available alternatives.
Establish target reduction or reduction requirements of plastic pollution within a specified time frame, such as the California Ocean Protection Council's Marine Debris Resolution of 2007.
Increase available research and factual information regarding the source, proliferation, and effects of plastic pollution on the marine environment and public health.

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4.a.4. Marine debris can save the world

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KEYWORDS
Behavior change, norm activation, littering behavior, marine debris solutions

BACKGROUND
We need a new world view, a new perspective from which we see and interpret the world in order to save the planet. We need a world view based in humility rather than hubris, service rather than entitlement, hope rather than pessimism, and global unity rather than blind nationalism. This is not a new idea. A long list of ecophilosophers, theologians, biologists, economists, environmentalists and ecologists have been urging a shift in our core views and beliefs for decades. Calls to change our ways have been echoing around the planet, but what seems to be missing are clear suggested paths forward to transform our world view, our perspectives and beliefs, for the un-environmentally indoctrinated. We need progress toward ecological consciousness for the non-green, non-deep ecology crowd, for the non-choir. Taking action on litter and marine debris can be a simple step on the path forward. It can provide glimpses of the new perspective we need.

METHODOLOGY
A literature review was conducted to determine the primary sources of land based marine debris, the cause of littering behaviors that lead to marine debris, road blocks to behavior change and ways to affect behavior change. This information was used to determine what points need to be emphasized before, during and after marine debris clean ups to affect behavior change, which ultimately affects the source of marine debris, and other environmental behaviors.

OUTCOMES
Litter and marine debris clean ups can be much more than just picking up trash. When framed correctly, these simple, accessible acts can be a part of this needed transformation of thought. All of the character traits we need for a shift deep in our ecological thinking are present when we pick trash: humility, service, hope, and empowerment. Litter and marine debris cleanups can inspire simple behavior and habit changes that can spawn larger ones. And these can get at the crux of the problem: changing our core world view from one that entitles us to over consume, to one that encourages moderation.

If framed correctly, litter and marine debris cleanups can help people recognize the effects of their actions and can establish personal responsibility for the marine debris problem, which are both needed to affect behavior change. Recognizing the effects of our actions and accepting responsibility are the same changes we need to solve other global environmental problems. When clean ups are done with the right frame of mind, these simple acts, sometimes viewed as pointless, may open the door to changing world views, just enough to effect the deep central change our species needs to survive.

PRIORITY ACTIONS

Introduce the marine debris problem before the cleanup to establish the right frame of mind – local empowering action as a solution to a large global problem. Highlight what items were found and where they come from, discuss the effects these items have on the environment, relate the source of these items to our daily activities to connect people to the problem, and establish personal responsibility. Focus on the positive character traits (humility, service, hope, empowerment) exhibited during the cleanup. Focus on consumer choice to reduce consumption and encourage ongoing cleanup efforts. Encourage continuing connection between people who participate in cleanups throughout the year.

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4.a.5. From cleanups to the classroom to community events: marine debris education in San Diego

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KEYWORDS
Marine debris education, single-use plastic, film screening, community event, cleanups

BACKGROUND
San Diego Coastkeeper, a part of the Waterkeeper Alliance, has coordinated community cleanups in San Diego for the last 15 years. In answer to multiple calls to become involved in more than just removal, educating and advocating for debris reduction on a local and a statewide level, we created our Marine Debris Program in 2008. The program involves removal, education and advocacy as a means to reduce sources of plastic pollution in San Diego County. Cleanups educate the public, especially when they collect data about the types of trash on our beaches and bays. Our removal data, formally introduced in 2007, has proven essential for dictating the direction of our advocacy work in support of cigarette butt, plastic bag, bottle, and Styrofoam reduction legislation as well as stricter stormwater regulation of trash. Coastkeeper also performs community education outside of cleanups, such as film screenings and public forums, helping us accomplish our goal of source reduction and advocacy for plastic pollution prevention in San Diego.

OUTCOMES
Cleanups are an essential way to engage the public in actively reducing debris and collecting data to learn about the types of trash in our environment. At our registration table, our educational outreach materials include a marine debris poster, jars of debris from Hawaii, albatross boluses, and Pacific Gyre sample, materials for current legislation, and a whiteboard with cumulative weight total of trash collected at that cleanup. Data cards also force volunteers to note what they are picking up, and we present this data annually in our organization's materials, on our website, and on our interactive online wiki.

Coastkeeper works to ensure that students receive the marine debris lessons incorporated into our Project SWELL 4th grade lesson, which was implemented in 2008. Project SWELL (Stewardship: Watershed Education for Lifelong Leadership) is a hands-on K-12 water quality and pollution prevention curricula balancing environmental and scientific studies which enhances science curricula. The curriculum is managed in partnership with the San Diego Unified School District, The City of San Diego Stormwater Department – Think Blue, and San Diego Coastkeeper. The 4th grade lesson, which reaches about 10,000 students at 130 different schools, teaches about "pollution you can see": the behavior and identification of trash in the environment, impacts of plastic debris downstream, and a fun hands-on activity modeling entanglement.

For the general public, Coastkeeper regularly hosts community events including movie screenings and lectures. Free movie screenings for documentary films such as *Tapped* reached over 500 people in 2009, with Q & A and special guest speakers before and after the screenings. A marine debris forum hosted by San Diego Coastkeeper in 2010 focused on solutions to marine debris, and included a Scripps Institution of Oceanography scientist, a representative of the Regional Water Quality Control Board, the sustainability coordinator from the City of Santa Monica, and local elected officials. Attendance soared above expectation to nearly 100 people. Essential elements of our events program is to use the best information available, make events free and open to public, and perform effective marketing of events with community partners.

PRIORITY ACTIONS

Collect data at all cleanups to educate the public about debris types and sources, and use this data in other educational efforts for plastic pollution reduction.

Include marine debris lessons and topics in science curricula, such as in the Project SWELL 4th grade lesson, and connect teachers with the most updated information about marine debris.

Regularly host educational community events to connect scientists, professionals, politicians, and activists to the latest developments in the field, including scientific studies, legislation, and other plastic pollution reduction measures.

4.b.1. Understanding the types, sources, and at-sea distribution of marine debris in Australian waters

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KEYWORDS
beach cleanup, marine debris, oceanographic modeling, threat

BACKGROUND
Marine Debris is a major issue for the integrity of marine ecosystems in Australia, with anecdotal reports of impacts on wildlife ranging from entanglement and drowning to increased transport of pollutants into food chains. While researchers have identified some animal populations that are heavily impacted by marine debris, such as turtles in the marine region to the North of Australia and seabirds nesting on some offshore islands, it is difficult to develop a synoptic description of the threat to ecological systems. This uncertainty is due in large part to a lack of understanding of the types of debris in marine systems and an inadequate quantitative description of the sources and at sea distribution of debris. To address the issue we have completed a data audit of marine debris monitoring sites across Australia, developed a profile of debris washing up on beaches across Australia, and built a predicted distribution at sea off Australia incorporating an ocean drift model to evaluate likely domestic vs. foreign contribution to local marine debris. We discuss our findings in relation to their application and relevance beyond Australian waters.

METHODOLOGY
We compiled data from beach clean up efforts in Queensland, Victoria, New South Wales, Western Australia and Tasmania. Because of differences in data collection among years, sites and states, not all data were comparable. From available data we identified high quantity sites with multiple years of data and at these sites we compared quantity and type of debris recorded.

We then built a predicted distribution of marine debris at see off Australia using a model of ocean drift that predicts particle movement in association with surface currents and wind. The model can be used to detect likely destinations or probable origins of marine materials. We released 'virtual particles' at multiple points across the region, as well as at cities along the coast to evaluate likely domestic and foreign contribution to local marine debris.

OUTCOMES
We found strong seasonal differences in marine debris origin and movement across the Australia. These differences varied amongst locations and seasons and appear to be driven by local currents and windage. While types and proportion of debris at selected sites were similar, debris such as hard plastic pieces and plastic bags occurred in higher frequency in areas with

larger population numbers. This approach can readily be applied to other continents and systems to understand movement and impacts of marine debris at local, state and national levels.

PRIORITY ACTIONS

This work demonstrates the importance of consistency in data collection for making large scale comparisons across sites, regions, states and continents. Seasonal and regional differences in movement of marine debris in the ocean were apparent, implying that survey and clean-up efforts will need to consider these prevailing patterns.

Overall patterns in the movement of debris also suggest areas that might be potential sources. In contrast to common assumption, Australia appears not to be a sink for debris from surrounding countries, with most drift predicted to be toward Indonesia and other neighboring countries. This suggests that priority be given to high seas sources and domestic sources, as they appear to generate the largest fraction of debris along Australian coastlines.

4.b.2. Impact of ingested marine debris on sea turtles of eastern Australia: Life history stage susceptibility, pathological implications and plastic bag preference.

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KEYWORDS
Sea turtles, impaction, perforation, life stages, marine debris, rubbish

BACKGROUND
Marine debris has become an increasingly significant problem, with impacts on numerous wildlife species. At least 177 marine species, including most of the world's seabirds and sea turtles have been recorded to ingest marine debris (Laist 1997). Ingestion of marine debris causes gut impaction, which is a clinically recognized condition that can cause paralysis of the gut, inhibiting the digestion process. Ingested debris can also puncture the gut lining, causing peritonitis, ileus or septicemia (Bjorndal 1997; McCauley and Bjorndal 1999). Prior to the current study, little was known about the impact of ingested marine debris on sea turtles found in Australian waters. The implications of debris ingestion for three of the most common Australian species of sea turtles, *Chelonia mydas, Eretmochelys imbricata* and *Caretta caretta*, as well as one *Natator depressus* were examined.

This study addressed four questions: 1 How widespread is the problem of ingested marine debris for stranded turtles sourced near one of Australia's fastest growing cities?, 2 Are certain species or life stages more susceptible to debris ingestion?, 3 What are some of the pathological implications of ingested marine debris (is perforation or impaction more of an issue)? and finally, 4 Are sea turtles targeting certain types of debris above and beyond what is available in the environment?

METHODOLOGY
Specimens were sourced from individuals found stranded within the coastal waters extending from 27° 37'S 153° 21'E to 26° 36'S 153° 08'E, in south-eastern Queensland, Australia between late 2005 and early 2010. Animals were either dead when found washed up on shore or perished after rehabilitation attempts. Necropsies were performed on 115 individuals (88 Green, 24 Hawksbill, 2 Loggerhead, 1 Flatback) and cause of death determined (when possible) using gross anatomical observations. Animals were placed into the following life history categories (post hatchling, lost years, new recruit, coastal immature and sexually mature) based on curved carapace length (CCL) and external observations (such as color of plastron, presence of plastron ridges and carapace serrations in green turtles). Sea turtles ranged in size from post hatchlings (minimum 6.1cm CCL) through to sexually mature adults (maximum 105.8cm CCL) with a mean size of 44.2 CCL (+/- 1.6 SE). Moreton Bay has been reported to have a sex bias towards

females (Limpus et al 1994). Accordingly, 79 of the turtles were female, 28 male and 8 were unknown.

Beach surveys were conducted where debris affected turtles were found stranded. A 100m long transect line was run parallel to the waters edge and debris was collected within this area from the waters edge to the storm surge line (18 to 70m wide). Debris was sorted into broad categories and compared to debris sourced from the gastrointestinal tract of marine turtles.

OUTCOMES

Marine turtle stranding records from Queensland indicate that interaction with debris (entanglement and ingestion) caused an average of 20% of stranding incidents between 1999 and 2002 for which a specific cause could be identified (Ceccarelli, 2009), while necropsies conducted by the author of this proposal has shown that 36% of turtles sourced from the eastern Moreton Bay region have died through the interactions with marine debris (30% ingestion, 6% entanglement) (Figure 1). Representatives of all four species studied were found to have died through the ingestion of marine rubbish (Green 28%, Hawksbill 29%, Loggerhead 50%, Flatback 100%). While 30% of all turtles were found to have ingested quantities of marine debris that contributed to cause of death (Figure 1); post hatchlings (67%), lost years (100%) and new recruits (41%) were most likely to be affected (Table 1). Various factors including size of animal, feeding strategy (surface feeding), location during life stage (open ocean vs. coastal areas) and length of time in open ocean may all play a role in the probability of the turtles dying due to ingested marine debris.

The other primary cause of death is due to heart blockages caused by a blood fluke from the spirorchiid parasite group (33%) (Figure 1). A similar study conducted on the western side of Moreton Bay found 41% of animals impacted by this naturally occurring parasite (Flint et al 2010). As any parasitologist knows, a successful parasite should not kill its host, for it kills itself in the process. It has been proposed that the large number of turtle deaths resulting from this naturally occurring parasite is due to decreased health levels of the local turtle population (Flint et al 2010), this in turn may be linked to pollution levels found in Moreton Bay. For example, dioxin concentrations found in the lipids of dolphins, dugong and green turtles from Moreton Bay have been shown to be high relative to other marine animals worldwide (Gaus et al 2001).

Of those animals that ingested marine rubbish, impaction (83%) was found to be a bigger issue than perforation (17%). The toxic implications of ingested plastic retained long term in the gastrointestinal tract are yet to be fully understood. Over 50% of the inorganic material sourced from the gastrointestinal tract was from flexible, film like plastics (e.g. plastic bags and cling film). This was significantly more than the proportion of these plastics found in surveys of rubbish washed up on surrounding beaches, supporting the hypothesis proposed by Mrosovsky et al (1981) that turtles may be targeting this material (Figure 2). Further investigations into the feeding behavior and visual acuity of sea turtles may provide insight into why sea turtles target the film like plastics.

PRIORITY ACTIONS

Marine debris is no longer just impacting animals that live close to populated areas. The problem has spread much further off shore, with oceanic staged turtles being impacted more than coastal zone ones. Priority actions that are recommended include 1. Developing drift models to determine the overlap of marine debris and turtle populations and 2. Conducting experiments to determine how and why turtles interact with marine rubbish by identifying visual and olfactory cues, which may be important in resource selectivity.

FIGURES AND TABLES

Table 1: Proportion of the sea turtles (all species combined) impacted by marine rubbish, sorted by life history stages.

Life history stage	CCL range (cm)	Number of debris induced deaths	Total necropsies	Proportion
Post hatchling	5 to 10	4	6	67%
Lost years	11 to 28	4	4	100%
New recruit	29 to 35	7	17	41%
Coastal immature	36 to 70	17	79	22%
Sexually mature	70+	2	9	22%

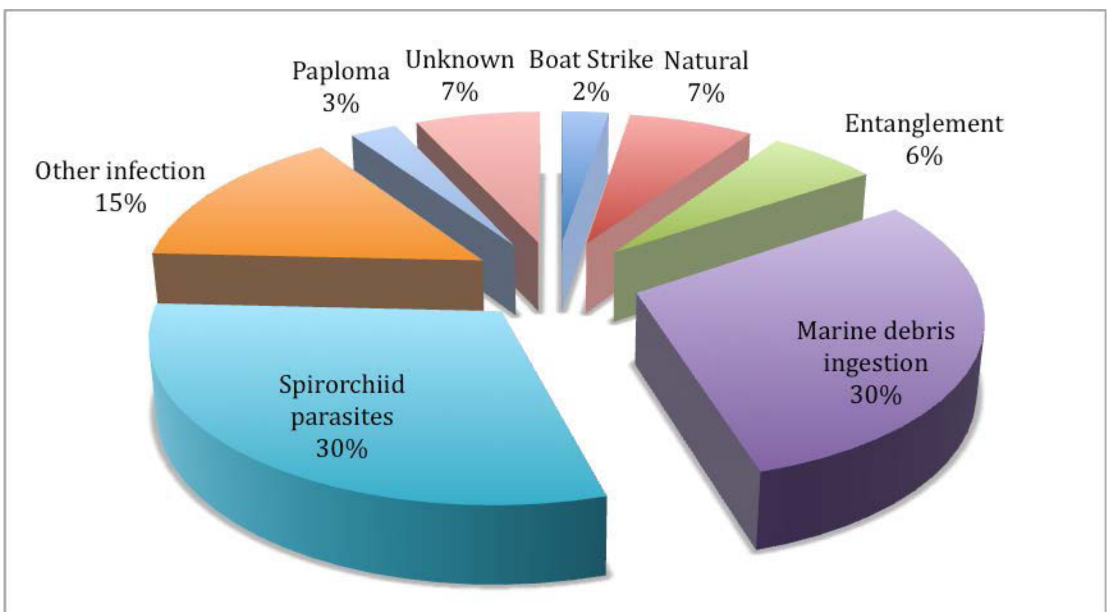

Figure 1. Necropsy results conducted on 115 turtles stranded from late 2005 to early 2011. Marine debris ingestion accounted for 30% of deaths.

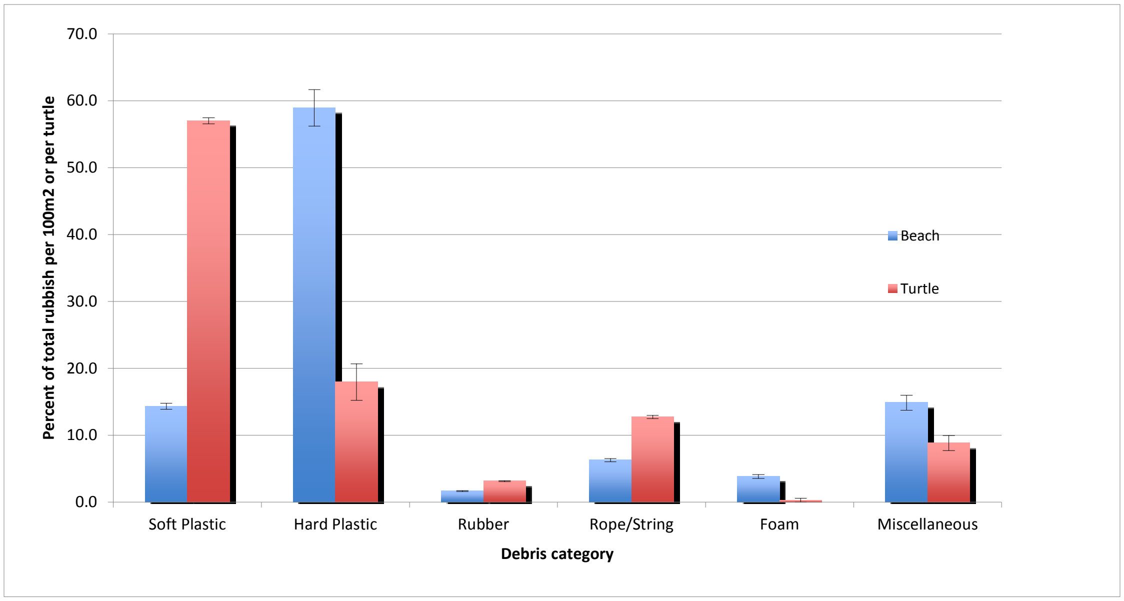

Figure 2. Proportion of total rubbish found per 100m2 on the beach or per the gastrointestinal tract of stranded sea turtles (n=13 beaches and n=13 turtles). Chi square values were highly sign different (Chi 172, 5=df, P>0.0001)

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4.b.3. Evidence for increasing plastic ingestion in northern fulmars (*Fulmarus glacialis rodgersii*) in the Pacific

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KEYWORDS
plastic ingestion, seabirds, bio-indicator, northern fulmar, Alaska, California, *Fulmarus glacialis*

BACKGROUND

As early as the 1970s researchers remarked on the propensity of seabirds, particularly surface-feeding species, to ingest plastic marine debris (Baltz and Morejohn 1976). Since this time studies have shown increases in the number of species affected in the North Pacific has increased (Day 1980, Robards et al. 1995) as has the North Atlantic (Provencher et al. 2010) and the frequency of ingestion (incidence) also has increased (Blight and Burger 1997, Vliestra and Parga 2002).

We lack appropriate bio-indicator metrics for plastic marine debris in coastal waters of North America (Hyrenbach et al. 2008). Such metrics are necessary to track changes in the relative importance of this human impact on the marine ecosystem to measure potential changes due to ocean policy initiatives to reduce marine debris.

METHODOLOGY

We quantified the plastic ingestion in an abundant North Pacific seabird, the Northern Fulmar (*Fulmarus glacialis rogersii),* collected opportunistically by NOAA fisheries observers in Alaska in 2005-2009 and by beach surveyors during unusual mortality events in four years in Humboldt Bay, northern CA (1997), and Monterey Bay in central California (2003, 2007, and 2010).

We conducted standard necropsies on all birds (Fig. 1) where we measured, photographed and extracted stomachs from birds following van Franeker (2004). We processed stomach contents through nested sieves and retained all natural prey remains (bones, squid beaks) and non-natural materials (plastic fragments, industrial plastic pellets) and other items (seed pods, rocks) based on method and categories in van Franeker and Meijboom (2002). We compared the incidence (or frequency of occurrence) and type of ingested plastic (industrial pellets or post-consumer fragments) among years. Plastic fragments and pellets were enumerated and weighed to the nearest 0.01mg.

OUTCOMES

In this study we quantified the incidence of plastic ingestion in Northern Fulmars and found a generally high level of plastic ingestion (75-80%). In addition to improving the methodology and capacity for a long-term monitoring program, this study has advanced the understanding of geographic and temporal pollution trends. The data indicated that marine debris is a continuing problem in both remote, relatively unpopulated regions (Alaska) and in areas with greater human populations (California). We found regional differences; birds sampled in California had a greater incidence of ingestion (94%) and contained more plastic by mass (89% > 0.1 g) than those sampled Alaska for incidence (63%) and mass (25% >0.1 g). Northern Fulmar plastic ingestion rates have increased in recent years in both areas; in CA (from 71% in 2003 to 85% in 2007; Fig. 2) and in AK (from 62% in 2005 to 72% in 2007-08). The mass of plastics measured in this study exceed the critical value for "acceptable environmental quality objective" defined for the North Sea by European Union (EcoQO target = 10% of samples contain < 0.1 g). Based on these results, we suggest the US develop and adopt an acceptable pollution level metric for the North Pacific using the fulmar as a biological monitor.

PRIORITY ACTIONS

We suggest the US needs to establish target thresholds for mitigation of marine debris in coastal waters of the West Coast of North America based on a seabird bio-indicator. We suggest using a target parameter similar to that adopted by the European union of 10% of birds or less with 0.1g of plastic as a workable metric which will be comparable with data obtained in the North Sea, North Atlantic and elsewhere throughout the North Pacific.

FIGURES AND TABLES

Figure 2. Examinations of stomach contents of seabirds such as this Northern Fulmar reveal increasing loads of plastic fragments in recent years. Inset shows detail of plastics in proventriculus (Photo: Hannah Nevins).

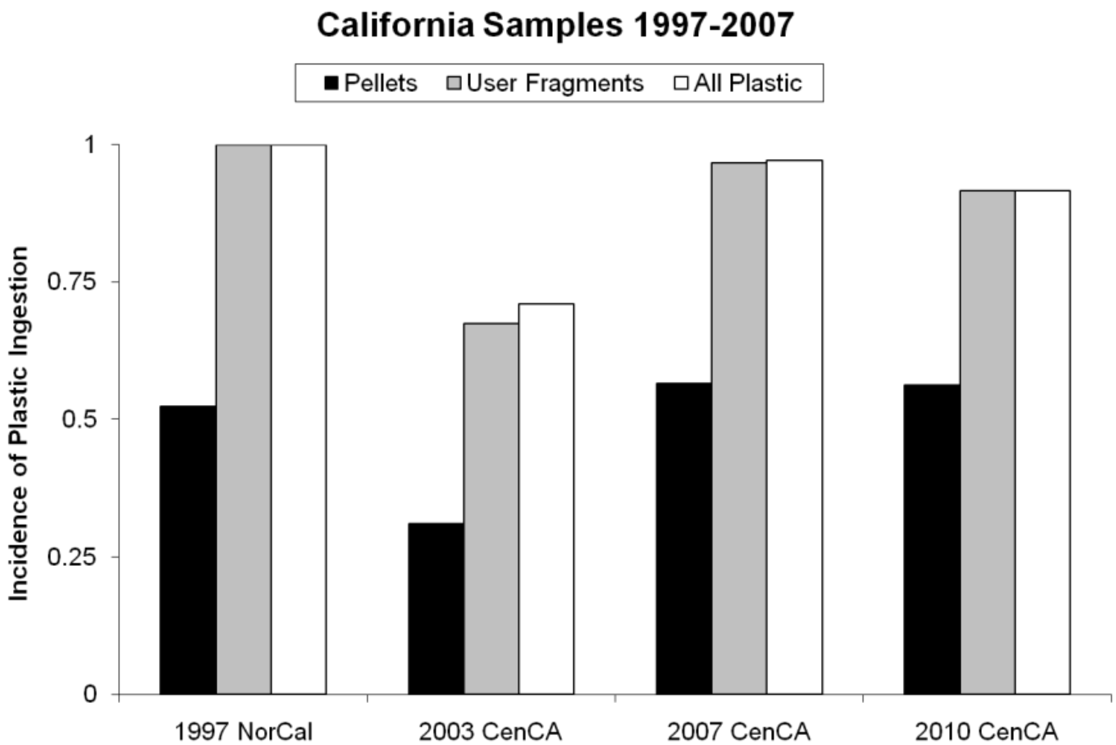

Figure 3. Comparison of frequency of occurrence (incidence) of plastic pellets, user fragments and combined total for all plastics from stomach samples of Northern Fulmars in California sampled in northern CA in 1997 (n = 22), and central CA in 2003 (n = 190), 2007 (n = 177) and 2010 (n = 48).

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4.b.4. Habitat associations of seabirds and marine debris in the Northeast Pacific at multiple spatial scales

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KEYWORDS
Marine Debris; Seabirds; Visual Surveys; Spatial Distribution; Subtropical Gyre; Pacific Ocean

BACKGROUND
To date most studies of marine debris at sea have focused on describing the micro (< 2 mm) and meso (2-20 mm) debris field (Ryan et al., 2009) by using neuston nets to sample floating material (e.g., Moore et al., 2001). While this method accurately quantifies all of the floating debris present over the small area the net samples (0.5 - 1 mile long deployment, by 1 – 3 m wide net opening), net tows are time intensive and provide data at coarse spatial resolution (tows separated by 10s – 100s km). While quantified visual observations of debris have not been extensively conducted in the past (but see Dahlberg and Day, 1985), they provide a continuous record of the macro (20 - 100 mm) and mega (> 100 mm) debris community that can be resolved and analyzed to multiple spatial scales. In addition, because visual observations can be easily conducted from ships of opportunity during transit, they provide a useful and inexpensive tool for monitoring marine debris accumulation and distribution at sea. However, the main limitations of visual observations are the inability to detect the smaller fragments (< 20 mm), and the inability to retrieve the material for subsequent analysis on-board the vessel. Because visual surveys do not collect the marine debris sighted at-sea, the observers have to estimate the size and color of the material in the field, during varying weather and light conditions.

This study focuses on the distribution and abundance of marine birds and floating debris over an area of known debris accumulation within the North Pacific Subtropical Gyre. The objectives of this study are to: (1) quantify the amount and types of marine debris present over a large heterogeneous ocean area, (2) characterize the seabird community over this same extent, and (3) assess the spatial overlap of the birds and the debris by identifying the oceanographic and weather variables which influence their concurrent distributions. To quantify the biological and physical variables which drive seabird and marine debris distributions we considered two spatial scales of analysis: smaller coarse scale (10s km) patterns which can explain species level relationships in abundance and how they relate to physical features, and larger meso and macro scale (50-100s km) patterns in abundance and distribution which can explain the community structure over this large ocean area (Haury et al., 1978).

METHODOLOGY
We conducted surveys during a 20 day (2 - 21 August 2009) 4400 km SEAPLEX cruise aboard the *R/V New Horizon*. The aim of the cruise was to seek out and sample marine debris accumulations within the North Pacific Subtropical Gyre. To this end, the vessel left from San

Diego, CA (32°42'N; 117°09'W), traveled west, reaching a maximum westerly extent of 141°W, and headed north east to Newport, OR (44°36'N; 124°3'W). A single observer surveyed seabirds from the flying bridge of the *R/V New Horizon*, while the vessel was transiting between stations in approximately 1 hour transects. We recorded all birds sighted within a 300 m range following standardized strip transect methods (Tasker et al., 1984). The observer identified the birds to the lowest possible taxonomic level, and recorded their behavior. We calculated densities of seabirds and their prey (number km^{-2}) by dividing the total number of sightings by the area surveyed (survey distance × 300 m). Because these seabird densities include multiple behaviors and assume that all species were perfectly detectable within the 300 m strip width, they provide a metric of relative rather than absolute abundance (Tasker et al., 1984).

The same observer carried out a marine debris survey concurrently with the seabird observations. Because we had no preconceptions about the ability to sight debris at sea, we followed standardized line distance sampling which can provide more accurate estimates of abundance (Buckland et al., 1993). The observer counted all pieces of marine debris sighted out to the horizon, and recorded their perpendicular distance from the ship's track-line assigned into one of seven pre-determined distance bins: 0-10 m, 10-50 m, 50-100 m, 100-200 m, 200-300 m, 300-600 m and > 600 m. Perpendicular distance from the ship was determined when the debris was directly abeam of the ship, and these distances were used to determine the effective strip width (ESW) (Buckland et al., 1993). In addition, each piece of marine debris was assigned to one of three pre-determined size classes, based on its larger dimension: Small (2 - 10 cm), Medium (10 - 30 cm) and Large (> 30 cm). The color of each piece and a description were also recorded. We pooled the marine debris sightings into nine groups based on size and color, to provide larger sample sizes for calculating the ESW estimates using DISTANCE 6 software. Densities (pieces km^{-2}) for each group were determined by dividing the corrected number of sightings by the effective area surveyed (survey distance × maximum ESW).

At the smaller transect scale, we determined the environmental variables driving seabird and marine debris distribution using forward Generalized Linear Models (GLMs) step-wise procedures, whereby the model assesses each environmental variable and retains those with the highest explanatory power. The larger-scale analysis (at the daily survey scale) examined the distribution of individual seabird species and marine debris groups, using the 15 daily surveys. We averaged the environmental variables across each day, and analyzed the daily scale distribution of seabirds and marine debris using Non-metric Multi-Dimensional Scaling (NMDS).

OUTCOMES

We surveyed a total of 1343 km along the 4400 km cruise track, during 74 hourly transects and 15 daily surveys, separated by "off effort" night-time periods. The SEAPLEX cruise traveled from the southern California Current and into the Subtropical Gyre, an area influenced by the North East Pacific subtropical high pressure center. We sighted 235 birds comprising 22 species over the extent of the cruise, and identified 92.7% to species. Of these, 69% were tubenoses (order *procellariiformes*), 26% were terns, phalaropes, skuas, gulls and alcids (order *charadriiformes*) and 5% were tropicbirds and boobies (order *pelecaniformes*). The avifauna changed over the cruise, and was dominated numerically by Black-footed Albatross (*Phoebastria nigripes*) and Red-tailed Tropicbird (*Phaethon rubricauda*) in the southern warm-water areas (days 5 – 10) and by Leach's Storm-petrel (*Oceanodroma leucorhoa*) and Sooty Shearwater (*Puffinus pacificus*) in the cooler more productive waters around the CCS (days 1 - 4 and 11 - 15). Overall, the bird densities varied across transects (range = 0 – 9.01 birds km^{-2}) and daily surveys (range = 0.04 – 2.93 birds km^{-2}). The highest densities occurred off of the Oregon coast and within the transition zone waters, while the lowest densities occurred far from land, within the low productivity warm gyre waters (Fig. 1).

We sighted a total of 3868 pieces of marine debris over the extent of the cruise, 95.5% of which were identified as plastic. The remainder was comprised of line, polystyrene foam, glass, wood, cardboard and burlap. While various different types of plastic objects were seen, fragments were the most dominant (90% of total, n = 3464). The marine debris density was also highly variable on both the hourly transect scale, ranging from 0 – 15,222 pieces km^{-2}, and the daily survey scale, ranging from 0 - 6334 km^{-2}. Small pieces (2-10 cm) of marine debris were the most abundant, accounting for 81% of the total, with medium (10-30 cm) and large (> 30 cm) pieces accounting for 14% and 5%, respectively. Despite observing a wide range of colors of marine debris, white was the dominant color with 89% of the total. Densities of marine debris were lowest close to the California coast and highest within the subtropical gyre. Densities declined as the vessel moved towards Oregon, however a spike in density was observed within the transition zone waters close to Oregon. At the daily transect scale, marine debris densities ranged from 0 to 6334.12 pieces km^{-2}. Daily density distributions mirrored those at the hourly transect scale, with the highest densities in the subtropical gyre and an area of high density within the transition zone waters off of Oregon (Fig. 1).

The GLM results showed that marine debris density was negatively related to latitude and longitude. Once this geographic effect was accounted for, the marine debris was positively related to depth and sea level pressure, and negatively related to wind speed. The GLM results also showed that seabird density was positively related to latitude and longitude.

The 15 daily transects were analyzed using NMDS ordination. All environmental and habitat variables were used as explanatory variables in the NMDS ordination, which produced a two axis solution that explained 80.2% of the observed variance in the bird and debris community composition. The NMDS also revealed interesting associations between the daily surveys and the different taxa. For instance, the daily surveys were arranged into two clusters on the ordination plot: days 4 - 13 were characterized by deep subtropical gyre waters, and days 1, 2, 3, 14 and 15 were characterized by low atmospheric pressure and colder waters. The ordination plot of the species and marine debris groups mirrored that of the daily surveys. The subtropical gyre days supported the lowest bird densities and the highest debris densities.

PRIORITY ACTIONS

Our results highlighted patterns of marine debris distribution and abundance within the North East Pacific Ocean, and documented large-scale (Daily-scale) aggregation associated with the subtropical gyre (an area of higher sea surface temperature and sea level pressure), and small-scale (transect-scale) variability within this aggregation area. Furthermore, our results showed that few seabird species in the North East Pacific overlap with this large-scale zone of debris aggregation, except for two far ranging petrels. These fine-scale (10s km) aggregations of seabirds and marine debris are difficult to characterize, and are likely influenced by dynamic physical processes (e.g., convergence zones that aggregate floating material and make seabird prey available) and by short-lived physical and biological processes. Yet, a better understanding of these fine-scale patterns of habitat use and aggregation seem critical to identify those locations where seabirds are at risk from plastic ingestion at-sea.

FIGURES AND TABLES

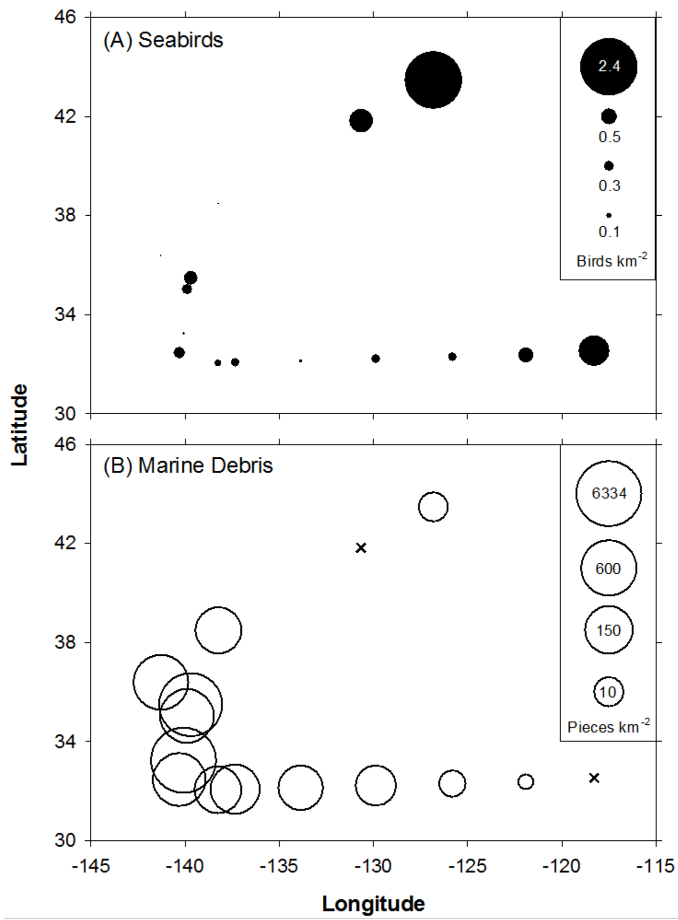

Figure 1. Log-transformed densities of birds (A) and marine debris (B) with respect to location (latitude, longitude) within the North East Pacific as covered by the cruise track. Circles shown are densities at the midpoints of daily surveys, x indicates zero density.

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4.b.5. Plastic ingestion by North Pacific seabirds: towards a hierarchical risk assessment

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ABSTRACT
Plastic debris is widespread and conspicuous in the marine environment, originating from diverse human activities at-sea (e.g., fisheries, shipping) and on shore (e.g., river run-off, beach litter). Many seabird species ingest this material at-sea, with published examples spanning the globe, from the tropics to the poles. Yet, few circumstantial records have ascribed the mortality to debris ingestion; involving the obstruction (e.g., plastic bags) and the abrasion (e.g., sharp fragments) of the stomach. Thus, it is largely unknown to what extent plastic ingestion affects individual birds directly, (e.g., by diminishing the growth and the survivorship of chicks), and indirectly (e.g., by the leaching of noxious chemicals - PCBs and phthalates - with long-term health and reproductive consequences). The mounting awareness of the vast and pervasive problem of plastic ingestion by seabirds in the scientific community and the media warrants efforts to identify critical knowledge gaps and priority research avenues. This synthesis is required to assess potential marine debris risks in relation to other known impacts (e.g., bycatch, introduced predators).

To this end, we present a frame-work for assessing the risk of plastic ingestion to seabirds, with an emphasis on North Pacific species. We propose a hierarchical approach to evaluating the likelihood and magnitude of impacts to the individuals and the populations, involving five steps: (1) assessing the spatial – temporal overlap of seabird and marine debris distributions; (2) quantifying seabird preference for different marine debris types (e.g., size, color); (3) ascertaining direct detrimental effects on individuals due to ingestion (e.g., mechanical damage, starvation, growth, survivorship); (4) quantifying indirect effects on individuals (e.g., leached pollutants); and (5) extrapolating population-level effects using demographic modelling. To the extent possible, we highlight the available knowledge and the data gaps for each of the five steps listed above.

4.b.6. A risk analysis based approach to understanding ghostnet impacts on marine biodiversity

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KEYWORDS
Ghost net, turtle, risk prediction, oceanography, map, threat

BACKGROUND
The estimated 640,000 tons of fishing gear lost, abandoned or discarded annually exerts a large but uncertain impact on marine wildlife. These 'ghostnets' can fish unattended for decades, killing huge numbers of threatened or commercially valuable species. Large numbers of ghost nets wash up in northern Australia, reaching densities as high or higher than those reported anywhere else in the world. These abandoned nets and other fishing gear are of substantial concern. Northern Australia supports populations of 6 of the 7 sea turtles in the world, including some of the largest remaining populations. It also has a variety of other critically endangered wildlife, and is likely the only sanctuary for many large sharks and related species who are heavily exploited elsewhere. All of these species have been observed caught in abandoned nets, and thus understanding the magnitude of the impact and the areas where the impact is the greatest is critical for both addressing the issue of abandoned fishing gear and for prioritizing conservation actions to address the species and populations most at risk.

METHODOLOGY
We used a model which predicts the drift of particles in the ocean affected by surface currents and wind to predict the paths of nets which were found on beaches in northern Australia. We divided the ocean in the Oceana region into 1 degree cells, and for each cell we recorded the size of every net predicted to pass through that cell. Summing across all of these nets for a single cell we were able to estimate the "fishing effort" of ghost nets in the cell. This allowed us to produce a map of the relative likelihood that an animal would encounter a net in any given cell.

We then used data from trawl fisheries and research surveys in the region to estimate the distribution of biodiversity for species that were known to be susceptible to nets. We divided the number of animals caught in each trawl by the area trawled to get a relative density for that trawl. We then averaged that estimate of relative density for all trawls in 5 degree blocks across the Oceana region. This yielded a map of biodiversity that would be susceptible to ghost nets.

Finally, we multiplied the values for the fishing effort with the biodiversity density to give an estimate of the relative risk of impact for each cell in the Oceana region. We compared these predicted values to the relative density of animals found in nets washing up in beaches in the region to determine if species and areas we estimate to have high risk are borne out in the stranding observations. This comparison provides a test of the risk analysis, as the stranding observations are independent of the data we used to estimate biodiversity risk.

OUTCOMES

We found that turtles were the most common marine species observed in ghost nets. There did not appear to be strong selectivity by species, with all 6 turtle species found in Australia occurring in nets. Our analysis predicted high relative densities of nets in the coastal margins of the Gulf of Carpentaria. Based on the trawl data, some of these regions were also estimated to have the highest densities of turtles anywhere in the region. As would be expected, this resulted in predictions of high encounter rates between turtles and nets, and thus a substantial threat to marine turtles in these areas. This prediction matched observations of turtles washed up on beaches, with nearly all stranded turtles occurring in predicted high risk areas. Of note is the fact that there were several high risk areas where there were no observations of turtles. These areas occurred offshore in areas where there were no observations of ghost nets.

PRIORITY ACTIONS

This work demonstrates a methodology for estimating the risk posed by marine debris to wildlife species that can be transported for use on other species and in other regions. Breaking the estimation problem down into understanding exposure, and given exposure, to predicting the impact of exposure, reduces the complexity of the data required. It also has the advantage of transparency, facilitating the exploration of alternative estimates of impact.

The next step in the analysis will be quantitatively estimate the number of turtles and other species killed, and to estimate the total number of nets in the region, not just those that wash up on beaches.

The analysis suggests several possible management actions. Understanding the causes of abandonment or gear loss is essential for addressing this significant threat. The resulting maps also suggest areas where removal of ghost nets is important and areas where it could have a large impact, given the likelihood of encountering sensitive wildlife.

4.c.1. Eyeballs, nets, and digital scanners: the influence of methodology in assessing plastic debris in the North Pacific

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ABSTRACT
Neustonic plastic debris in the North Pacific has received considerable scientific and media attention, but lacks a consistent monitoring program and methodology. We compared three different methods for quantifying both macro- and microplastic debris distribution and abundance in the North Pacific Central Gyre. We contrasted the density, size and type of debris detected by visual surveys and 333 μm manta tows during the 2009 SEAPLEX cruise, and determined relationships between the abundance of macro- and microplastic. We also assessed the tradeoffs in microplastic quantification between the broadly replicable at-sea manual sorting method utilized for many years by the Sea Education Association and the time-intensive Zooscan method developed at SIO, in which a digital optical scanning device accurately measures the size, area, and shape of particles sorted from samples under a stereomicroscope. We discuss the advantages and tradeoffs inherent in each of these methods, and how they influence our understanding of the quantity, composition, and size frequency distribution of plastic debris in the North Pacific Central Gyre.

4.c.2. Ocean Voyages Institute/Project Kaisei – reports on four development projects of marine debris collection equipment

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KEYWORDS
Marine debris collection, plastic proliferation, clean-up methods, adapt purse-seining nets for collections, oil skimmers, the beach, adapting oil spill technology and fishing for the removal of plastics, ghost nets, micro-plastics, large and mid-sized pieces.

BACKGROUND
Marine debris, including derelict fishing gear, plastic items ranging from toothbrushes to car fenders and micro-plastics are becoming an increasing toxic epidemic in the global ocean. From Ocean Voyages Institute/Project Kaisei 2009 and 2010 expeditions to the North Pacific Gyre, we have seen firsthand the need for the development of efficient equipment and strategies for at-sea debris collections as well as the need to use our expeditions as scientific tool and educational vehicles for awareness regarding pervasive plastic pollution.

METHODOLOGY
A think-tank of naval architects, marine engineers, professional maritime industry primaries, sailors and ocean scientists have been assembled to assist Project Kaisei of Ocean Voyages Institute with the development, adaptation and testing of marine debris collection devices during 2011 and 2012. Evaluation trials are being conducted coastally and at sea.

OUTCOMES
Through study and observation, the basic characteristics and behavior of the environmental results of marine debris, we are in the process of developing appropriate tools for removal.

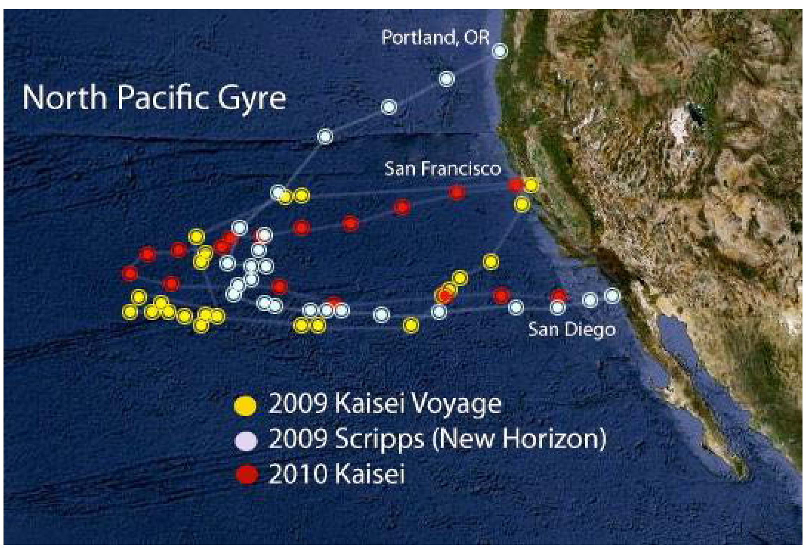
For larger marine debris objects, we do not need to reinvent the wheel, we can adapt fishing and oil spill technology. For micro-plastics, more invention and design is necessary. The beach concept, using principles of bio-mimicry, with the design assistance of our naval architects and marine engineers holds promise for future testing.

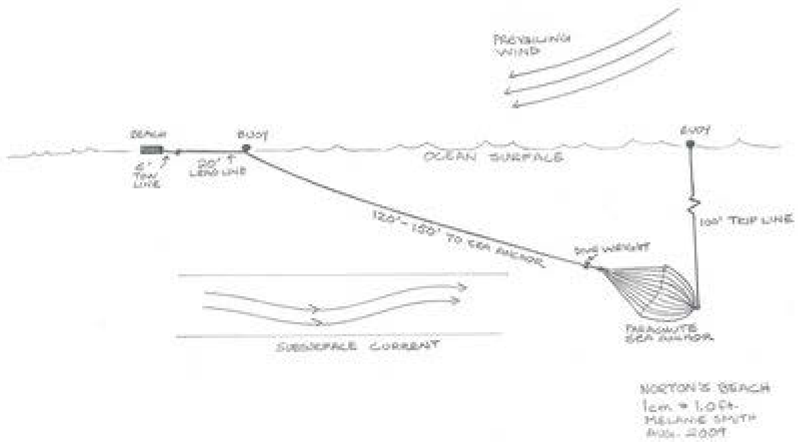
We will work with Nikolai Maximenko and Jan Hafner on adding to the prototypes of the beach, equipment to collect water temperature, wind, wave and other applicable information. Project Kaisei is engaged in both coastal and mid-ocean projects.

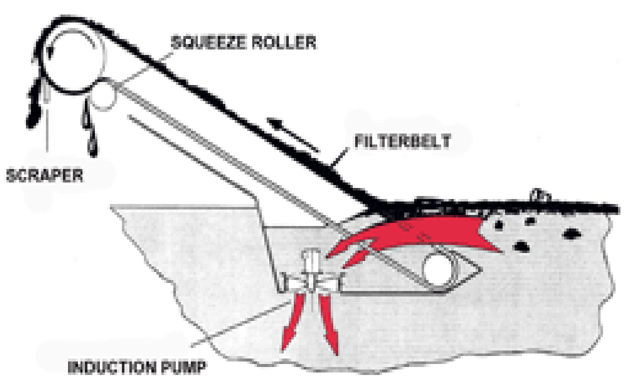
PRIORITY ACTIONS
Development of a universal methodology of cataloging observations of marine debris, to be used by NOAA, research ships, citizen scientists, yachtsmen, commercial maritime industry and commercial fishermen and to include aerial observations. Ocean Voyages Institute/Project Kaisei is grateful to have a dynamic multi-disciplinary team testing and developing equipment.

We welcome and solicit information and experiences of other at-sea, mid-ocean, or coastal clean-up endeavors to add to our information data. Our goal is global ocean clean-up and our information and equipment design and adaptation will be shared with others tackling ocean clean-up.

FIGURES AND TABLES







MARCO POLLUTION CONTROL

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4.c.3. Application of balloon aerial photography to measure total marine litter weight across a beach and the quantification of heavy metals carried by plastic litter

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KEYWORDS
beach litter, balloon aerial photography, polymers, toxic metals

BACKGROUND
The marine pollution by beach litter has been recognized as a serious trans-border environmental issue due to their flotation and transportation over a long distance [1]. Hence, the protection of the marine environment from such pollution must involve international cooperation with neighboring countries. On the other hand, marine litter poses a great threat to marine wildlife because of the ingestion of plastics by animals and entanglement in drift nets [2]. However, only few reports on toxic metals derived from marine litter are available [3]. In polymers, toxic metals are widely used as plasticizers, catalysts, stabilizing additives, and pigments [3-6]. These metals may leach out from the plastic and transfer to animals in the environment when plastic are degraded or digested. Hence, the present study attempts:

- To establish a reliable method to measure the total litter mass over a beach by aerial photography using a digital camera attached to a balloon.
- To estimate the mass of toxic metals in plastic litter over a beach using the X-ray fluorescence analyzer.

METHODOLOGY
A beach survey was carried out on October 22, 2009 on the Ookushi beach in Goto Islands, Nagasaki, Japan. Ookushi beach is located neither within a narrow channel nor behind a headland (see Fig. 1), and thus it can be assumed that the beach is directly influenced by litter floating across the East China Sea with north-eastward ocean currents [7]. Moreover, because of its inaccessibility, this beach is unlikely to be cleaned and thus it is an appropriate beach on which to base a case study on the mass and composition of beach litter in the absence of direct anthropogenic disturbance.

The beach litter was measured by aerial photography using a digital camera attached to a balloon (see Fig. 2). In order to estimate the total litter mass (kg) over the beach by multiplying the total litter-covered area (m^2) obtained by aerial photography, measurements of the beach litter mass per unit area (kg/m^2) were carried out. Total litter mass (kg) was estimated by multiply the total litter-covered area (m^2) was arrived. Besides the *in-situ* beach survey mentioned above, we collected litter samples randomly from each square box (4 m^2) on the beach to investigate the materials in it, especially the types of plastics and polymers. To measure the mass of each material, all collected litter samples were brought to our laboratory and categorically classified.

Special attention was given to differentiate plastic litter based on their polymer types (e.g. polypropylene, polyethylene, etc.) using near-infrared spectrometer (Plascan-modelC. Systems Engineering Inc.) and Fourier transform infrared spectrophotometer (FT-IR, ALPHA, Bruker Optics). The types of polymer found on the Ookushi beach were polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), polyvinyl chloride (PVC), polystyrene (PS), acrylonitrile-butadiene-styrene (ABS), acrylonitrile-styrene (AS), polyamide (PA) and polyurethane (PUR).

To estimate litter-derived toxic metals, we used a handheld X-ray fluorescence analyzer (XRF: Innov-X, a-6500). Accuracy of these analyses was examined using standard reference materials, EC680k and EC681k (European Reference Materials). Uncertainty were determined by 10 measurements using reference materials. Quantitation limit (LOQ: 10σ) were determined by 10 measurements of reference materials and virgin polyethylene pellets (Grand Polymer Co. Ltd. Japan).

OUTCOMES

Total mass of beach litter on the Ookushi beach

The total area covered by beach litter is found as 123.5 m^2 on the entire beach and the average litter mass is 5.8 kg/m^2. Multiplying the total litter-covered area (123.5 m^2) by the mean litter mass (5.8 kg/m^2) yields the best estimate of the total litter mass of 716 ± 259 kg by a t-test with a 95% confidence limit.

Composition and total mass of each polymer type

Plastics prevail among various materials on the ten boxes of the Ookushi beach, the mass of plastics accounts for 74% (i.e., 530 ± 201 kg), in which five polymers such as PE, PP, PET, PVC and PS accounted for 98% (Fig.3).

Estimation of toxic metals derived from plastic litter

To estimate litter-derived toxic metals, we analyzed five polymers (PE, PP, PET, PVC and PS). Lead (Pb) is the most common toxic metal among plastic litter. The concentrations of Pb ranged from less than the quantification limit to 36,000 mg/kg. Table 1 shows the average concentrations of Pb in each type of polymer collected in this study. Amazingly, very high concentration of Pb was detected in PVC plastic litter. Furthermore, it exceeded the EU regulation on packaging and packaging wastes level of 100 mg/kg in PE and PP plastic litter. The concentrations of Pb derived from plastic litter over Ookushi beach was estimated at 392 ± 196 mg/kg. Therefore, it is possible to estimate the total mass (g) of Pb carried by litter by multiplying the concentration (mg/kg) with the estimated plastic mass over the beach (530 ± 201

kg) and calculated as 207 ± 130 g. Lead chromate is often used as pigments in plastics [6] and potentially leaches out in to the beach environment during degradation of plastics.

This study demonstrates a reliable method to estimate the concentration of toxic metals included in plastic litter over a beach. Our future research will be focused on their bioaccessibility/bioavailability to the resident organisms.

PRIORITY ACTIONS

Continuing our research to measure total marine litter and the quantification of toxic metals carried by plastic litter on Ookushi beach.

FIGURES AND TABLES

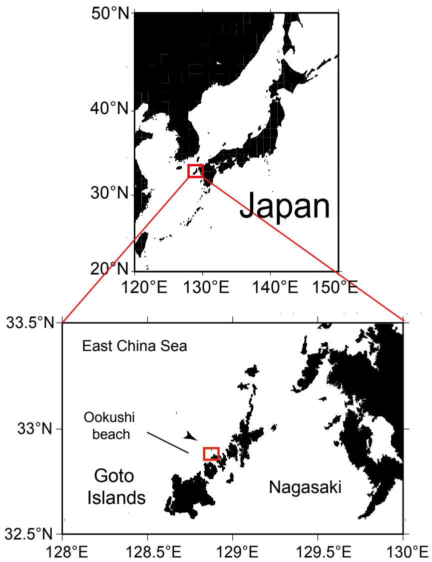

Figure 1: The location of Goto Islands, Nagasaki, Japan with their enlarged map.

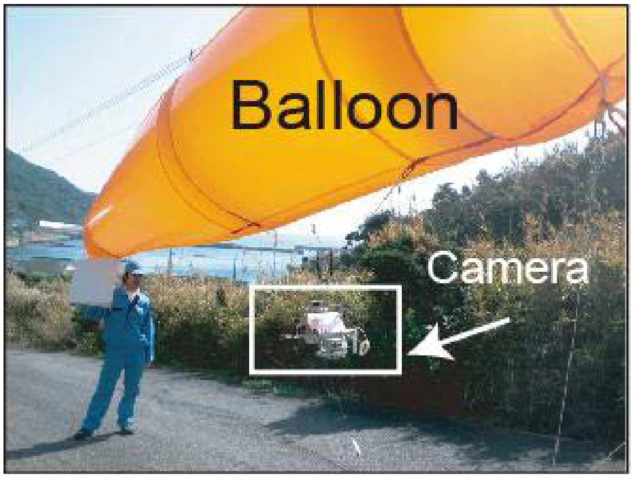

Figure 2: The balloon equipped with a remote-controlled digital camera for aerial photography.

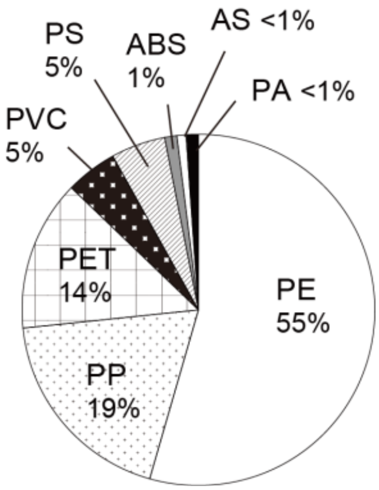

Figure 3: Mass ratios (%) of types of polymer collected from Ookushi beach .

Table 1: Estimated mass of Pb (g) of each type of polymer collected from Ookushi beach .

	PE (*n*= 367)	PP (*n*= 275)	PET (*n*= 75)	PVC (*n*=17)	PS (*n*=39)
Average (mg/kg)	68	92	<LOQ	14,000	<LOQ
Standard Deviation	470	540	-----	11,400	-----
Estimated Concentration of Pb (mg/kg)	68 ±48	92 ±64	-----	14,000 ±6000	-----
Estimated Litter Mass (kg)	292 ±114	102 ±50	69 ±48	27 ±27	27 ±24
Estimated Mass of Pb(g)	20 ±15	9 ±8	-----	38 ±49	-----

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4.c.4. EPA shoreline and pelagic marine debris monitoring methods

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KEYWORDS
Marine debris, monitoring, trends, lessons learned, land-based, protocol, sampling, methodology

BACKGROUND
The U.S. Environmental Protection Agency has been monitoring marine debris for over 20 years. Recently, EPA's efforts have focused on shoreline monitoring through the National Marine Debris Monitoring Program (NMDMP), as well as developing a pelagic marine debris monitoring protocol to be used onboard EPA's research vessel, the Ocean Survey Vessel (OSV) Bold. Both of these efforts are focused on determining the types and sources of debris that exist within U.S. waterways and oceans. The presentation will explore EPA's sampling methods used onboard the OSV Bold for marine debris collection and monitoring, along with examining the strengths and weaknesses and lessons learned from the NMDMP.

METHODOLOGY
The National Marine Debris Monitoring Program was a five year study developed to standardize marine debris collection in the United States using a scientifically valid protocol to determine marine debris status and trends. During the study, the United States was divided into nine regions based on the types of marine debris found in those areas, the prevailing currents, and logistical considerations of access and other parameters with identification of and random selection of 20 beach sites within each region. The purpose of this study was to: 1) determine if the amount of debris on our coastlines changing; and 2) what are the major sources of the debris? During the five-year period, approximately 600 volunteers conducted the NMDMP surveys across the country. The surveys were conducted on 28-day intervals and covered a 500-meter stretch of beach at each study site. The volunteers collected and recorded the various marine debris items found on standardized NMDMP data cards with debris items grouped according to sources of debris: land-based, ocean-based, and general source.

The OSV *Bold* is EPA's only ocean and coastal monitoring vessel. The OSV *Bold* is equipped with state-of-the-art sampling, mapping, and analysis equipment including sidescan sonar, underwater video, water sampling instruments, and sediment sampling devices, and collection nets which scientists can use in various monitoring activities. Recently, working with NOAA to use a similar monitoring approach, EPA started developing a standardized methodology for marine debris collection onboard the *Bold* to determine the type and quantity of debris in pelagic environments. The sampling methodology uses 335 µm to 500 µm mesh size manta nets to conduct 15 minute tows at survey sites. All relevant survey information (sea conditions, trawl parameters, and site location) are recorded for each survey site. Additionally, following each survey, any debris collected is processed, sorted, recorded, and stored for further analysis.

OUTCOMES

The results of the NMDMP indicated that there was no significant change in the total amount of marine debris monitored along the coasts of the United States over the five-year period. However, when the data were analyzed specifically by source, the study did show an increase in general source items (plastic bags, straps, and plastic bottles). The study indicated that land-based sources of marine debris accounted for 49% of the debris surveyed nationally, in comparison to 18% from ocean-based sources and 33% from general sources. The study also found plastic straws, plastic bottles, plastic bags, metal beverage cans, and balloons to be the most abundant types of marine debris littering our coasts.

Following the completion of the NMDMP, EPA developed a National Marine Debris Monitoring Program – Lessons Learned White Paper to identify the strengths and weaknesses of the monitoring protocol, explain the best practices and lessons learned, and provide specific recommendations for developing future marine debris monitoring protocols. The lessons learned from the NMDMP included: 1) ensuring long-term funding to successfully complete monitoring; 2) a strong volunteer training program managed at a local level; 3) ensuring an adequate number of monitoring sites, with backup sites identified; 4) utilizing strategic monitoring sites, such as those near commercial areas, outfalls, and recreational beaches; 5) using photographs in training manuals to properly identify debris items; 6) integrating an online data collection system; and 7) incorporating a statistician as a fully integrated member of a project team. In addition, any future marine debris monitoring activities need to be planned to ensure that they will support a specific resource management framework and are conducted using valid protocols that are replicable statistically. In other words, know where and why you are surveying an area, what are you collecting and documenting and how often, how will the data be processed and analyzed, and who will receive this information.

Marine debris collection surveys on the OSV *Bold* have been performed along the U.S. Mid-Atlantic coastline (Virginia to New Jersey) and around Puerto Rico since 2007. During these surveys, there has been minimal debris collected. Of the collected items, the large majority is very small pieces of plastic which are difficult to sort and identify. Any samples collected have been packaged and taken to a laboratory for further identification.

PRIORITY ACTIONS

- Use the National Marine Debris Monitoring Program results to address marine debris regionally.
- Develop action plans for targeting specific marine debris sources and items.
- Finalize EPA OSV *Bold* Marine Debris Monitoring Protocol.

FIGURES AND TABLES

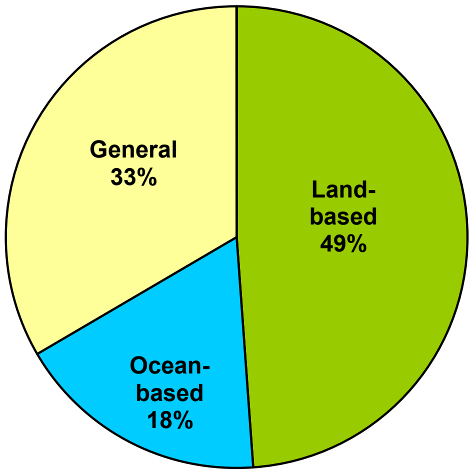

Figure 1. National Marine Debris Monitoring Program, Trends on U.S. Beaches

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4.c.5. Monitoring marine litter within the European Marine Strategy Framework Directive (MSFD): scientific and technical basis

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KEYWORDS
Marine Strategy Framework Directive, MFSD, litter, marine litter, monitoring, microplastics, marine debris, beaches, sea floor.

BACKGROUND
The European Marine Strategy Framework Directive (MSFD, 2008/56/EC, European commission, 2010) aims at reaching Good Environmental Status (GES) in European marine waters by 2020. In order to do this, Member States (MS) have to develop a marine strategy. The MSFD defines 11 descriptors to promote consistency in the approach by which EU Member States (MS) assess the extent to which Good Environmental Status (GES) is achieved. The first step in the implementation of the MSFD is an initial assessment by the MS of the present state of and pressures and impacts on their marine waters. This should be completed by 2012. MS should cooperate with neighbouring countries through the regional seas conventions (OSPAR for the NE Atlantic, HELCOM for the Baltic Sea; Barcelona Convention for the Mediterranean Sea and the Bucharest Convention for the Black Sea). This Initial Assessment will include a social and economic analysis of the use of the sea and the cost of degradation of the marine environment. At the same time, each MS, in cooperation with its neighbours, has to describe what is meant by GES and which targets they want to achieve. By 2014, a monitoring programme is to be installed in order to monitor progress towards achieving GES. A programme of measures to achieve GES is to be implemented by 2015.

A Task Group (TG10) was established to develop proposals for methodological standards on assessing marine litter to be included, for the first time, in European monitoring programmes (Cardoso et al. 2010: Galgani et al. 2010). Descriptor number 10 for "Marine Litter" states that properties and quantities of marine litter should not cause harm to the coastal and marine environment. The group proposed that definitions of the acceptable levels of harm and good environmental status must consider impacts as assessed by the amount of litter in different compartments of the marine environment (seabed, sea surface, water column, coastline), ecological effects of the litter (e.g. plastics ingested by marine organisms; entanglement rates) and problems associated with degradation of litter (microparticles) as well as social and economic aspects (reduction in aesthetic value and public safety, cost to tourism, damage to vessels, fishing gear and facilities, losses to fishery operations, cleaning costs). Because the litter will persist in the marine environment for years, decades and even centuries, evaluations of sources alone will not be sufficient and long term monitoring of litter in the marine environment will be required to assess inputs, accumulation, impacts, degradation processes, and spatio-temporal trends..

METHODOLOGY

The quantities and composition of litter (amount on the coastline, the sea floor, in the water column and on the waters surface), the amount ingested by animals and entanglement rates are considered as the best links to pressures. The task group recommended that the overriding objective should be a measurable and significant decrease of the total amount of marine litter in comparison with initial baseline values by 2020 using the following criteria and methodologies for the evaluation of the state of good environmental status.

- Amount, source and composition of litter washed ashore and/or deposited on coastlines. The attribute will indirectly measure inputs, impacts on aesthetic values, the presence of toxic compounds and socio-economical damage.

- Amount and composition of litter in the water column - including floating and suspended litter - and accumulation on the sea floor. The attribute will measure litter dynamics and potential interactions with marine life. Accumulation areas will be located.

- Amount and composition of litter ingested by marine animals. The attribute measures time-trends and spatial variation in inputs of litter and its impact on marine life.

- Amount, distribution and composition of microparticles (mainly microplastics). The attribute will measure quantities, types, degradation processes and potential sources of contaminants.

The monitoring of these attributes was proposed and agreed upon by European MS on 1.9.2010 (2010/477/EU). Methodological standards in Europe are currently available for the assessment of litter on coastlines (OSPAR, HELCOM and Black sea regions). For litter at sea there are a number of methodologies in place such as the International Biological trawling surveys in the NE Atlantic and Mediterranean, diving or photographic transects for surveying litter on the seafloor, aerial surveys for large scale assessment of floating litter, ingested litter in seabird stomachs through the OSPAR Ecological Quality Objectives for the North Sea, and microparticle abundance through sea surface sampling, continuous plankton recorder and beach sampling.

More generally, the OSPAR and HELCOM based regional approaches, which link pressures and activities to the quality of ecosystem components, will be considered for implementation and extension to other areas in Europe in order to assess temporal trends, regional differences and compliance with a set target for acceptable ecological quality. The monitoring results combined with research on social, economic and ecological harm will lead to improved knowledge of critical thresholds.

OUTCOMES

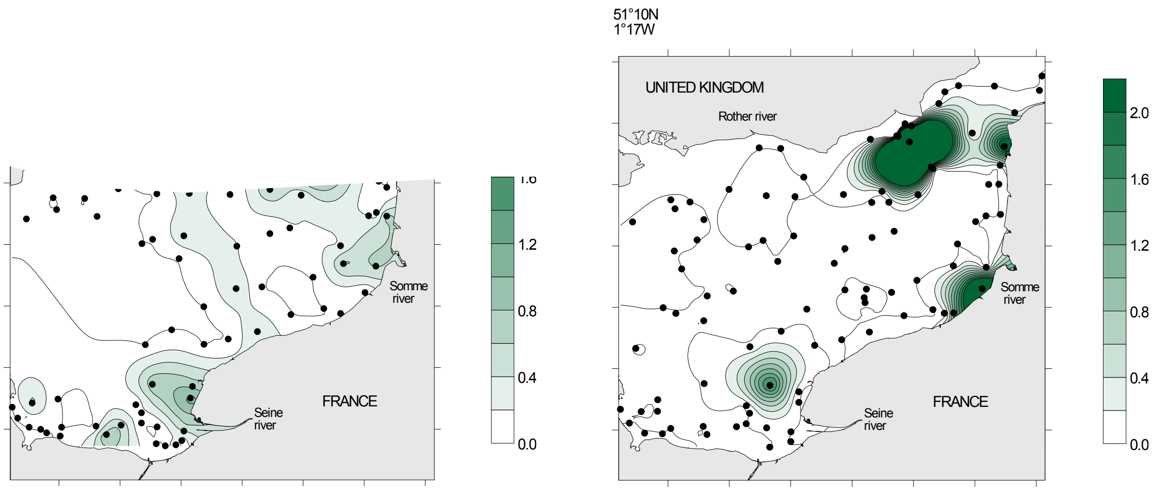
Quantities, composition and distribution of litter, including the distribution and concentrations of degradation products of litter (microparticles in sediments and the water column) as well as impact rates on organisms and the potential chemical pollution resulting from plastics are good indicators of the deterioration of the state of the marine environment through the impact of marine litter. Monitoring the quantities and distribution of litter in the different compartments of the marine environment will also give a basis for the present and future assessment of socio-economic and ecological impacts of litter. The first challenge of the MSFD process is to assess these indicators. A further challenge will be to link the indicators with pressures (e.g. point and diffuse sources of litter, coastal or packaging industries, tourism, shipping, fishing, aquaculture and offshore activities) and other factors such as rainfall, riverine input, currents, winds and geomorphological factors, which influence the distribution and abundance of litter.

It will be possible to evaluate litter on beaches and at sea as well as microplastics using standard protocols on a European scale (example in figure 1). Evaluating the impact of litter on marine organisms will be done at regional or sea-basin level, enabling transposition of protocols to local species. Highly polluted areas will be monitored locally. When possible, temporal scales should take into account seasonal variations. An initial evaluation is required by all member states on the current state of research in their region/subregion, in order to supply a scientific and technical basis for monitoring as well as to identify gaps in knowledge and priority areas for research. This will need to include the improvement of knowledge concerning impacts on marine life, degradation processes at sea, the study of litter-related microparticles, the study of chemicals associated with litter, the factors influencing the distribution and densities of litter at sea (human factors, hydrodynamics, geomorphology etc.), the standardisation of methods and the determination of thresholds. The assessment and monitoring of socio-economic harm will also need to be addressed.

Finally, the whole process will be supported by a group of experts (EU Technical Subgroup on Marine litter) whose job it will be to harmonize monitoring approaches, to produce common guidelines to assess GES on regional and European scales, to prepare recommendations for the evaluation of good environmental status, to give scientific support for the definition of objectives and to organize data management and coordination.

PRIORITY ACTIONS

Harmonization of monitoring of litter in the different compartments of the marine environment, exchange and comparison of data as well as further research (e.g. fate, degradation processes, drift modeling, impact on marine life and toxicity) will demonstrate the relationship between



2010

..y measuring total litter on the sea floor (items/Ha, ..) from the eastern channel in 1998 (mean = 0.149 +/- ..7+/- 0.127, n=107). Results were obtained from CGFS ..rnational Bottom trawl Surveys) cruises are scientific cruises ..tic countries (Norway, Germany, Nederland, UK, Ireland, ..t may provide litter data on standardized protocols covering the ..nd scottish, irish , celtic , french, spanish and portuguese continental ..rranean, the MEDITS program is also based on standardised procedures ..ves for Spain, France, Italy, Adriatic sea and Greece.

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4.d.1 The Oregon partnership to address lost crab pots: project overview

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KEYWORDS
crab pots, sonar, grapple, ghost-fishing, partnership, volunteer, dungeness, buoy

BACKGROUND
Derelict fishing gear is a continual problem in many marine/estuarine ecosystems and can have serious impacts to habitats and potentially significant losses of natural resources from ghost fishing. Each season in Oregon, over 125,000 Dungeness crab pots are used by local fishermen, with thousands of these being lost due to various factors ranging from adverse weather to user error. These pots pose multiple risks, including ghost fishing impacts, gear conflicts with other fisheries as well as abrasion of sensitive habitat.

METHODOLOGY
The partnership worked to address derelict crab pot impacts through four complementary efforts:

Stray Pot Removal – In 2009 and 2010, the project hired local fishermen to remove derelict crab pots which had moved from their original fishing sites as the result of weather conditions These pots had buoys still attached, and had aggregated at locations which were known to fishermen. Once retrieved, these pots were returned to shore where 98% of them were returned to their original owners for reuse. Pots which did not have buoys still attached were targeted for removal by grappling devices which had been specially designed to cause minimal impact to the ocean bottom habitat. Pots which were not claimed by their owners were sent to the Fishing for Energy program location in Oregon for energy co-generation and material recycling.

Partnership Promotion – Apart from the contracted removal, the project worked with the local fishing industry to promote and coordinate removal of derelict crab pots through volunteer efforts by local fishermen. This effort was targeted to continue and grow through partnership and outreach over the course of the project.

Data Gathering – The project used multiple methods to gather data on the abundance of derelict crab traps in the study area. This was first accomplished by side-scan sonar survey by a combination of local sonar technicians working from local fishing vessels. The resulting sonar data was processed and through analysis provided insight on gear loss patterns, as well as providing data to evaluate the efficiency of grappling operations. Secondly, the project worked with the United States Coast Guard to conduct aerial surveys of the fishing grounds to provide additional data on derelict gear locations and patterns of loss. This survey occurred throughout the entirety of the Oregon coast, and provided valuable data of opportunity to give context and scale to the overall effort.

Outreach and Education – The overall work was backed by a diverse outreach and education program. This included local media outreach through newspaper and TV interviews to raise awareness of the work, as well as the issues that were being confronted and discovered. A videographer was also employed to film field activities and other aspects of the project. This footage was combined into an educational DVD which described the project activities and gave background to the overall program.

OUTCOMES

Through the overall project over 1400 derelict crab pots were removed from the marine environment, both through targeted removal of stray pots, as well as volunteer removal and grappling operations. Volunteer fishermen on 8 vessels conducted removal operations. Project staff conducted both side scan operations, and leveraged USCG partnership to conduct five spotting flights with trained observers. Staff analyzed both side scan and remotely operated vehicle video data to determine both derelict pot impacts, as well as measure the effectiveness and impact of grappling techniques. The project DVD was installed at the local Hatfield Marine Science Center, allowing for viewing by the 150,000+ annual visitors to the center.

4.d.2. Lessons learned from developing a derelict fishing gear program in Puget Sound: behind the scenes stories

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ABSTRACT
In times of scarce financial resources, the problems that are unseen – such as impacts from derelict fishing gear – are the most tempting for managers to ignore. Developing a comprehensive derelict fishing gear program takes time, patience, persistence and a willingness to deal with politics, science, fishermen, managers, lack of funding and inertia. The Puget Sound derelict gear program started in 2002 and has been operating at an increased capacity year by year by gaining support of managers, fishermen, scientists and a wide variety of funders. This presentation will discuss the development of the Puget Sound derelict fishing gear program from the first steps of discovery to the most recent success of receiving $4.6 million of economic stimulus funding for derelict net removals. It will cover establishing a "no fault" reporting system, the database for reporting and removals, media coverage, research and an overview of how we convinced managers that it's more than a "feel good" project. By March 2011, we are also hopeful that we can report that our neighbors to the north (Canada) are replicating some of our work.

This presentation will complement presentations by other speakers on the more technical aspects of the Puget sound project including impacts to wildlife, survey methodologies and hot spot analysis.

4.d.3. The Gulf of Carpentaria, northern Australia

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ABSTRACT
GhostNets Australia formerly the Carpentaria Ghost Nets Programme was formed in 2004 as an alliance of the 18 indigenous communities surrounding the Gulf of Carpentaria in northern Australia. The first years of the program were focused on building the capacity of these communities to respond to the massive issue of ghost nets on their shores. This included resourcing these community organisations with equipment, wages for the indigenous rangers and operating expenses; training the rangers to collect and report data; as well as building the institutional frameworks of their organisations. The current program has evolved to include a strong partnership with the Australian Government's lead research organisation, mental health and well-being practitioners and the Australian Art industry.

4.d.4. The Gulf of Mexico Marine Debris Project: survey and mapping of marine debris after Hurricanes Katrina and Rita

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KEYWORDS
marine debris, survey, mapping, side scan, hurricane, gulf of mexico

BACKGROUND
In 2005, Hurricanes Katrina and Rita inflicted severe damage on the Gulf of Mexico coastal region and deposited huge amounts of debris over large areas of the Gulf coast. This marine debris posed a persistent hazard to fishing, navigation, and recreation. To address this hazard, Congress directed the National Oceanic and Atmospheric Administration (NOAA) to survey and map the impacted Gulf coast areas. Survey work began in September 2006, was completed in December 2009, and covered coastal waters from eastern Alabama to the Louisiana-Texas state line. NOAA cooperated closely with its federal and state partners to conduct side scan sonar surveys, map potential marine debris items, and post data on the project Web site.

Major storms will occur in the Gulf of Mexico and elsewhere, and will create similar marine debris problems. This project's experience suggests that marine debris should be addressed early in the response process and will work best when federal, state, and local agencies cooperate closely on the various aspects of the response. Additionally, any response should address permitting and consultations as early as possible, and should cooperate with local agencies to tailor outreach efforts to best suit the local population.

METHODOLOGY
The project had two distinct phases. In the first phase NOAA surveyed and mapped areas along the coasts of Alabama, Mississippi, and Eastern Louisiana. In the second phase NOAA completed the survey and mapping along most of the remaining coast of Louisiana. In both phases, the NOAA Office of Coast Survey utilized five contractors to conduct side-scan sonar surveys and process the survey data. The NOAA Office of Response and Restoration and its contractors established a project team to maintain a nearly continuous presence in the region, and with input from stakeholders, developed a number of products: static and interactive maps depicting over 7,150 submerged objects in the 1,577 surveyed square nautical miles; data tables for each map with specific information on the submerged objects; data analysis, including submerged objects density and summary statistics; and a website, a powerful conduit to provide all this information (and more) to users.

In the second phase of the project, the project team continued to provide the products of the first phase and added to them an additional, password-protected Web site to assist the United States Coast Guard (USCG) with planning and communication as well as a Google Earth product to display side-scan images of survey targets and display inshore survey maps and photos, provided by USCG. Most importantly, the team established and facilitated a target review process in which representatives from the Federal Emergency Management Agency and the State of Louisiana reviews survey items and decided whether they are eligible for removal.

OUTCOMES

An internet presence was a critical component of this project, where by submerged debris items considered a danger to navigation were listed as such and promptly reported to the USCG for inclusion in a Local Notice to Mariners. The information gathered was publicized through the project's Web site at: http://gulfofmexico.marinedebris.noaa.gov/ The site provides both static maps and GPS coordinates that can easily be downloaded and printed as well as an interactive mapping option where users can zoom in to a specific area and select an individual contact to access more information.

The project team conducted an extensive outreach effort to make fishers and boaters aware of the survey and mapping efforts, and the contacts found. Project outreach included: public service announcements on twelve local radio stations, including one broadcasting in Vietnamese; Web site ads on popular local sites linking to the project Web site; printed materials; video clips; and person-to-person outreach conducted by Sea Grant extension agents.

In addition to a final project report (NOAA, 2010), supplemental products were completed to further leverage the project effort and increase its usefulness: 1) a marine debris density model to predict debris dispersion into nearshore waters after a major storm (Nixon and Barnea, 2010); and 2) a marine debris emergency response plan, incorporating lessons learned and valuable information from the project partners. The plan will be presented in greater detail at this conference (Murphy et al., 2011) as a tool to respond to major marine debris dispersions in the future.

PRIORITY ACTIONS

Project experience demonstrates the need for clear lines of authority and responsibility among responders to maintain a cooperative and collaborative approach. This may be accomplished by communicating early and often, and having a plan to shift responsibility to the lowest possible level as response capacity improves.

Marine debris projects following an event, supported by consistent planning and preparedness strategies, should remain flexible as conditions on the ground change, and more (or fewer) stakeholders are engaged. Additionally, projects should recognize and be sensitive to unique local characteristics.

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Murphy, P., N. Barnea, and N. Parry. 2011. Proactive collaboration to storm debris – cyclone debris case study. Presentation at the Fifth International Marine Debris Conference, 20-25 March 2011, Honolulu, HI.

4.d.5. CoastWalk: a regional model for a global community

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KEYWORDS
Marine Debris, Alaska, Cleanup, Prevention, Education, Coastal Monitoring, Baseline Data

BACKGROUND
The Center for Alaskan Coastal Studies (CACS) is a 501 (C)(3) non-profit organization located in Homer, Alaska. The CACS mission is to foster responsible interactions with our natural surroundings and generate knowledge of marine and coastal ecosystems through science-based environmental education and stewardship. There are few things that bring together all of our goals like our marine debris CoastWalk program. Beginning as a small regional program in 1984, CACS now extends the reach of its CoastWalk program to schools, community organizations, and tribes in other coastal communities throughout Alaska.

Alaska has roughly 44,000 miles of coastline, and its freshwater and marine ecosystems support the largest array of commercial fisheries in North America. As one of six hot spots for marine debris identified by the NOAA Marine Debris Program, Alaska presents an important opportunity for restoration, protection, conservation, and enhancement. Currently, very little is known about Alaska's marine debris and its affect on Alaska's resources. With fewer than 700,000 residents in the state, it is imperative that we get as many citizens involved in marine debris removal and prevention as possible. The goal of our CoastWalk program is to create this involvement through a combination of education, beach cleanups, and baseline data collection. Our program has been successful in a variety of circumstances involving many diverse communities and groups, and because of this we believe that the CoastWalk model has the potential to be expanded to any community.

METHODOLOGY
In 1984, the Center for Alaskan Coastal Studies began to organize and support an annual Kachemak Bay CoastWalk to document and study the consequences of environmental changes occurring on the beaches and near shore habitats of Kachemak Bay. Kachemak Bay has many recreational beaches, several harbors and is home to many fishermen, boat owners, and boat captains, including captains of large tanker vessels. The program was developed to increase awareness about the condition of the shoreline and the overall health of Kachemak Bay environments and has grown to include significant outreach to increase awareness of the causes and prevention of marine debris. It was designed as an annual snapshot of the shoreline, which proved especially important immediately following the 1989 Exxon Valdez oil spill. Kachemak Bay has been divided into 32 zones for surveying and data collection purposes. The highest impact beaches are surveyed every year for re-accumulation rates, while the more inaccessible and low impact beaches are surveyed less often. As the program continued to grow we expanded our partnerships to work with the Ocean Conservancy, local school and community groups, and

the NOAA Marine Debris Program. In 2007, we began to expand our model to other Alaskan communities, municipalities, and tribal groups through a re-granting program made possible through the NOAA community-based marine debris grant program.

Each year CoastWalk begins with a community event to raise awareness of the cleanup and generate enthusiasm. During this event, we host guest speakers, coordinate with volunteers, assign beaches, and showcase marine debris projects completed throughout the previous year. This kickoff event also serves to help us connect with local partners who are willing to donate resources for cleanups. School rallies and group education events take place throughout the first month of the program and ensure that our data sheets are used correctly and that volunteers understand the local and global issues posed by marine debris. After the cleanups are completed, we review the data for trends and changes and work to create year round marine debris outreach projects. These projects evolve and change each year in order to keep the community interested and involved in marine debris issues. Recently, they have included marine debris art contests, community recycling events and a variety of education efforts including presentations to community organizations, schools and tribes, as well as radio broadcasts and newspaper articles.

OUTCOMES

The CoastWalk project benefits coastal habitats, living marine resources and their habitats, including commercial and recreational fishery resources (marine and shellfish), and anadromous fish spawning and migrating in coastal streams. This beach cleanup and monitoring event has been sustained for more than 25 years and is one of the most successful and longest enduring programs of its kind. We have logged over 10,000 volunteer hours, and this year alone reached over 600 people in our cleanup and prevention education efforts.

The types of marine debris have shifted from marine to land-based sources, which underscore the need for local prevention education. This year we had a drop in pounds of debris collected in Kachemak Bay even though we had a significant rise in volunteer hours and miles cleaned. We also noticed a drop in the overall percentage of recreation debris collected and a rise in the percentage of smoking debris in Kachemak Bay. This trend matches the global percentage trends as seen in the 2010 Ocean Conservancy data. Rather than demonstrating an increase in new smoking debris, we believe that these statistics show that we are becoming more successful with our marine debris prevention message and have reduced and collected much of the large and most noticeable items from our beaches. Our volunteers are now able to concentrate on the smaller, though no less harmful, debris items. We have been able to use these data trends to focus our educational efforts on the most poignant local issues.

Our year round outreach projects have been very successful in keeping community members involved in marine debris cleanup and prevention. In 2010, over 75 local artists created marine debris art using buoys from a local cleanup. These buoys were then displayed throughout the community by local businesses for four months prior to our fall 2010 CoastWalk kickoff event. We also instituted fishing line recycling programs on various local waterways this past fall and have already seen a greater awareness of proper fishing line disposal near recycling locations. We believe that effective stewardship of our local, regional and global ocean resources is fostered through continued community involvement throughout the state and beyond and through these prevention and cleanup efforts the global issue of marine debris will be solved.

PRIORITY ACTIONS
Assessment and removal of marine debris must be considered a community responsibility. In order to enable communities to play a meaningful role in cleanup and prevention, marine debris education programs should be created, delivered consistently and expanded.

FIGURES AND TABLES

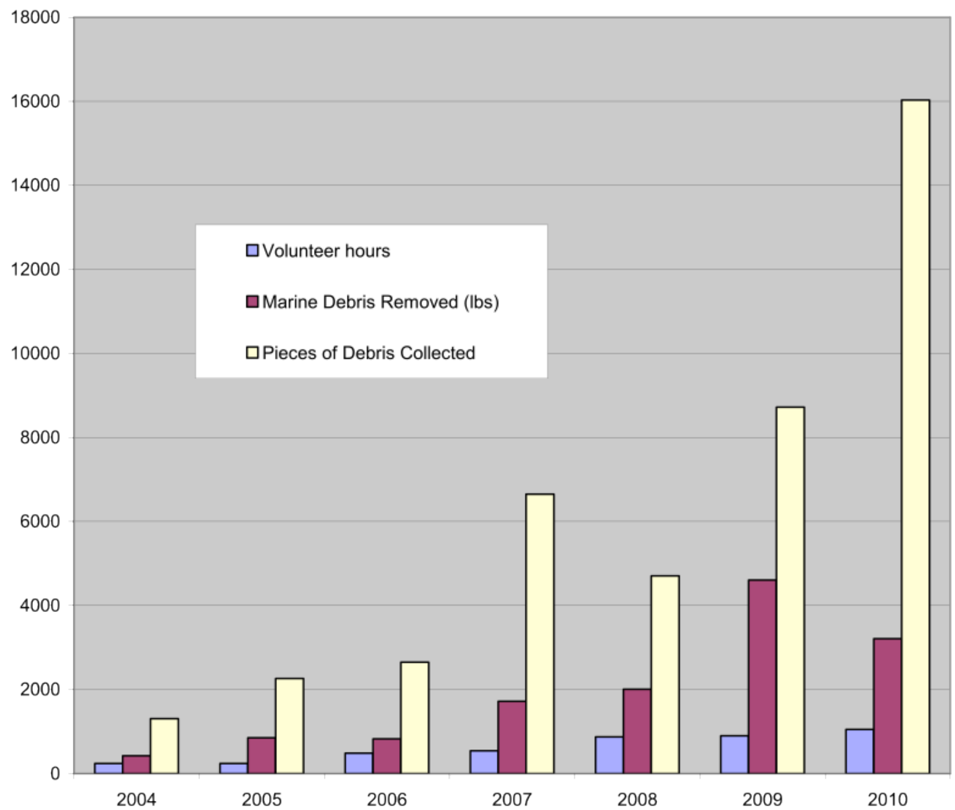

Figure 1. This graph illustrates the growth and accomplishments of our programs during the past seven years. It also shows a steady rise in pounds of debris collected until the 2010 cleanup during which we saw a decrease in weight despite the increase in pieces collected.

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5.a.1. Quantifying the relationship between fishing effort and derelict fishing traps (DFT) using autonomous underwater vehicles (AUV) in the U.S. Caribbean.

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KEYWORDS
Coral reef, fish traps, marine debris, autonomous underwater vehicle, detection

BACKGROUND
Derelict fishing gear is a continual problem in most marine/estuarine ecosystems. Derelict gear can have serious impacts to habitats and potentially significant losses of natural resources from ghost fishing. Due to many anthropogenic and natural factors, derelict traps are becoming a serious management and economic problem in the US Caribbean.
This project intends to generate several databases of commercial fishing effort, lost trap density and location, and test the use of AUV's to locate and quantify derelict traps in the territorial and federal waters around St. Thomas and St. John US Virgin Islands.

METHODOLOGY
Datasets of fishing effort were developed by the St Thomas Fisherman's Association and the US Virgin Islands Dept of Natural Resources. Additionally, the STFA and other sources provided detailed information about areas of lost or derelict traps in the region. These datasets served as the focal point to use autonomous underwater vehicles (AUV) that uses sidescan sonar technology to locate the traps. The US NSWC has AUV's with software detection capability to detect mines and the technology is being used and assessed to evaluate its effectiveness in trap detection. AUVs have not been used to locate derelict traps in a coral reef ecosystem. Two 500 m^2 areas were seeded with 25 traps to determine the AUV detection rate in areas with heterogeneous benthic rugosity. The test areas were examined with several ranges of sidescan swath widths to determine efficient methods for live derelict trap detection.
Areas of high fishing effort were targeted for initial AUV survey. Surveys were conducted in 1 km^2 boxes with either one or two AUV's working simultaneously. Targets will be verified by divers on SCUBA or ROV.

OUTCOMES

Fishing occurs throughout most of the region around St. Thomas and St. John; however effort is greatest on the south shore of St. Thomas. STFA fishermen deployed traps at depths from 100-300’, while information gathered by USVI DPNR suggest that another contingent of fishermen may exist that fish closer to shore around the entire island.

Trap detection was positive at 74%. Traps on flat substrates such as sand and rhodoliths (a macroalgal formation) were near 100%. Traps that were deployed close to reefs or structures with slope greater than 15% were detected at much lesser rates; 46% within patch reefs and 38% on aggregate reefs.

Approximately 8 km^2 of area was surveyed with the AUV. Inclement weather forced some surveys to be conducted in the absence of fishing effort data. Overall, 165 targets were identified in the survey areas. 74% of the targets (n=122) were possible traps, the remainder were tagged as items of interest, or some man-made object other than a trap. About 20 targets, possibly traps, were located inside the Virgin Islands Coral Reef National Monument, a protected area where fishing of any kinds is not permitted.

Currently, target verification has not been completed; however, three traps were verified by previously collected photos from a benthic mapping mission and from a camera that was being test on the Navy AUV. All survey targets will be verified by ROV in April 2011.

PRIORITY ACTIONS

Target verification needs to be conducted to determine what the percentage of targets are derelict.
More AUV sidescan surveys must be completed to be able to quantify the density of derelict traps in the region.
Develop a trap disposal site on St. Thomas.
Develop shipping lanes in the region to avoid gear entanglement with boats.

FIGURES AND TABLES

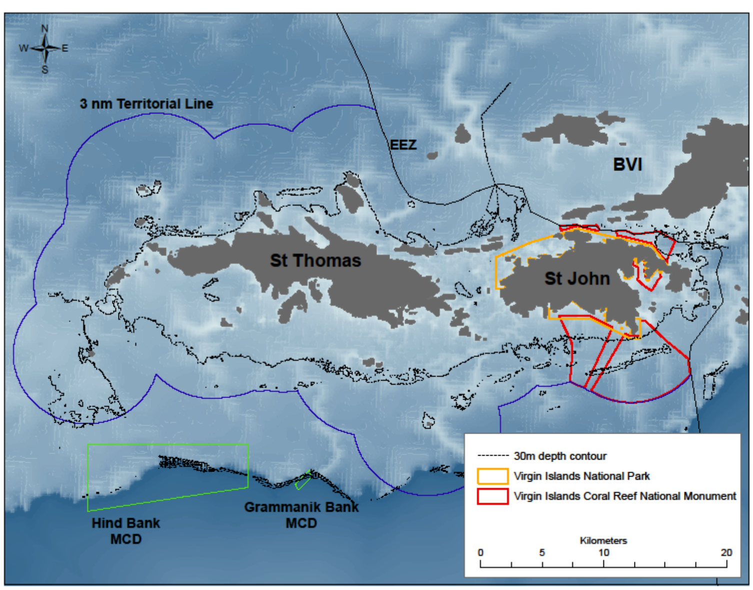

Figure 1. Derelict fish trap study area.

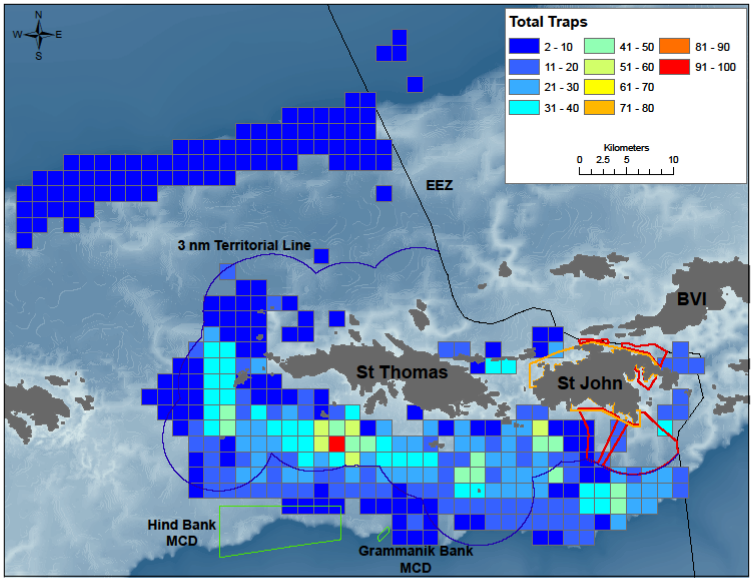

Figure 2. Fishing effort by the St Thomas Fisherman's Association.

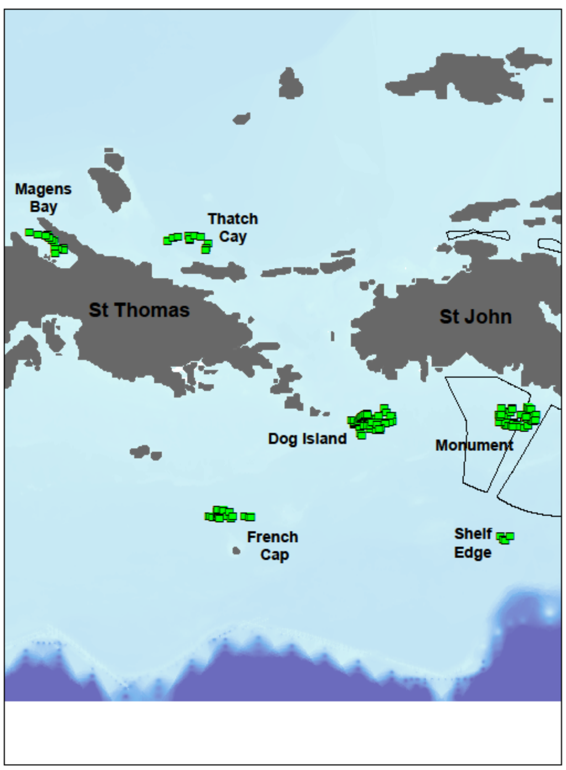

Figure 3. Potential trap targets in the study area.

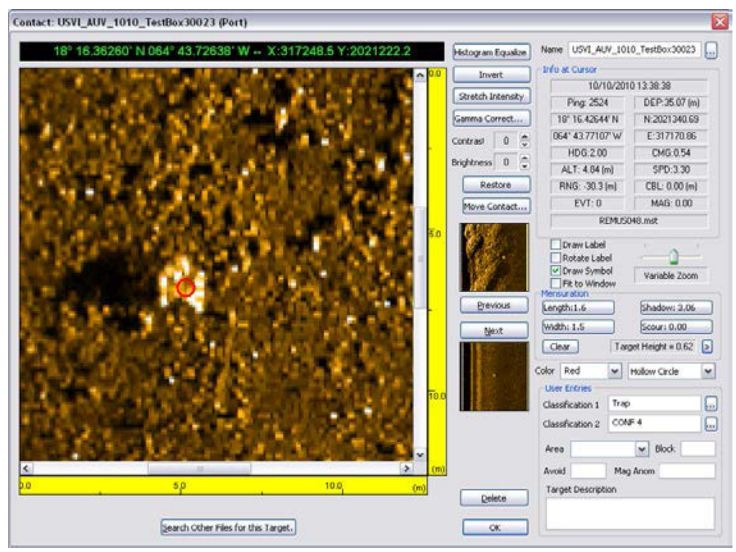

Figure 4. Sidescan composite image of chevron shaped trap.

5.a.2. Towed-diver derelict spiny lobster trap surveys in Florida Keys National Marine Sanctuary

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KEYWORDS
towed-diver, manta tow, marine debris, fishing gear, derelict traps, spiny lobster, Florida Keys

BACKGROUND
Understanding the sources and processes that drive spatial patterns of marine debris distribution is crucial to remediation efforts. Given the limited resources in most regions, prioritization of sites for debris removal is an unfortunate reality. Although recent attempts have been made to characterize benthic marine debris in Florida Keys National Marine Sanctuary (FKNMS), these surveys utilized fixed, swimming transects and were limited to those habitats known to attract recreational fishers and SCUBA divers (i.e., coral reef and hardbottom; Chiappone et al., 2002, 2004; Miller et al., 2008) without consideration for those benthic habitats encompassing a greater area of the Sanctuary seafloor (i.e., seagrass; FWC and NOAA, 2000).
The manta tow technique has recently been utilized in surveys of derelict fishing gear in the Hawaiian Islands (Donahue et al., 2001; Boland and Donahue 2003; Dameron et al., 2007). Given the potential for greater areal coverage with this technique, we chose to employ towed-diver transects to estimate the abundance, composition, and spatial distribution of benthic marine debris in the FKNMS. We also examined habitat- and user group-mediated patterns of debris which are discussed in Uhrin et al., "Distribution and Abundance of Trap Debris in Florida Keys National Marine Sanctuary" (this Proceedings), with specific reference to derelict trap debris.

METHODOLOGY
A stratified random sampling design was employed to obtain data on the spatial distribution, abundance, and composition of marine debris found in the FKNMS. We used a geographic information system (GIS) and a digital database of the benthic habitats and bathymetry of the Florida Keys to facilitate spatial delineation of the sample universe, sampling strata, and sample units (FWC and NOAA, 2000). The entire sample universe encompassed all benthic habitats ≤ 15m deep in the FKNMS, partitioned into six zones (sampling strata) reflecting historic commercial trap-use patterns in the FKNMS, and consisting of the Upper, Middle, and Lower Florida Keys on both the Atlantic Ocean and Florida Bay sides of the Florida Keys island chain (Matthews 2001). The entire sample universe was overlain in a GIS with grid of 1 minute latitude × 1 minute longitude cells. Within each trap-use zone, twenty cells to be sampled were randomly selected *a priori* from the grid, with the center point of each cell serving as the start point for a single towed-diver survey transect (sample unit).

Marine debris surveys were initiated in May 2007 and were completed in December 2007. The center point of each randomly selected grid cell was located using a Garmin GPSMAP® 3206 chartplotter (GPS). Paired SCUBA divers were deployed from a small boat with tow boards in hand, each equipped with a re-usable data sheet and bottom timer (Figure 1). Tow boards were fastened to 30m of adjustable-length polypropylene line using a stainless steel swivel shackle and tow lines were individually secured to the stern cleats of the boat. The length of line deployed during each tow varied with water depth in order to maintain a constant height of the divers above the seafloor. Placement of the towlines allowed for diver separation of 4m. Towing commenced following a pre-arranged acoustic signal from the boat, at which point a waypoint was marked in the GPS to more accurately indicate the start of the tow. Using the GPS as a guide, the coxswain navigated for 1km in the direction of a predetermined, randomly selected bearing (0 - 360°) while maintaining a relative speed of 1.6 knots, yielding an effective transect swath of 8m x 1000m (8000m^2, or 0.8 hectares). Tow direction was only altered when necessary to adjust for current and to exclude land, boats, and other navigation hazards.

Upon commencement of towing, divers started the bottom timers and maneuvered the tow boards to maintain approximately m height off the seafloor. Divers documented the type of habitat encountered at one-minute intervals, continuously recorded individual debris items observed within 2m on either side of their respective towline, and noted the type of habitat associated with all debris. Upon cessation of towing, divers recorded the total tow time, safely ascended to the surface, and were recovered.

Habitat categories were generalized from the existing digital habitat database of the Florida Keys (FWC and NOAA, 2000) to include bare substrate, algae, seagrass, hardbottom, and coral reef. Marine debris was described and categorized based upon source and composition and included: 1) commercial trap debris; 2) monofilament line; 3) cement; 4) plastic; 5) glass; 6) metal; 7) wire; 8) rubber; 9) fabric; 10) lumber; and 11) unknown. Debris generated by the commercial trap fisheries (spiny lobster + stone crab) was further categorized as follows: 1) whole traps [fishing vs. nonfishing]; 2) intact trap bottoms/trap frame; 3) cement slabs; 4) plastic throats; 5) wood slats/parts; 6) rope; and 7) trap sides. Total incidences of debris encountered and percent of total incidences of debris were estimated for each debris category.

OUTCOMES

A total of 96 marine debris surveys were completed, covering 768,000m^2 (76.8 hectares) of seafloor in the FKNMS (Figure 2). Habitats encountered were dominated by seagrass (38.1 ha). The low encounter rate for coral reef (3.7 ha) highlights the low density of this habitat on a per area basis (FWC and NOAA, 2000).

Given the location, water quality, and specific questions to be addressed, towed-diver transects proved to be an effective method for surveying derelict spiny lobster and stone crab traps and trap-generated debris in the FKNMS. Out of 797 total incidences of marine debris sighted during our surveys, 596 (~75%) could be ascribed to the commercial trap fisheries. Non-trap debris was dominated by metal objects (e. g., beverage cans, pipe, and sheeting) and plastics (namely, bags and PVC). The remaining debris included lumber, glass bottles, cement blocks, rubber (tires), wire, and fabric and were grouped together as “Other” as each contributed to ≤ 5.0% of all debris incidences. Monofilament line comprised only 1.3% of total observed debris incidences.

PRIORITY ACTIONS

The surprisingly overwhelming contribution of trap debris to submerged marine debris in the FKNMS highlights the need for debris surveys to accurately identify debris sources (i.e., commercial vs. recreational fisheries) which will enable prevention and removal programs to better prioritize and target those sources. Randomized surveys may be appropriate for identification and quantification of debris but targeted surveys are more suitable to improve the efficiency of debris removal. Towed-diver surveys were shown to be suitable for preliminary assessments of debris impact.

The pros and cons of using towed-diver surveys for detecting derelict trap debris in the FKNMS include:

Pros

Greater survey coverage versus fixed, swimming transect method
Inexpensive startup, minimal equipment
Ability to effectively survey shallow water (≤ 15m)
Can multi-task/overlap surveys

"Eyes in the water" allows:
Accurate classification of traps as actively fishing
Accurate ID of small debris items
Accurate habitat classification
Perceptions of pattern

Cons

May overlook debris in crevices versus fixed, swimming transect method
Potential hazards for divers
Inability to effectively mark debris "on-the-fly" for relocation
Increased effort, reduced coverage vs. sonar or autonomous underwater vehicles
Ability to conduct tows dependent upon visibility, sea state, current speed, and boat traffic

FIGURES AND TABLES

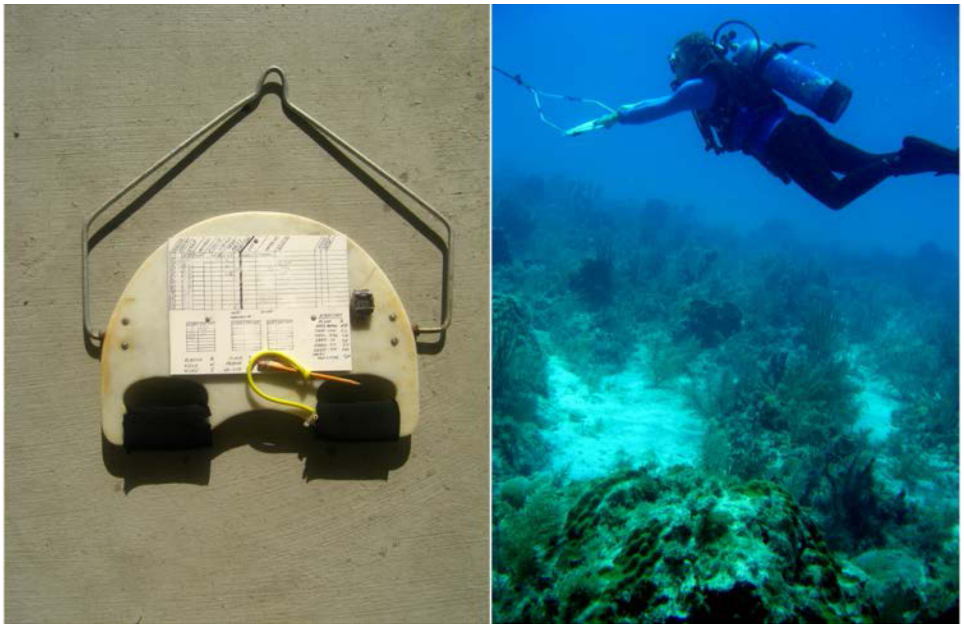

Figure 1. Tow board (left) equipped with data sheet, bottom timer, and pencil. At right, a diver is towed across reef habitat in the FKNMS.

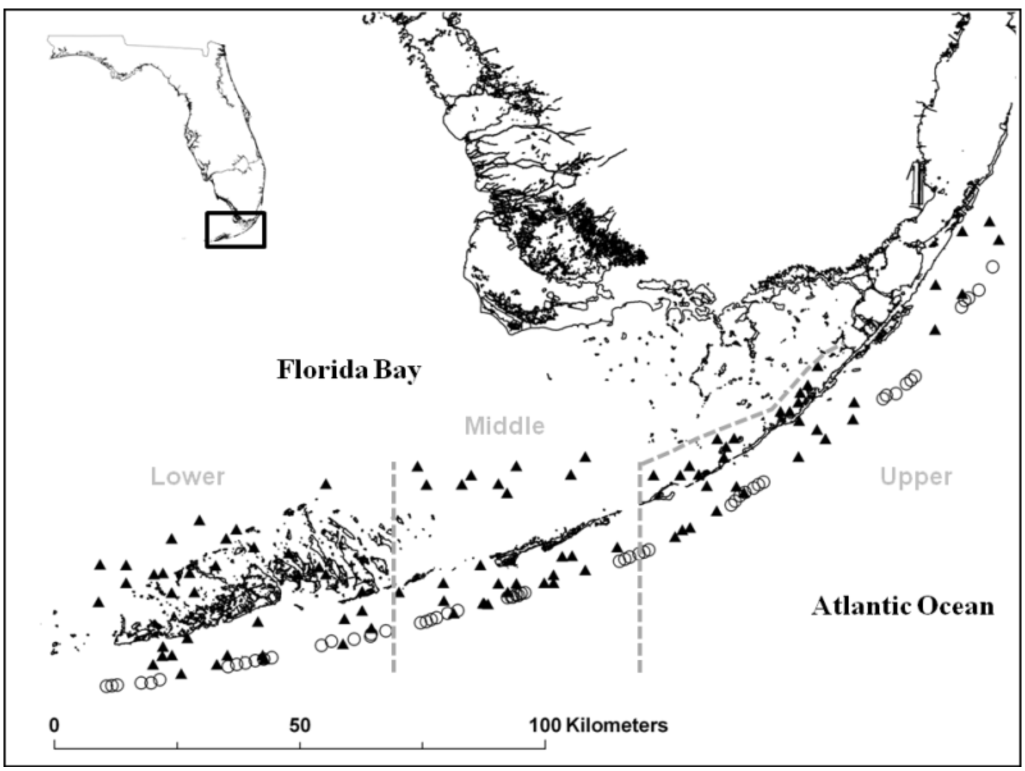

Figure 2. Locations of towed-diver surveys. Filled triangles indicate random tows, open circles indicate reef-specific tows (not discussed), and dashed lines separate historic trap-use zones.

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5.a.3. Utilizing high resolution side scan sonar to detect derelict fishing gear (nets, pots/traps) in Washington State's Salish Sea

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KEYWORDS
Derelict fishing gear, side scan sonar surveys

BACKGROUND
Since 2002, the Northwest Straits Initiative (NWSI) has been conducting derelict fishing gear survey and removal in the Washington State waters of the Salish Sea. Extensive fishing in the region for several decades has left thousands of nets, pots/traps, and other fishing gear items on the seafloor. Crab pots, lost in the popular Dungeness crab fisheries (recreational and commercial) have been surveyed and identified through the use of high resolution side scan sonar since the inception of the NWSI's derelict gear project. The metal frame of a crab pot often can be easily identified with the sonar signal. However, gillnets made of monofilament are much more difficult to detect with side scan technology. Therefore, surveys for nets have been limited to drop camera transects and diver reports. Although often successful when investigating known areas of heavy historical fishing effort, these methods are very limited in the amount of seafloor being observed per transect. In Salish Sea waters, poor lighting, obstructions to field of view and lack of water clarity reduces visibility to few meters or less, making the area of seafloor observed during a single survey relatively small, whereas a single transect with high resolution side scan can cover hundreds of meters in swath width. During the NWSI's Derelict Fishing Net Removal Project (July 2009-December 2010), Fenn Enterprises with Marine Sonic Technology Ltd. made modifications to the side scan sonar equipment used for locating crab pots that has proven effective in identifying both obstructions likely to snag nets, as well as the nets themselves. This new method has given the NWSI the ability to survey the entire area of high priority fishing grounds, as opposed to only subsampling the areas with drop-camera and diver surveys.

METHODOLOGY
Resolving derelict traps requires resolution high enough to image a one-meter target, best accomplished with a 600-kilohertz (kHz) transducer operated at a 50 meter range. However, for the purpose of detecting larger geologic features which may entangle nets, a 300 kHz transducer operated at a 100 meter range has proven most effective in both identifying features and gaining full coverage of designated 'high priority' survey areas. In either case, once the vessel has reached survey speed (3 to 4.5 knots), the towfish is deployed and lowered to an altitude above the seafloor equivalent to 10 percent of the range per channel (e.g., if you are suveying on a 50 meter range, a good rule of thumb would be to have the towfish 5 meters above the seafloor). Once the towfish is "flying" at the desired altitude, the sonar operator adjusts the gain or

attenuation to produce the desired image and then calculates the layback and offset of the towfish in relationship to the GPS antenna. Due to high probability of towfish collision with derelict gear or other obstructions during surveys, the NWSI team employs a Marine Sonic Technology heavy-duty, commercial-grade sonar system, including a 57 kilogram stainless steel towfish and clutched hydraulic winch with heavy cable. The quality of side scan sonar images can be compromised when surveying through thermocline or halocline differences in the water column, a problem that can be alleviated by reducing the range of the sonar during the survey to avoid these features. Additionally images can be obscured by "noise" such as waves, whitecaps and propeller turbulence, therefore limiting survey days to those when weather and sea conditions remain fairly calm (preferably <1.5 ft chop), and maintaining a survey speed below 5 knots. Diver safety regulations limit NWSI derelict gear removals to water depths between 0 and 105 ft, therefore, surveys were generally not conducted in waters beyond 105 feet deep. Because of the steep slopes in Puget Sound and the wide area covered by side scan sonar, full survey coverage of the allowable diver depth within many of the high priority areas was achieved with only one transect.

Once features and areas were identified as likely to contain derelict nets, the specific area was resurveyed with a reduced sonar range of 50 meters in order to increase image detail. Although real-time sonar image analysis is beneficial in identifying these locations while on-site and noting items for later examination, the majority of targets are identified during detailed post-survey processing onshore. Targets identified displaying characteristics of net or line are entered into the database as "Unknown Nets", and geologic or man-made features displaying a high probability for snagging derelict gear are entered as "Sidescan Targets."

Subsequent to shallow water surveys at depths divers can work, interest in derelict gear impacts on deep water rockfish, resulted in side scan sonar surveys for derelict gear, primarily derelict gillnets, being conducted in areas of critical habitat for rockfish. These surveys are ongoing with both the 300 kHz sonar for large-scale surveys and a 600 kHz sonar for detailed examination of suspected derelict gear items. For deep water surveys a USBL or acoustic tracking system is added to the survey package which allows the operator to track the location of the towfish in relationship to the GPS antenna. Surveys have been successfully conducted to depths of 650 ft and derelict gear has been found at depths up to 350 ft in critical rockfish habitat.

OUTCOMES

During the NWSI Derelict Fishing Net Removal Project, side scan sonar surveys covered roughly 733 linear miles (1,180 km) of high priority areas, with swath widths ranging from 75 to 200 meters. Data analysis provided the identifications of 948 possible net or line targets (Unknown Nets) and 2,293 geologic features and underwater obstructions possibly having derelict nets (Sidescan Targets). Of the 407 "Unknown Net" targets investigated, 277 proved to be nets or other debris and a total of 540 derelict nets were identified and removed in these locations. Of the 500 "Sidescan Targets" investigated, 160 nets were found and removed (Table 1). Another 77 items such as crab pots, crab lines, longlines and cables were identified during target investigation and removal. The total area of net removed from targets found during side scan surveys equaled 74.8 acres. Nets were not found at 130 of the "Unknown Net" target sites. At many of these locations, divers observed organisms such as bull kelp (*Nereocystis luetkeanus*) and "cucumber grass" (*Gracilariopsis sp.*), and geologic features such as ridgelines and cracks that were interpreted in the sonar image as possible nets or lines. Images of those targets were later studied by the surveyor and adjustments were made in future target selection that proved to minimize false-positives.

In addition to appearing as possible derelict gear targets, gas-charged materials such as the bull kelp, cucumber grass, eel grass and other types of vegetation block detection of derelict fishing gear, as side scan sonar will not pass through these plants. Vertical underwater cliffs have also been identified as areas where derelict gear targets are difficult to distinguish, due to the vast amount of cracks and fissures displayed on the rock faces that can often be interpreted as possible net or line. However, recent side scan sonar surveys in rockfish habitat (deeper than allowable diver depths) in the Puget Sound positively identified derelict net locations on high-relief rocky substrate and near vertical rock walls that were later verified with use of drop camera surveys.

Removal operations that involved investigation of "Sidescan Targets" showed clearly that searching for derelict gear amid geologic features and other underwater obstructions only proves worthwhile where there is definite evidence of heavy historical fishing effort in that specific area.

PRIORITY ACTIONS
Use various sources such as historical fishing effort data, local knowledge, bathymetric and geologic information, etc. to properly identify locations within your area/region that should be designated as "high priority" areas for derelict fishing gear surveys and removal. Then develop a multiple-option plan, with particular consideration towards feasibility, that when carried out will lead to your desired goal. Then find the funding.

FIGURES AND TABLES

Table 1. Findings from investigation of targets identified using side scan sonar during NWSI's Derelict Fishing Net Removal Project (July 2009 – December 2010)

	Total Targets Investigated	# Found	% Found	Additional Targets Found	Total Targets Found	# Targets per Investigated Site
Unknown Nets*	407	277	68%	316	593	1.46
Nets		247		293	540	1.33
Pots		5		19	24	0.06
Line		4		2	6	0.01
Debris		21		2	23	0.06
Sidescan Targets**	500	127	25%	57	184	0.37
Nets		107		53	160	0.32
Pots		13		3	16	0.03
Line		4		1	5	0.01
Debris		3			3	0.01
All SS Targets	907	404	45%	373	777	0.86
Nets		354		346	700	0.77
Pots		18		22	40	0.04
Line		8		3	11	0.01
Debris		24		2	26	0.03

*Several terms generalized as 'Possible Line or Net', entered into DB as 'Unknown Nets'. Line, Net, Net or Geo, Net or Line, Net or thermocline/halocline, Possible line, Possible Net or Line, Possible Net or Line (bull kelp?), Possible Net or Line (Geo?)
**Several terms used to describe substrate and target type, generalized as 'Rocky Substrate/Boulders/Unk Target', entered into database as 'Sidescan Target'

REFERENCES

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5.a.4. Detecting derelict fishing gear in the Stellwagen Bank National Marine Sanctuary using the HabCam habitat mapping camera system

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KEYWORDS

Derelict fishing gear, ghost pots, lost gill net

BACKGROUND

Marine debris, specifically derelict fishing gear (DFG), presents a threat to the wildlife of NOAA's Stellwagen Bank National Marine Sanctuary (SBNMS) as well as the fishery productivity of the sanctuary. Quantifying this threat is a prerequisite for deciding to invest time and money in the retrieval of DFG, particularly in deepwater areas.

METHODOLOGY

Our criteria for detecting and quantifying DFG was to use a sampling device that provided geo-rectified, high resolution, continuous optical imagery of the seafloor, and was cost-effective and efficient at collecting and processing large quantities of image data over broad areas. These criteria were met by using a non-invasive optical sampling device, the Habitat Mapping Camera system (HabCam), developed and operated by The HabCam Group, a consortium of commercial fisherman, scientists and engineers (http://habcam.whoi.edu). HabCam is towed at 5 kts collecting ~500,000 images covering ~0.25 km2 per day. Images and associated data are transmitted to the ship over a fiber optic link at 5-6 Hz where they are displayed, processed, and recorded in real-time (Fig. 1).

OUTCOMES

Repeated habitat surveys for the past four years in the SBNMS, the area of which is ~2180 km2, have yielded ~15 million images (~7.5 km2 coverage). Manual identification of manmade objects yielded 21 categories of which 10 were DFG (Fig. 1). Example categories include nets (trawl, gill), lines (cable, monofilament, rope, wire), tackle (lures, plugs), and lobster pots (Table 1). SBNMS was divided into two regions, one within the boundaries of the Western Gulf of Maine Closure Area (closed to bottom fishing since 1998) and the remaining region open to fishing (Figure 2).

Within the open region, an area of approximately 0.07 km2 (~130,000 images) was sampled yielding 204 observations of DFG (Table 1). Line and rope dominated the open area with an average of 928 observations over the sampled area and a projected total abundance of about 3.4

million. However, care should be taken in interpreting the projected total abundance since DFG are not uniformly distributed. It is also possible that these are overestimates since observations from one image to the next may be revealing the same gear, particularly for line and rope, but also for gillnets. However, no gill or trawl nets were observed in the open area.

Within the closed region defined as the Sliver, an area of approximately 0.10 km2 (~200,000 images) was sampled, yielding 246 observations of DFG (Table 1). Observations of gill nets lying on or near the seafloor dominated the closed area with 138 observations producing an average density of 1,380/km2 and a projected total of about 700,000. Line, rope, and monofilament line ranked second with 96 observations over the sampled area, an average density of 320/km2 and a projected total abundance of about 164,000. No lobster pots were observed in the closed area.

A special area was identified in the south east sector of SBNMS we called GOM_ridges. In this area ridges of gravel, cobble and boulder rise from a soft, silty-sand bottom and form habitat for a variety of organisms, particularly lobsters. High flyer buoys for active lobster traps were scattered throughout the area. While line and rope again dominated observations of DFG with an average density of about 1,600 observations/km2, 16 derelict lobster traps were observed for an average density of 640/km2 and a projected total for the area of about 61,400. Derelict traps were classified by the presence of extensive growth on the wire mesh, which would not be present on an actively fished trap (Fig. 1).

Geolocated observations were entered into a PostgreSQL database to allow queries by space and time. DFG-specific plots were generated in Google Earth with each data point linked to an image so a user could click on a point to observe the type of gear (Fig. 2).

Conclusions: Sampling effort was greatest in the closed area (Sliver) and the GOM Ridges providing the highest level of certainty about projected total DFG present in those areas. Therefore, a projection of 640 derelict lobster pots in the GOM Ridges area appears realistic. The density of derelict gill nets in the closed area (Sliver) was more than 1000/km2 suggesting that it may be worth targeting and retrieving those that are clearly continuing to fish unmanaged or lost on the seafloor.

PRIORITY ACTIONS

- Continue wide area surveys in regions that are known to contain high densities of derelict gear
- Use automated processing to scan large numbers of images
- Correlate DFG locations with depth and substrate type to enable prediction of probable DFG areas.
- Geolocate and retrieve derelict gear, particularly gill nets and lobster traps that threaten local species.

FIGURES AND TABLES

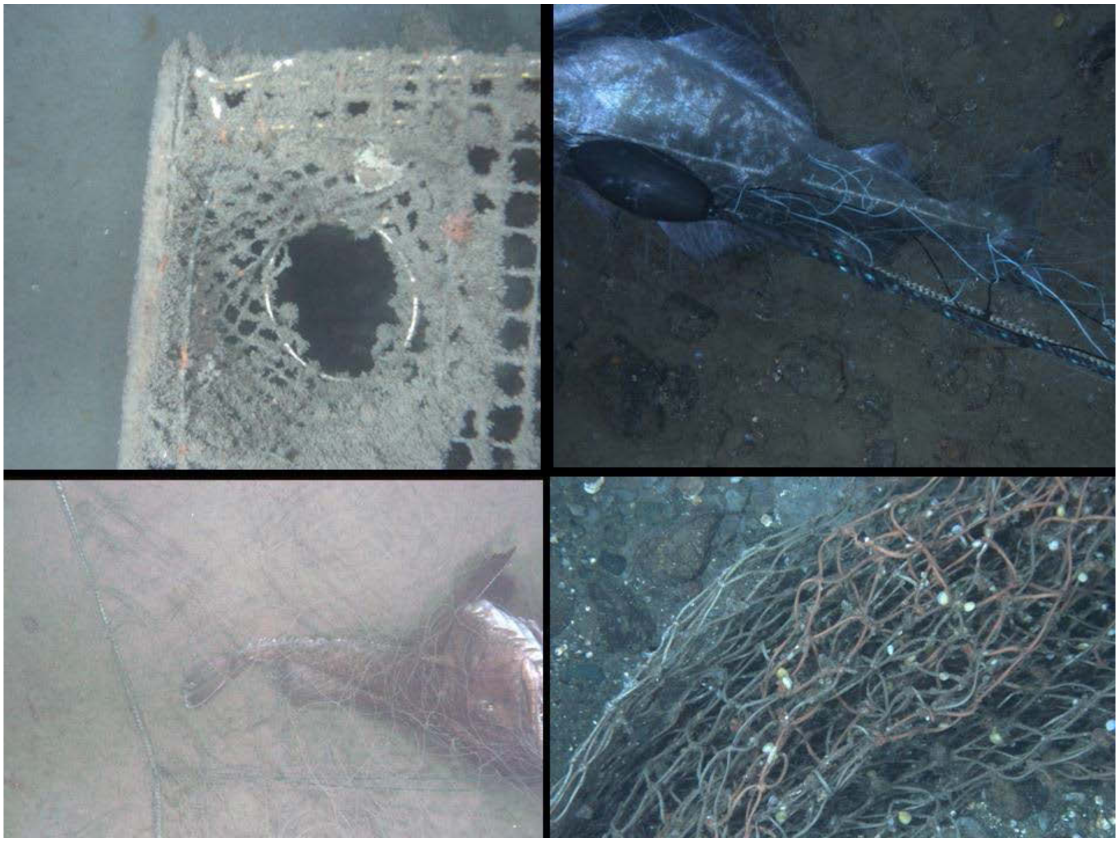

Figure 1. Example images of lost gear presumed to be derelict. (top left) lobster trap; (top right) gill net with entrained ground fish, most likely pollock; (bottom left) gill net with entrained goosefish; (bottom right) trawl net.

5.a.5. Sonars, robots and seeing through the dark: using integrated technology to locate and remove marine debris (especially derelict fishing gear)

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KEYWORDS
Rozalia Project, ROV, remotely operated vehicle, sonar, VideoRay, Blueview, Lyyn, Tritech, derelict fishing gear,

BACKGROUND
Derelict fishing gear is an issue that must be addressed. Off the coast of New England, between 5-10% of all lobster traps set are lost each year[1]. Trap loss occurs because of storms as well as getting fouled and cut on propellers or cut by boaters.

Locating and recovering lost traps is difficult for fishermen who have few options to recover their traps. Grappling is the most used option. Even grappling however, costs time and money and fishermen are faced with the decision to spend precious fishing time and fuel searching for traps they cannot see or, they are forced to replace the traps with new ones. In addition, grappling has the potential to damage the seafloor.

Rozalia Project for a Clean Ocean is using a micro-ROV along with side scan sonar, imaging sonar and image enhancement technology as a cost effective and accurate method to locate and remove marine debris including derelict fishing gear.

METHODOLOGY
The equipment Rozalia Project uses integrates to allow for accurate and efficient debris/gear detection and removal.

We start with a Tritech Starfish side scan sonar. This is a towed sonar that gives a big picture of the density, type and location of debris targets over a larger area than the ROV can see. We develop a mission plan based on the Starfish's images.

Once we have identified debris targets, we deploy the VideoRay ROV equipped with the Blueview imaging sonar and Lyyn image enhancement system. The Blueview is real-time, sonar 'video' that 'sees' out to 180'. This allows us to see in even highly turbid water and fly straight to targets. Once the ROV's video acquires the target, the Lynn enhances the image by suppressing the dominant color allowing for more contrast.

Once at the target, we are often able to use the manipulator to recover the debris. In the case of derelict fishing gear, we are developing a system that will allow us to quickly attach a line and float to the trap. This will mark the traps for efficient pick up over a specified area.

In 2010, Rozalia Project completed surveys to target areas and will return in 2011 to execute gear removal in areas with large amounts of derelict gear, such as Newport, RI.

OUTCOMES

Integrating this technology has proven to be an accurate and effective method of locating and retrieving marine debris and derelict fishing gear.

The limitations we found were related to depth (the VideoRay was limited to 500 feet) and wave action. The benefits however, are that the side scan sonar accurately locates targets and the ROV equipped with imaging sonar quickly reacquires them. In addition, there is nearly zero impact to the sea floor (no dragging), the equipment is easy to use, is small enough to be handled by one operator, used on virtually any boat and can gather information concurrent to the act of cleaning via recordable ROV and sonar video.

PRIORITY ACTIONS

1. Locate it: find and map marine debris using efficient technology.
2. Remove it: recover and catalogue marine debris.
3. Dispose of it: seek methods to reuse or recycle marine debris with proper land-filling the last resort.

REFERENCES

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5.a.6. Lessons learned in planning and execution of a derelict crab pot detection project in SE Alaska

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KEYWORDS
Sonar, Video, Detection, Dungeness, Crab Pot, Depth, Turbidity, Technology, Best Practice, Processing

BACKGROUND
When looking to reliably detect marine debris in any body of water, there are many variables that must be taken into account when deciding which technology to use. Each detection method carries its own inherent detection error, which will vary by the environment and conditions of the survey area. Target depths might suggest one method of detection, but that can be overwhelmed by water clarity or temperature. Additionally, the method of detection must be suited to the end goal of the project – a survey that requires removal must have a high degree of spatial accuracy, while one based strictly on abundance can use transect timing methods. All of these facts were put to the test during the planning and execution of a two year project conducted in Southeast Alaska to study the abundance and impact of derelict Dungeness crab pots. This presentation will focus on lessons learned through both the selection and deployment of detection technologies in this study.

METHODOLOGY
The study utilized a Klein 3900 side scan sonar unit, towed from a small research vessel. Data collected was processed using the Chesapeake Technologies SonarWiz.Map software set. This sonar data was then geo-referenced and exported into mapping products for use during dive operations as well as data analysis. These products included data on target location, dimensions, classification, as well as imagery.

The method of towing was a significant lesson learned in and of itself. In the first year, funding and timing meant that the towpoint of the sonar unit was an adapted crab-pot retrieval machine. This proved stable for towing, but did not allow for rapid or reliable manipulation of the towfish depth, restricting the operational plan to specific depths and survey lines. In the second year, a powered reel was purchased, which allowed for more accurate and precise depth manipulation but also introduced additional mechanical variables to the project.

OUTCOMES
Through the planning stages of this project many technologies were evaluated for detection; scanning sonar, remotely operated vehicles with multiple sensor packages, towed video sleds, as well as multiple side-scan sonar solutions. Through this process it became clear that the system we would be able to use would be primarily based on the resources we had available, combined with the capabilities of the system itself.

The project resulted in the detection of 694 total potential crab pot targets, 128 of which were successfully removed by divers. The identification probability of survey and diving operations, expressed as the likelihood of any dive operation resulting in the successful location of a crab pot, increased from year one to year two (63% to 78%). This increase is thought to be the result of increased geo-referencing accuracy during diving operations, but is not clearly correlated with any one change.

PRIORITY ACTIONS

When planning a project with a detection element, approaching the technology and protocol selection process with consideration for end goals combined with the survey environment will provide a project the highest potential for success.

FIGURES AND TABLES

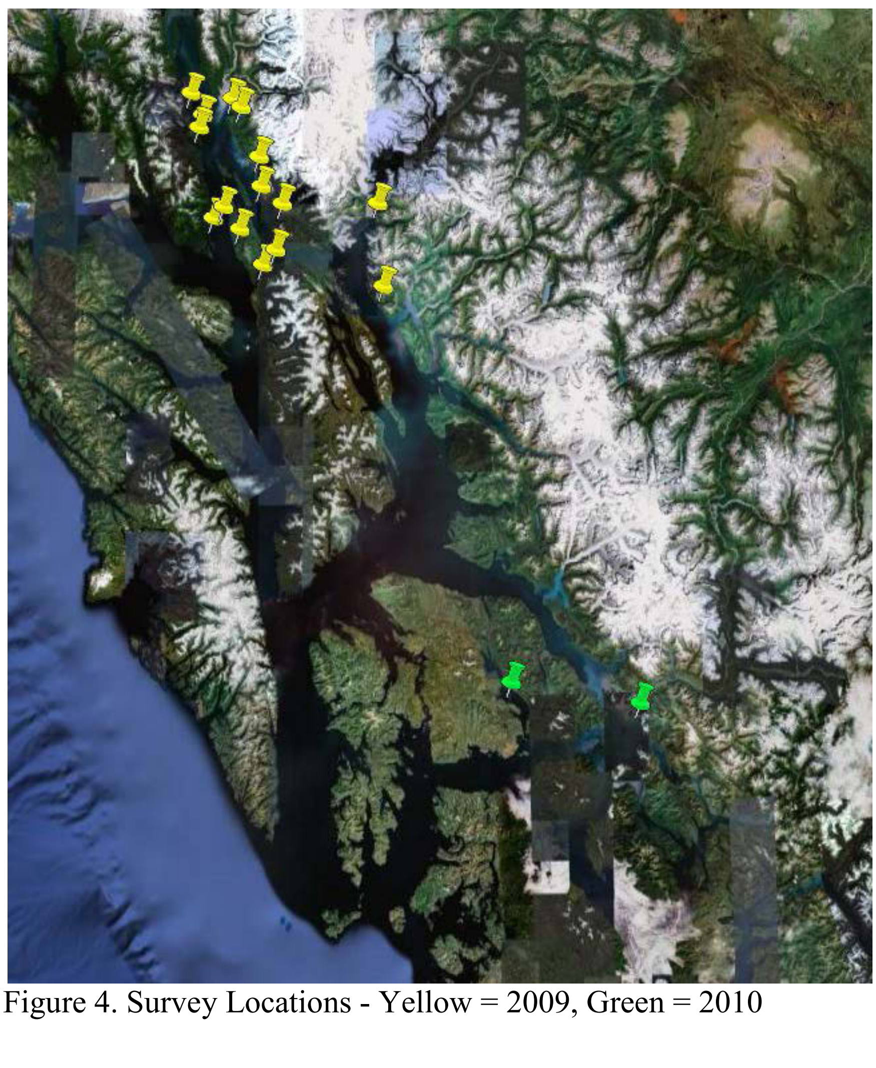

Figure 4. Survey Locations - Yellow = 2009, Green = 2010

5.c.1. Midway Atoll as a sentinel site for Pacific-wide marine debris

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KEYWORDS
Midway Atoll, Pacific basin, monitoring, plastic fragments, land-based debris, ocean-based debris

BACKGROUND

The Papahānaumokuākea Marine National Monument (Monument) was established by President George W. Bush on June 15, 2006. It became apparent that marine debris is one of the crucial management problems facing the Monument. Section 3.3.1 of the Monument's Marine Debris Action Plan seeks to "reduce the adverse effects of marine debris to Papahānaumokuākea Marine National Monument resources and reduce the amount of debris entering the North Pacific Ocean." Because the majority of debris is not produced locally in the Monument, the islands can give us important information about types and abundance of marine debris at the Pacific-wide scale.

OUTCOMES

We developed a beach monitoring protocol for Midway Atoll to characterize the debris that washes up on the shore of the island. Five 150 m monitoring sites (4 on Sand Island and 1 on Eastern Island) were randomly selected in May 2008. Surveys were conducted monthly June 2008-February 2010. Over 13 surveys, 25,302 total debris elements (identified items and pieces) were collected; total weight was 609 kg. Seventy-two percent of the total was pieces; 91% of the pieces were made of plastic materials. Identifiable items were 28% of the total; 46% of the identified items were ocean-based (i.e., fishing, aquaculture, and shipping) and 54% were land-based (beverage-related, plastic bags, food containers, toys/sport equipment, smoking-related, personal items (health, beauty), equipment, construction material, and automobile parts). None of the land-based items were produced from activities on Midway Atoll. Eighty-four percent of the ocean-based items were oyster spacer tubes, rope, and floats/buoys; 78% of the land-based items were caps/lids and beverage bottles. Sites facing the North Pacific Gyre received the most debris and proportionately more pieces. Chemical analysis of 141 unidentifiable pieces/ fragments indicated that 56% were polyethylene (PE) – samples included PE homopolymer and some blends of PE with very small amounts of polypropylene (PP), 30% were PP homopolymer and impact modified PP, 7% were ethylene vinyl acetate, and 7% were non-polymers. These plastic pieces were related to food packaging and cutlery, beverage bottles, electronic cases and other products. Land and ocean-based debris on Midway Atoll indicates broad problems in solid waste management in the Pacific basin. The amount and condition of the fragments indicate numerous pathways for degradation (UV, exposure duration, wave action, abrasion and incomplete combustion). The chemical composition of fragments, while somewhat inconclusive, indicates that the primary likely source is land-based. This information establishes a baseline for marine debris on Midway Atoll as an indicator of Pacific region-wide solid waste management issues; other research can be used to help target regional sources of debris and lead to prevention activities for abatement of marine debris impacts and occurrence.

PRIORITY ACTIONS

- Use information to connect people's waste-management habits to what is appearing on remote islands (such as Midway)
- Work with fishing and shipping industries to improve understanding of how waste is generated and handled and then develop strategies to reduce these sources of waste.

5.c.2. Coastal cleanup and marine debris trends analysis in Puerto Rico (2002-2010)

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KEYWORDS
Marine debris, Puerto Rico, cleanups, International Coastal Cleanup

BACKGROUND

Marine debris has become the most significant and persistent contamination problem across the shorelines around the World. Marine debris kills, injures, and entangles thousands of animals and plants every year. It is a potential threat to our food supply and personal health. It affects the countries economic activities. Finally marine debris degrades oceans health and infringes its ability to adapt to climate change (Ocean Conservancy, 2010).

Unfortunately, Puerto Rico does not escape this reality. Marine debris is one of the most pervasive and solvable pollution problems affecting the coast and other waterways of Puerto Rico. This problem is particularly important if we think that our shorelines are an important touristic attraction for our Island, making it an economical problem as well as a pollution, health, and ecological problem. Puerto Rico is one of the major waste producers of the World generating more than 7,500 tons of solid waste daily (Solid Waste Authority, 2009). Today, the Island has only 5 landfill zones and they are progressively being closed because of over filling and completeness of life expectancy. Because we live on an island, our lengthy coasts are full with litter that gets carried into our watershed systems.

The changing of behavioral patterns is the key if we truly want to make a sustainable change in our way of life. Scuba Dogs Society (SDS) believes that direct citizenship participation in any effort to promote environmental conservation is the most effective way to make these changes. SDS works not only with coastal beach shorelines but also with rivers, lakes, estuaries, and any other body of water. By presenting citizens with the opportunity to participate in cleanups, recycling, reforestation, and restoration projects, SDS has made it one of the organizations top priorities to educate the public about the marine conservation. This hands-on education in our schools combined with the activities of the Coast to Coast Cleanup Program, the International Coastal Cleanup (ICC), and the Escambrón Marine Park Restoration Project provides educational programs that instill environmental values and leadership in all who participate. In this paper we like to present the coastal cleanup and trends analysis in Puerto Rico from 2002 to 2010.

METHODOLOGY

Before coastal and underwater efforts, SDS prepares and launches an aggressive Media campaign to motivate and recruit participants island-wide. Also, SDS has integrated government, private sector and communities to work together.

The methodology from the Ocean Conservancy protocol is being used to cleanup beaches. The data that volunteers collect is just as, if not more important. The volunteers work in groups of 5 persons and use the data card to collect information about every item, keeping accounting of trash on areas cleaned. This data has been collected systematically since 2004 in the summary cards for the coordinator or coastal captain, after this data is sent to Ocean conservancy for world report.

Create additional activities to engage the volunteers in other conservation efforts like coastal reforestation, recycling, install trash containers, rescue entangled species and distribute educational materials.

OUTCOMES

Since Scuba Dogs Society took over the ICC in Puerto Rico, the coastal cleanup movement has grown dramatically. In 2002, 590 volunteers removed 8,000 pounds of garbage in 10 beaches that represented 8.25 miles of coastline. In 2003, 1,407 volunteers removed 24,848 lb in 21 beaches. In 2009, 250 coasts including rivers, beaches, lakes and reservoirs were cleaned by 14,926 volunteers (80% were students from schools and universities) in 63 municipalities of the island and 230,000 pounds of garbage were gathered from 400 miles of coast. Puerto Rico placed in the 5th position for the number of volunteers participating among all the participating countries and was only surpassed by USA, Philippines, Canada and India. Additionally volunteers and sponsors have contributed in the creation of a scientific database of marine debris. Data collected from volunteers is used for public education and a variety of resource agencies and researchers.

The activities have been a success measured not only in terms of the numbers of participants but in the decrease of the marine debris. The number of volunteers is our major accomplishment and our best way to demonstrate our success and maintain our credibility in the communities. Since our beginning in 2002, more than 72,590 volunteers including families, young adults and organizations from both private and corporate sectors participated in the ICC in Puerto Rico. These volunteers donated their time to remove more than 1,677,363lbs of debris from over 1,651.78 miles of shorelines. The ICC integrated 270 coasts including beaches, rivers, lakes and other bodies of water in 63 municipalities.

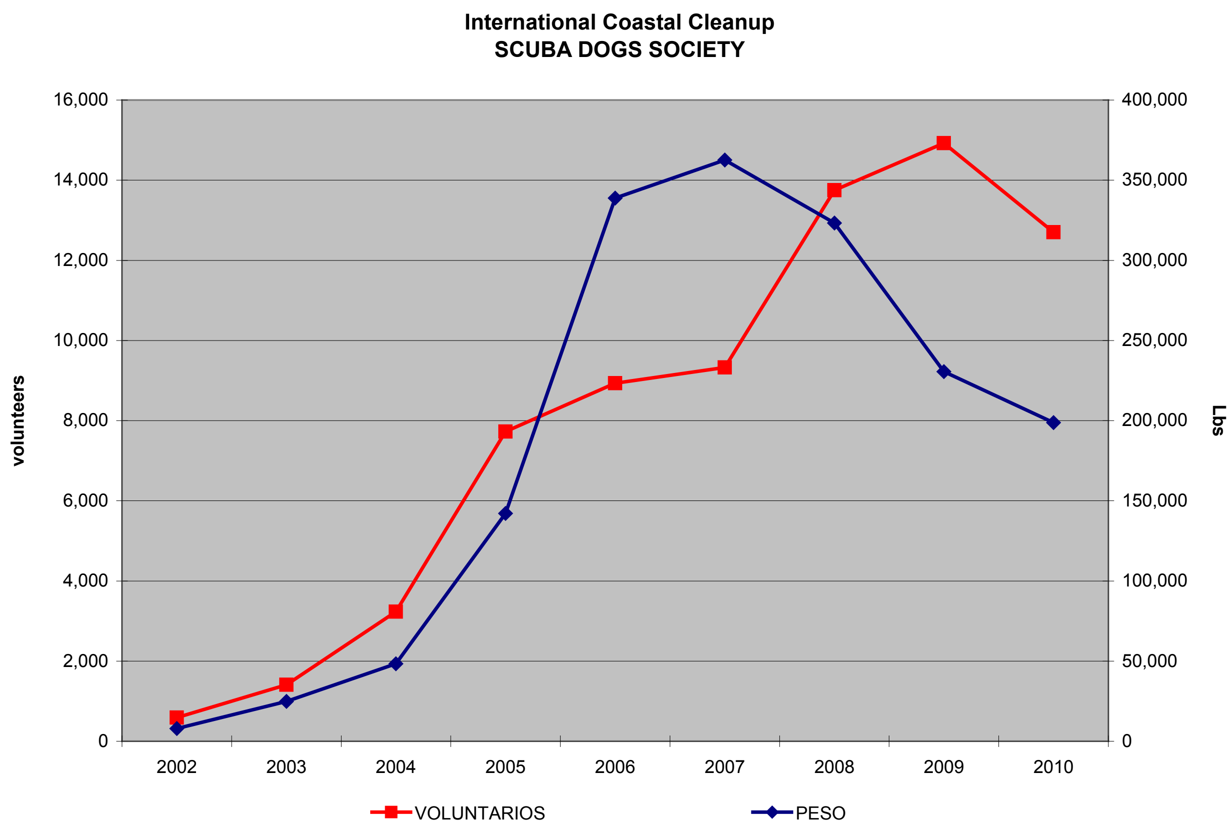
Since 2007 and for three consecutive year the results show a positive trend. It is a growth in the number of volunteers and a diminishment in the total waste removed. These results indicate that there has been a change in behavior of the communities and people of Puerto Rico.

This effort has had a positive effect in the number of coastal cleanups year round by communities and other organized groups. Today there are better prepared communities and an increased interest in the conservation of their coasts. This achievement is of supreme importance in well informed environmental decision making and marine management of coastal areas. This information has served to stimulate and achieve national laws as it is the case of the Law # 329 of December 29, 2003. In 2010, according to the data reported of the cleanup sites, around 13,000 volunteers participated gathering 215,000 pounds of waste. We are proud to say that we have been creating awareness and engaging thousands into taking positive action to help cleanup, protect and preserve our natural resources.

PRIORITY ACTIONS

The main priority action for Scuba Dogs Society is promoting education and empowerment within the communities. Other priority goals to reach are: stimulating leadership actions in young students and volunteers, and creating awareness in Puerto Rico in order to reduce waste trough environmental educational campaigns.

FIGURES AND TABLES



TOP TEN PARTICIPATING COUNTRIES & LOCATIONS

RANK	COUNTRY OR LOCATION	NUMBER OF VOLUNTEERS
1	UNITED STATES	218,779
2	PHILIPPINES	74,493
3	CANADA	37,147
4	INDIA	18,284
5	PUERTO RICO	14,705
6	JAPAN	13,867
7	BRAZIL	13,664
8	DOMINICAN REPUBLIC	11,636
9	SOUTH AFRICA	7,832
10	MEXICO	6,772
	108 COUNTRIES & LOCATIONS	498,818

SOURCE: OCEAN CONSERVANCY/INTERNATIONAL COASTAL CLEANUP 2009

TOP TEN PARTICIPATING COUNTRIES AND LOCATIONS

RANK	COUNTRY AND LOCATION	NUMBER OF VOLUNTEERS
1	United States	183,194
2	Philippines	37,728
3	Canada	34,320
4	Japan	13,887
5	Brazil	11,731
6	Mexico	9,543
7	Puerto Rico	8,637
8	Ecuador	8,379
9	South Africa	7,003
10	India	6,147
	104 Countries and Locations	390,881

Source: Ocean Conservancy/2008 International Coastal Cleanup

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5.c.3. Characterization of beach litter in Cijin and its implications on solid waste management.

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KEYWORDS
Transect survey, Plastics, Styrofoam, Source reduction, Waste management

BACKGROUND
Beach is an important tourist attraction and contributes to improve the quality of life. Clean beach is a main indicator of the coastal environmental quality. The anthropogenic marine litter not only reduces the aesthetics of the beach, but also results in many undesired environmental consequences such as causing adverse health risk, threatening coastal wildlife, reducing tourism quality, and inflicting fishery loss. Hence, many countries have established monitoring plan and management strategies to prevent marine litter. Beach litter survey is important since the results can be used for beach management and for establishing related regulatory measures. However, most of the survey results were not compared to the land-based waste management policy. The practice for waste management on land should have prevented most of the litter from entering the marine environment and its influence has seldom been discussed in the literature. In this study, we performed a yearlong transect survey to investigate the fluctuation of marine litter on four selected beaches in Chijin, Kaohsiung. The results were compared with the literature and the territorial waste management practices in Taiwan to evaluate if the current practice has any influences on the characteristics of the beach litter found in the survey.

METHODOLOGY
Four beaches were surveyed every two months in Cijin, Kaohsiung for a year. The beaches near Cijin coastal park and tourist center are popular recreational sites that are typically crowded with tourists, while the other two beaches are in more remote areas, one near a municipal wastewater treatment plant and one near a ship container distributing center. A 100m x 5m transect strip along the top wet strandline was chosen at random in each site. The coordinates of each site was recorded with a Global positioning system (GPS) to allow the subsequent survey in the same stretch of beach and for use in possible GIS mapping. The collected litter items were recorded using a standardized data card developed for this study. The marine litter was categorized by its type of material and source for litter generation activities. The amount of marine litter, seasonal variation, and top 10 items were then analyzed. Results of the litter survey were compared with those found in the literature from other countries for detailed comparison. The territorial waste management practice in Taiwan was reviewed and its implication on litter found on beach was then discussed.

OUTCOMES

There are 10,653 items of marine litter that weights 20,650 grams in this survey. The density was 0.88 item per square meter. In Table 1, it can be seen that plastic is the most dominant debris in the beach litter survey, whether in this study or other surveys in various countries. The material type for most of the items was plastic (79.8%), while the major contribution was from the recreational activities (42.2%). Seasonal pattern was also found: most of the debris items were plastic fragments in spring and summer, while Styrofoam debris were the major items in autumn and winter. These Styrofoam fragments originated from wasted floating device for oyster farming and the number was increased evidently after the typhoon. For the activities that generated marine litter, we found that there are more dumping activities and ocean-based activities litters in this study when compared with those surveys done in other countries. In Table 2, it can be seen that the top 3 debris items in Cijin were plastic fragment, Styrofoam fragment, and straw, which was clearly different from the results in USEPA's National Marine Debris Monitoring Program (NMDMP).

By comparing our results with litter characteristics in NMDMP survey, we observed that some waste management strategy in Taiwan may help in alleviating marine litter problem. Specifically, there are two policies regarding to the use of plastic products: Plastic restriction policy and Compulsory trash-sorting policy. The former restricts the use of plastic shopping bags and disposable plastic tableware for some certain stores and the later requires the recycling of plastic products such as beverage bottles in the household. In Table 2, it can be seen that plastic beverage bottles and plastic bags were the top 3 items in NMDMP while they were not in the top 10 items in Cijin. The absent of these two items in Cijin may be attributed to the efforts of these two land-based waste management policies.

PRIORITY ACTIONS

It should be noted that the cleanup activities cannot eliminate marine litter. The territorial waste management strategies may have influences on what we found in the beach litter survey. Mitigation measures for marine debris should be focused on source reduction, waste recycling and management, specifically for plastic products, and pursue for a long-term public education campaign to raise the public awareness of this problem.

FIGURES AND TABLES

Table 1. Comparison of marine debris composition with various sites around the world.

Site	Plastic	Paper	Glass	Metals	Other	Reference
Cijin, Kaohsiung	79.8%	9.7%	1.8%	0.8%	7.9%	This Study
Orange County	66.2%	24.9%	1.6%	5.2%	2.1%	Moore et al., 2001
Around Japan Sea	92.9%	1.0%	2.2%	1.0%	2.4%	Kusui and Noda, 2003
Forth Bay, Scotland	54.2%	4.7%	9.4%	5.5%	26.3%	Storrier et al, 2007
Armacao dos Buzios, Brazil	64%	6%	3%	18%	9%	Oigman-Pszczol et al., 2007
Oman Bay	61.8%	2.1%	2.7%	3.4%	29.9%	Claereboudt, 2004
Transkei, South Africa	93.1%	1.1%	3.2%	0.5%	2.1%	Madzena and Lasiak, 1997
Edinburgh, Scotland	65.4%	1.7%	15.1%	1.4%	16.4%	Velander & Mocogni,

						1997
Fog Bay, Australia	45.1%	1.5%	15.6%	35.1%	2.7%	Whiting, 1998

Table 2. Top 10 items for beach litter survey in Cijin and USEPA NMDMP

	NMDMP Top 10			**This study Top 10**		
Rank	Item	No.	%	Item	No.	%
1	Straw	65,384	27.5%	Plastic fragment	2,632	24.7
2	Plastic beverage bottles	30,858	13.0%	Styroform fragment	2,391	22.4
3	Plastic bag (< 1m)	21,477	9.0%	Straw	900	8.4
4	Balloons	18,509	7.8%	Plastic bag fragment	474	4.4
5	Metal beverage cans	17,705	7.4%	Cigarette filter	440	4.1
6	Rope (≥1 meter)	13,023	5.5%	Sponge	433	4.1
7	Plastic food bottles	8,355	3.5%	Fire cracker wrapping	352	3.3
8	Other plastic bottles	8,078	3.4%	Bottle cap	332	3.1
9	Fishing line	8,032	3.4%	Fire rocket cap	295	2.8
10	Cotton swabs	6,325	2.7%	Fire rocket stem	212	2.0
Top 10 total		197,746	83.1%	Top 10 total	8,461	79.4%
Grand total		238,103	100%	Grand total	10,653	100%

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5.c.4. Monitoring marine debris in Trinidad

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KEYWORDS
Trinidad, recreational resource, beach debris, awareness raising, perception, plastic, beach use

BACKGROUND
Unlike its small sister island Tobago, whose idyllic beaches draw in international tourists, present day Trinidad's economy and culture is driven by industrial investment and consumerism. In Trinidad, international marine tourism is limited to catering for recreational boats that have taken shelter in marinas south of the hurricane belt and ecotourists interested in the turtle nesting beaches, such as Grande Riviere, in the northern part of the island (Gaskin, 1998). There are, however, renowned bathing beaches to the north of the island, such as Maracas, Las Cuevas and Tyrico. As a result, many of Trinidad's beaches provide a recreational resource for the local population. On the west coast, close to Port of Spain, the Chagville/Williams Bay/Harts Cut area of Chaguaramas is a popular area for swimming, fishing and late night BBQs. It is also a marine debris hotspot.

The debris is unsightly, unnecessary and potentially unsafe. However, on these non-tourist beaches locals still bathe in areas impacted by high concentrations of marine debris. Most are using the beach unaware of any health implications.

METHODOLOGY
Fig. 1 shows the locations of the sampled beaches from around the Chaguaramas Peninsula in the west of the island. The beach at Williams Bay is a popular bathing beach; with easy access to the road and car parks along its length. The beach at Chagville is relatively popular at its western end, but the eastern end of the transect represents much quieter sands, away from easy access by road. The final beach at Hart's Cut is a small pocket beach, used frequently for gatherings after dark, and surrounded by yachts from local marinas.

Drawing inspiration from a 6-year beach monitoring pilot project undertaken by the OSPAR Commission for the North-East Atlantic that has subsequently been formalised as Regional Guidelines (OSPAR, 2010), the University of Trinidad and Tobago (UTT) produced a protocol for beach litter monitoring on 100m stretches of beach in Trinidad. Beach surveys were conducted by UTT in 2007 and 2009. Data was collated and compared using the χ^2 test to establish whether statistically significant differences were found both between beaches, and between years. Since the sample sizes are large, significance tends to be concluded from these tests with relatively small differences in data. Thus, Cramer's V was calculated in order to address the notion of the strength of association.

OUTCOMES

UTT recorded debris concentrations of between 2 and 38 items per metre in 2007, and 1 and 20 items per metre in 2009, dependent upon the beach surveyed. Whilst plastic predominates at all sites, each site has its own 'signature', which is related to the type of use it has. Williams Bay is predominantly used by families during the weekends, and its high proportion of glass and plastic reflects the eating and drinking that occurs on this beach. On the other hand, Hart's Cut is used predominantly by young adults after and around dark, and recreational fishing during the day, and the high levels of Styrofoam cartons reflect the 'junk' food and party culture that this beach is more renowned for. Plastic dominates the whole sample, making up over a third of all the marine debris counted across the two sampling periods. Whilst varied in type, it was observed that in some areas, especially Hart's Cut, empty, but capped, plastic drinks bottle appeared to represent a significant proportion of plastic debris. Local observations suggested that both Williams bay and Chagville were cleaned regularly, due to their use by the wider public. However, the 'unofficial' nature of bathing at Hart's Cut, along with the prevailing wind and current, which drives circulating eddies in this area, have led to the steady accumulation of debris over time, which was rarely removed by beach cleaning.

Statistically, the χ^2 analysis would suggest that there is a significant difference between each beach, across each survey. Analysis of the Cramer's V statistic suggests that only some of these differences are particularly strong enough to consider. The analysis suggests that each beach is different from another, echoing the suggestion that each beach has its own debris 'signature' related to predominant use. This findings is confirmed by two sample Kolmogorov-Smirnov tests which show no significant differences in the distributions of litter on a single beach between 2007 and 2009, but do show significant differences in distributions **between** beaches (at $p<0.05$). Numerically, it also suggests that, for Williams Bay and Chagville, the number of debris items collected is not significantly different. However, there does appear to be a significant fall in litter counted at Hart's Cut. This may be due to the sampling team encountering a large amount of trapped debris in 2007, where litter had ponded behind large logs, which were no longer there in 2009, rather than a reflection of improved beach management.

These data broadly reflect the findings of Trinidad and Tobago's Environmental Management Agency, in their clean up of Salybia Beach, in the north-east of the island (EMA, 2007). However, comparable data from elsewhere around Trinidad is relatively scarce. Clearly, the message of plastics, particularly drinking bottles, is one that prevails in many studies from the wider region (see MPB papers). Also, the high concentration of debris in pocket beaches and/or areas of very localised entrapment is one that has been demonstrated elsewhere (Debrot *et al.*, 1999). Previous work by UNEP (2009) has suggested that the debris make up is consistent with a high land-based contribution (91.7%), although these surveys found it difficult to separate inland/river sources from recreational boating and, perhaps, international shipping. There are certainly observational and oceanographic data to suggest that much of the debris comes into the Gulf of Paria from the Caroni River, and is then moved towards Chaguaramas by the prevailing circulation patterns (Neale and Mohammed, 2010). Moreover, with such a low tidal range, much of this debris could have come from beach users themselves. It appears that over the two years between the surveys, the incidence of marine litter has only really decreased in the most impacted areas, where inshore currents aggregate floating debris into sheltered backwater mangrove areas, suggesting some localised beach cleaning may have improved the situation.

A potential area for future work would be to explore the hypothesis that in terms of marine debris international tourism is a ‘benefit’. This would be on the basis that, in Trinidad at least, ‘domestic’ beaches contrast sharply with those catering for international tourists, which are regularly cleaned and for whom ‘spotless white sands’ is integral to their branding.

PRIORITY ACTIONS
Management strategies that conceptualise the coastline as a single indivisible landscape unit are short-sighted. Understanding the use of beach space by predominant user groups may best help mitigate some of the issues raised in this paper. Clearly a ‘one size fits all’ beach clearing strategy has some merit, in slightly lowering the total debris load. However, targeted campaigns may further ameliorate the problem by lessening the most prominent litter types.

Actions are also important at source, working with industry and vendors. In the authors’ view there is merit in revisiting a culture of re-usable glass soft drinks bottles, for which a small reward can be redeemed upon their collection and return, rather than ‘one-off’ disposable plastic bottles.

FIGURES AND TABLES

Table 1. Percentage contribution of categories of marine litter collected from three beaches in Trinidad

	Williams Bay		Chagville		Hart's Cut	
	2007	2009	2007	2009	2007	2009
Glass	48.6	43.3	11.2	13.2	4.1	3.1
Paper	2.0	4.1	1.8	2.1	0.9	0.2
Wood	1.8	3.1	2.7	3.5	1.4	9.8
Metal	6.4	6.0	4.7	2.7	1.4	5.4
Plastic	25.7	25.1	49.1	42.4	35.0	40.4
Cotton	4.5	7.2	8.3	15.8	0.4	0.4
Foam	4.9	5.1	16.7	15.2	55.1	24.9
Other	6.3	6.0	5.5	5.1	1.6	15.7
Items per metre	2	2	2	1	38	20

Table 2. χ^2 statistics from testing the distributions of seven categories of marine litter from three beaches in Trinidad (χ^2_{crit} = 14.067, df = 7, p<0.05), along with each test's Cramer's V value. Cramer's V values are in italics, and underlined where the association is deemed to be moderate to strong.

	WB07	WB09	C07	C09	HC07	HC09
WB07		29.21	818.56	333.36	2873.71	580.70
WB09	*0.09*		450.88	192.64	1774.17	395.93
C07	*0.43*	*0.40*		33.88	1039.95	188.47
C09	*0.34*	*0.37*	*0.12*		763.11	166.65
HC07	*0.67*	*0.60*	*0.42*	*0.41*		524.07
HC09	*0.45*	*0.54*	*0.28*	*0.41*	*0.34*	

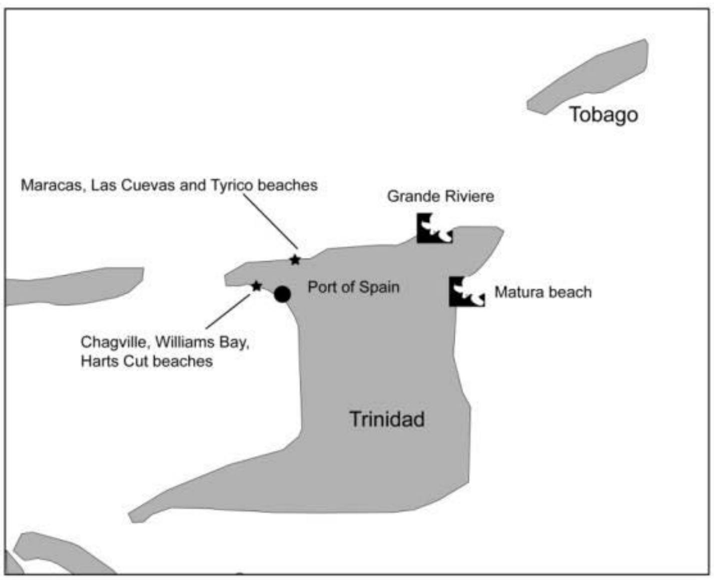

Figure 1. Location of beaches in Trinidad

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5.c.5. Trends in marine debris along the coast of the Continental United States 1996-2007

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KEYWORDS
trends, indicator debris, monitoring, United States, ocean-based debris, land-based debris, general-source debris

BACKGROUND
Marine debris is a widespread and globally recognized problem. Although there are many short-term studies on marine debris, a longer-term perspective and the ability to compare patterns among regions has heretofore been missing in the United States. Processes, along with patterns, are keys to understanding debris deposition and creating mitigation and education programs.

OUTCOMES
We used data from a national beach monitoring program to evaluate and compare amounts, composition, and trends of indicator marine debris on beaches of the United States at the continental, coastal, and regional scales. We used monthly counts of beached indicator debris from 72 survey sites, each 500 m in length. Data were collected from 1996-2007 by volunteers. Indicator items provided a standardized set that all surveys collected; each was assigned a probable source: ocean-based (e.g., nets, rope, floats), land-based (e.g., metal beverage cans, straws, syringes), or general-source (e.g., plastic bottles, plastic bags). The continent was divided into three coasts (Atlantic, Gulf of Mexico (Gulf), and Pacific) and seven regions based on large-scale circulation patterns.

Overall, most debris was found on the Atlantic and Gulf coasts. Regionally, most debris was found in the mid-Atlantic and western Gulf. These regions are affected by oceanic circulation patterns that move debris close to shore. Continentally, most of the items were in the land-based and general-source categories. By coast, the Gulf coast had more general-source and ocean-based indicators than the Pacific and Atlantic coasts. Regionally, the mid-Atlantic and southern California had the most land-based indicators; the northeast Atlantic had the most ocean-based indicators. Continentally and on each coast, ocean-based debris declined. Regionally, ocean-based debris declined in all but the northeast Atlantic which has a large and relatively stable commercial fishery. Continentally, land-based debris amounts were stable over time. By coast, there was no trend in land-based debris along the Pacific coast, a decrease along the Gulf coast and an increase along the Atlantic coast. Regionally, two regions had decreasing trends, four showed no change, and one region had an increasing trend. Continentally, general-source debris increased. By coast, there was no change in general-source debris along the Pacific and Gulf coasts while there was an increase along the Atlantic coast. Regionally, general-source debris showed no change in five regions, a decrease in one region, and an increase in one region.

There are few studies that have been able to investigate spatial and temporal differences in marine debris patterns. In this study, we found complex nonlinearities in debris deposition patterns across years and space. Researchers are just beginning to understand how much variability there is in these systems and how that variability can affect conclusions regarding debris patterns. Thus, whether looking for trends or assessing the impact of mitigation strategies, spatial and temporal variability are key considerations for constructing monitoring programs and analyses that will yield robust results. What processes drive temporal and spatial variability remain to be elucidated. In a study at the regional scale on the Atlantic Coast of the United States, Ribic et al. (2010) demonstrated that fairly simple measurements based on human activity and physical processes gave insight into debris deposition, which suggests significant potential for using knowledge of local and regional drivers to inform management strategies for reducing beach debris loads. Thinking carefully about drivers during the planning of monitoring programs and collecting information about the proposed mechanisms during the program will lead to greater insights into potential management strategies and better information for policy makers.

PRIORITY ACTIONS

Work with local authorities on debris monitoring efforts so that information can be used for resource management decisions

Determine existing monitoring information before developing additional monitoring efforts.

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5.c.6. Plastic marine debris in the Portuguese coastline.

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KEYWORDS
Plastic, Beaches Debris, Monitoring, Pellets, POP.

BACKGROUND
Plastic marine pollution constitutes a major threat to ocean integrity, in a global scale. The high persistence of plastic material, together with poor lifecycle management strategies and consequent discard of high volumes of plastic entering the water streams, promote accumulation throughout the sea.

Beach surveys, ocean monitoring programs and collected plastic analysis show that there are reasons for concern: physical effects on marine fauna, ecotoxicological effects from ingestion of plastics due to adsorption of persistent organic pollutants (POP) and other chemicals), alien species transport, and other economical and social reasons. Portugal coast is vulnerable to plastic accumulation on beaches, therefore a monitoring program and laboratorial work were carried on to identify the main categories of plastic found in selected beaches (from micro to macro size), determine POP concentrations in pellets and evaluate the coastline state.

METHODOLOGY
Sediment and plastic samples were collected from 10 beaches (from the 2cm upper layer) according to three different approaches: 1) 50x50cm quadrats and 2) 2x2m quadrats, to assess plastic categories, i. e. size and type of plastic in abundance and weight (including particles <5mm and >20µm in diameter) and 3) 2m transects between low-high tide marks to evaluate the state of the coast, by calculating the Clean Coast Index (only particles >5mm in diameter). Some microplastics were set apart for polymer identification through Fourier transformed infra-red spectroscopy (micro-FTIR), resulting in samples spectral answers that are compared with the Thermo Nicolet® OMNIC FTIR database to identify the polymer present. To analyse POP concentrations, pellets were separated according to color in three groups - white, aged and colored pellets. Concentrations of PAHs, PCBs and DDTs were determined through gas chromatography mass spectrometry (GC-MS).

OUTCOMES
Plastic pellets, styrofoam and plastic fragments accounted for ~90% of the total abundance of plastic debris, and in relation to size categories (particles from 50µm to 20cm) the smaller the plastic, the more abundant it is, as expected due to degradation processes enhanced by residence time in the sea. No significant differences in plastic types with the highest abundance, among the 5 beaches studied (ANOVA, p>0,05, f=4). Araújo *et al.* (2006) also pointed plastic (general) and

styrofoam as main categories in their study but did not include pellets analysis. Regarding plastic size, 90% were under $10x10mm^2$, in accordance with the values obtained by Madzena and Lasiak (1997), 33,3% for $10mm^2$ size, and higher than the 64,2% of plastic identified under $20x20mm^2$, found by Costa *et al.* (2009). The evaluation of the coast state using Clean Coast Index demonstrated that 4 of the 5 beaches studied are "very clean", and only 1 was identified as "moderate". It's important to remark that more beaches should be surveyed so that the variability of plastic marine debris at the Portuguese coastline can be assessed. An accurate evaluation of the influence of sea and land sources, beaches physiography, form, orientation and dynamics, and meteorological conditions are essential to better understand the amounts and types of beach stranded plastic debris.

Polymers identified through micro-FTIR were polyethylene, polystyrene, polyethyl, polyester and unspecified fiber. Ng and Obbard 2006 also found microplastics of the same polymers in beaches sediment in Singapure, being polystyrene the more abundant. POP concentrations are variable, as tPCB: 5,6-36,0ng.g-1, tHAP: 43,4-489,7ng-g.1, tDDT: 1,2-85,87ng.g-1, verified also in pellets collected in Japan, by Mato *et al.* 2001 (PCB: 4-117ng.g-1 e DDE: 0,16-3,1ng-1g) and Endo *et al.* 2005 (PCB: <28-2300ng/g).

These results point for two problems: the known higher concentration of POP in smaller plastic particles, due to higher surface/volume ratio and even higher in aged pellets (as remarked by Endo et al. 2005), these last ones being more mistaken for food, and thus ingested by marine organisms as verified by the same author. These facts are worrisome due to the potential direct and indirect ecological impacts on marine ecosystems.

PRIORITY ACTIONS

Including microplastics in stranded marine debris assessment brings a novel insight into this type of analysis, as plastics are expected to degrade and break into smaller pieces, of which size is unknown.

For the sake of comparability, a standardization of methods for monitoring plastic debris must be done. Research should focus on long-term studies in hot spots where higher debris accumulation is predicted (by modeling and other techniques that track marine debris).

FIGURES AND TABLES

Figure 5 – Portuguese Coastline and sampling sites.

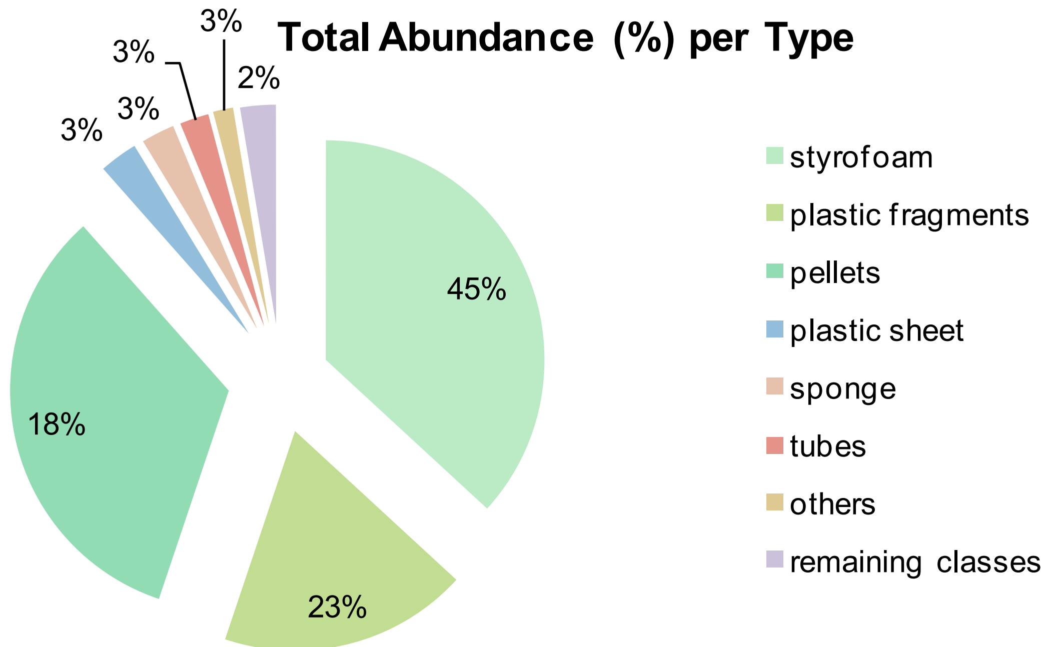

Figure 2 – Abundance (%) of type categories.

Table 1 – POP concentrations in pellets, under 5 beaches sampled for categorization of plastic.

Beach	**Sample**	**Weight (g)**	**tPCB (ng.g-1)**	**tHAP (ng.g-1)**	**tDDT (ng.g-1)**
Agudela	AGUb	2,9	36,0	65,5	11,08
Cova de Alfarroba	COVb	25,34	7,1	43,4	1,2
	COVe	20,13	5,6	112,6	2,3
	COVc	1,23	11,6	92,1	6,6
Cresmina	CREb	6,63	13,73	48,0	4,1
	CREe	3,73	34,55	69,4	21,3
Fonte da Telha	FONb	6,65	35,1	67,8	14,01
	FONe	3,47	55,0	479,7	85,87

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5.d.1. Microplastic: from domestic sinks to global sinks

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ABSTRACT
Plastics are used in huge quantities, but little is recycled and it degrades slowly. Plastics are diverse in chemical nature, but all accumulate in nature. Microplastics are particularly problematic because they are small enough to be ingested by many animals and then enter cells and tissues, making them difficult to detoxify. Microplastics are thought to come from the degradation of larger pieces, from washing clothes made from synthetic fibres and from abrasive scrubbers in cleaning products. Although larger pieces of plastic are removed in sewage treatment plants, existing filtration methods are unlikely to retain the microplastics. Much sewage is disposed of in the sea, so there is widespread potential for contamination of marine organisms far from the sites of origin of the plastics. I will describe recent work investigating the spatial extent of this material across the world's beaches, the possible role of sewage as a source and the quantity of microplastic released from washing machines and cleaning products. The significance of my findings will be discussed in relation to using better science to understand and manage problems caused microplastics.

5.d.2. Bio-plastics and their interaction with the environment

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KEYWORDS
Kelly Polich, The Dow Chemical Company, bio-based plastics, bio-degradable plastics, recovery bio-plastics

BACKGROUND
Sustainability and the environment have become top priorities for many individuals and businesses. When examining plastic products and their impact on the environment, many struggle to understand how these materials can positively contribute to sustainability and to improving environmental conditions. Although plastics may be misperceived by some as being detrimental to sustainability, wasteful and a drain on resources, these materials actually make positive contributions by making efficient use of resources and energy during their manufacture, transport, use and final disposal.

One potential industry solution to this environmental concern is the introduction of bio-plastics as a substitute for traditional plastic materials. Significant progress has been made in the development of bio-plastics, but there continues to be confusion as to what bio-plastics are and their environmental impact. This presentation will provide an overview of bio-plastics, explaining the difference between bio-based (using renewable carbon as a feedstock) and bio-degradable (end-of-life option), and why the diversity of bio-plastics and their varying properties make it difficult to make simple, generic assessments as to whether plastics made from traditional or renewable feedstocks are “good” or “bad.” Even if some bio-plastics meet biodegradable testing standards they are not intended for disposal into the environment, including the ocean, and must be recovered in a controlled and eco-efficient manner.

OUTCOMES
A better understanding of the differences between a material that is a bio-based plastic versus a bio-degradable product and the consequences of those products in solid waste processing.
A better understanding of the different feedstocks used to produce plastic material.
A better understanding of all the types/definitions of bio-degradable plastics
Understanding the impact of bio-plastics on micro-plastics.

PRIORITY ACTIONS
The plastics industry will continue to innovate. Plastics made from both traditional and renewable feedstocks will play an important role in creating the packaging systems of tomorrow and will offer multiple end-of-life alternatives.

Preventing litter requires a combination of awareness, education, the enforcement of suitable laws, and sound waste management practices. All individuals and companies should practice and promote the 4Rs - Reduce, Reuse, Recycle, and Recovery.

5.d.3. Plastic marine debris in the Atlantic Ocean and Caribbean Sea: abundance, distribution, characteristics, and trends

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KEYWORDS
plastic microdebris, North Atlantic, Caribbean Sea, subtropical convergence, neuston net, polyethylene, polypropylene

BACKGROUND
Since the first reports of plastic marine debris in the open ocean in the 1970s there have been very few quantitative studies in the North Atlantic that can address the most basic questions about the abundance, distribution, and spatial and temporal trends in plastic microdebris, or the composition of the debris itself. We will present an analysis of a 24-year record of buoyant plastic microdebris collected from Newfoundland to the Caribbean Sea, and from the U.S. east coast to 40°W longitude, by undergraduate students and faculty scientists in the SEA Semester® program since 1986.

METHODOLOGY
Plastic microdebris was collected using a surface plankton (neuston) net with a 1.0 x 0.5 m opening and 335 μm-sized mesh. The net was towed off the port side of the vessel to avoid interference by the ship's wake for a 30 minute period at a ship speed of two knots, resulting in a typically 1.8 km long tow. Undergraduate students onboard the ship hand-picked, enumerated, and archived plastic pieces from the net sample. Plastic debris concentration is reported as pieces per square kilometer, with area computed using the actual tow distance calculated from one-minute GPS positions. Laboratory analysis of a subset of archived samples included measurements of longest dimension, mass, and density, and additional elemental analysis was carried out to determine the composition of plastic fragments.

OUTCOMES
More than 100,000 pieces of plastic debris were collected in more than 6100 neuston net tows. We will show, using oceanographic data together with measurements of plastic debris, that floating debris accumulates in the subtropical convergence zone of the western North Atlantic in a latitude band centered on 30°N and extending at least as far west as 40°W. No trend in plastic concentration was observed over the study period despite large increases in global plastic production and in the amount of plastic discarded in the United States municipal waste stream.

This result has not yet been satisfactorily explained, given the poorly quantified sources and sinks of plastic debris to the open ocean. (Law et *al*., 2010)
An analysis of ~750 archived plastic microdebris samples (Morét-Ferguson et *al*., 2010) showed that the majority of debris consists of plastic fragments less than 1 cm in size, with a mass less than 0.05 g. Nearly all samples were less dense than surface seawater, and elemental analysis revealed properties consistent with high and low density polyethylene and polypropylene. In contrast, samples collected on a local beach were composed of all six common consumer plastics (plastic resin codes #1-6). It appears that the material density of plastic changes with exposure to the open ocean environment, possibly as a result of bioaccumulation or chemical degradation.

PRIORITY ACTIONS

In order to accurately close the mass budget of plastic marine debris in the open ocean the sources and sinks of debris must be identified and quantified. A successful scientific assessment of the size and scope of this environmental problem will allow citizens and policymakers to better allocate resources to possibly clean up, and more importantly prevent, plastic debris in our oceans.

FIGURES AND TABLES

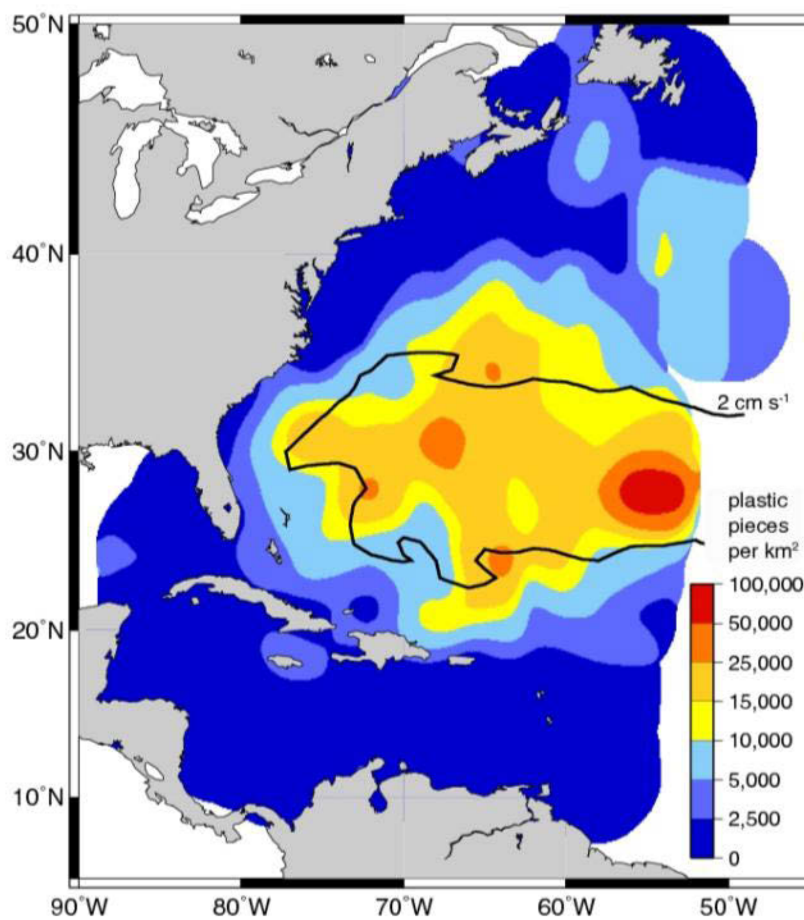

Figure 1: Average concentration of plastic marine debris (color shading) computed from more than 6100 observations. Black line indicates 2 cm/s contour of surface current velocity from Maximenko et *al*. (2009), corresponding to the subtropical convergence zone. There is a very

strong correspondence between the highest observed plastic concentration and the converging surface currents that act to concentrate the debris. Figure from Law et *al*., Plastic Accumulation in the North Atlantic Subtropical Gyre, Science 3 September 2010: 329 (5996), 1185–1188. Published online 19 August 2010 [DOI:10.1126/science.1192321]. Reprinted with permission from AAAS.

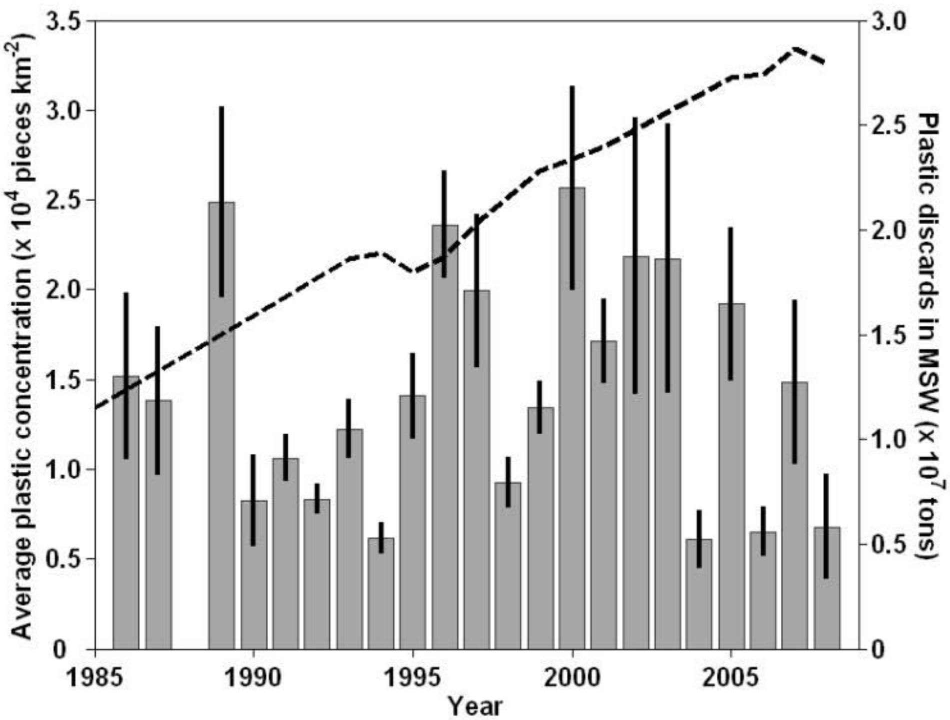

Figure 2: Annually-averaged plastic concentration in the western North Atlantic accumulation zone from 1986–2008 (bars), and amount of plastic discarded (after recycling) in the United States municipal solid waste (MSW) stream (dashed line). Large interannual variability was observed in the concentration of floating plastic debris, but there was no increasing trend. This was surprising given the likely increase of plastic waste into the ocean as inferred from the MSW record. MSW data from U.S. Environmental Protection Agency. Figure from Law et *al*., Plastic Accumulation in the North Atlantic Subtropical Gyre, Science 3 September 2010: 329 (5996), 1185–1188. Published online 19 August 2010 [DOI:10.1126/science.1192321]. Reprinted with permission from AAAS.

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5.d.4. Spatial and temporal distribution of microplastics in the Puget Sound, USA

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ABSTRACT
Our study is the first to systematically measure the concentration and composition of marine microplastic particles in an enclosed North American estuary. During 2009-2010, plastic particles between 330 and 5000 μm were collected from surface waters throughout Puget Sound using a modified Manta net. Samples include material floating on the sea surface as well as those suspended in the upper 0.5 meters. For each sample, the Manta net was slowly towed behind a small boat for approximately 15 minutes, and the water volume sampled was estimated using an flow meter installed in the mouth of the net. Plastics were isolated from the net tow samples using selective physical and chemical methods developed in our laboratory, and quantified gravimetrically. Briefly, non-plastic particles with densities greater than 1.6 g/cm^3 are removed by settling in salt solution, and the remaining low-density particles undergo aggressive chemical oxidation with iron-enhanced hydrogen peroxide to remove naturally occurring labile carbon. The resulting isolated particles are examined under a microscope and any remaining non-plastic particles are removed. The purified sample is then weighed to determine the microplastic concentration. Microplastics comprise a surprisingly large fraction of the particles floating in Puget Sound. Concentrations are highly variable, ranging from 5 to 225 mg/g-dry weight in samples analyzed to date. Highest concentrations are found in wet and cold conditions during February in urbanized embayments of Puget Sound. These may result from increased stormwater loadings. Alternatively, we find very few microplastic particles in surface waters during algal blooms, suggesting that microplastics may be removed from surface waters as plankton grows, is grazed, and settles. A limited number of samples analyzed so far from remote regions of Puget Sound indicates a regional background concentration of microplastics in the range of 10's of mg plastic/g-dry weight.

5.d.5. A summary of neustonic plastic density and abundance in the North Pacific Gyre, 1999-2009

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KEYWORDS
Plastic, marine debris, North Pacific Central Gyre, manta trawl, plastic abundance, plastic density, spatial distribution, temporal distribution, pollution, neuston

BACKGROUND
Marine debris poses a danger to marine organisms through ingestion and entanglement, it is more than just an aesthetic problem. This study shows evidence of spatial distribution of plastic debris throughout the marine environment.

METHODOLOGY
The potential for ingestion of plastic particles by organisms in the open ocean was assessed by measuring the relative abundance and mass of neustonic plastic and zooplankton during six voyages through the North Pacific Ocean (between 18N-43N and 120W-180W) in 1999, 2000, 2002, 2005, 2007-2008 and 2009. Neuston samples were collected using a manta trawl with a rectangular opening of 0.9 x 0.15 m^2, and a 3.5 m long, 333 micron mesh net with a 30 x 10 cm^2 collecting bag. The trawl was towed at a speed between 1.5 and 3.5 knots depending on the sea state. The net was towed at the surface outside the wake of the vessel. Each trawl was conducted for a random distance. Sample were fixed in formalin, then soaked in fresh water and transferred to isopropyl alcohol. Separation of the plastic particles from the remainder of the sample was completed under a dissecting microscope. Plastic was sorted by size through a set of Tyler sieves of 4.76, 2.80, 1.00, 0.71, 0.50, and 0.35 mm. The plastic was oven dried at 65º C for 24 h and weighed. The plastic was then categorized by physical type (fragment, Styrofoam, pellet, line, and film). Then the pieces of plastic were counted.

OUTCOMES
Every sample collected during these voyages contained plastic. The highest particle count /m^3 during the decade of sampling was 9.686 particles/m^3 at 37.012N and 144.663W in August 2002 and the lowest particle count /m^3 was 0.005 particles/m^3 at 37.803N and 136.987W in August 2005. A focus on eleven sites (between 34.67N-36.08N and 138.51W-142.08W) near the center of the area known as the Eastern Garbage Patch were resampled nine and ten years after the original study at these sites, the average plastic weight and particle count densities were 0.017 g/ m^3 and 1.510 particles/m^3 in the first voyage in August 1999, 0.028 g/ m^3 and 2.733 particles/m^3 at the same locations in February 2008, and 0.043 g/m^3 and 1.362 particles/m^3 in September 2009. A trend of increasing weight densities was observed.

PRIORITY ACTIONS

Further study is needed to examine plastic pollution in the North Pacific Ocean, as well as the effect of sea state on the vertical mixing of microplastic particles.

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5.d.6. Abundance, distribution, and ecology of plastic microdebris in the North Pacific Central Gyre

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ABSTRACT
The North Pacific Central Gyre (NPCG) is among the oldest and largest biomes on Earth. Reports of increasing plastic debris in the NPCG, particularly microdebris less than 5 mm in diameter, have caused significant public concern. The Scripps Environmental Accumulation of Plastics Expedition (SEAPLEX), in collaboration with the nonprofit group Project Kaisei, documented the abundance and distribution of plastic debris over a 5,000 km cruise track in 2009. Plastic abundance and size was further quantified using a digital scanner (Zooscan) combined with image analysis software. Results indicate that plastic microdebris in the NPCG and nearby regions is widespread and abundant, reaching densities of 4.1 particles per m^2. Microdebris less than 1 cm^2 in diameter accounts for 93% of the available surface area, and is colonized by a subset of the North Pacific subtropical rafting community. We compared neuston samples from 2009 to samples collected in 1973-74, and found that the density of plastic microdebris had increased by over 1000%, but that there had been no corresponding change in the abundance of the substrate-dependent pelagic insect *Halobates sericeus.* These results are a first step to understanding the ecological implications of plastic microdebris in the NPCG.

6.a.1. Design-based surveys of lost fishing gear and other marine debris in the Florida Keys

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KEYWORDS
Angling gear, coral reefs, fishing, Florida Keys, habitat map, lobster traps, marine debris, marine reserves, stratified sampling, underwater surveys

BACKGROUND

Fishing constitutes one of the most significant threats to marine biodiversity and ecosystem function, evidenced by the body of information on the numerous impacts to populations, community structure, and habitats (Jones and Syms 1998, Auster and Langton 1999). Besides the more obvious effects on species population structure (Jennings and Lock 1996), fishing activities may also reduce the structural complexity of habitats and cause corresponding changes in ecological processes such as competition and predation (Jones and Syms 1998). These patterns are most obvious in areas where explosives, poisons, or other destructive fishing methods are used (Saila et al. 1993). Ecological effects can be expected, however, in areas where traps, mobile fishing gear, and, potentially, even large numbers of recreational fishers operate (Chiappone et al. 2002). Fishing gear can destroy benthic organisms and entangle both benthic and mobile fauna (Chiappone et al. 2004). The loss and disposal of fishing gear is internationally recognized as a major environmental issue (Watling and Norse 1998) and several approaches to reduce debris are continually advocated (Jones 1995). Despite such recognition, the spatial distribution of debris and the effects on organisms and ecological processes are not well studied. Intensive fishing and other activities such as recreational boating continue to exacerbate the problem and cause cumulative impacts (Jennings and Polunin 1996, Auster and Langton 1999).

The Florida Keys have a long history of commercial and recreational fisheries that target a great diversity of fish and invertebrate species using a multitude of gears (Bohnsack et al. 1994). The Florida Keys is the most important area in the state in landings, dockside value, and numbers of commercial fishing vessels, especially for highly valued invertebrate fisheries such as shrimp and spiny lobster. There are also significant effects of tens of thousands of recreational fishers who target hundreds of species using mostly hook-and-line and spear guns (Bohnsack et al. 1994). Baseline data on fishing gear and other marine debris were collected as part of a larger assessment of benthic community structure in the Florida Keys National Marine Sanctuary (FKNMS) (Miller et al. 2002), a large (9500 km^2) marine protected area bordering three national parks in southern Florida. Diver-based visual surveys of marine debris conducted at 131 sites Keys-wide during 2000-01 quantified the prevalence, extent, and biological impacts of marine debris to benthic coral reef organisms (Chiappone et al. 2002, 2004, 2005). Subsequent surveys were carried at 145 sites Keys-wide in 2008 and 120 sites in the upper Florida Keys region during 2010. These data are particularly timely because the Florida Keys continue to experience a growing number of fishers, especially recreational anglers, but also hundreds of thousands of traps deployed annually for spiny lobster and stony crab (Bohnsack et al. 1994, Ault et al. 1998). The marine debris surveys carried out during the past decade attempted to address: 1) the spatial extent and frequency of remnant fishing gear at multiple spatial scales in the Florida Keys; 2) the factors, such as habitat type (depth) or management regime (closed or open to fishing) that affect the spatial variability of marine debris occurrence; and 3) the biological impacts of marine debris on benthic organisms such as hard corals and sponges. The latter topic is addressed in a separate poster presentation at the 5IMDC.

METHODOLOGY

Surveys of marine debris have been conducted around the world using a variety of methods such as beach surveys and benthic trawls. The present study used *in situ* underwater observations to document the spatial distribution of lost fishing gear and other marine debris in benthic habitats of the Florida Keys National Marine Sanctuary (FKNMS). Surveys were conducted in 2008 and 2010 (Figure 1) that continued earlier debris surveys in the Florida Keys (Chiappone et al. 2002, 2005). Marine debris surveys were incorporated into an existing sampling survey design program for benthic coral reef organisms (Miller et al. 2002, see http://people.uncw.edu/millers). The Florida Keys survey domain was partitioned into strata based upon: 1) benthic habitat type (cross-shelf position), 2) geographic region (along-shelf position), and 3) management zone, including areas inside and outside of existing no-fishing zones. A geographic information system containing digital layers for benthic habitat, bathymetry, and no-take marine reserve boundaries was used to facilitate delineation of the sampling survey domain, strata, and sample units. Existing resolution of benthic habitats is such that the survey domain was divided into a grid of individual cells 200 m by 200 m (40,000 m^2) in area that that serve as primary sampling units. Grid cells containing targeted reef and hard-bottom habitats were designated as primary sample units. A second-stage sample unit was defined as a belt transect of fixed area (15-m x 1-m or 4-m in dimension) within a primary sample unit. No-fishing zones in the Sanctuary are incorporated as an additional stratification variable that delineates areas open and closed to consumptive activities.

Marine debris surveys in 2008 were conducted at 145 sites from northern Key Largo to Key West and encompassed benthic habitats from the shallow patch reef environment to 15-m depth on the fore-reef. Four replicate 15-m x 4-m transects were surveyed for the type and amount (length, if applicable) of marine debris, as well as counts of benthic coral reef organisms (e.g. sponges, corals, gorgonians) that exhibited abrasion stress (i.e. debris abrading the individual or colony and causing tissue loss). The 2008 surveys also included an assessment of the wet weight of marine debris per unit area, whereby bottom debris was removed and weighed per belt transect sample. The 2010 surveys encompassed 120 sites, in which four replicate 15-m x 1-m belt transects per site were surveyed for the type and frequency of debris.

OUTCOMES

During 2008, a total of 686 pieces representing 59 different debris items or categories were recovered from 34,800 m^2 of sampled benthic habitat, with ~443 kg (wet weight) of debris removed. Of the 686 total debris items counted and retrieved, 363 (53%) items were hook-and-line gear (monofilament, wire leaders, hooks, lead sinkers, etc.), followed by 241 trap debris items (35%), and other debris (82 items, 12.0%). A total of 477.6 m of angling gear was measured and retrieved from the bottom, mostly represented by monofilament line and wire leader. For trap debris, 944.3 m of rope, either free (not attached to something) or attached to wooden slats and/or metal gratings, was measured and retrieved. Hook-and-line gear was the most frequently category of marine debris in 2008 in terms of the number of sites and number of items encountered. Lost angling gear is ubiquitous throughout the Florida Keys, at least for the habitats sampled. Site-level mean (± 1 SE) densities were as high as 8.50 items per 60 m^2. Hook-and-line debris was recovered from 59% of the sites in all benthic habitats sampled. Mid-channel patch reefs (1.35 ± 0.49 items per 60 m^2) and high-relief spur and groove (0.66 ± 0.15) yielded the greatest angling gear densities. No-fishing zones and corresponding reference areas were roughly similar in terms of lost hook-and-line gear densities for most habitats, and in several instances, angling gear densities were greater within no-fishing zones.

Lobster/crab trap debris was the next most frequent category of marine debris encountered in 2008 in terms of the number of sites present and the number of items retrieved. Trap debris consisted of rope, wooden slats, cement slabs, plastic pot openings, and metal mesh trap grating, not including intact, but un-buoyed, traps on the seabed. The distribution of trap debris indicates that it is ubiquitous throughout the Florida Keys in all of the habitats sampled. Site-level mean (± 1 SE) densities of trap debris were as high as 3.75 items per 60 m^2. Trap debris was recovered from 85 out of the 145 sites (58.6%) and all five habitats sampled. Inshore habitats yielded greater densities than offshore habitats. Similar to lost hook-and-line fishing debris, no-take zones and reference areas were roughly similar in terms of trap debris for several of the habitat types, and in several instances, trap debris densities were greater within no-fishing zones.

PRIORITY ACTIONS

Survey design techniques provide a robust framework for estimating the abundance and extent of lost fishing gear and other marine debris. The pervasive nature of marine debris in the Florida Keys reflects the intense usage of marine resources and the challenges of patrolling a large marine protected area, as evidenced by the abundance of marine debris in no-fishing zones.

FIGURES AND TABLES

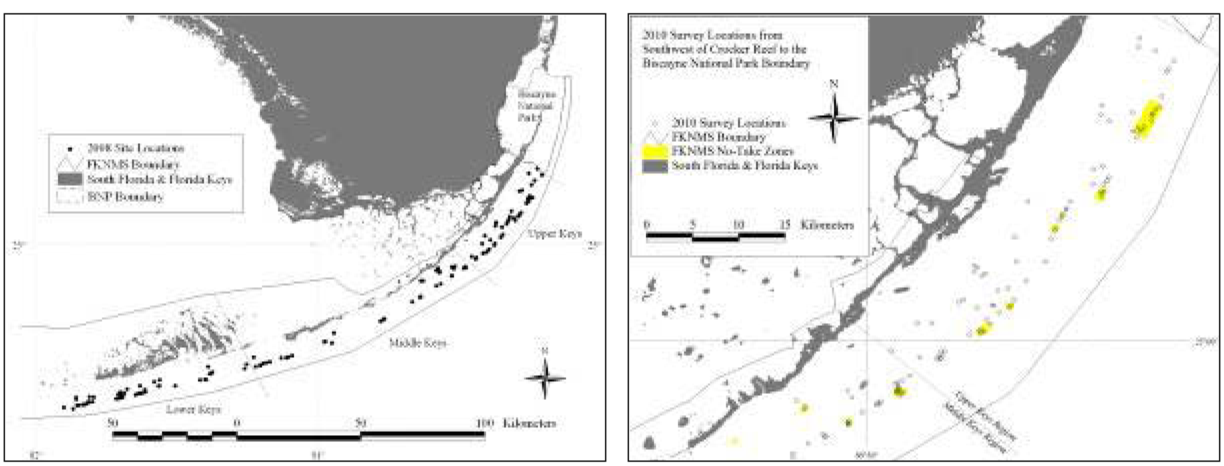

Figure 1. Sampling locations for marine debris in the Florida Keys National Marine Sanctuary during 2008 (left panel, 145 sites) and 2010 (right panel, 120 sites). At each site, diver-based

surveys using four replicate belt transects 15-m x 4-m (2008) or 15-m x 1-m (2010) were used to determine the presence and density of marine debris using a stratified random sampling design based upon benthic habitat type, along-shelf position, and management zone. In 2008, data on the amount (length) and wet weight of debris per transect sample were also collected.

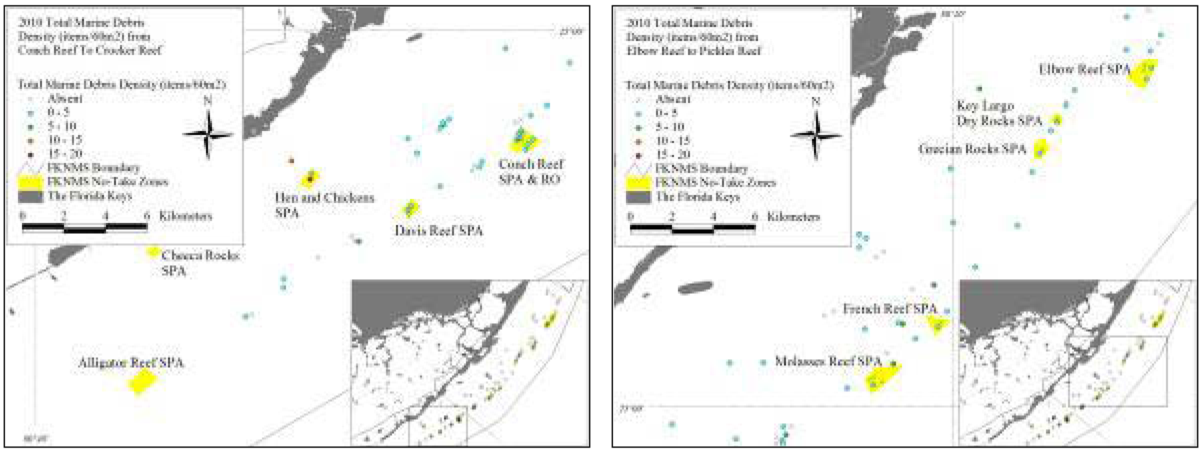

Figure 2. Example debris density map for the Florida Keys National Marine Sanctuary illustrating total debris densities (no. items per 60 m^2) from Alligator Reef to Conch Reef (left panel) and from Molasses Reef to Elbow Reef (right panel) surveyed during June-August 2010. The distribution data indicate the ubiquitous nature of marine debris, even in no-fishing zones.

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6.a.2. The removal and disposal of a derelict vessel from a remote marine protected area

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KEYWORDS
Papahānaumokuākea, Marine Protected Area, Vessel Salvage

BACKGROUND
The removal and disposal of derelict vessels from remote marine habitats has many challenges, and these can become compounded when the location is within a pristine marine protected area. The agencies that manage such areas are not equipped to carry out salvage and disposal operations and must develop unique partnerships with public and private sector entities to accomplish such tasks.

Papahānaumokuākea Marine National Monument (PMNM) in the Northwestern Hawaiian Islands comprises one of the largest protected areas in the world. The PMNM, a vast, remote, and largely uninhabited marine region, encompasses an area of approximately 139,793 square miles (362,061 square kilometers) of Pacific Ocean in the northwestern extent of the Hawaiian Archipelago. Covering a distance of 1,200 miles, the 100-mile wide PMNM is dotted with small islands, islets, and atolls and a complex array of marine and terrestrial ecosystems. Kure Atoll is at the northwestern extent of the PMNM and includes both lagoon and fore reef habitat used by the endangered Hawaiian Monk Seal, the threatened Pacific Green Sea Turtle, Spinner Dolphins, and the endemic Hawaiian Black Grouper.

The sailing vessel GRENDEL was discovered grounded in the lagoon of Kure Atoll in June 2007 by refuge staff. This vessel represented a threat to the coral reef habitats and associated protected species. A process was implemented for removal that took the form of a partnership between the PMNM, the United States Navy and the private sector to carry out the salvage and responsible disposal of this vessel. Through the United States Department of Defense Innovative Readiness Training program, personnel from the U.S. Navy Mobile Diving and Salvage Unit (MDSU) and a salvage vessel from the U.S. Military Sealift Command were tasked to carry out this operation in the summer of 2010.

METHODOLOGY
There were two goals that defined the direction of the salvage operation for the PMNM. The first goal was to salvage the vessel following best management practices and the second was to bring all material back to Honolulu for either proper disposal or recycling. A long-standing partnership between the PMNM, the NOAA Marine Debris Program and a metal recycling company in Hawai'i readily allowed the project to achieve the second goal. Best management practices were determined from the standpoint of guidelines for protecting endangered and threatened species and minimizing damage to essential coral reef habitat. The National Oceanic and Atmospheric

Administration (NOAA), National Marine Fisheries Service (NMFS), Pacific Islands Regional Office (PIRO), Protected Species Division (PSD) provided best management practices intended to reduce or eliminate adverse effects on protected species, such as the Hawaiian Monk Seal and Pacific Green Sea Turtle. Protection of essential coral reef habitat was done on a project specific basis through discussion of methodologies for salvage that would lessen the likelihood of direct and indirect impacts to coral reef habitat.

OUTCOMES

The best management practices shaped and influenced the execution of small boat and diving operations during the course of the salvage operation. Maintaining vigilance for potential interaction with protected species was assigned to specific individuals under the oversight of a PMNM resource management representative during the course of each field day. A series of logistic and methodology meetings were held with the MDSU dive team and the Military Sealift Command over many months prior to the salvage operation. Methods for anchoring, diving and equipment operations were agreed upon that would lessen or prevent habitat damage from the salvage efforts. Safe and mindful boat and equipment operations based on the best management practices and predetermined approaches were responsible for an incident free operation.

PRIORITY ACTIONS

A continued pursuit of partnerships with public and private sector entities is imperative to be able to conduct resource protection activities, such as this effort, in remote marine protected areas. In addition, the institutional and bureaucratic impediments to timely execution of efforts such as this will continue to hamper resource managers.

6.a.3. Indigenous protected areas: challenges and triumphs

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ABSTRACT
A significant portion the Australian National Reserve System is made up of an extensive system of Indigenous Protected Areas (IPAs) that cover over 23 million hectares of the continent. In this session, the contribution that IPAs make to improved coastal management in Australia will be discussed, focusing on the central role that local indigenous peoples play in the management and monitoring of marine debris. Forming partnerships with indigenous communities introduces the need for cultural issues to be considered by the project, including the need for cultural protocols to be observed, respecting traditional ownership of the land and the preservation of local traditions.

The umbrella effect of strong communication and partnerships allow goals of the program to be achieved, including respect for cultural traditions, improved management of marine debris and threat abatement of protected species. The mutual benefits that these aspects provide, and the lessons that we have learned, can be applied to a wide range of partnerships and have contributed to the success of the work of GhostNets Australia.

6.a.4. Dealing with marine debris in MPAs at Europe's extremities

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KEYWORDS
Macaronesian islands, marine protected areas, vectors, biodiversity impact, MSFD, OSPAR

BACKGROUND
At the extreme south-west of Europe, macaronesian marine nature reserves are increasingly blighted by marine debris, brought from elsewhere by currents to remote shorelines. Two case studies – La Palma (Canary Islands) and Ilhas Selvagens (Madeira) – are the subject of this paper.

The marine reserve of Isla de la Palma was established in 2001. Management is the responsibility of the central government, as the reserve is located in waters beyond any baselines, and restrictions apply to certain activities. The Ilhas Selvagens, a tiny archipelago of 3 islands (Selvagem Grande, Selvagem Pequena and Ilhéu de Fora) and several islots, 160 miles south of Madeira, are a strict nature reserve since 1971 (the oldest reserve in Portugal). The reserve is managed by the Regional Government of Madeira, through the Service of the Parque Natural da Madeira. The only permanent human residents are the park wardens.

In both these cases marine debris is undermining the objectives of the marine reserves by adversely affecting communities of protected species; impacting upon seabed habitats and providing a vector for rodents and insects that in turn threaten indigenous fauna. Species impacted include marine mammals, turtles and seabirds.

METHODOLOGY
A first step, to raise awareness, has been quantification of the problem. Remoteness of these areas makes scientific survey costly and problematic. In La Palma marine debris has been recorded, photographed, and, where possible, attributed to source by fisheries patrol staff engaged in surveillance and protection. In Ilhas Selvagens, debris has been photographed and a clean-up operation undertaken every year by the park wardens, separating wood debris, which are used as fuel for cooking, from plastic and metallic debris which are packed and sent to Madeira for recycling. Tar residues are eventually incinerated in situ. Stomachs of dead seabirds have also been collected in order to assess the presence of plastics in their contents.

Monitoring to establish impacts on biodiversity has taken into account implications of plastic debris on habitats and species (Gregory, 2009). Consideration of the larger political implications has then been drawn to the attention of decision-makers within the autonomous regions and the central state authorities.

OUTCOMES

Much of the debris can be linked to agricultural and fishing activities and the majority of debris is floating plastics. Agriculture in both the Canary Islands and Madeira uses all available fertile land (i.e. farming to the edge of the cliff top) and plastic covering to both protect crops and 'speed up' cropping.

The marine reserve of La Palma is part of the EU Natura 2000 network and a UNESCO biosphere reserve. Diversity of biological communities is enhanced by ecological niches created in crevices, caves and tunnels. Ecological studies have been undertaken by the two universities of the Canary Islands, the Spanish Institute of Oceanography and reserve personnel. Ilhas Selvagens are also part of the EU Natura 2000 network and have been granted the European Diploma for nature reserves by the Council of Europe. On-going studies of the seabirds are being done by teams of the Natural Park of Madeira, the Natural History Museum of Funchal and the University of Lisbon. In 2010 a large marine survey involving nearly 70 scientists of over 30 Portuguese Universities and other scientific institutions made an inventory of marine fauna and flora from the shore down to 1000 m of depth. This initiative of the Portuguese Ministry of Defense is expected to generate more than a dozen scientific papers and all information is being fed to the M [at] rBis database, managed by the national Institute of Nature Conservation and Biodiversity.

La Palma supports protected marine invertebrates (e.g. the Mediterranean slipper lobster (*Scyllarides latus*), protected algae species, many fish, bottlenose dolphins (*Tursiops truncatus*) and loggerhead turtles (*Caretta caretta*). Ilhas Selvagens are important also for rare marine invertebrates and thousands of breeding seabirds including species such as White-faced Frigate petrel (*Pelagodroma marina*), Bulwer's petrel (*Bulweria bulwerii*), Cory's Shearwater (*Calonectris diomedea borealis*), Madeira Storm Petrel (*Oceanodroma castro*), Madeiran Little Shearwater (*Puffinus baroli*) and Roseate tern (*Sterna dougallii*).

Within the Ilhas Selvagens, two locations, Selvagen Pequena and Fora Islet have never suffered from introduction of non-indigenous animals or plants, a rather unique situation amongst Atlantic Ocean islands. Many species of plants and invertebrates are endemic.

The principal impact of litter in La Palma marine reserve is the effect on marine turtles and marine mammals, especially dolphin. Also impacts over seabeds communities, including algae and sponges. Problems include entanglement, ingestion, suffocation and smothering. Although the impact of marine debris on shore of the Selvagens have not been fully assessed, it is certain that these include direct impacts on coastal invertebrates, namely on the endemic periwinkle (*Osillinus attratus selvagensis*) and the limpet (*Patella candei candei*). They may also pose a threat to the seabirds which gather in huge concentrations at sea at the end of the day, before coming into their nests. Lighter plastics are also blown up to the interior of Selvagem Pequena causing threat in the Frigate petrel's breeding grounds.

In these European cases, the islands are autonomous regions of Spain and Portugal respectively. Thus there is an opportunity for these administrations to seek support and resources from their national governments in order to tackle marine debris to achieve ‘ good environmental status’ as required by the European Union’s Marine Strategy Framework Directive (EU, 2008). Potential future inclusion of these areas within the OSPAR Maritime Area would bring them within overarching policies and targets for marine litter reduction (OSPAR, 2009). Marine litter awareness raising has also been included as an integral element of education and training programmes on integrated coastal zone management.

PRIORITY ACTIONS

In both these special locations park wardens will continue to work with the scientific community to draw attention to the threats posed to species and habitats by marine debris. Solutions must involve public and private sectors, environmental education, remedial clean up and collaboration with the farming and fishing sectors. Waste management improvement in neighbouring States is also essential. Further work is needed to establish whether dispersal of alien species associated with marine debris is endangering these sensitive coastal environments.

FIGURES AND TABLES

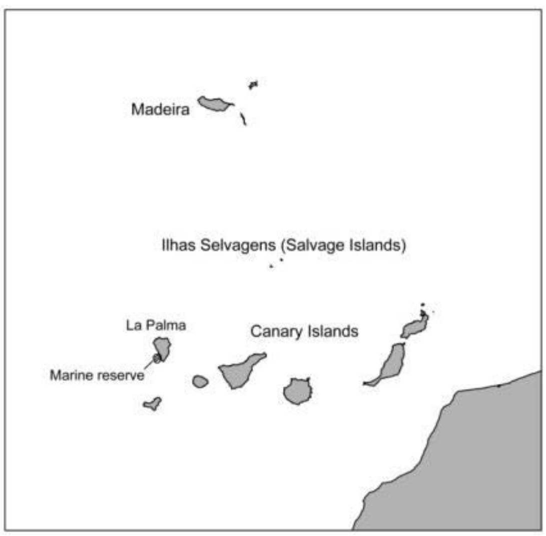

Figure 1: Location of Isla de la Palma marine reserve in the southwestern area of La Palma (Canary Islands) and Ilhas Selvagens (Salvage Islands) a small archipelago in the North-East Atlantic roughly midway between Madeira and the Canary Islands, which is the southernmost region of Portugal

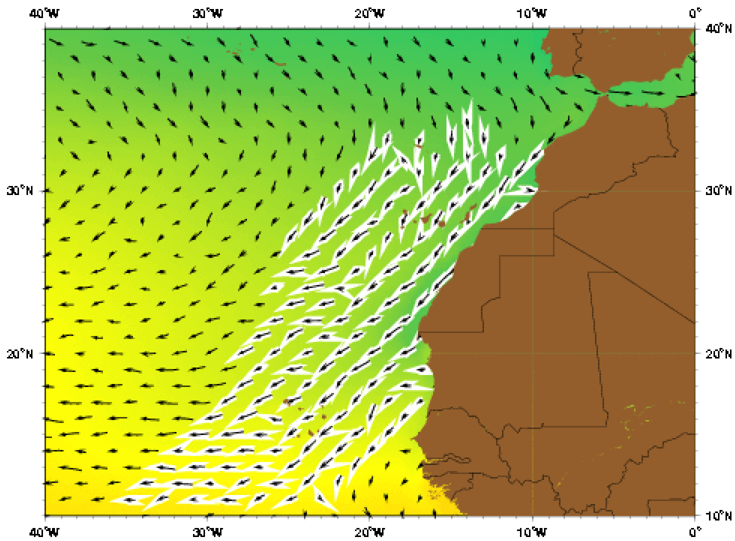

Figure 2: Prevailing currents carry marine debris to remote protected shorelines. The Canary current as represented by the Mariano Global Surface Velocity Analysis (MGSVA). The Canary current is the southwestward flow component of the North Atlantic subtropical gyre.

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6.b.1. Waste management in small island states: spreading the success of innovative ideas, integrated systems and practical community action for large-scale change

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ABSTRACT
Marine debris is a global challenge. With waste management standards differing significantly around the world, in order to "nip (this source of marine debris) at the bud" best practices, innovative community-based solutions and capacity-building development systems must be proactively offered and shared.

Many small-island states have poorly managed or non-existent waste systems - often because constructing a landfill on a low-lying island causes contamination of the water table through leachate. In 2009, we spearheaded a partnership between New Zealand and Tongan NGOs, private sponsors and government departments to trial the introduction of a new system. This involved education (school-based and adult), a large-scale community clean-up action and media coverage to raise awareness and introduce the idea, shipping containers to remove waste to proper landfill and legislation to implement the formula on an ongoing basis with innovative tools. This cross-sectoral cooperative project had a string of measurable outcomes with the most important being the successful implementation of a community-based waste management system where previously there was none.

The formula can be adapted and rolled out in comparable regions across the world to facilitate large-scale reduction of sources of marine debris and provide developmental opportunities for nations to sustainably manage their own waste management systems. Innovative solutions include a manually-operated can crusher to aid economic opportunities for recycling, legislation enforcing use of biodegradable materials (eg woven palm bags) that concurrently encourage local business, re-use of materials on-island to reduce transport costs (glass-crete) and gasification of waste wood to contribute sustainable energy production to the system. Xtreme Waste, in Raglan, New Zealand provides the case study of a successful integrated waste management model. It is a non-profit community enterprise that has helped the community to divert 75% of waste from landfill, whilst up-skilling and employing local workers.

Through collaboration, effective capacity building and open sharing of intellectual property, systems can be implemented combined with practical action to facilitate behaviour change in consumers. In this way the global challenge of marine debris can be greatly alleviated.

6.b.2. Avoiding unintended consequences – controlling land-based sources of marine debris while enhancing terrestrial waste management and recycling policy, law, and practice

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KEYWORDS
Extended producer responsibility, land-based sources of marine pollution, Clean Water Act, Waste management, recycling

BACKGROUND INFORMATION
Plastic pollution from land-based sources that becomes marine debris can have a significant impact on ocean ecosystems, but legal and regulatory efforts to control this pollution must also consider how plastics are produced, marketed, recovered, and recycled on land. It is important to ensure that legal and regulatory measures to stop plastic from entering the water, or reduce its impact if it does, do not inadvertently undermine waste management and recycling activities.

There are principles and considerations that should be incorporated into laws and regulations to control marine plastic pollution and will minimize unintended consequences of such efforts. In developing laws and policies to control the land-based sources of marine debris, there are also important opportunities to improve waste management and recycling.

METHODOLOGY
This presentation is based on the work of the Natural Resources Defense Council's (NRDC) Oceans and Urban Programs in researching and developing legal and regulatory frameworks to improve waste management and recycling thereby reducing the sources of marine debris, i.e. marine plastic pollution. Since the 1990's, NRDC has been working on extended producer responsibility and recycling enhancement programs, which help to reduce the amount of plastic waste that could then become marine plastics pollution. Staff knowledge of waste management and recycling systems has also been applied to minimize negative unintended consequences of laws to control specific types of plastic pollution.

OUTCOMES
In the U.S., there are opportunities to improve the control of plastic pollution that ends up as marine debris using existing legal mechanisms, such as the Clean Water Act. For example, if given sufficient resources, State and local water quality entities can determine, list, and update waterway impairments due to trash under the Clean Water Act. These controls can have a positive impact in reducing the amount of trash entering waterways and, subsequently, the ocean.

Additionally, new state or local laws have been passed around the U.S. to control specific types of marine plastic pollution, such as plastic bags or Styrofoam packaging. Although this presentation will not delve into significant detail about the numerous states and municipalities that have passed such laws, it will offer a basic review of these efforts and discuss the characteristics of well-designed measures that avoid negative unintended consequences for waste management and recycling.

Finally, this presentation will review the growing efforts in some U.S. states to advance the approach of extended producer responsibility ("EPR"), or product stewardship, to reduce the amount of packaging in the waste stream. The EPR approach has been applied to packaging in a number of locales, and EPR is being used successfully to address other problematic elements in the municipal waste stream, most significantly electronics (or "e-waste"), but also increasingly carpeting, paint and other difficult items. EPR requires that the manufacturers of these products take financial responsibility for proper management their products at end-of-life. Over time, holding manufacturers responsible for these costs will lead them to think more about how the products they make are designed in the first instance and ultimately could reduce the quantity of plastics that are making their way into our oceans.

PRIORITY ACTIONS

- Identify opportunities to put existing laws and regulations to better use in controlling land-based marine plastic pollution.
- Where appropriate, create new laws and regulations to control high-priority marine plastics on a category-by-category basis.
- Educate the public and decision makers about extended producer responsibility and how this approach can be applied to one of the most significant sources of marine plastic pollution: packaging.
- Evaluate lessons learned from successful EPR frameworks that have been developed around the world.
- Determine interim legal and regulatory measures that lay the groundwork for EPR for packaging.

6.b.3. Synthesizing human development with coastal zone management: the Niger Delta Experience

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ABSTRACT
The coastal and marine environment covering about 840km constitute a major socio-economic pivot in enhancing the quality of life of more than 40% Nigerians. However, the numerous land-based domestic and industrial activities infringe upon the coastal regions of the country have resulted in severe environmental degradation. The paper sets out to establish a correlation between the solid waste discharge methods along selected upstream settlements in the coastal cities of the Niger Delta region in order to determine the compliance and response pattern to existing legislative frameworks that can safeguard the health of down-stream settlements. The paper affirms that factors of ignorance, attitudinal notions, poverty, lack of institutional support for proper solid disposal and improper discharge from industrial activities all contribute to the deterioration of the coastal and marine environment. The paper advocates for the adoption of locally acceptable initiatives and sensitization measures to guard against degradation, incorporation of strict penalties to defaulting units and personnel as recommendations to enable the protection of the coastal and marine environment in Nigeria.

6.b.4. Global Partnership on Waste Management (GPWM)

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BACKGROUND
Waste generation rates have been increasing rapidly due to urbanization and industrialization. Per capita waste generation rates in many developing countries have now crossed the one-kilogram per day mark. In most OECD countries, municipal solid waste generation rates are slightly above one-kilogram per capita. Moreover, the population growth and urbanization in developing countries is very high in comparison to OECD countries. In year 2000, when world population crossed 6 billion mark, more than 5 billion people were living in developing countries as in OECD countries population growth since 1990s is about 0.7% and urbanization rate is around 1% while the world urbanization rate stands at 2.5% and it is projected that by 2015, more than 50% world population will be living in urban centres.

Conventional waste management systems were not designed for either of these trends - increased waste generation rates and new and special waste streams. Such systems in many developing countries were also not based on 3R principles (reduce, reuse, and recycle) as the per capita generation rates were low, and scavengers picked up almost all recyclable waste. There are various initiatives at local and international level to raise the awareness, fill the information gaps, build the capacity and strengthen the current waste management system for improved waste management based on 3R approach. However, there is no over-arching partnership for already existing activities and initiatives, which are undertaken in a sectoral manner but lacking the holistic approach, such as Partnership on Mercury Waste, Solving the E-waste Problem (StEP), 3R Forum in Asia, UN-DESA Partnership on moving towards Zero Waste, UN-Habitat programme on sanitation, etc.

METHODOLOGY
The Global Partnership on Waste Management (GPWM) is an open-ended partnership for international agencies, governments, businesses, academia, local authorities and NGOs. GPWM supports the development of work plans to facilitate the implementation of integrated solid waste management at national and local level to overcome environmental, public health, social and economic issues inflicted by waste and its impact. GPWM will also support to undertake policy dialogues and other activities to exchange experiences and practices. It will facilitate enhanced awareness raising and capacity building. This partnership would focus on major waste streams such as municipal waste, industrial waste, healthcare waste, waste agricultural biomass, WEEE/e-waste, hazardous waste, etc. The related themes such as capacity building, information collection and sharing, financing, policies, technologies, etc. would also be covered. However, this partnership will not work directly on issues such as nuclear waste, munitions waste, chemical weapons, etc. UNEP is in contact with Chemicals Weapons conventions and will refer the requests to these conventions.

Out of this comprehensive list, the participants proposed the following priority areas (subject to the confirmation of respective lead members)

1. Waste prevention (ISWA)
2. 3R for waste management (UNCRD)
3. Waste agricultural biomass (UNEP-IETC)
4. Integrated solid waste management (UNEP-IETC)
5. E-waste management (SBC)
6. Hazardous waste management (SBC)
7. Marine Litter (UNEP-DEPI)

OUTCOMES

Expected outcomes are as follows:

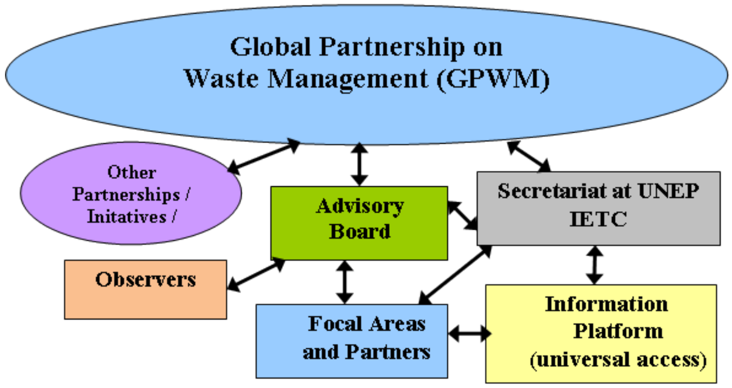
a. Holistic approach on waste management as described earlier is facilitated
b. Already available information is shared and additional information is created to fill the gaps
c. Members get benefited from each others' actions
d. Enabled complementarities with various waste conventions, initiatives, and activities
e. Partners are approached and activities are undertaken in a coordinated manner
f. Resources are utilized efficiently and effectively on various activities implemented– avoiding duplication of efforts, streamlining of resource utilization and information sharing across multiple activities
g. Synergized efforts in holistic manner - Government's efforts, activities and initiatives within countries to be developed and implemented in synergy and in holistic manner
h. Built synergy including academia, NGOs, private sector, government and international organizations
i. Enhanced transfer of technology and knowledge

PRIORITY ACTIONS

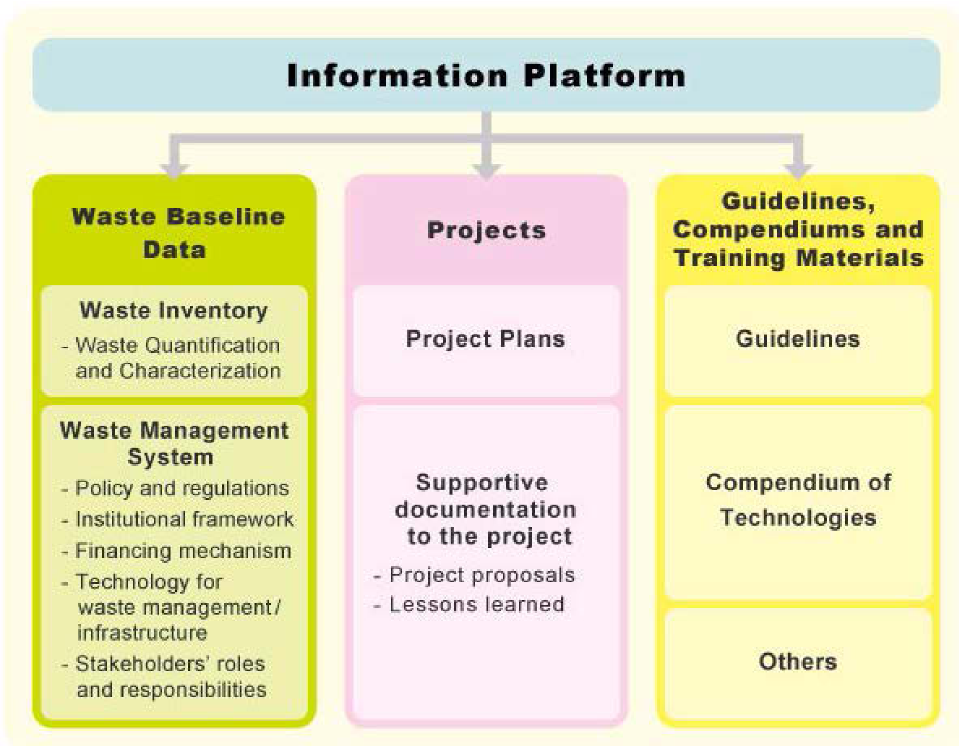
- Develop strategy to work with Global Partnership on Waste Management (GPWM) for coordinated, efficient and effective efforts for marine debris management
- Implement marine litter led by UNEP-DEPI as one of the focal areas of Global Partnership on Waste Management (GPWM)
- Fill the gaps in the information and improve the information sharing by working with current mechanisms such as Information Platform on Waste Management

FIGURES AND TABLES

Conceptual structure of Global Partnership on Waste Management:



Structure of Information Platform on Waste Management
http://www.unep.or.jp/Ietc/GPWM/info_platform.html



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6.b.5. Waste management and recycling in the Galápagos Islands

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KEYWORDS
Galápagos Islands, waste management, recycling, education, partnership, WWF, Toyota

BACKGROUND
The Galápagos Islands are home to more than 30,000 people and attract more than 160,000 tourists annually. Besides an accelerated demand for energy and water this trend also caused an increasing generation of waste of all kinds and improper waste management practices. Since 2006, WWF and Toyota have been working together in the Galápagos Islands on issues related to waste management and recycling systems. To do so, WWF and Toyota developed the Waste Management Blueprint for the Galápagos Islands and provided financial resources, on-site technical assistance, and technical support to the Municipality of Santa Cruz Island –the most populated island of the archipelago- to implement an effective waste management and recycling system, including waste separation at source, improvement of recycling processes, environmental outreach campaigns and the development of environmentally safe disposal and treatment options, among others. This effort also included the collection of waste and used oil generated by tourism boats operating in the Galápagos Marine Reserve (GMR).

WWF and Toyota have also provided technical expertise and worked together with the Municipality of Santa Cruz to design, create and implement the first Municipal Environmental Department in Galápagos. They also supported the Municipality to implement environmental policies, and develop environmental standards and guidelines. Through a four-year education campaign on recycling practices, to date, we have reached 99% of Santa Cruz Island's population, which represents 59% of the overall population in the archipelago. Currently, the waste management and recycling system on Santa Cruz Island is considered the most efficient initiative in Ecuador. Nearly 50% of the overall waste generated on Santa Cruz Island is currently being recycled, and the system has become a model that should be replicated in other places. Through the implementation of this initiative we have learnt several lessons to ensure the long-term sustainability of such projects.

METHODOLOGY
The overall goal of this partnership with Toyota and the local government, utilizing WWF's conservation expertise and Toyota's technical expertise, is to transform Galápagos into a model for clean energy and sustainable waste management systems. To do so, we carried out a 4-year outreach education campaign with pre and post-evaluations every 12 months; provided technical expertise, equipment and capacity building within the Municipality; implemented environmental policies; developed environmental standards and guidelines; and developed the "Waste Management Blueprint for the Galápagos Islands."

The project's key objectives are:

- Increase awareness about recycling practices in the local community of Santa Cruz Island.
- Increase the percentage of waste collected and recycled by the system in place in Santa Cruz Island.
- Install a mechanical composter in Santa Cruz Island to increase workers' efficiency.
- Strengthen the capacity of the Municipal Environmental Departments of San Cristobal and Isabela Islands to improve their waste management and recycling systems in order to replicate the experience of Santa Cruz Island**.**

The primary target group is the 16,000 inhabitants of Santa Cruz Island and the secondary target group is the total population of the Galápagos Islands, which has approximately 28,000 inhabitants currently. The indirect target is the 160,000 tourists visiting the Galápagos Islands each year.

OUTCOMES

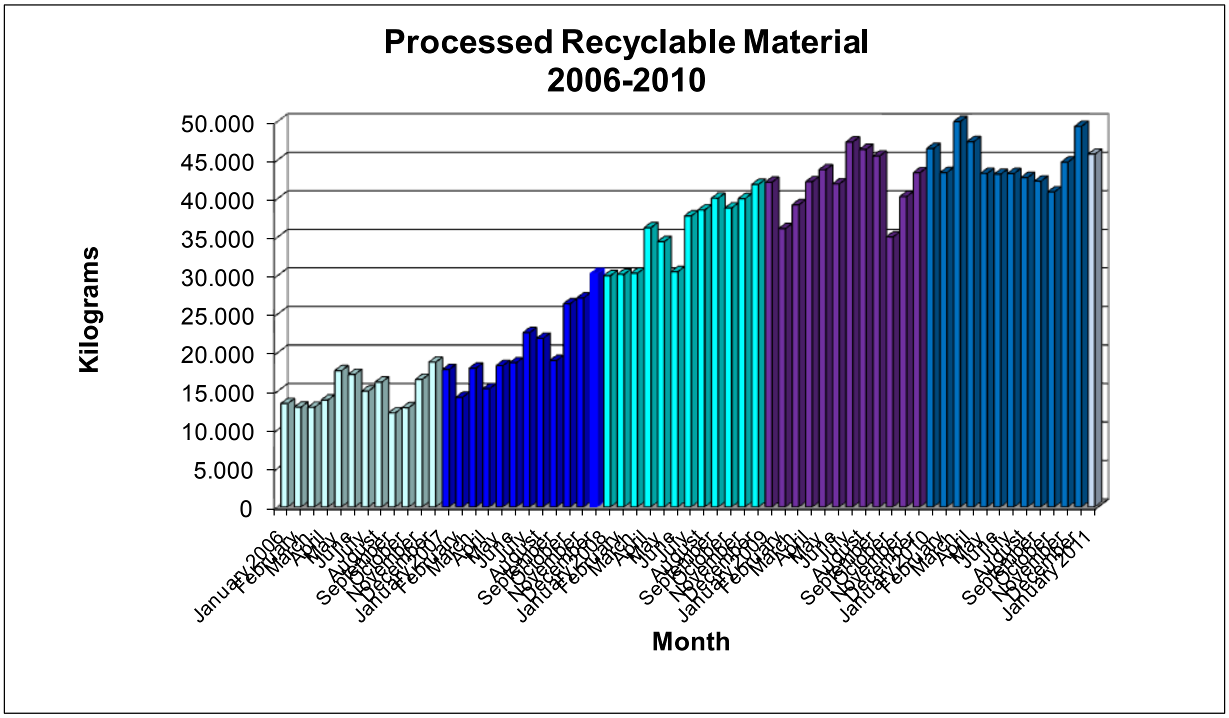
The Waste Management and Recycling System in the Galápagos Islands has combined education, technical assistance, and policy enforcement through a strong partnership between the governmental sector (Municipality of Santa Cruz), the private sector (Toyota) and the non-governmental sector (WWF). Some results achieved to date are:

- Through the on-going education campaign on recycling practices, to date we have reached 99% of Santa Cruz Island's population, which represents 59% of the overall population in the archipelago.
- Provided ongoing and on-site technical expertise to the Municipality of Santa Cruz, and created the Municipal Environmental Department in Santa Cruz in 2007 to ensure a successful recycling system on the island, and to influence the Municipality's policies by introducing environmental standards and guidelines.
- Achieved a 400% increase in composting and recycling system efficiency and, as a result, the Santa Cruz waste management and recycling system is the most efficient recycling initiative in Ecuador. Nearly 50% of the overall waste generated on Santa Cruz Island is currently being recycled, and has become a model that should be replicated in other places.
- The Waste Management Blueprint for the Galápagos Islands was produced jointly by WWF and Toyota and was built through a participatory process of consultation with the three existing Municipalities of Galápagos, key stakeholders and representatives of different sectors. Several technical studies were also completed to determine the status of the waste management and recycling systems in all inhabited islands of Galápagos. The document can be downloaded at http://www.worldwildlife.org/what/wherewework/galapagos/publications.html

PRIORITY ACTIONS

1. Develop long-term and strong environmental education campaigns focused on the prevention principle.
2. Provide continuous technical assistance onsite to create lasting and transferable local knowledge.
3. Develop and enforce strict guidelines and norms for waste management.

FIGURES AND TABLES



Graphic from years 2006 to 2010 showing the amounts of recyclable material processed at the Recycling Center on Santa Cruz Island as part of the waste management and recycling system jointly implemented and supported by the Municipality of Santa Cruz, World Wildlife Fund and Toyota.

6.c.1. A global harmonized methodology for monitoring marine litter: the UNEP/IOC guidelines

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KEYWORDS
Marine litter, marine debris, monitoring, survey, guidelines, beach clean up, beach litter, assessment.

BACKGROUND
Marine litter is found everywhere: in all oceans, seas and types of coastline, not only in densely populated regions, but also in remote places far away from any obvious source. Despite global and regional efforts, current estimates are that the magnitude and pervasiveness of marine litter and the associated environmental and socio-economic impacts is growing.

The severity of the global marine litter problem was recognized by various resolutions of the General Assembly of the United Nations. Resolution A/60/L.22 (Nov.2005) calls, among others, for national, regional and global actions to address the problem and notes the lack of information and data on marine debris as a significant barrier to the proper management of the problem.

Over the years, many groups have tried to 'estimate' the scale of the marine litter problem (e.g. 6.4 million tons of plastics enter the ocean every year; 46,000 pieces of plastic can be found for every square mile of ocean and many others). Such estimates are, however, of limited utility because they are not based on consistent or agreed quantitative assessment methods. The absence of a common, simple, agreed-upon and science-based methodology (to monitor and assess marine litter) makes it difficult to either assess the size of the marine litter problem or the efficacy of alternative management and control strategies. This applies equally to litter found on the sea surface, in the water column, on the sea bed and on beaches.

The basic understanding of the marine litter phenomena, including litter sources, distribution, weathering and fate is an elementary step towards designing actions, management approaches and solutions. This underpins the need for a global harmonized methodology to support programmes that monitor and assess marine litter. The lack of consistency in data collection as well as in the design of the sampling and assessment protocols is a serious barrier.

METHODOLOGY
The overall objective of the UNEP/IOC guidelines is to provide a harmonized and globally agreed scientific methodology to monitor changes in accumulation of marine litter, to allow for comparative studies, improved quantification and characterization and by this to better understand and manage the threats to biota, ecosystems and humans.

In working to achieve this outcome it became clear that there was also a need to address the different underlying purposes, particularly in relation to beach litter assessments, and to that end two classes of surveys were developed: 1) Comprehensive surveys for beach, benthic and floating marine litter (with protocols targeted at the collection of highly resolved data to support the development and/or evaluation of mitigation strategies; the protocol for these surveys includes a highly structured framework for observations at regional, national and international scales; 2) Rapid surveys for beach litter - this protocol comprises a simplified version of the comprehensive beach survey, targeted primarily at developing public awareness and education about marine litter issues and is thus not constrained by the need to fit within a broader spatio-temporal comparison framework. Such surveys may be used as a vehicle for broader based community engagement and in building community capacity when working towards inclusion within the comprehensive survey framework.

OUTCOMES

The absence of harmonized and globally agreed upon scientific methodologies to monitor changes in accumulation rates and the composition of litter, and the effectiveness of management arrangements over time are critical issues that require the development of appropriate guidelines. In order to address this problem the Regional Seas Programme (RSP) of UNEP, together with the IOC of UNESCO, and with the support of the Government of Australia, within the context of the *'UNEP Global initiative on marine litter'* initiated the work on developing guidelines for the 'standardization' and harmonization of the survey and monitoring of marine litter worldwide.

The guidelines will contribute to the global efforts, especially of developing countries, to address and abate marine litter and will assist scientists, governmental authorities and policy makers (including NGOs, Regional Seas Programmes and other relevant organizations) to address the problem of the monitoring and assessment of marine litter.

The UNEP/IOC 'global guidelines' provide technical and practical guidance on the survey and monitoring for four basic types: i) Beach litter surveys; ii) Benthic litter surveys; iii) Floating litter surveys; and - iv) Rapid assessments of beach cast litter.

The survey design, guidance and data recording protocols are intended to support comprehensive surveys and monitoring as well as rapid surveys suitable for application by community-based or other non-research trained personnel. Given the extensive logistical requirements for surveys of floating and benthic litter, it is not practical to develop rapid assessment surveys for litter in these environments. It is recognized however, that community groups may well participate in *ad-hoc* clean-up and removal operations for floating or benthic litter which may then be reported in general terms (e.g. total volume or weight of material collected). Similarly, while there is broad agreement about the importance of microplastics as a threat to wildlife, investigations into this type of litter are technically demanding and require specialized equipment and training; specific survey guidelines for this form of litter have not been included.

Development of the guidelines was coordinated by UNEP and the UNESCO/IOC with the support of the Government of Australia through the establishment of an international Technical Working Group (TWG), comprising sixteen experts from various regions and countries of the world. The TWG began work in July 2007 and Prof. Anthony Cheshire from Australia acted as a chief scientist and coordinator.

The TWG undertook a detailed review of 13 different sampling protocols that were being used around the world to survey beach cast, benthic and/or floating marine litter. Survey protocols were assessed against 46 criteria related to the basic structure of the survey, the analysis of sampling units, the frequency and timing of surveys, the systems used for litter classification and the underpinning framework for facilitation and management of logistics.

Results of this review were summarized and then used to determine the best way to structure different types of litter surveys. The outcomes from this work have been incorporated into the development of these Operational Guidelines. In framing these recommendations a set of draft guidelines were reviewed by all members of the TWG and these were further developed during a workshop held in Phuket, Thailand during May 2008. Following this workshop the results were compiled into a set of operational guidelines to support the delivery of marine litter surveys.

In total four sets of guidelines have been developed, one for each of:
1) Comprehensive assessments of beach cast litter;
2) Assessments of benthic litter;
3) Assessments of floating litter; and
4) Rapid assessments of beach cast litter.

Chapter I of the report presents an introduction to marine litter and the associated problems. General information about the application of these guidelines in a global / regional framework is detailed in Chapter II while the detailed methodology for each of the guidelines is presented in Chapters III-VI. Appendix A lists the TWG membership while Appendix B provides a summary of the findings from the review of the various litter assessment programmes that formed the background to these guidelines.

PRIORITY ACTIONS

Conclusions

Given the greater capacity for volunteer communities to participate in beach litter studies more effort has been put into the development of specifications, guidelines, manuals and protocols for the beach litter assessments. In the future there would be merit in looking at how to engage the broader community including "ships of opportunity" into assessments of floating litter, particularly in areas which are not accessible to the general community (e.g. global ocean surveys). Similarly the fishing industry could well participate through collection of data about trends in litter accumulation on the sea floor.

There is an increasing need to better manage marine litter problems as well as to better quantify ecological and ecosystems threats. A common methodology would facilitate the analysis of data from long term, large scale surveys and the consequent assessment of status and trend in litter loads.

A key challenge in developing assessment guidelines is to balance the need for more complex litter survey designs against the need for 'practicality'. This drives 'compromises' around issues such as how litter is classified (material composition, size, source etc), the measurement of litter quantity (weights vs volumes vs item counts), the choice of sample locations (size or area, geographic spread, beach characterization) the definition of sampling effort, the time interval between surveys and the necessary logistics to support litter collection. The UNEP/IOC protocols, like others have taken into account such issues and present a protocol which has tried to balance these sometimes conflicting challenges while harmonizing methods with other existing and well established monitoring programs.

Having a harmonized and standardized protocol for many parts of the world will facilitate the understanding of the marine litter phenomenon and its status and trend and will strengthen the science-based management decision making.

Recommendations

In view of the United Nations General Assembly Resolution (A/60L.22) which states that one of the most significant barriers to addressing the global problem of marine litter is the absence of information that can be used to determine the sources, the movement and paths, the oceanographic dynamics, the trend and the more general status of marine litter;
In order to assess the impact of marine litter on national, regional and global scales;
In the absence of harmonized and globally agreed upon scientific methodologies to monitor changes in accumulation rates and the composition of litter, and the effectiveness of management arrangements over time;
Recognizing that not all countries and/or organizations will be able to adopt and implement the UNEP/IOC guidelines (especially those countries which have already implemented their national monitoring systems over a long period of time);
Also recognizing that the UNEP/IOC guidelines are probably not perfect but rather represent a 'logical compromise' –

It is recommended that the UNEP/IOC guidelines be adopted by countries and national or sub-national authorities responsible for marine and coastal litter that are considering the establishment of new monitoring programmes. For countries that have existing monitoring programmes, these guidelines present an opportunity to review and update current practice and thereby seek to better integrate existing surveys to support regional and global analysis of marine litter data .

It is also recommended that the global action plan on marine debris that is being developed during 5IMDC will make reference to the UNEP/IOC guidelines and will advise countries that have not yet adopted a comprehensive monitoring program to use the guidelines in developing their respective programs.

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6.c.2. Marine debris monitoring and assessment in China

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KEYWORDS
marine debris, monitoring, assessment

BACKGROUND

Marine debris is found in all the oceans of the world, not only in densely populated regions, but also in remote places far from obvious sources and human activities. Most marine debris has a very slow rate of decomposition, leading to a gradual, but significant accumulation in the coastal and marine environment [1]. Marine debris is an environmental, economic, health and aesthetic problem. It causes damage and death to wildlife. It threatens marine and coastal biological diversity in productive coastal areas. As the characteristics of cross-border movement of marine debris, impact on marine ecological by marine debris is more serious than envision. Despite efforts made regionally, nationally and internationally, there are indications that the marine debris problem keeps growing [2].

Marine debris problem has attracted growing attention in China in recent years. One of the challenges to address marine debris issue is the lack of useful information for management. For the purpose of getting the science-based monitoring information, estimating the amounts, types and possible sources of marine debris, Marine Debris Monitoring and Assessment Programme were carried out along the coastal areas of China from 2007. The floating debris, beaches debris and seabed debris were monitored at 50 survey sites from September to October. The focused demonstration monitoring areas were recreational beaches, harbors and ports, mariculture areas, estuaries and marine protection areas. The debris were collected and sorted into categories, including plastics, Styrofoam, wood, rubber, metals, paper, cloth, glass/pottery, and other items. During the survey, information of date, time (start and end), location, weather conditions, current and tide, geographical conditions, coast and beach conditions were recorded.

METHODOLOGY

<u>Beach debris survey method</u>

For the beach debris monitoring, categories, amount and weight were measured. On the beach, at least 4 survey transects were set. The width of transect was 5 m; the length was the distance from the water edge to the backshore zone of beaches. The number of survey transect for each beach depended on the beach length. Source of debris items were also recorded according to their use [3].

<u>Floating debris survey method</u>

For the floating debris monitoring, sighting survey [4] and trawling survey methods are developed according to the debris size. If the debris size were greater than 10cm, belt/line transect sighting surveys method were used. For belt survey, during observation, investigator searched the debris floating on the water surface. Only objects within a specified distance from the side of the ship were counted. The effective observation width was usually 100 m; the length was the distance of ship moving. For line transect survey, all objects were counted regardless of the distance from ship. The vertical distances from the object to the ship and the angle between object and observer need to be measured [5]. The small-size (<10 cm) floating debris were collected by the trawl. A surface 0.5×1×2m neuston net (0.05mm mesh) sampler was used to sample the surface water while the ship was moving at speeds less than 5 knots. The sampler is placed on outside of the ship so that it can sample water surfaces.

Seabed debris survey method

For seabed debris items monitoring, trawling and diving survey method were developed. When trawling seabed debris items, the speed of survey ship was kept at 3 knots. The trawl was released from the stern of the ship. Once the trawl net reached the bottom, the time was recorded. Trawling time was generally 15~30 min. Survey length was the distance of the ship moving straight; effective width was the width of the trawl net mouth. As trawling on the seabed impacted on the living environment of benthic organism, areas of marine protection zone, marineculture zone are forbidden to conduct trawling survey. Oceanic dumping areas, steep slope areas, large rocks and pinnacles areas are forbidden to trawl seabed debris for protect the trawling net.

For diving survey, at least three transects which parallel to the coastline were set on the seabed. During survey, 100m of rope was placed on the seabed, the divers moved along the line holding a pole parallel to the bottom, one end of the pole touched the line and the pole was held at 90°angle to the line. Within the pole scanned areas, the divers picked the debris up and took it to the ship or beach [6]. For the big or huge debris that impossible moving, divers took photos under water.

OUTCOMES

The monitoring data indicated [7], as fig1 showed, average density of beach debris on demonstration sites were 4×10^3 items/km^2, 8×10^3 items/km^2 and 12×10^3 items/km^2 in 2007 to 2009. Most of beach debris was plastic bags and bottles. The densities of large floating debris were 10 and 21 items/km^2 in 2008 and 2009(data of 2007 missing). The densities of small floating debris were 2.9×10^3 items /km^2, 1.2×10^3 items/km^2 and 3.7×10^3 items/km^2 in 2007 to 2009. Most of floating debris was Styrofoam food containers, plastic bags, and fishing line, etc. Seabed debris trawling survey was conducted on six demonstration sites and diving survey was conducted in Sanya coral reef areas. Statistical results indicated the debris that settled on seabed were mainly plastic bags, glass bottles, metal cans and fishing nets. Densities of seabed debris were 3.2×10^3 items/km^2, 0.4×10^3 items/km^2 and 0.2×10^3 items/km^2 separately. Furthermore, the proportion of plastic debris, which float in seawater, accumulate on the beaches and seafloors debris, were 33%, 49% and 48% separately.

According the background information, such as geographical conditions, coast and beach conditions, the debris source were analysised. There was significant difference of marine debris source in different region. For example, in Sanya coral reefs, with the development of coastal tourism, the debris mainly came from tourists diving, many diving equipment were discarded by the tourists. Along the coastal areas of Xiamen City, large quantities of debris enter the sea from the JiulongJiang River every year. So, relevant management activities are expected to be performed according the monitoring and assessment information.

Though Marine Debris Monitoring and Assessment Programme were carried out for 4 years in China, only 50 demonstration areas were involved in the plan. The surveyed length of coastline is less than 1% of the total coastline of China; the results just reflected the marine debris pollution state of demonstration areas. Furthermore, the choices of some surveyed locations were based on whether it was easy to proximity or not, the result can not accurately reflect regional marine debris pollution status. So, future study will focus on optimizing the monitoring plan and carrying research of marine solid waste impaction on the marine ecological environment.

FIGURES AND TABLES

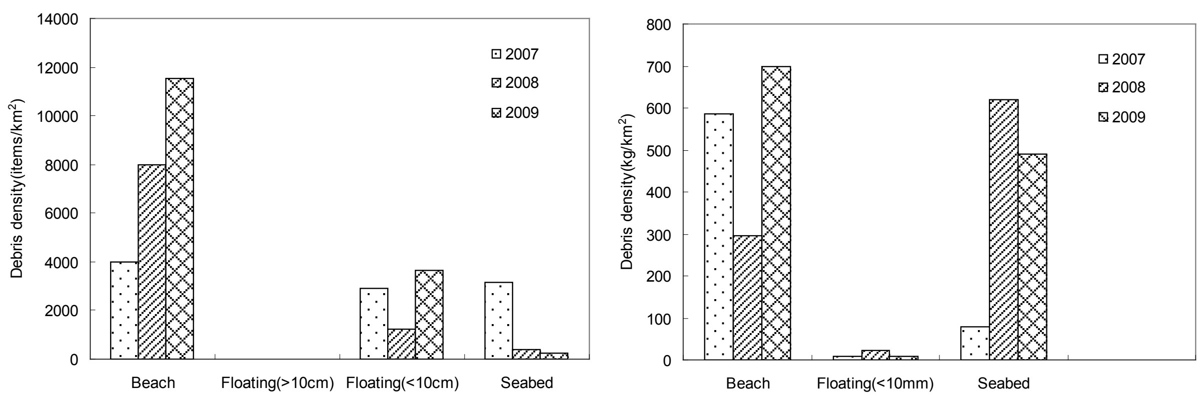

Fig1. Density of beach debris, floating debris and seabed debris at demonstration sites

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6.c.3. Tridimensional sampling method to estimate abundance of plastic pellets in sandy beaches

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KEYWORDS
Plastic pellets, nibs, marine debris, pollution, beaches, method, Brazil.

BACKGROUND
The pollution is a major threat to the marine life, bringing negative effects to the oceans (Santos *et al*., 2009). The plastic is one of the items of special preoccupation, because it is the major pollutant found in the marine environment. The plastic raw material is transported as pellets and, sometimes, it is accidentally lost during the manufacturing, transportation, or industrial processes (Ogata *et al*., 2009).

In the literature, sampling methods of plastic pellets is mentioned, in majority, on the surface layer of the sediments and in the high tide line of sandy beaches (Mato *et al*., 2001; Ogata *et al.*, 2009; Costa *et al.*, 2010), but a recent study (Manzano, 2009) showed that the plastic pellets can be found up to 2 meters in depth in Santos Bay, SP, Southeastern Brazil. Until now, there only exists a methodology to sample in the sand surface and, knowing the occurrence in depth, it is necessary to develop a new method and strategy for this kind of sampling. Therefore, the present work proposes the definition of a quantitative sampling method to collect plastic pellets in depth in sandy beaches.

METHODOLOGY
The Santos Bay is located in Southeastern Brazil (Figure 1) and was chosen for the present study by the quantity of plastic pellets reported in its beaches (Manzano, 2009). To propose a quantitative sampling method to collect plastic pellets in depth, three steps were performed: 1) the definition of the sampler diameter (post hole auger); 2) the number of samplers in a transect (cross-shore sampling); and 3) the determination of number of transects in a sandy beach.

<u>Choice of sampler</u>
The best way to collect plastic pellets in depth is by using a post hole auger (samplers), which have diameters of 4, 6, 8, 10, and 12 inches. Because of size variation, it was necessary to choose a sampler to best fit this type of work. The first step was to calculate the equivalence of the number of samples necessary to each sampler in order to get the same quantity of sediment in total as shown in table 1. An area was marked in the upper portion of backshore of Embaré beach, where samplers were performed between the months of May and June/2009. The plastic pellets were separated from the sediment by flotation and counted. The time spent with each sampler and in each sample was also recorded.

Number of samples per transect

After determining the best sampler, the next step was the determination of the ideal number of samples to be done in each cross-shore transect, since pellets are distributed across the whole back-shore. Then, another area inside Santos Bay was determined, where samplers were taken every 1 m across shore, adding up to 45 samples (because of the backshore size). The samplings were taken out by removing the sediment using the post hole auger and then the plastic pellets were separated from the sediment by flotation and counted.

Number of transects per beach

The last step was the determination of the number of transects per beach. Twenty transects were drawn randomly in all of extension of the Santos Bay (about 7 km). The digging was made up to 2 meters deep, the plastic pellets were collected by flotation and counted.

OUTCOMES

Choice of sampler

The density of plastic pellets/m^3 varied between the samplers used with the larger values estimated by the major samplers ($F=26.4723$; gl=4; $p<0.001$; SNK: 4=6=8<10=12. The Levene test ($F=24.654$; gl=4; $p<0.001$) showed that there is no homogeneity in the variance between the samplers and it also rises with the size of the samplers (4=6=8<10=12).

There was a variation in the time spent between the different samplers ($F=219.350$; gl=4; $p<0.001$). The collect time of each individual sample increased according to the increase in the size of the diameter of the sampler and, as opposed, the total time to sample 0.7 m^3, which is an equivalent volume for all samplers decreased according to the increase in diameter of the sampler (Figure 2). The time spent to sampling with the 8” sampler was intermediate between all the samplers tested and based on the results of density of plastic pellets, the same sampler presented the standard deviation similar to the smaller ones. So, the best combination between sample effort (collect time) and the variability in estimates of abundance of the pellets (standard deviation) was obtained with the 8” sampler.

Number of samples per transect

The abundances of plastic pellets were interpolated and produced estimates of samples quantity to be made per transect, based on the different intervals (1, 2, 3, 4 m until the limit of 2 samples by transect); then were calculated the mean, the standard deviation and the standard error corresponding. The standard deviation and the mean of each of the obtained estimates were compared and evaluated along with the standard error equivalent. According to Figure 3, it is possible to observe that the 4th interval was the interval that has the standard error and the standard deviation following a similar trend. From this range, the values of the error and the standard deviation fail to follow the same trend, and became high and/or erratic, which is not desirable. Based on the intervals and the calculated mean, standard deviation and standard error, the 4th interval, with a number of 12 samples was chosen to sampling in each transect.

Number of transects per beach

The sample size calculation (number of transects) related with the abundance estimate of plastic pellets, in a entire beach, was performed allowing the identification of changes of 10%, 20%, 30%, 40%, and also 50% in this variable. The obtained results were, respectively, n = 3,380; 845; 375; 211 and 135. According to the obtained results of the plastic pellet amount in each sample and also per transect (Tab. 2), a cluster distribution of this pellets along the beach can be deduced, as already reported by Manzano (2009). Thus, to monitor the Santos Bay with a 10% precision it would be necessary to use a huge number of samples, i.e., 3,380 transects. For this reason, it is difficult to estimate and to monitor the amount of plastic pellets in a particular beach, especially in highly heterogeneous ones. We suggest monitoring stretches of beaches with extensions of approximately 100-200 meters.

PRIORITY ACTIONS

Quantitative sampling is an important demand to monitor microplastics (including pellets) in sandy beaches. Considering a tridimensional distribution of pellets we purpose sampling in depositional areas with along-shore extension of approximately 100-200 m, using a post hole auger with 8” in diameter to make, at least 5 random transects, containing 12 equidistant samples each one. This procedure is relatively time costing but is able to produce more reliable estimates than superficial samples.

FIGURES AND TABLES

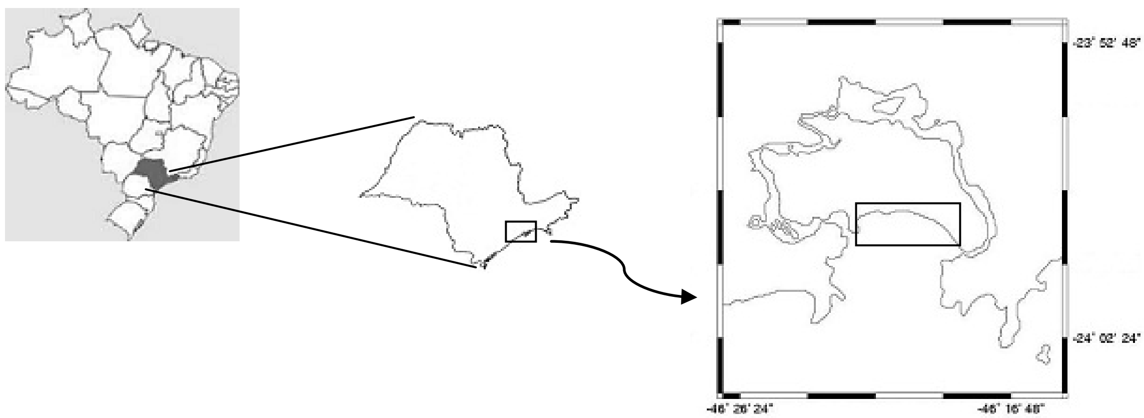

Figure 1 - Location of Santos Bay (Cesar *et al.*, 2006)

Table 1 - Comparison between sampling areas and equivalence in number of samples between different samplers (post hole auger)

Samples (diameter in inches)	Area (m^2)	N – equivalence between samplers	Total area (m^3) round numbers
4	0.008	91.25 (91)	0.728
6	0.018	40.56 (41)	0.738
8	0.032	22.81 (23)	0.736
10	0.051	14.31 (14)	0.714
12	0.073	10 (10)	0.730

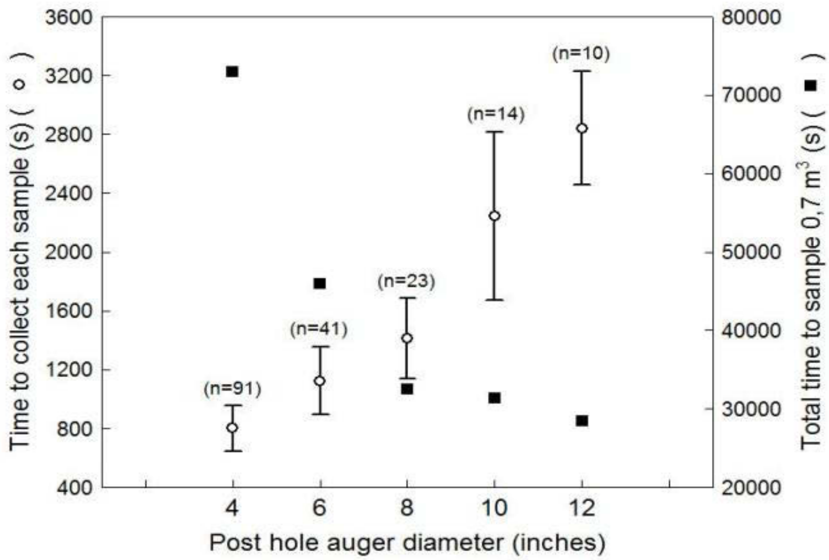

Figure 2 - Average time (seconds) to collect a sample and the total time necessary to collect 0.7 m^3 according to the diameter of different samplers (inches). The errors bars are equivalent to standard deviation; n – number of samples performed with each sampler

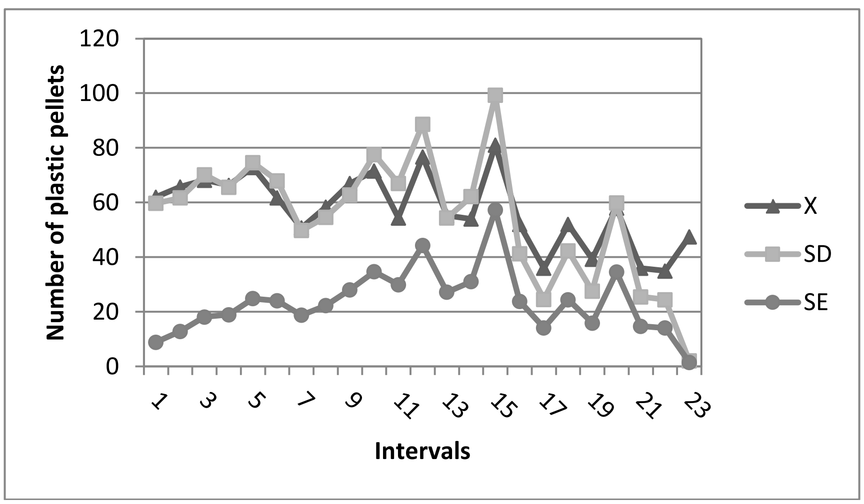

Figure 3 – Number (mean), standard deviation, and standard error of plastic pellets calculated using different intervals along a transect.

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6.c.4. Creating a citizen-science monitoring program to quantify microplastic marine debris in oligotrophic oceans

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KEYWORDS
Citizen scientist, Plastic Pollution, Social network, Mircoplastic, Gyre, Oligotrophic

BACKGROUND
Approaches to quantify and understand the temporal and spatial distributions of microplastic marine debris in oligotrophic oceans have typically been disperse. Incomparable data sets have been produced and many projects have trouble maintaining a funding source that allows for studies on a large scale. One solution to these problems is the creation of a citizen-scientist microplastic monitoring program. A unified effort such as this allows for a cost-effective, internationally accessible, and targeted set of data on marine microplastics.

This presentation will focus on the current efforts to start citizen scientist monitoring programs to monitor plastic marine pollution in oligotrophic oceans. The successes and areas for improvement and growth within these programs will be explored. Suggestions on ways to establish a more cohesive effort in the development of these programs will be discussed as well. Ideas will be shared on ways to create a program that is appealing to volunteer boaters, including the design of a low cost, high speed, compact surface trawl.

METHODOLOGY
A unique set of protocols needs to be developed for use by citizen scientist that includes the following elements:

1. Usable by citizen scientist who may have no previous scientific training.
2. Provides results that are useful to the end-user, ie the scientific community, resource managers and policies makers.
3. Requires an effort level appropriate for volunteers.
4. Sampling equipment should be lightweight and compact allowing for easy transport and stowage on small vessels.
5. Sampling equipment should be low cost to produce.
6. Does not use hazardous materials or have other safety concerns.

OUTCOMES
The development of a global network of volunteer citizen scientist monitoring the temporal and spatial distributions of microplastic marine debris in oligotrophic oceans will allow for analysis of plastic pollution on a global scale.

PRIORITY ACTIONS

- Build partnerships and capacity that can support the key elements of the project.
- Online social network
- Development and production of sampling equipment
- Research design

6.c.5. Rapid assessment of beach litter pollution in the beaches of Busan, Korea: application of Litter Pollution Index

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KEYWORDS
marine debris, rapid assessment, beach litter, litter pollution index, pollution map

BACKGROUND

Litter Pollution Index (LPI), developed by Ministry of Land, Infrastructure, Transport and Tourism of Japan and Japanese NPOs (JEAN and Partnership Office), can be used as an alternative way to rapidly assess the beach litter pollution in a wide area. Surveyors can easily assess the pollution level of a beach with the reference photos and estimate the total amount of litter [1]. The strengths of LPI suggested are 1) no special skills are needed, 2) wide areas can be covered in a short time, and 3) surveyors can assess the litter pollution from a distance from sites to be assessed [2].

This study aimed at understanding the status of beach litter pollution of the coast of Busan, Korea, with rapid beach litter assessment by LPI. Efficiency of LPI as a method for beach litter survey was also examined.

METHODOLOGY

All the accessible beaches in the natural coastline of Busan were assessed with LPI from 21 to 28 of October 2008. LPI uses a litter volume estimation table (Table 1) and associated reference photos to help surveyors in their data collection. Surveyors assessed the litter pollution level of each beach and calculated the amount of litter with the LPI table.

Site photos were taken with a standardized method for verification. Geographical locations of the survey sites were obtained by a Sony GPS. Potential litter source, inflowing streams, and land use types around the sites were also recorded.

OUTCOMES

The total volume of litter on the 70.5 km natural coastline of Busan in October 2008 was estimated at 31,642 pieces. A beach litter pollution map was produced by marking the levels of litter pollution of each transect on a map (Fig. 1.). About 60% of the litter was concentrated in highly polluted beaches that occupied 10% by beach length (Fig. 2.).

This map would help coastal managers of the Busan Metropolitan City easily locate highly polluted areas and prioritize beach cleanup activities. Majority of highly polluted areas were adjacent to rural villages. Dumping by village residents seems to be the main source of litter in those areas.

LPI could provide a useful tool in the evaluation of beach cleanups as well as in the planning process, because surveyors can cover a wide area in a short time. There could be subjective bias of different surveyors in the estimation of litter volume and diverse litter composition on different beaches could introduce errors in the litter volume estimation. It appears, however, that LPI could still be a useful tool for understanding the relative distribution of litter pollution in an area in a short time.

PRIORITY ACTIONS

Development of a rapid assessment method for marine litter
Application of LPI assessment for efficient beach cleanups

FIGURES AND TABLES

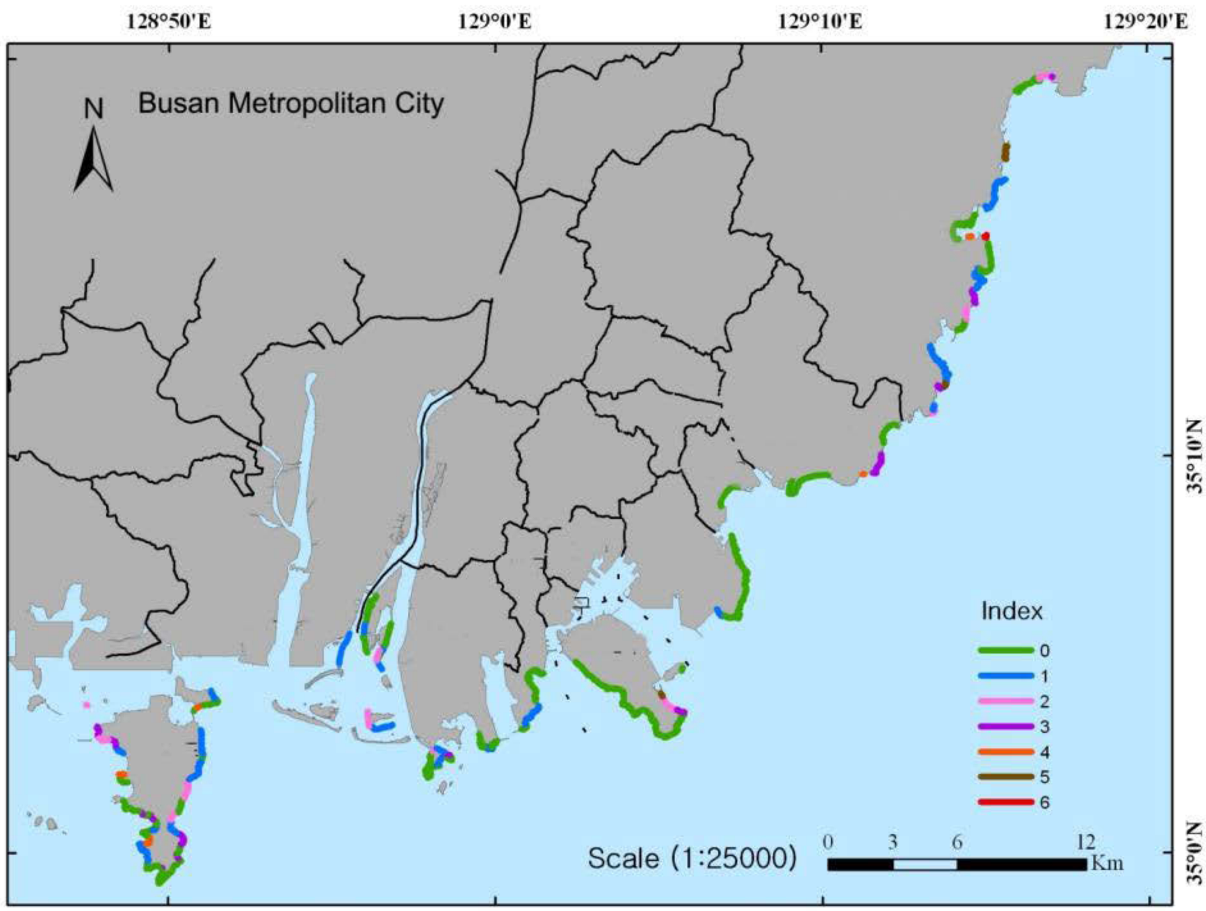

Figure 1. Beach litter pollution map of the Busan Metropolitan City, Korea, produced using the data collected following the method of the Litter Pollution Index (LPI) in late October 2008 [3].

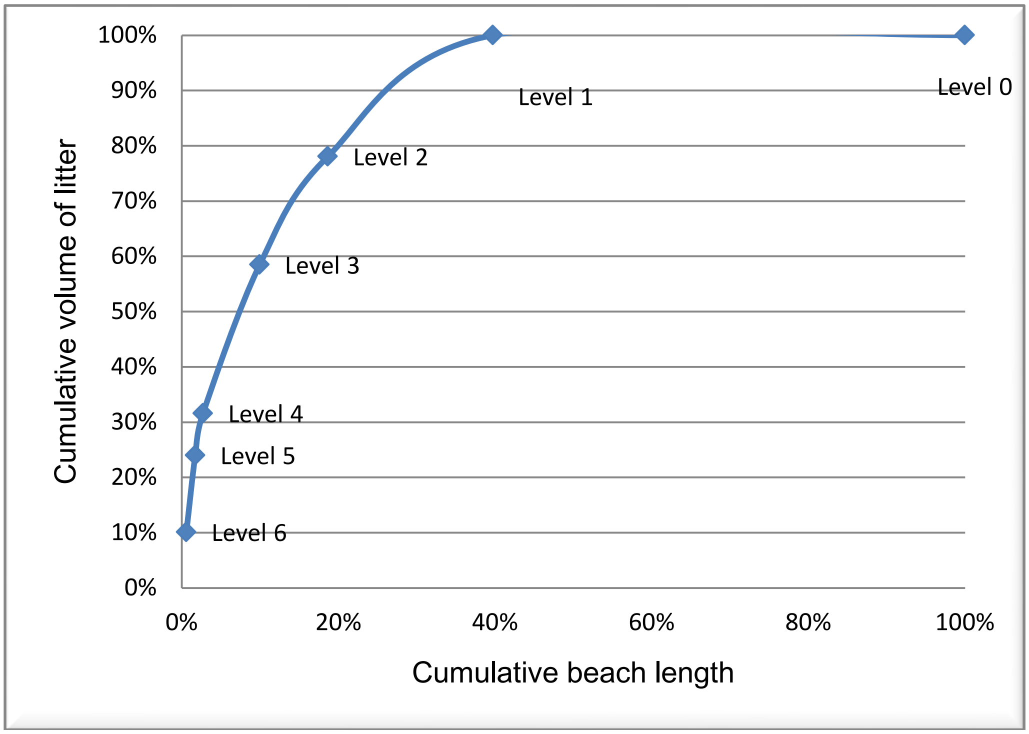

Figure 2. Cumulative litter volume as a function of the cumulative beach length that shows the degree of areal concentration of beach litter along the natural coastline of Busan. About 60% of litter were concentrated in a few highly polluted beaches.

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6.c.6. Using a rapid survey approach to identify relationships between beach physical factors and micro- and meso-debris pollution

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KEYWORDS
shoreline, beach, debris, survey, method, environmental factors, morphodynamics, volunteer

BACKGROUND
Various approaches have been used to assess the abundance of plastic debris in the marine environment. These include beach surveys, at sea surveys and estimates of amounts entering the sea (Rees and Pond 1995). Beach surveys constitute a method that can readily be applied with minimum infrastructure and at a low budget. They are resilient, straight-forward methods that allow volunteers to conduct surveys and rapidly collect a large amount of data. They have successfully been used by organisations such as the UK Marine Conservation Society who have generated comprehensive datasets from beach-clean campaigns conducted by large numbers of volunteers over many years. However, beach-clean campaigns often target macro- and mega-debris only, and hence little is learnt about the occurrence of meso- and micro-debris. Studying meso- and micro-debris could yield important additional information. For instance it has been suggested that meso- and micro-debris reflect the at-sea abundance of plastic debris better (Ryan *et al.* 2009). This type of debris is also more likely to affect animals by ingestion. Also beach surveys to date have shown a large within-site variability that may be attributed to random sampling missing patchy accumulations of debris. There are different approaches to monitoring plastic debris on beaches: standing stock and accumulation surveys. Standing stock on beaches is determined by a number of physical factors (currents, beach structure etc.) and interactive factors (land-based sources, cleanups) (Sheavly 2007; Isobe *et al.* 2001). Accumulation studies meanwhile are considered to give a better representation of the amount of plastics at sea. However, these are more elaborate than standing stock studies, and cannot be applied in studies that target meso- and micro-debris as this would involve complete removal of all targeted debris in each repeated survey event. For a micro- and meso-debris survey it would therefore be beneficial to devise an alternative approach.

It is argued that repeated measurement of standing stock reflects the accumulation of debris on a beach (Ryan *et al.* 2009). As repeated measurements require a quick effective survey method that is not constrained by logistics, we examined a simple approach to monitoring the standing stock of micro- and meso-debris on beaches returning temporally resilient semi-quantitative data with low within-site variability. We used this approach to identify physical factors that influence the plastic debris abundance on a set of beaches for which physical factors had previously been assessed (Scott, 2009). This work was conducted in close co-operation with a local community group with a strong focus on knowledge transfer and dissemination.

The aims of our work were to validate a quantitative rapid survey method, targeting meso- and micro-debris on beaches that could be applied by volunteers and to begin to identify morphodynamic factors that promote plastic debris accumulation on beaches.

METHODOLOGY

Sampling locations were selected from a list of beaches with known morphodynamic parameters (Scott, 2009). In addition, parameters describing beach geometry (i.e. radius of curvature, apex angle, length and distance to lateral obstructions) were determined cartographically.
A 100-200 meters transect was laid parallel to the waterline. The ten locations along the transect with the highest accumulations of meso- and micro-debris were flagged (hereafter referred to as 'dirty'). In addition, five random locations were positioned at random coordinates within the area determined by the minimum convex polygon around the positives. All locations were then sampled using $1m^2$ quadrats. Quadrats were photographed (Fig. 1) and assigned a plastic debris 'burden score' ranging from 0 (no debris) to 5 (more than 10^4 pieces) by visual assessment. This burden score was validated by comparing it to actual counts, weights and measurements of plastic debris in a subset of quadrats.
In order to reduce noise caused by a large number of independent variables, the number of independent variables used to predict burden scores was reduced by grouping morphodynamic parameters into 'context clusters' summarised using principal components analysis. The context clusters were beach slope, sediment size, tidal characteristics and wave action. The first principal components (minimum eigenvalue = 0.85) for each cluster were used as independent variables, along with beach geometry measurements. The burden score variance to mean ratios of both random and dirty quadrats for each site were calculated in order to establish which method returned the lowest within-site variance, random sampling or the deliberate selection method. We tested for relationships between mode dirty burden and the independent variables.

OUTCOMES

The calibration of the visual quadrat burden scoring method showed a relationship with all three measured values (fragment abundance, cumulative size and weight). The visual scoring system can therefore be considered a reliable indicator of debris burden. The burden scores resulting from the deliberate selection method showed a variance to mean ratio 75 percent lower than random sampling. The strong reliability of the visual scoring system and the low within-site variation returned by deliberate selection sampling suggest that this method constitutes a useful instrument for the quick semi-quantitative indexing of plastic debris burden on beaches. The mode burden score of the dirty quadrats was therefore used as an index of the plastic pollution on a beach. None of the first principal components of the morphodynamic parameters (Scott, 2009) showed a significant relationship with the mode dirty burden. The regression analyses using the beach geometry variables showed a significant negative relationship between the radius of curvature and the mode dirty burden (Table 1).

PRIORITY ACTIONS

The public awareness of the beach plastics issue and the willingness to tackle it is becoming more and more pronounced. Developing and disseminating simple and robust survey methods would further empower public campaigns to actively contribute to plastic debris research.

FIGURES AND TABLES

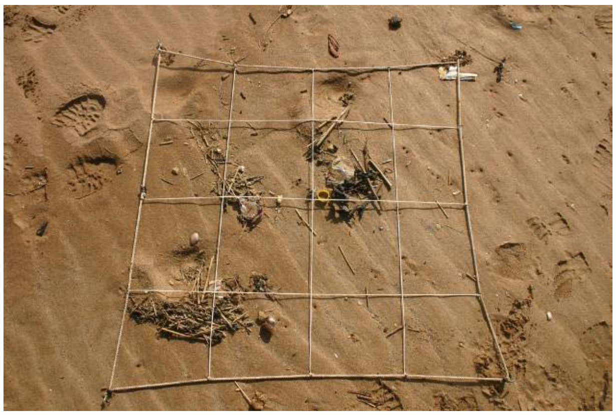

Fig.1: Photo reference of a burden score 3 sampling quadrat.

Model	β	Sig.
Radius	**-0.436**	**0.022**
Apex	**-0.338**	**0.049**
Length	-0.177	0.350
Obstruction	-0.087	0.597

Table 1: Linear regression of mode dirty burden vs. beach geometry, **n=36**.

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6.d.1. Characterization of the microbial community structures associated with ocean polymers

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KEYWORDS
Polymers, biofilms, microorganisms, sequencing

BACKGROUND
Plastics are a major and persistent contaminant of ocean waters. Many of these plastics are contaminated with toxic and synthetic chemicals that persist in the environment with minimal degradation. The purpose of this study is to look at the effects of the microbial community structures associated with synthetic polymers found in the marine environment.

METHODOLOGY
Various conventional and alternative techniques were used to extract microbial DNA and RNA associated with polymers found in the marine environment. Microbial community structures of bacteria, archaea and eukaryotic organisms were quantified by PCR. Cloning and sequencing analysis was done to determine the community of the polymer associated microbes.

Imaging of the polymers for biofilm formation was also performed using scanning electron microscopy.

OUTCOMES
Images gathered show that organisms are able to grow and form biofilms on the polymers commonly found in the ocean. Further molecular analysis to determine the identity of the community associated with these types of surfaces is still pending.

6.d.2. Biological communities in concentrated debris regions: Who shares the ocean surface with plastic in the Eastern Pacific and North Atlantic?

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ABSTRACT
What biological communities share the ocean surface with marine debris and in what concentrations? Who is interacting with high concentrations of pelagic plastic? Media has consistently popularized the question of biology and plastic by highlighting ratios of pelagic plastic to plankton and inferring that *Sargassum* algae acts as a strainer for plastic debris though there is limited large-scale data on these subjects. Here we present the spatial relationships between concentrations of biologic communities and plastic debris from the Eastern Pacific and North Atlantic over the last nine and 24 years, respectively. In areas with concentrated plastic debris we will describe more specifically the composition of zooplankton communities and discuss how and why we should quantify these relationships. This study highlights large geographical discrepancies between *Sargassum* and pelagic plastic distribution in the Atlantic and underscores the value of direct field observations. Understanding zooplankton and *Sargassum* relationships with oceanic plastic is an important first step in assessing potential impacts of plastic debris on marine ecosystems.

6.d.3. Reshape and relocate: seabirds as transformers and transporters of microplastics

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KEYWORDS
Plastic; ingestion; digestion; degradation; transport; Fulmarus-glacialis; Procellariiformes;

BACKGROUND
The reduced abundance of industrial plastic granules in seabird stomachs since the 1980's (Van Franeker et al. 5IMDC abstract 0054; Vlietstra and Parga 2002; Ryan 2008) suggests that plastic debris may disappear faster from the marine environment than would be expected from physical characteristics of the material. Plastics may end up in benthic or coastal sediments, from where bottom or beach clean ups may truly reduce the amount of plastic litter in the environment. Many marine organisms ingest plastic litter. Does such ingestion behaviour help, or maybe counteract the cleaning up of the marine environment?

METHODOLOGY
Many seabird species ingest significant quantities of different types of marine plastic debris. Some species regurgitate poorly digestible remains from the stomach, whereas others can only get rid of the materials by 'grinding' items until they are small enough to pass the gut. The Northern Fulmar (*Fulmarus glacialis*), and most of its relatives, uses the latter mode of processing ingested items. Using methods from the North Sea Fulmar monitoring system (van Franeker et al. 5IMDC abstract 0054), studies in polar environments give some quantitative insights into the processing of ingested plastics in seabird stomachs and the environmental implications.

OUTCOMES
Studies of stomach contents of Antarctic fulmarine petrels provided some information on the rates of disappearance of indigestible hard items from their stomachs. At the start of the Antarctic breeding season, birds may return from wintering areas with plastics or prey items that are not or rarely replenished in their colony foraging range. Plastics in stomachs of Cape Petrels disappeared at rates of an estimated 75% per month after arrival (van Franeker & Bell 1988; Table 1). In a similar way, squids are fairly common in the winter diet of several of the Antarctic fulmarines, but not in their feeding range in summer. Squid beaks probably have a similar digestion and wear resistance as hard plastic particles, and disappeared from stomachs at a very similar rate as plastics (Van Franeker 2001). From such data, an estimated monthly disappearance rate of ca. 75% per month for plastics in stomachs of petrels is probably a conservative estimate because based on the harder types of objects. Many user plastics like sheets and foams are likely to be processed much faster and had already largely disappeared before the Antarctic species arrived in our study area. Similar sharp reductions in plastics, by

about order of magnitude over the breeding season, can be derived from data for fulmars (Mallory 2008) and murres (Provencher et al 2010) in the Canadian Arctic.
In the North Sea, Northern Fulmars are used for monitoring marine litter (Van Franeker et al 5IMDC abstract 0054). Averaged over nearly 1300 stomachs of beached specimens from around the North Sea over the 2003-2007 period, each stomach contains about 35 particles and 0.31 gram of plastic. Since no difference in stomach contents can be demonstrated between starved specimens and healthy birds that died instantly, these figures can be applied to the whole fulmar population of the North Sea, estimated at an average of about 2 million individuals. The conservative figure of 75% monthly reduction of stomach contents then predicts that North Sea Fulmars annually reshape and redistribute about 630 million plastic particles, representing ca. 6 tons of plastic mass. Fulmars reduce the size of plastic particles in their muscular stomach to the lower millimeter range before passage to the gut becomes possible. By doing so, they may accelerate the ultimate full breakdown of plastic waste. However, the excreted materials in part reenter the marine environment, but in a reduced size-range that is unlikely to be ever cleaned up if microplastics prove seriously harmful. Another part of the plastics will be transported to terrestrial habitats, thus "cleaning" the marine environment, but contaminating another. Like in the marine environment, transport to terrestrial habitats not only concerns the plastics themselves but could also include chemicals connected to plastics. Elevated levels of persistent pollutants have been found below high-arctic fulmar colonies (Choy et al. 2010)

With the Fulmar study as a starting point, plastic ingestion by seabirds may be considered in broader perspective of quantities of plastics being reduced to microplastic size and/or being transported between different areas, sometimes all around the globe.

PRIORITY ACTIONS
Marine litter impact assessments should take into account not only the quantity of litter and the likelihood of the direct impact on marine wildlife, but also the role of impacted wildlife in resizing and redistributing such pollution and the potential secondary effects.

FIGURES AND TABLES
Table 1 Disappearance rate of plastics from stomachs of Cape Petrels at Ardery Island (66°S-110°E) after their arrival in clean Antarctic waters (data 1985-86; derived from van Franeker and Bell 1988). The single October bird in this series compares well to a larger sample of 18 Cape Petrels from near South Africa with 83% incidence, and averages of 8.6 particles and 0.106 gram of plastic per bird (Ryan 1987).

	23 ***October***	*10* ***December***	*20* ***January***	*% decrease*
	n=1	*n=9*	*n=20*	*Dec-Jan*
plastic incidence		56%	20%	*64%*
average number of items per bird	11	1.67	0.25	*85%*
average mass per bird (g)	0.290	0.027	0.003	*88%*
average mass per remaining particle (mg)	*26.7 (n=11)*	*16.1 (n=15)*	*13.4 (n=5)*	*17%*

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6.d.4. GESAMP initiative on micro-plastic particles as a vector for persistent, bio-accumulating and toxic compounds

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ABSTRACT
GESAMP (the United Nations Joint Group of Experts of Scientific Aspects of Marine Protection www.gesamp.org) has identified micro-plastic debris as an emerging issue that warrants further investigation as part of a potential global assessment programme. This presentation will report on the GESAMP initiative including the results of an international workshop that took place in June 2010, on micro-plastics as a vector for persistent, bio-accumulating and toxic compounds. This was hosted by IOC, sponsored by the EU and SIDA, and attended by representatives of industry, policy, NGOs and research institutions, covering the Americas, south-east Asia and Europe.

6.d.5. How concerned should we be about microplastics?

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KEYWORDS
Microplastic, contamination, ingestion, accumulation, sources, sinks, solutions

BACKGROUND
Microplastics are small fragments of plastic debris (Arthur et al. 2009; Thompson et al. 2004). This material has been reported on shorelines and in the water column on a global scale (Carpenter et al. 1972) (Colton et al. 1974; Law et al. 2010) and there are concerns it may present hazards to wildlife and to human health (Barnes et al. 2009; Thompson et al. 2009).

Methods to separate and quantify microplastics from environmental samples are time consuming and represent an incomplete estimate of contamination; however these semi-quantitative approaches have successfully identified microplastic as small as 2µm in diameter, have shown that the abundance of this debris has increased over recent decades and that microplastics are widely distributed in the environment (Barnes et al. 2009; Ng & Obbard 2006; Ryan et al. 2009). The sources of microplastic debris are most probably fragmentation of larger items of marine litter (Thompson et al. 2004) and the direct release of small pieces of plastic from various cleaning applications (Fendall & Sewell 2009). Plastic products bring many societal benefits and as a consequence, annual global production has increased from 5 million tonnes in the 1950s to over 260 million tonnes today (Andrady & Neal 2009). However, because of their disposable nature substantial quantities of plastic items are discarded to the environment and so the abundance of microplastic is likely to increase over the next few decades (Barnes et al. 2009). Laboratory experiments have shown that microplastics are ingested by filter feeders, deposit feeders and detritivores and there is concern that ingestion of this material could present a physical hazard to wildlife, for example by compromising the ability to feed (Thompson et al. 2004). In addition, there is evidence, that small fragments of plastic could facilitate the transfer of toxic substances to wildlife. Two routes have been suggested: (1) the release of chemicals incorporated during manufacture as plasticisers, flame retardants and antimicrobials, and (2) the release of persistent organic pollutants (POPs) that have arisen in the environment from other sources and have sorbed to plastic debris in seawater (Browne et al. 2007; Endo et al. 2005; Mato et al. 2001; Ogata et al. 2009; Teuten et al. 2007; Teuten et al. 2009).

METHODOLOGY
This presentation will review evidence on the accumulation of microplastics considering both spatial and temporal trends, will consider the sources and sinks and the potential environmental consequences of this debris. Evidence will be synthesized to present a summary of current research priorities.

OUTCOMES

Reaching robust, environmentally relevant conclusions about the abundance and the potential impacts of microplastic debris is not a trivial task and further research on this area should be considered a priority. The presentation will highlight key areas for research relating to the sources, sinks and potential consequences of this debris. There is also an important need for parallel research and policy focusing on solutions to established problems associated with the production, usage and disposal of plastics.

PRIORITY ACTIONS

- Establish the key sources of microplastic (contrasting direct release of particulates with the fragmentation of larger items of debris).
- Establish key sinks for microplastic debris and the associated rates of accumulation
- Identify the potential environmental problems associated with this debris and set in to broader context to indicate importance / urgency of actions in relation to other debris related problems.
- Identify potential solutions to problems associated with microplastic based on a risk assessment approach.

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7.a.1. Derelict crab pots in the Chesapeake Bay

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KEYWORDS
Marine debris, derelict fishing gear, blue crab, crab pot, ghost fishing, degradable, by-catch.

BACKGROUND

The blue crab, *Callinectes sapidus*, is an icon of the largest estuary in the United States, the Chesapeake Bay, and contributes both ecologically and economically to the region. The prominent capture method is a wire trap usually referred to as a crab pot. Crab pots are approximately 0.6 m cubes in size and generally galvanized or vinyl-coated with two-chambers designed to be deployed and recovered by a line and buoy system. Typically, pots become lost when buoy lines are severed by vessel propellers, lines break because of age, pots are abandoned or are vandalized, or storms roll pots pulling the buoy below the water surface. It is estimated that 10% to 30% of deployed commercial pots are lost annually. Once lost, pots can continue to capture both crabs and other animals, particularly fish, and contribute to a self-baiting phenomenon. Depending on pot type and location, pots can take up to four years to degrade to the point of no longer capturing animals.

Virginia Institute of Marine Science side imaging bottom surveys in 2004 revealed an abundance of derelict crab pots in the York River in Virginia, USA. Subsequent discussions with NOAA's Marine Debris Program resulted in research to quantify the extent and impacts of lost crab pots. In addition, in 2008, funding through the U.S. Department of Commerce commercial fishery failure declaration allowed for programs to remove derelict pots from the Chesapeake Bay utilizing commercial watermen. Derelict crab pots remain a problem for both blue crabs and associated by-catch.

METHODOLOGY

Two separate programs (coordinated through the Marine Resources Commission in Virginia and the Department of Natural Resources in Maryland) were established to hire watermen to remove derelict crab pots. The program in Maryland provided watermen with maps of previously located derelict pots and datasheets and had the watermen dredge for pots in nine locations in 2010 (Slacum 2010).

In Virginia watermen were provided Hummingbird side-imaging units, instructed on their use, and removed pots in the off-season (December to mid March) of 2008, 2009, and 2010 (Havens et al. in press). Watermen were consulted in determining survey areas. The side-imaging units recorded participant track lines, GPS coordinates of pots, and a sonar image of each pot. In addition, each participant was provided a waterproof digital camera for cataloging a photographic record of bycatch and pot condition and a datasheet for each retrieved item. Every other week data from the units, digital photographs, and datasheets were collected. After each data download, quality assurance evaluations were conducted to ensure participants were following protocol and using technologies correctly. Participant vessel track lines were used for auditing and accountability purposes, as well as quantification of the areal extent surveyed. A spatial database was created of derelict crab pot information to visualize distribution and patterns of items collected and marked.

To evaluate pot loss rates, a census of active crab pots in the York River, Virginia was conducted in the summer of 2010 as well as four years of active vs. lost pots in a tributary of the York River. In addition, watermen were surveyed regarding lost rates. To determine the capture life of lost pots, pots were deployed in multiple locations and periodically sampled for four years. In addition, oyster growth on recovered functional derelict pots was aged for anecdotal information.

OUTCOMES

As of the middle of January 2011, around 31,000 derelict crab pots have been removed from the Bay (approx. 6,000 from the Maryland program and 25,000 from the Virginia program (Figure 1). Blue crab catch from the Maryland removal program was recorded at 1,371 (Slacum, 2010), while blue crab catch and bycatch from the Virginia removal program was 19,632 and 4,105, respectively (Table 1). Derelict pots can continue to capture and kill animals for over 4 years (Havens et al. 2008; Havens unpublished data). Some derelict pots become encrusted with oysters aged 5 to 7 years suggesting that pots could provide structure for habitat if designed with components that disable it from continuing to capture organisms.

Loss rate of commercial pots reported by watermen was 20% (SE 2.1%). Average loss rate from four year York River tributary study was 21%. Preliminary analysis of loss rates calculated from active crab pot census data and derelict crab pots removed from specific areas of the York River show loss rates from 5% to over 50% depending on active pot density and recreational boating activity level (considered as proximity to high use ramps and marinas)(Havens et al. unpublished data).

The annual loss of pots suggests a need for a mechanism, such as state-of-the-art biodegradable panels (Stanhope et al. 2011), that disables the pot from capturing crabs and bycatch once the pot is lost. Some designs have been shown not to affect commercial blue crab catch (Bilkovic, in review).

PRIORITY ACTIONS

- Require properly designed biodegradable panels to reduce blue crab and bycatch mortality.
- Conduct educational programs to reduce resource use conflicts between commercial and recreational boating and commercial crabbers.

FIGURES AND TABLES

Table 1. Number and type of animal captured in derelict pots in Virginia during Dec 2008 – Mar 2009, Dec 2009 – Mar 2010, and Dec 2010 – Jan 11, 2011.

Number of Animals in pots	2011 (as of 1/11/11)	2010	2009
Female Blue Crab	5178	4526	1875
Male Blue Crab	3135	3504	1414
Oyster Toadfish	421	797	856
Whelk	158	360	300
Black Seabass	91	218	63
Atlantic Croaker	82	120	27
White Perch	8	51	65
Catfish	0	64	27
American eel	34	44	22
Spot	24	31	15
Flounder sp.	10	29	9
Turtle (terrapin)	3	19	19
Tautog	3	20	6
Bluefish	1	0	0
Bowfin	0	1	0
Butterfish	2	0	0
Cunner	0	1	0
Duck (general unknown)	0	2	0
Hogchoker	0	2	0
Horseshoe Crab	0	0	3
Lobster	1	0	1
Menhaden	0	0	1
Merganser (diving duck)	0	0	1
Mullet	0	4	0
Muskrat	0	0	1
Pigfish	0	8	0
Puffer	17	4	0
Rappa Whelk	3	1	3
Red Drum	0	1	4
Sheepshead	16	0	7
Sole	2	0	0
Spadefish	9	0	0
Spiny Puffer	2	0	0
Stargazer	0	1	0
Striped Bass	2	1	6
Unknown Species	8	18	65

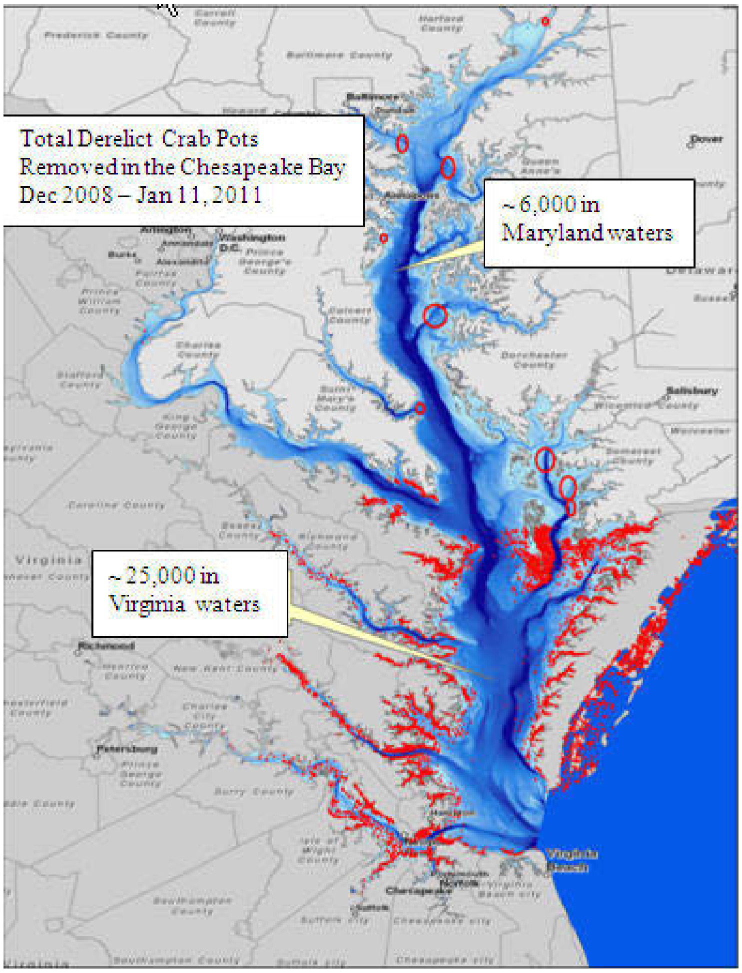

Figure 1. Derelict crab pots removed from Chesapeake Bay waters from Dec. 2008 – Jan 11, 2011. Red dots = derelict crab pots removed in VA, red circles = areas in MD where pots were removed.

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7.a.2. Quantifying the impacts of derelict blue crab traps in Chesapeake Bay

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ABSTRACT
During routine side scan sonar survey operations in 2005, the NOAA Chesapeake Bay Office (NCBO) Habitat Assessment Team identified large numbers of derelict crab traps in high value blue crab habitat in upper Chesapeake Bay. NCBO created its Derelict Fishing Gear Program (DFGP) with support from the NOAA Marine Debris Program to evaluate the scope and character of potential fisheries impacts from potential habitat degradation and 'ghost fishing' traps in Chesapeake Bay. The primary objectives of this program were to (1) quantify the density, distribution, and abundance of derelict crab traps throughout Chesapeake Bay, (2) to evaluate the direct effects of derelict traps on blue crabs and other estuarine species through field experiments and trap retrievals, and (3) to provide reliable information to develop and facilitate appropriate remedial actions. Major elements of this survey included developing the survey design, conducting a stratified random transect survey, and developing specific image analysis protocols to aid with the detection and enumeration of derelict traps in side-scan sonar imagery and to assess the accuracy of detecting derelict traps during the review. The survey results indicate that derelict crab traps appear to be ubiquitous throughout areas where the commercial hard crab trap fishery is active in the Maryland Bay. In addition, the survey also uncovered identifiable spatial patterns of derelict traps. NCBO DFGP developed acoustic survey and groundtruthing methods to accurately identify, locate, and quantify derelict crab traps in the Bay. The total number of derelict traps in the Maryland Bay in the winter of 2007 was estimated to be 84,567 traps based on a total of 285 side-scan sonar transects. DFGP initiated a parallel survey in Virginia waters in partnership with the Virginia Institute of Marine Science Center for Coastal Resource Management. To quantify the effects of derelict traps on blue crabs and other estuarine species, DFGP conducted field experiments during 2006 and 2007 simulating ghost fishing to estimate the impacts of derelict traps on blue crabs, and non-target bycatch species. Field experiments supplied information on overall catch, CPUE for blue crabs, bycatch, crab mortality, escapement, trap degradation, and fouling. To simulate actively fishing derelict traps in the Maryland Bay, a set of experimental crab traps was deployed and monitored across all four seasons between October 18, 2006, and March 6, 2008. The purpose of this study was to determine the overall effects that derelict blue crab traps have on fisheries resources in the

mesohaline portion of the Chesapeake Bay. Specifically, the objectives of this study were to 1) document what species enter derelict traps, 2) determine trap retention rate by species, 3) determine how those rates change as a function of "deployment time," and 4) determine overall mortality to all species caught in the traps. Trap monitoring revealed that both blue crab and other by-catch species continue to be captured and killed after bait from the trap is gone. Traps that were not lost or vandalized during the study continued to capture species for the entire study time-frame indicating that derelict traps last for at least 14 months. White perch had the highest mortality of all by-catch species and seem to be highly susceptible to derelict traps. Blue crab mortality is estimated to be 20 crabs/trap/year.

7.a.3. Survey and impact assessment of derelict crab pots in the southeastern Alaska commercial Dungeness crab fishery

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KEYWORDS
Alaska, Dungeness crab, derelict pots, ghost fishing, trap loss, crab entrapment, *Cancer magister*, commercial fishery

BACKGROUND
Dungeness crabs (*Cancer magister*) in southeastern Alaska sustain important commercial and non-commercial fisheries, with the first recorded commercial harvest occurring in the 1930s (Hebert et al. 2008). The extent of the impact of derelict pots on Dungeness crab populations in southeastern Alaska is unknown, but impacts from other areas have been quite substantial. In the Fraser River District, British Columbia, Breen (1987) estimated a 10.9% annual trap loss rate with a ghost fishing loss of 7.2% of the reported catch in the Dungeness crab fishery. In the Puget Sound Dungeness crab fishery, 37% of derelict pots were still actively fishing even if their rot cord had degraded, and continued fishing for at least one year (June 2007). Furthermore, the estimated annual catch rate per actively fishing derelict crab pot in Puget Sound was 74 crabs for an annual loss of 372,000 Dungeness crabs (June 2007). This represents inadvertent destruction of 30–40% of the average annual catch. Unlike commercial and non-commercial harvests, which target legal males only, ghost fishing traps do not discriminate among sex and size (assuming crabs greater than the cull ring) of captured crabs. This could possibly result in a greater impact on the population due to inadvertent removal of females.

METHODOLOGY
The derelict crab pot surveys were conducted within a six-week period from August 15 to September 30, during the summer closure of the commercial Dungeness crab fishery. This summer closure protects crabs during the primary female molt and mating period. The southeastern Alaska Dungeness crab fishery is managed by the Alaska Department of Fish and Game (ADF&G), which requires statistical area-specific reporting of harvest and effort information. Side scan sonar surveys were conducted within selected statistical areas to identify derelict commercial Dungeness crab pots (Figure 1). Nine statistical areas near Juneau were surveyed in 2009. In 2010, two statistical areas near Petersburg and Wrangell, with the highest Dungeness crab harvests in southeastern Alaska, were surveyed. Within each statistical area, three factors were used to identify the potential Dungeness crab habitat to be surveyed. These included: bottom depth from 6 to 30 meters, muddy, sandy, or silty bottom substrate; and observations of commercial Dungeness crab pot buoy locations during ten years of annual ADF&G aerial survey data.

Derelict crab pots were retrieved by a team of two divers after prepositioning buoyed anchors at preselected GPS coordinates obtained from the side scan sonar surveys. The divers noted condition of the pots, as well as any animals entrapped in situ prior to attaching a line for topside retrieval. Once topside, the condition of the crab pot and whether it was legally rigged the length of the line and possible causes of pot loss were recorded. The weight, length, sex, leg loss and condition of any entrapped crabs were also recorded. All data was standardized to the number of derelict crab pots and entrapped crabs per square kilometer within each of the statistical areas surveyed.

OUTCOMES

The total surveyed area in 2009 and 2010 encompassed eleven ADF&G statistical areas and 59 square kilometers of Dungeness crab fishing grounds (Figure 1). A total of 543 derelict commercial crab pots were identified with the side scan sonar (9.2 per km^2), of which 123 were retrieved. The retrieved crab pots contained a total of 215 entrapped crabs (9.6 per km^2) of which 20% were females. Detection probabilities, calculated as the number of verified crab pots found by divers and the expected outcome from side scan sonar imagery was greatly improved between the two years of surveys. In 2009, the detection probability was only 53.6%, while it increased to 82.5% in 2010 (Table 1).

Over 90% of derelict crab pots found were legally rigged with biodegradable escape mechanisms (cotton rot cord) as required by Alaska Statute, with only one out of 18 behind Douglas Island (Statistical area 111-40), four out of 33 in Duncan Canal (106-43) and five out of 40 in Wrangell (108-40) being noncompliant. However, there was no statistically significant difference in ghost fishing levels of non-compliant and compliant pots; 44% of the noncompliant derelict crab pots and 40% of legally rigged ones were ghost fishing ($p=0.411$, 1-tail, 2 proportions Z-test). Ghost fishing rates generally declined with derelict pots time at large; 56% of pots derelict for less than 4 years, 20% of pots derelict for 4-6 years, and 22% of pots derelict for more than 6 years were ghost fishing. However, the oldest derelict crab pot found still actively ghost fishing was over 7 years old based on the attached ADF&G permit tag date. Furthermore, our laboratory observations showed that Dungeness crabs are less likely to escape when there is no gap between the lid and the side of the crab pot, even when minimum force is required to push the lid open. Therefore marine growth closing the escape path and metal fatigue of the crab pot lid closing on top of the pot effectively disabling the escape mechanism enables derelict crab pots to ghost fish for many years.

The entrapped Dungeness crabs accounted for less than 3% of the average annual commercial harvest at each of the surveyed locations (Table 2). However, it is important to note that this includes only the crabs entrapped in the derelict crab pots at the time of the survey. The actual cumulative entrapment rates of ghost fishing crab pots are unknown.

PRIORITY ACTIONS

In Southeast Alaska, derelict crab pots are currently entrapping less than 3% of the average annual commercial Dungeness crab harvest; however, the cumulative effect of entrapment can be substantially greater. Although less effective with time, derelict crab pots continue to ghost fish necessitating an improvement in biodegradable escape mechanisms.

FIGURES AND TABLES

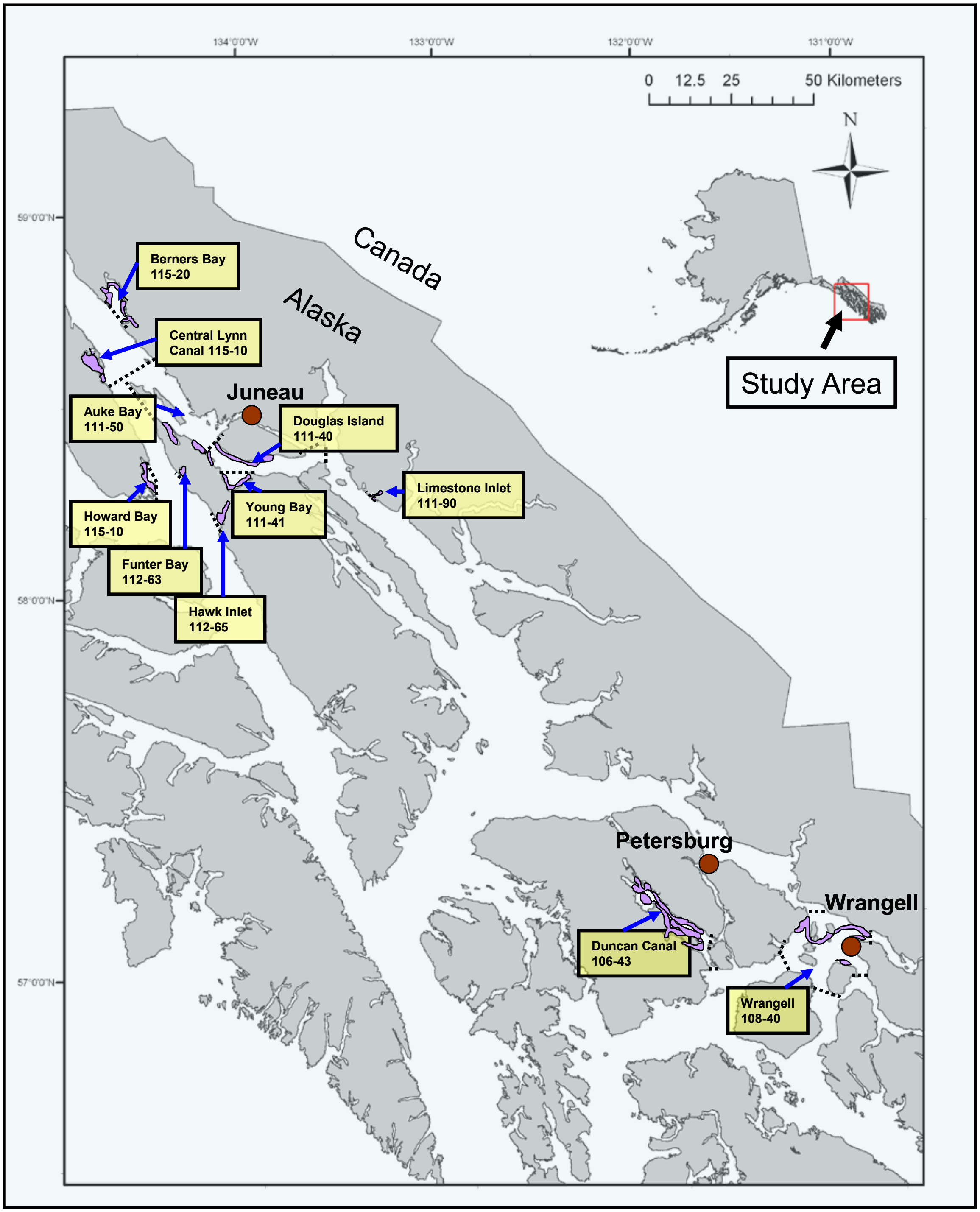

Figure 1. Study area in Southeast Alaska with surveyed ADF&G statistical areas highlighted.

Table 1. Side scan sonar surveys and ground truthing results. Duncan Canal and Wrangell were surveyed in 2010 and all other areas in 2009. Detection probability for the three sites that were not ground truthed was computed based on the average from the 2009 surveys.

ADF&G Statistical Area	Location	Sonar targets	Detection probability	Crab pot abundance	Survey area km^2	Pot density per km^2
111-50	Auke Bay	11	0.250	3	2.44	1.13
115-20	Berners Bay	46	0.611	28	4.58	6.14
111-90	Limestone	7	0.250	2	0.52	3.37
111-40	Douglas Island	29	0.625	18	7.29	2.49
115-10	Central Lynn	142	0.828	118	5.45	21.57
111-41	Young Bay	7	0.500	4	2.23	1.57
106-43	Duncan Canal	204	0.721	147	24.04	6.12
108-40	Wrangell	222	0.930	206	9.47	21.80
112-61	Howard Bay*	9	0.634	6	0.97	5.87
112-63	Funter Bay*	4	0.634	3	0.27	9.52
112-65	Hawk Inlet *	13	0.634	8	1.65	5.01

* Denotes locations where side scan sonar surveys were performed without ground truth retrieval surveys.

Table 2. Percent of annual commercial Dungeness harvest at each location that is entrapped in derelict crab pots.

Location	Survey year	Lost pots per km^2	Entrapped crabs per km^2	Fishing grounds km^2	Total lost pots	Total entrapped crabs	Average annual harvest (crabs)	% of Harvest entrapped
Auke Bay	2009	1.13	3.39	2.77	3	9	582	1.6%
Berners Bay	2009	6.14	12.29	5.29	32	65	9,035	0.7%
Limestone	2009	3.37	0.00	0.55	2	0	246	0.0%
Douglas Island	2009	2.49	0.00	7.30	18	0	6,238	0.0%
Central Lynn	2009	21.57	19.97	5.56	120	111	23,766	0.5%
Young Bay	2009	1.57	1.57	2.89	5	5	899	0.5%
Duncan Canal	2010	6.12	5.84	24.49	150	143	165,250	0.1%
Wrangell	2010	21.80	25.34	10.96	239	278	231,401	0.1%
Howard Bay*	2009	5.87	6.93	1.54	9	11	5,298	0.2%
Funter Bay*	2009	9.52	11.24	0.83	8	9	3,327	0.3%
Hawk Inlet *	2009	5.01	5.91	2.52	13	15	5,634	0.3%

* Denotes locations where side scan sonar surveys were performed without ground truth retrieval surveys.

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7.a.4. Investigating the "ghost-fishing" capacity of derelict lobster traps

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KEYWORDS
Ghost gear, marine debris, lobster, traps, pots, biodegradable, escape vent

BACKGROUND
In 2009, nearly 3.2 million trap tags were sold to commercial and recreational lobstermen by the Maine Department of Marine Resources (Maine DMR). Throughout the fishing year, plastic coated wire mesh lobster traps become lost on the ocean bottom as a result of storm activity, boat traffic, conflict with mobile gear or other causes. Despite tag replacement protocols, there is no good estimate of the number of derelict fishing traps along the Maine coast, and very little research has been done to assess the impact of lost gear on habitat or the living resource.

Due to State of Maine regulations restricting the handling of lobster gear by anyone other than its owner, collaboration between state government and industry is required to undertake gear recovery projects. The partnership between Maine DMR and the Gulf of Maine Lobster Foundation (GOMLF) provided the infrastructure for a pilot retrieval project to take place in coastal fishing towns that allows for the proper handling and disposal of derelict fishing gear. A primary goal of the project is to collect data during the removal of derelict gear from the water to investigate the impact of derelict lobster gear on the living marine resources.

METHODOLOGY
Maine's coast is divided into seven lobster management zones. This two-year project focused on three zones during year 2010 and will focus on four zones in year 2 (2011). One harbor was selected in each of the Downeast lobster zones for at-sea derelict fishing gear collection and disposal. At each harbor, a maximum of ten fishermen volunteered to grapple for approximately 6-8 hours a day, for two days, in an effort to recover lost fishing gear. Each vessel was given a marine debris logbook to record data on each grappling event. Data collected included location, number of traps, tag number and most recent tag year, status of biodegradable escape panel, animals found in trap, and bottom type.

In conjunction with fishermen logbooks, a trained observer was placed on one vessel for two days per port. The observer collected additional biological information for species retained by derelict gear. Data by the observer was recorded on a per trap basis by the observer, while the fishermen collected data based on the overall gear retrieved per hauling event. Data from logbooks were entered into a relational database. Analysis of results included the percentage of activated biodegradable-panel vents, spatial distribution of recovery and enumeration of retained species.

OUTCOMES

A total of 1,130 traps were retrieved from near-shore waters during the 6 days of the project in early Spring 2010. Retrieval occurred over a period of 43 boat hours as a measure of 'sampling effort'. Trap tag years observed during grappling ranged from 1992 to 2009, with 2009 having the most number of traps recovered during this project. Of the 1,130 traps observed, 577 (51%) traps had open bio-vent panels while 438 (39%) traps did not. For the remaining 115 (10%) traps, information was not available due to trap condition (i.e. crushed) or absence of bio-panel vent from trap construction.

A total of 533 lobsters were liberated from derelict fishing traps during this project. Other marine life observed and released from derelict gear included: sculpin, Acadian redfish, sea raven, wrymouth, lumpfish, cod, sea cucumber and mussels.

As expected, the majority of older traps had open biodegradable escape vents. There were fewer legal-sized lobsters observed in traps with open escape vents, suggesting that the vents do assist in deactivating lost fishing gear. Many of the traps recovered during this project bore 2009 tags and 88% of 2009 traps had closed biodegradable escape vents. Traps recovered with a 2008 and 2007 tag had 49% and 31% closed biodegradable escape vents, respectively, suggesting a greater release potential over time. Future research is needed to determine the time-frame needed for biodegradable escape vent closure mechanisms to deteriorate.

PRIORITY ACTIONS

The efficiency of the biodegradable escape vents could be improved by choosing a specific location on the trap where the interference from other trap components would be minimized. The use of cable ties and wood laths may not be as suitable as degradable metal hog rings for effective and timely vent release on derelict traps.

FIGURES AND TABLES

Table 1: Number of traps retrieved per zone by year indicated on trap tag. Of the 1,130 traps retrieved, 186 did not have a year tag.

Zone	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
A	1	1	2	6	4	3	2	8	8	8	3	20	36	116	218
B	8	11	5	12	17	11	11	26	31	50	27	47	80	168	504
C	5	5	2	8	10	12	2	24	8	23	12	34	27	50	222
Total	14	17	9	26	31	26	15	58	47	81	42	101	143	334	944

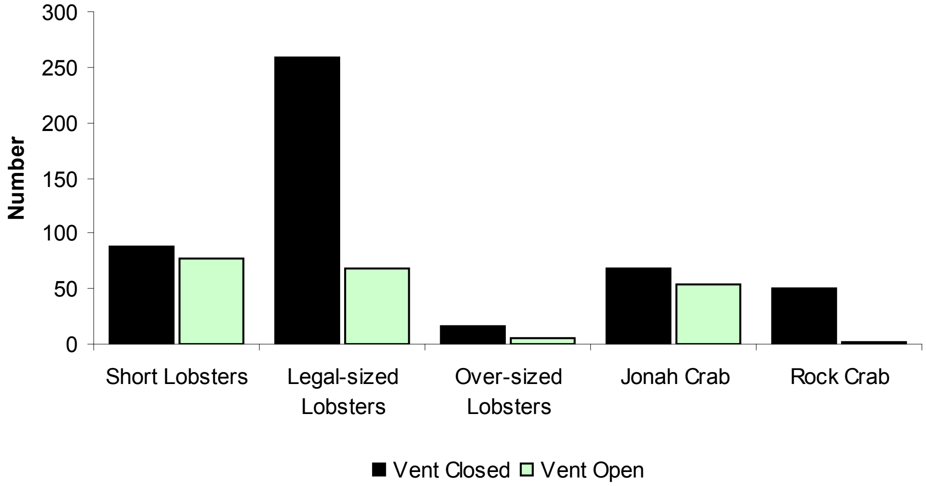

Figure 1: Lobsters (general size class) and two crab species were enumerated during all 6 days of derelict gear retrieval. In all cases, there was more retention of crustaceans in traps with closed biodegradable vent panels.

7.a.5. Derelict spiny lobster traps in Florida Keys National Marine Sanctuary: tradeoffs between habitat impacts and ghost fishing

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KEYWORDS

Derelict traps, spiny lobster, Florida Keys, bycatch, ghost fishing, coral

BACKGROUND

Recent surveys identified debris generated from spiny lobster traps as the primary type of submerged marine debris in the Florida Keys National Marine Sanctuary (Uhrin et al. 2011). Lost traps have been implicated in reductions in coral cover, ghost fishing, lobster mortality, and diminished aesthetics (Matthews et al. 2001, Chiappone et al. 2004). For each of the past 8 fishing seasons (2003-2010), the number of traps permitted in the fishery was approximately 500,000. Historically, 90% of traps were made predominately of wood and were largely biodegradable except for the concrete used as weight and plastic throats. Other traps in the fishery were wood-reinforced with wire (8%), primarily of wire (1%), or plastic (1%) (Matthews et al. 2005). Mail surveys of fishermen between 1993 and 2005 indicate that tens of thousands of traps were lost each fishing season and direct observations by divers in 2007 identified many intact, ghost fishing traps and trap debris on coral (Uhrin et al. 2011). The majority of lost or abandoned traps lack surface buoys and only 3,500 to 6,500 lost traps were recovered during annual trap retrieval programs (FWC unpublished data).

Damage to habitat, particularly coral reefs occasionally occurred when traps were near reefs (Chiappone et al. 2005). The effect of actively fished traps and lost traps on reefs was exacerbated when traps move during storms (Lewis et al. 2009). We attempted to address this problem by developing alternative trap designs to existing wood traps that would move less during storms, maintaining or increasing the number lobsters caught, not increase the bycatch of fish, and not cause more ghost fishing.

METHODOLOGY

We tested a suite of alternative lobster trap designs, ropes, buoys, and weights to determine if these alterations reduced the movement of traps during storms. Twenty-six unique trap configurations (treatments) were tested, including 11 trap designs, 3 rope sizes, 3 buoy types, 4 trap weights, and 2 bridal attachment sites. Each treatment was tested during at least two storms with the exception of standard trap +20 lb treatment. Each treatment per storm included 5 replicate traps. A standard trap, made primarily of wood, with specifications defined by fishermen, was used during each storm as a control. Trap movement was measured after nine storms between 1/22/09 and 1/20/10. Trap movement was measured underwater by divers for each trap after each storm. Between eight and ten treatments were tested per storm.

Several trap designs that moved less during storms were then tested to quantify the abundance of lobster and fish bycatch. Five trap designs were fished in each of two locations, the Atlantic in the Middle Keys and the Gulf of Mexico in the Lower Keys during the 2010-2011 fishing season. The contents of each trap were identified and measured each time fishermen pulled the traps. In a second experiment, three trap designs were used to simulate ghost traps, defined as lost traps that continue to fish but are unattended by fishermen. New traps were deployed at three locations, the Gulf of Mexico north of the Middle Florida Keys, nearshore, within one km of the Middle Keys in the Atlantic, and near the reef tract (reef), representing the typical areas traps were fished. Divers examined these traps periodically for 16 months and recorded the fishing condition of each trap, the number of lobsters and fish in each trap, and any dead animals.

OUTCOMES

Standard traps modified by changing buoy types, rope size, or bridal placement moved on average 7% less than standard traps; suggesting that alterations of the buoy type, bridal, or rope size were ineffective methods of reducing trap movement. Traps with 10 and 20 lbs additional weight moved 32% less than standard (72 lb) traps. Other modifications to the standard trap included the trapezoid shaped trap and adding 2 inch legs to each bottom corner of the trap. The trapezoid shaped traps moved 23% more than standard traps. Traps with legs moved 42% less than standard traps. Wire basket traps moved 90% less than standard traps. All wood frame traps modified with wire replacing all or some of the wood slats, including those with as little as two 24” sides wire, a hybrid trap with 3 sides made from wire and one side made from vertical wooded slats, or all four sides made from wire moved 44% less than standard traps. Although increasing the weight of traps and the addition of legs reduced trap movement, these alternatives were not considered viable trap construction options by commercial fishermen involved in the project because they would cause additional safety and deployment issues. Consequently, we continued additional research on lobster and fish catch rates in alternative traps where wire replaced wood parts.

During commercial fishing operations, catch rates of legal-sized lobster for wire, partial wire, wood traps reinforced with wire, or hybrid traps did not differ significantly from standard traps (17.6 lbs) in the Gulf. In the Atlantic, wood traps reinforced with wire caught significantly more lobster (14.1 lbs) than standard traps (9.6 lbs). However, relative catch differences of a few pounds, similar to those observed are considered relevant by commercial fishermen. Although not significantly different than standard traps, wire traps in both the Atlantic (8.0 lbs) and the Gulf (14.3) caught the fewest lobsters. Catch rates of fish were significantly higher for wire traps at all locations. Few dead fish were observed in all trap types, but many of the smaller fish appeared to have air-expansion injuries and subsequently died as the traps were pulled from a depth of approximately 30 feet. Given the higher catch rates of fish in wire traps, fish mortality due to air expansion was more common in wire traps. Fish catch rates and mortality observations were consistent with previous studies of trap bycatch (Matthews and Donahue 1997, Matthews et al. 2005)

Lobster mortality did not differ between ghost traps of different types despite higher abundance of lobsters in hybrid traps than in wood or wire traps. Lobster mortality appeared to increase later in the fishing season and when fish, especially triggerfish were in traps. Fish mortality in ghost traps was 4x to 20x higher in wire traps than in standard traps or hybrid traps. Fish mortality appeared related to the overall abundance of fish observed in each type of trap. That is, a fish had the same chance of dying in any trap but there were more fish in wire traps so more dead fish were observed in wire traps. During the 16 month duration of the study, only 36 of the 120 taps were rendered non- fishing. Research is ongoing to identify any differences in the time these alternative trap designs ghost fish.

PRIORITY ACTIONS

The increased protection potentially afforded corals by the increased use of wire traps must weigh the tradeoff of the potential risk of increased ghost fishing and increased debris accumulation. Hybrid traps with three sides made of wire and one side made of vertical wood slats, could potentially reduce trap movement by half and not exacerbate fish bycatch or reduce lobster catch. However the increased use of nondegradable plastic coated wire may exacerbate the accumulation of trap debris and pose a fishery and ecosystem management impasse in a fishery where trap loss is common and the ability to recover traps is minimal. Alternatives actions to reduce debris and its impact include restricting trap use near coral reefs. More trap debris was observed on reefs than in other habitats where fishing was more common. Restricted access to reefs may reduce trap loss. Trap debris reduction might be best addressed by considering better alignment of the number of traps in the fishery with economic assessments of maximum economic yield and the amount of latent fishing effort. However, reductions in the number of traps alone would likely not substantially increase protection of corals. Less than 3% of traps were observed near reefs during a recent survey. Reductions in the number of traps would likely have an insignificant effect on number of traps near reefs.

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7.a.6. Derelict trap hotspots in Chesapeake Bay: integrating a spatially explicit model with waterman ingenuity to clean-up derelict traps

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ABSTRACT
Chesapeake Bay is home to one of the largest commercial trap fisheries for blue crab in the United States. The Bay also accommodates significant marine leisure activities (recreational fishing and boating) and major commercial shipping industries. Where these activities overlap and are most intense, derelict traps and other fishery debris tend to accumulate and persist. We developed a geographically-weighted regression (GWR) model to predict the densities of derelict crab traps throughout the Maryland portion of Chesapeake Bay. Three independent variables (the observed distributions of boating intensity, commercial crabbing effort and known derelict trap densities) were used to construct the GWR. Model output was used to guide a one-time large-scale derelict trap cleanup project, integrating previously established side-scan sonar survey techniques with the ingenuity of Chesapeake Bay watermen. Cleanup efforts occurred in nine general locations covering approximately 154 km^2 of the Bay bottom. Over 12,000 pieces of debris were collected and most of the collected debris was associated with derelict crab traps; however a diverse array of other debris was also collected. Future iterations of the GWR model will incorporate data gathered during this clean-up effort in order refine and enhance its usefulness to resource managers. In addition, our results will be used to evaluate possible management scenarios and to develop management recommendations to reduce blue crab trap losses in Chesapeake Bay.

7.b.1. Partnering for a regional strategy: West Coast efforts to comprehensively address marine debris

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BACKGROUND
Since the 1980's, awareness of the challenges posed by marine debris has been raised significantly, largely due to the success of volunteer coastal cleanup efforts but also thanks to advocates and educators around the world who have focused attention on the problems caused by marine debris. As a result, efforts at cleanup both on land and at sea have improved; volunteer cleanup programs have grown significantly, and more funding has been funneled towards removal of derelict fishing gear, especially along the coasts of the United States.

However, marine debris is a difficult challenge to address specifically because of the nature of the debris itself. Since marine debris emanates from a wide variety of sources, especially land-based contributions of marine debris, it raises significant management problems in efforts to address the issue at local, state, and national levels. Without a single authority vested with a mandate to address marine debris in all its forms and from all its sources, efforts to prevent, reduce, and remove marine debris have been fragmented, lacking in coordination and funding, and ultimately, have proven unsuccessful at reducing the amount of material entering the ocean.

METHODOLOGY
A new effort underway along the West Coast of the U.S. seeks to turn the tide on the pattern of scattered and inadequate management of marine debris. The West Coast Governors' Agreement on Ocean Health (WCGA) was signed by the Governors of Washington, Oregon, and California in September, 2006. Since that time, staff and members of the public have been working diligently to help bring about a cohesive form of regional governance for our shared coast and ocean. In the WCGA Work Plan, issued in 2008, marine debris was highlighted as a priority issue, and an Action Coordination Team (ACT) was assembled to develop a work plan specific to the issue. At the ACT's first meeting, the lack of coordination among all of the entities working on marine debris along the West Coast (academia, nongovernmental organizations, the private sector, and federal, state, local and tribal governments) arose as the single biggest hurdle to overcome in order to gain traction on addressing the issue. The ACT set out to develop a work plan[1] that would help solve this problem through increased coordination on a single, unifying strategy to comprehensively address marine debris along the West Coast.

OUTCOMES
The WCGA Marine Debris ACT has already embarked on its efforts to develop the West Coast Marine Debris Strategy. In March, 2010, the ACT held the first of what will ultimately be three workshops to discuss different sources of marine debris and develop recommendations to address those sources. These recommendations will form the heart of the final Strategy. The March 2010

workshop focused on Derelict Fishing Gear. In February, 2011, the ACT held its second workshop focused on marine debris that originates from land-based sources. A third and final workshop will likely be held in October, 2011, and will focus on finalizing the strategy and launching the tri-state Marine Debris Alliance.

The ACT, which itself has 16 formal members, has invited outside experts in the specific fields addressed at the workshops to help inform the recommendations that will be in the final Strategy. These experts, along with research conducted by ACT members, helped to move the workshop discussions towards the ongoing programs from within the three states that have proven most effective, while also allowing for new or enhanced ideas for programs and policies to arise. The workshops thus far have enjoyed a remarkable level of consensus on a number of actions and recommendations that, when implemented, could drive effective marine debris reduction efforts in the years to come. One example of these recommendations was to develop a tri-state Marine Debris Database that includes information on both derelict fishing gear and land-based marine debris. This database would cover the entire coastline of the three states, bringing together existing and new data in a uniform way that would allow for the establishment of baselines of existing marine debris while also serving as a tool for evaluating future programs and efforts at reduction. Based on this recommendation, the ACT has applied for and received grant funding to begin the development of the tri-state Marine Debris Database.

While the West Coast Marine Debris Strategy is an important outcome of these efforts, the Marine Debris ACT recognized early on that a strategy is only effective if it is carried out. To continue this work beyond the life of the ACT itself (which will dissolve once the Strategy is finalized), the ACT will also form a three-state "Marine Debris Alliance," a body that can collaboratively help prioritize efforts across the three states, pursue funding for those projects, continue to advocate for the marine debris strategy's implementation in the years to come, and provide the coordination needed to effectively address marine debris across the region. The formation of the Marine Debris Alliance will be the subject of the ACT's third and final workshop, and therefore does not yet have a detailed organizational structure; however, enthusiasm over the concept of the Alliance is such that the Canadian Province of British Columbia has already committed to joining the Alliance once it is formed. Additionally, the representatives of the three Governors involved in the West Coast Governors' Agreement are interested in seeing the Alliance continue to expand beyond the West Coast, ultimately helping to form a network of such partnerships around the Pacific Rim.

PRIORITY ACTIONS

The priority actions for the WCGA Marine Debris ACT are the completion of the West Coast Marine Debris Strategy and the formation of the tri-state Marine Debris Alliance. Within those actions is another priority that includes broadly publicizing the recommendations included in the final strategy, through a public comment period and beyond, in order to bring further attention to the challenge of marine debris and the urgent need to address it comprehensively.

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7.b.2. Hawaii Marine Debris Action Plan: an archipelago-wide approach focused on results

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KEYWORDS
strategic planning, Hawaii, results

BACKGROUND
The Hawaiian archipelago stretches approximately 2,400 km and encompasses environments ranging from the heavily touristic Waikiki beach to the remote and uninhabited coral reef atolls of the Northwestern Hawaiian Islands. Marine debris results in ecological, human health and safety, and economic impacts in Hawaiʻi. Marine debris research, prevention, and removal activities have been carried out since at least the mid 1980s. Following the creation of a national marine debris program within NOAA, a series of regional meetings were planned. At the first, a 2007 planning meeting in Hawaii, members of Hawaii's marine debris community identified a key next step, to hold a regional workshop to develop a local action strategy for marine debris.

METHODOLOGY
A comprehensive state-wide action plan was developed through a series of seven meetings involving 71 partner organizations. Results chains, a tool developed by the Conservation Measures Partnership (CMP) and Foundations of Success (FOS, 2007; 2009), were used to develop conceptual models and a results framework for the local action strategy. Four strategic areas, or threat-reduction goals, were explored through results chain teams: introduction of solid waste and fishing gear at sea and coastal areas decreased, land-based debris in waterways reduced, number of abandoned and derelict vessels decreased, and backlog of marine debris reduced. The conceptual model (Figure 1) and results chain (Figure 2) for backlog of marine debris reduced are included as examples. The Hawaii Marine Debris Action Plan was rolled out in January 2010, with endorsement from state and county officials (NOAA, 2010).

The results chains teams focused on reducing the backlog of marine debris has continued to meet and develop evaluation measures and an implementation plan. Activities have been planned or completed related to rapid response to marine debris sightings and at-sea detection of derelict fishing gear.

OUTCOMES
This is the first time the authors know of the CMP approach being applied to the problem of marine debris. In one sense, this is a drawback, because the CMP approach advises that all threats be considered. However, in an area where marine debris activities have long been carried out but have been largely left out of conservation action planning, this was a good starting point

for drawing together the various parties working on marine debris and focusing their activities on measurable results. This process took longer, required more adaptation, and needed more parties involved than anticipated. Maintaining momentum through a long planning process was challenging for parties working on marine debris as a small part of their portfolio and for those with a specific mandate.

PRIORITY ACTIONS

Refine and begin reporting on metrics for the “backlog of marine debris reduced” results chain, possibly using the NOAA-hosted federal information clearinghouse.
Convene HI-MDAP partners post 5IMDC to identify and begin Hawaii actions to implement Honolulu Strategy.

FIGURES AND TABLES

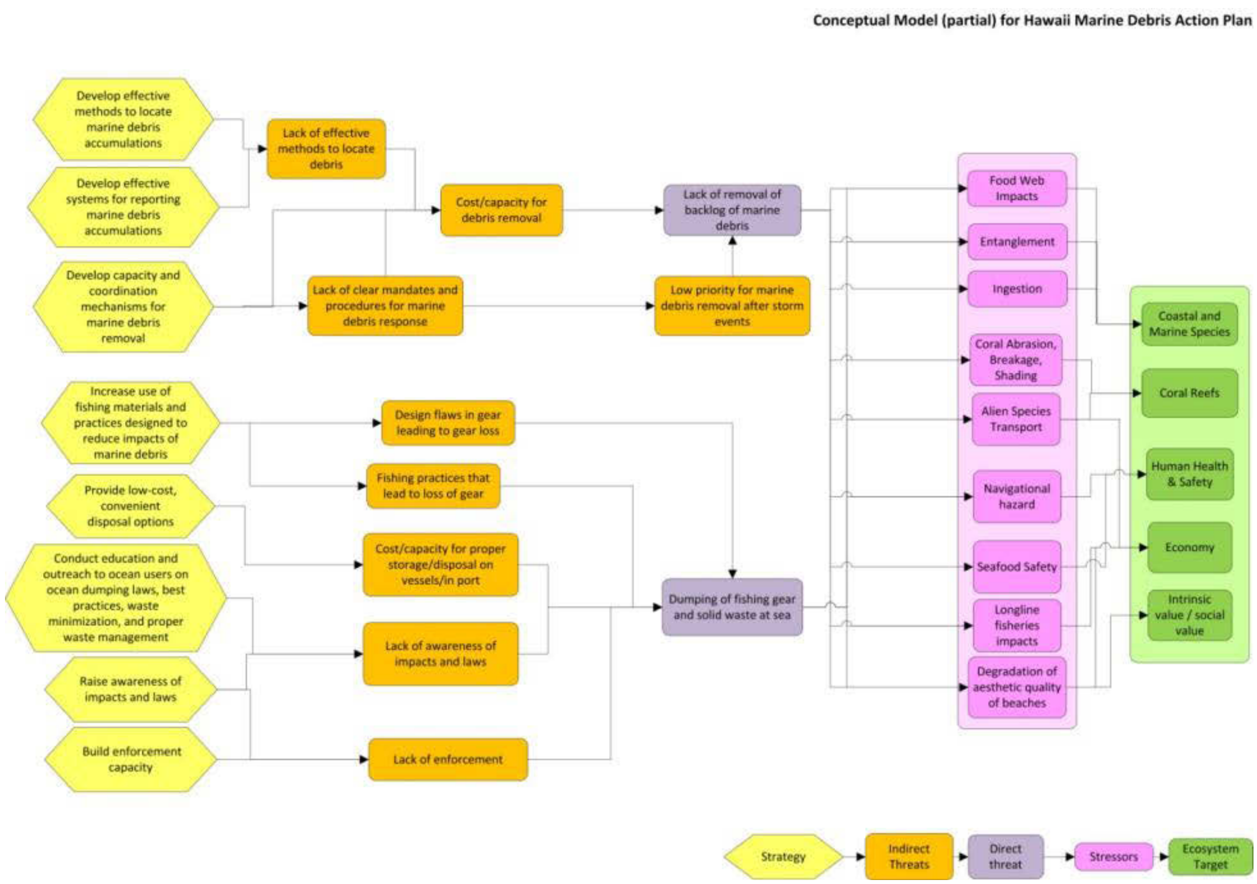

Figure 1. Partial conceptual model for marine debris showing relationship between resources at risk (green boxes), through direct and indirect threats, to strategies (yellow hexagons). Top three strategies address threats from lack of removal of backlog of marine debris.

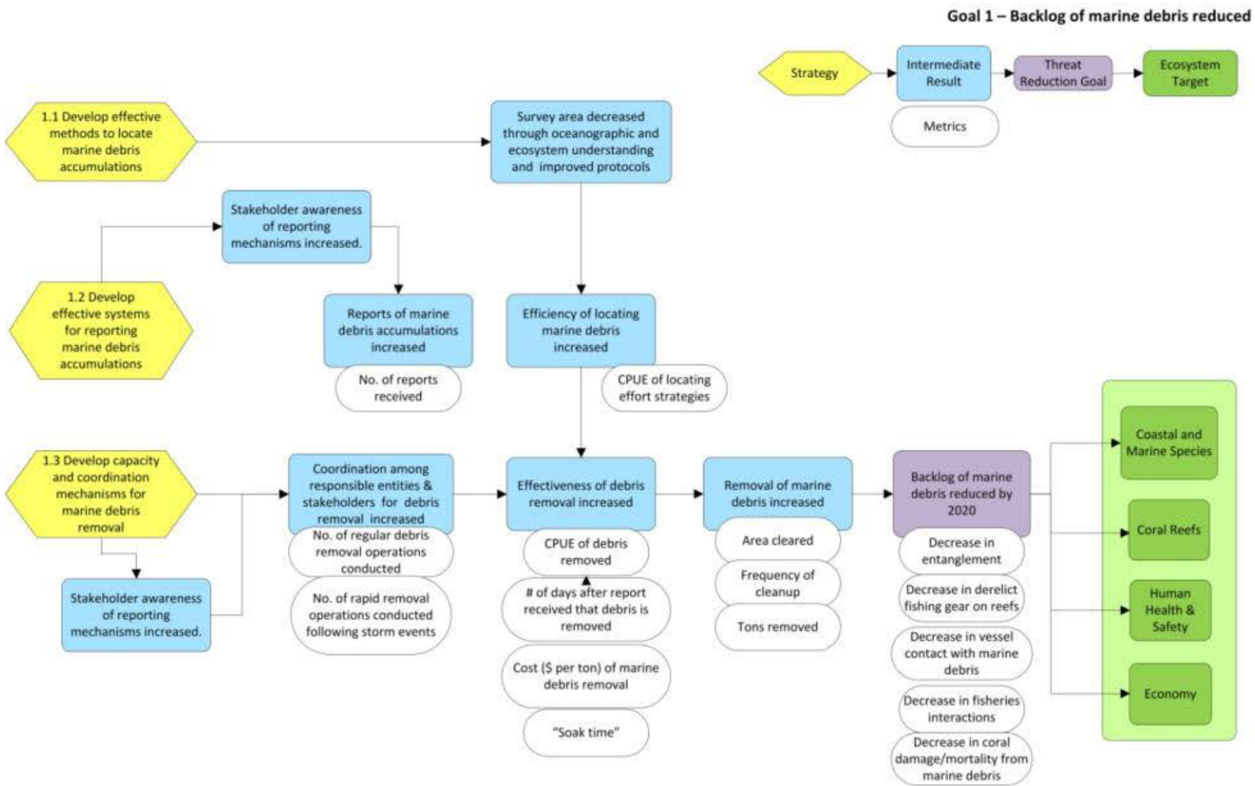

Figure 2. Results chain with strategies and draft metrics for measuring intermediate results and attainment of threat reduction goal 1, Backlog of marine debris reduced.

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7.b.3. Regional action on marine litter in the North-East Atlantic

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KEYWORDS
OSPAR Commission, Ecosystem Approach, QSR 2010, guidelines, biomonitoring

BACKGROUND
The OSPAR Commission is the Regional Seas Convention for the North-East Atlantic and has been at the forefront of delivering the Ecosystem Approach through the development of robust measures to deal with marine pollution.

Marine litter or debris, particularly plastics (Barnes *et al.*, 2009), is emerging as a significant issue put in context by OSPAR's most recent holistic Quality Status Report (OSPAR, 2010a). The QSR 2010 highlights the fact that marine litter levels are frequently unacceptable in the region, albeit that the spatial distribution of marine beach litter is significantly different throughout the maritime area. However, despite year on year variability, the overall amount of marine litter is consistently high and is not reducing despite recent efforts. In order to address this OSPAR has developed several products involving cross-sectoral partnerships.

METHODOLOGY
OSPAR works by establishing consensus between its Contracting Parties, the fifteen States (together with the European Union) whose activities have the potential to impact on the marine environment of the North-East Atlantic. On the basis of peer reviewed science and guiding principles, such as the precautionary principle, legally binding Decisions and voluntary Recommendations are agreed. To combat the adverse impact of marine litter OSPAR has developed:
a common methodology, guidelines and analysis techniques to quantify beach litter, that have been developed in a collaborative project involving Contracting Parties, Observers and NGO's, as part of the Convention's monitoring programme;
in partnership with Observers and the fishing industry developed guidelines and a Recommendation on 'fishing for litter' initiatives to raise awareness in the sector and facilitate the direct removal of litter; and
an Ecological Quality Objective (EcoQO) evaluating plastic particles ingested by Northern Fulmars as a means of biomonitoring for the Greater North Sea Region.

OUTCOMES
Beach litter monitoring standards were agreed following a 6-year pilot exercise (2001-2006) led by Sweden. Highest levels recorded during the pilot exercise were in the Greater North Sea Region with 600-1400 items per 100m of beach surveyed in the Northern North Sea and 200-800 items per 100m in the Southern North Sea. The pilot project identified several indicator items

specific to different sources in an attempt to analyse trends. The monitoring protocol established as a result is now a voluntary part of the OSPAR Coordinated Environmental Monitoring Programme. To underpin the QSR 2010, OSPAR undertook an assessment of the problem in the North-East Atlantic with the support of UNEP (OSPAR, 2009). Compared to beached litter there is less confidence concerning amounts of marine litter in the water column and on the sea floor (Galgani *et al.*, 2000). Ottertrawling during a scientific cruise at a depth of 4450m in December 2010 highlighted that marine debris is accumulating on the abyssal plain in the North-East Atlantic (Christiansen, pers. com 2011), but this data remains indicative.

The only quantitative data on the environmental impact of marine litter is from the background study into the EcoQO on plastic particles in Fulmars' stomachs. Averaged for the whole North Sea, 94% of birds investigated contained plastic: on average 34 pieces and 0.3 gram mass. The widespread presence of microscopic plastic particles is identified as an emerging issue with 150-2400 particles per m2 in the um to mm size range.

One of the most innovative and successful projects to tackle marine litter at sea is 'Fishing for Litter'. Originated by the North Sea Directorate of the Dutch government in cooperation with the Dutch Fisheries Association in March 2000, KIMO International (Local Authorities International Environmental Organisation) extended pilot schemes to harbours in Scotland, Sweden and Denmark as part of an EU Interreg funded 'Save the North Sea' project between 2005-2007. Participating vessels are given large hardwearing bags to collect marine debris that collects in their nets. Participating harbours monitor and remove the waste. A key benefit is engaging fishermen, one of the main stakeholders, raising their awareness and reducing their costs (KIMO estimate that these can be up to £30,000 per boat per year). Another NGO, the European Union for Coastal Conservation (EUCC), have initiated a project to cut away abandoned fishing gear from the numerous wrecks in the North Sea (http:www.duikdenoordzeeschoon.nl/). Since Spring 2009 the project has undertaken 15 diving days per season (of approximately 12 man/dives/day), concentrating on 3 large WW2 wrecks off the Hook of Holland. This national award winning project is set to develop wreck conservation plans including ongoing debris removal. KIMO International have further highlighted the economic impacts of marine litter, building on estimates of direct costs incurred by the fishing industry and local authority beach cleaning, to include, for example direct costs to agriculture from wind blown marine litter in coastal locations (Mouat *et al,* 2010). Hidden costs are also a factor, such as financial provisions made by marine dredging operators for time lost to clean and unblock suction equipment (van der Salm, pers com 2010). These initiatives and knowledge gained from them has provided a major contribution to European Marine Strategy Framework Directive (EC, 2008)) criteria and methodologies for dealing with marine litter, that European Member States will use to assess their achievement of 'Good Environmental Status' (GES) for national marine waters by 2020. Further to a detailed Task Group report (EU, IFREMER and ICES, 2010), an EU technical working group on marine litter is developing work on which Member States should base targets and indicators.

Marine litter was a key issue addressed at the OSPAR Commission Ministerial Meeting in Bergen in 2010. During the meeting, through side events, NGOs helped draw the attention of ministers to the problem by launching a debate and live dissection of a fulmar's stomach to show litter ingested. Ms Maud Fontenoy, an ambassador for the International Oceanographic Commission, highlighted the OSPAR Guideline, which includes advice on selection of reference beaches, sampling units of 100m and 1km, and photoguides in different languages for identification and categorization of litter including dealing with small pieces and/or entangled litter (OSPAR, 2010b). As a result ministers agreed:

The Bergen Statement: a high level political document including commitment to marine litter reduction measures and targets, in association with other international organizations such as the International Maritime Organisation;

Agreement 2010-3, The North-East Atlantic Environment Strategy (2010-2020): a vision, objectives and strategic directions including an overarching ecosystem approach and, within the biodiversity and ecosystems theme, a commitment to ‘substantially reduce marine litter within the OSPAR Maritime Area to levels where properties and quantities of marine litter do not cause harm to the coastal and marine environment. Specifically this included:

i. by 2012, based on an evaluation of progress made and available data, establish regionally[1] coordinated targets for marine litter;
ii. by 2014, a coordinated monitoring programme for marine litter;
iii. promotion of research to improve the evidence base with respect to impact of litter, including micro-particles, on the marine environment;

[1]“Sub-regionally” for the purposes of the Marine Strategy Framework Directive

Recommendation 2010-19 on the reduction of marine litter through the implementation of Fishing for Litter initiatives:

On this basis, partnerships between OSPAR experts have informed and guided recent political commitments.

PRIORITY ACTIONS

Lessons learned from the OSPAR work identify future ways in which marine litter can be tackled. However, collective political will must be translated to action. As a priority all OSPAR Contracting Parties should build on the current work on monitoring to develop comprehensive programmes that can identify key sources and sinks. National measures will also be essential in contributing to overall reductions along with OSPAR-wide measures such as the Recommendation on Fishing for Litter. Within OSPAR an expert level intersessional group is working on other facets including enhancing stakeholder awareness, port waste reception, benthic sampling and deep sea observations.

FIGURES AND TABLES

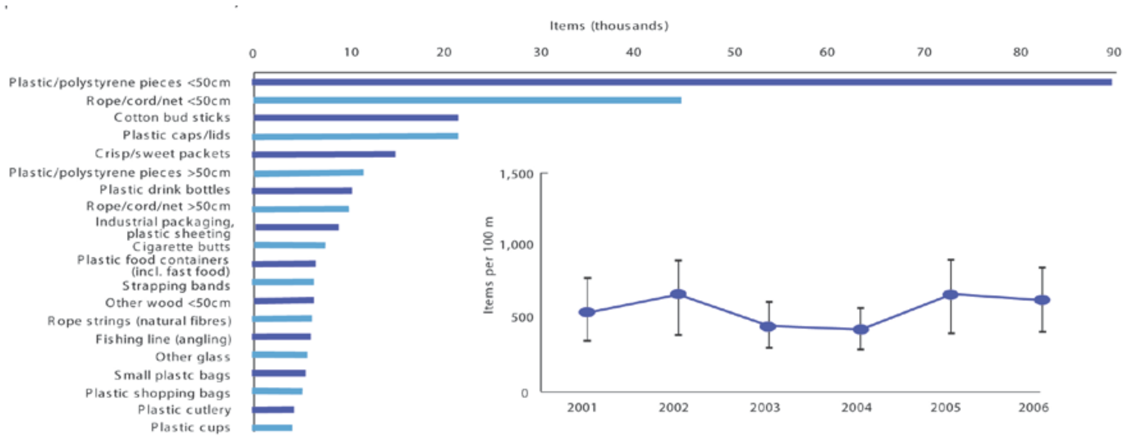

Figure 1. Composition and numbers of marine litter items found on reference beaches. The bar chart shows the total numbers of the most common items. The points in the line diagram represent the average of annual averages for individual beaches (Error bars = 95 per cent confidence interval) (OSPAR, 2009).

Figure 2 Trends in the average number of items of marine litter collected on reference beaches in three-month periods in Regions II, III and IV (OSPAR, 2010a).

Figure 3 Fishing for litter (KIMO International)

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7.b.4. A NETwork of partners

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KEYWORDS
Ghost nets; Australia; Indigenous partnerships

BACKGROUND
GhostNets Australia (GNA) aims on a sub continental scale, to find a solution to the high numbers of ghost nets that wash onto north Australian coastlines from South East Asian waters. GNA works in an extremely remote environment that is sparsely populated and difficult to access by sea or land. To achieve its goals GNA relies on strong, effective partnerships with a range of organisations. These include highly diverse Indigenous communities (who are majority of the region's population), research, industry and international, government and non government, stakeholders. Using GNA as a case study we explore the pivotal role that partnerships play in making our work a success by comparing and discussing three different types of partnerships: expedient, opportunistic and strategic, where the focus is different and how that relates to outcomes.

METHODOLOGY
Definitions
In the context of this discussion 'partnership' refers to a cooperative relationship between people or groups who agree to share responsibility for achieving some specific objective or goal. Depending on the nature of this agreement determines the level of contractual process. Agreements can be bound by handshake, Memorandum of Understanding or contract.
The prime focus of expedient partnerships is to obtain resources, (funding, assets or labour) that enable the organisation to achieve its goals. Expedient partnerships inherently reward one partner more than the other, limiting the scope and potential growth of the partnership and often do not result in outcomes beyond those agreed upon (Figure 1). Examples of expedient partnerships are those created through the grant process, sponsorships and corporate investments.

Opportunistic partnerships can develop between organisations focused on very different ultimate agendas but who find they are conducting similar activities to achieve their goals (Figure 2). These partnerships are rarely planned and often retain an element of dynamism and flexibility that enable the collaboration to mature. An example is that between GNA and the Centre for Remote and Rural Mental Health Queensland (CRRMHQ) aimed at delivering workshops in Indigenous communities that encourage the creation of contemporary artworks. For GNA, the workshops achieve the recycling of ghost nets by community artists while for the CRRMHQ, the aim is to relieve depression by bringing people together for social interaction, laughter and fun.

Finally, Strategic partnerships focus on developing symbiotic relationships between different organisations to achieve greater outcomes beyond the scope of any party individually. In this partnership often the goals of the partner organisation can take precedence over the project goals for the shorter term in order to achieve the longer term outcome for the project and even a shared outcome. (Figure 3)

OUTCOMES

GNA recognised at the beginning of the project that in order for GNA to be able to achieve its goals of understanding the abundance, distribution, movement and ultimately the source of ghost nets drifting into Australian waters, it was necessary to develop appropriate and long term partnerships. One potential, and expedient, partnership was with the Australian Defence Force which could provide strong 'top down' management and large supplies of resources to achieve immediate short term clean up results. The alternative was strategic relationships with the indigenous people of the region who would take longer to produce results, but could provide community driven management and a longer term commitment. For these reasons, the latter partnership was chosen.

Through a intense consultative process prior to the project, it was obvious that Indigenous people of coastal north Australia; 1;shared a desire to mitigate the threats to their marine resources that they were collectively experiencing. 2; have culturally diverse backgrounds and 3; a wide range of experience and training in environmental management. By choosing to forge strategic partnerships with these communities GNA inadvertently became part of a fledgling community driven movement towards long-term social, cultural, physical and sustainable economic development called "Caring for Country". In order to achieve the objectives of cleanups and data collection, GNA first had to resource and train the rangers in a variety of skills so they could confidently and accurately do the work. Combined with customary and knowledge and exceptional "bush skills", ghost net training and data collection techniques contribute to a broad suite of environmental services that Indigenous landowners deliver to other partners, such as: border protection; survey and destruction of quarantine risks; wildfire abatement, carbon sequestration and the control of invasive weeds and feral animals.
The shared outcome of this strategic partnership with GNA and the network of Land and Sea Rangers across northern Australia includes a substantial rise in resources and skills to many communities, which in turn provides sustainable, comprehensive and ongoing management of coastal environments

Ghost nets have wide ranging impacts on such elements as health, safety, culture, biodiversity, the environment and economics. To solve this issue, strong relationships need to be developed between a variety of parties including the fishing industy (both gear manufacturers and the industry itself), legislators, consumers, fish wholesalers, retailers, waste disposal agencies, environmental managers and the community. Engaging and maintaining such a diversity of partners will require an understanding of the value, role and intrinsic nature of each relationship as well as an appreciation of the mutual benefits for each partner.

PRIORITY ACTIONS

Research the product life of fishing gear, to develop partnerships to drive product stewardship
Investigate the types and variety of fisheries in the South East Asian region; how they operate; what their drivers and pressures are and the legislative frameworks they operate within.

Create strategic partnerships with these fisheries, where possible to improve the Environmental management Systems thus contributing to the prevention of ghost nets.

FIGURES AND TABLES

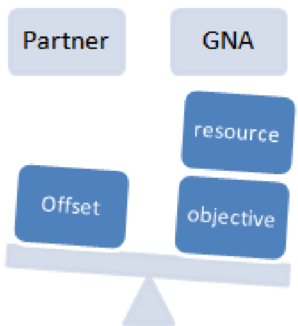

Figure 1: Expedient or Resource focused partnerships benefit one partner more than the other.

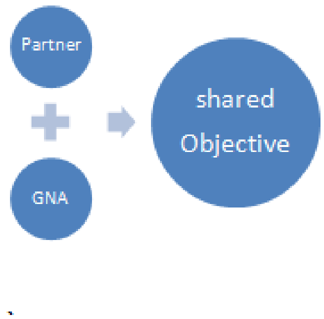

Figure 2: Opportunistic Partnerships focus on shared objectives

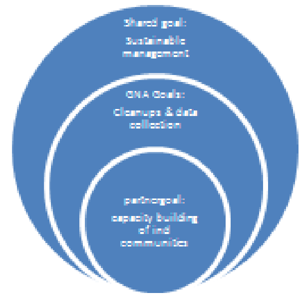

Figure 3: Strategic partnerships focus on building the relationship of the partnership to achieve both each others as well as shared goals.

7.b.5. The role of an MPA network in marine debris reduction in the wider Caribbean Region

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KEYWORDS
Marine protected areas, MPA network, best practices, Wider Caribbean

BACKGROUND
Marine debris is a pervasive pollution problem that affects oceans and coastal areas globally and that plagues the countries of the Wider Caribbean region. It is a trans-boundary environmental problem that damages natural resources and affects economies in the region. Studies by UNEP have shown that land-based sources account for the bulk of marine debris in the Wider Caribbean region. Indeed, marine debris problems have been recognized by Caribbean governments and, accordingly, various national regulations and laws exist, as do international and regional treaties and conventions. Yet the marine debris problem in the Wider Caribbean persists. This presentation recounts how a marine protected areas (MPA) network is facilitating efforts on the ground in five countries to implement best practices in an attempt to reduce marine debris entering the Caribbean Sea.

METHODOLOGY
In response to a call for proposals from the US Department of State to work on marine debris reduction efforts, CaMPAM consulted with its members about their concerns in relation to marine debris and the perceived need for local projects for marine debris reduction. The resulting discussion revealed a number of common needs and interests among member MPAs, and indicated potential for synergy from a regionally-coordinated approach. CaMPAM and GCFI seized upon the most promising local ideas arising from the consultation process and advanced with a joint proposal for five countries.

The resulting project provides a platform to assist local NGOs, community-based organizations, MPA managers and relevant government organizations working on-the-ground in marine conservation in the Wider Caribbean in launching the strongest and most innovative of these ideas as achievable country-specific sub-projects in the Bahamas, Belize, Grenada, Jamaica and St. Vincent and the Grenadines. The lead representative in each country is a member of the CaMPAM network and nearly all have participated in the UNEP/CaMPAM regional Training of Trainers course on ecosystem and marine protected areas management. The national organizations share a common interest in pursuing the proposed efforts related to marine debris reduction and are well-positioned to take part in the proposed project thanks to a solid network of in-country contacts and community-based organizations to help support their work. Oversight of the project by GCFI is ensuring a broader regional perspective and is helping to develop locally adaptable action plans based on the successful case studies.

OUTCOMES

Grounded in the recommendations of the Action Plan for Marine Litter of the United Nations Environment Programme's Caribbean Environment Programme, the project brings together a number of promising local ideas for marine debris reduction. The broad goal of the project is to develop greater appreciation and personal responsibility for waste management for litter that would likely end up as marine debris in each of the five participating countries. Through a combination of public education, teacher training, the development of litter warden programs and the establishment of well-placed waste and recycling stations, the project provides for a number of visible and practical pilot litter control programs.

The project is still underway but already there is interesting progress to report in terms of which activities have been most quickly taken up in the different countries, how the capacity of the MPA affects this, and the role the network is playing in driving the work. For example, we are seeing important advances in legislation related to marine debris and greater acknowledgement of institutional responsibilities in the Bahamas. In Belize there have been great advances in the use of environmental communications tools by the lead MPA. In St. Vincent and the Grenadines the development of essential teacher-training resources has benefited all of the countries involved in the project.

The in-country experiences also serve to highlight some of the challenges facing MPAs in implementing marine debris reduction efforts. Difficult socio-economic settings can derail even the best-laid plans. A lack of local capacity for implementation of marine debris reduction efforts, and sometimes stakeholder cynicism, can be obstacles in the path to project implementation.

A professional MPA network can do much to stimulate action, by helping to build bridges between partners, facilitate sharing of essential materials and advice, and by lending much-needed support and guidance in the application of best practices. However, only local partners can provide the necessary insight into which approach and which materials are likely to work best in their communities. Flexibility on the part of the donor and by GCFI has proven to be a key aspect of the project's success. For example, in-country partners are able to make decisions on the best approach to community education, which has been a crucial first step in joint planning and developing best litter management practices in the target communities. They have also had the flexibility to follow-up and pilot the practices they deem potentially most effective within their own social and environmental settings.

As marine debris reduction efforts progress, the CaMPAM network is serving an essential role in disseminating information about the project, sharing resources among in-country partners, and further promoting best practices for replication among the network's members across the Wider Caribbean region. Without the leadership and guidance of the network, the five participating countries would likely never have come together to work on this topic, nor would the MPAs involved likely have individually secured the funding that the project won from the US Department of State. Only with the regional oversight of the MPA network has the sharing of lessons learned been so immediate among the in-country partners and so extensive among the members of CaMPAM across the Wider Caribbean.

PRIORITY ACTIONS

MPAs provide a meaningful context for marine debris reduction efforts, serving to illustrate the biodiversity impacts of marine debris, highlighting the trans-boundary nature of the issue, and demonstrating the potential ecosystem benefits of debris reduction;

Reflecting the diversity of actors that stand to play a role in marine debris reduction work, flexibility in implementing activities and ideas across a network of MPAs is essential. One size does not fit all islands nor does it fit all MPAs;

MPA networks serve to bring together leaders of marine debris reduction efforts; in the face of common challenges and local limitations, the network can help to hold together marine debris reduction efforts; and MPA networks can be instrumental in sharing experiences and in promoting best practices.

7.b.6. Regional cooperation in dealing with marine litter: NOWPAP experience

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KEYWORDS
Marine litter, marine debris, NOWPAP, MALITA, RAP MALI

BACKGROUND
NOWPAP has been established in 1994, as a part of UNEP Regional Seas Programme, by four member states: People's Republic of China, Japan, Republic of Korea and Russian Federation. NOWPAP activities are addressing marine and coastal environmental issues which member states consider important for the region: oil spills, harmful algal blooms, land-based pollution, etc.

NOWPAP member states decided to address marine litter (marine debris) problem in November 2005, when NOWPAP Marine Littler Activity (MALITA) was launched.

OUTCOMES
In 2006-2007, NOWPAP MALITA has been successfully implemented under the overall responsibility of the NOWPAP Regional Coordinating Unit in close cooperation with the UNEP Regional Seas Programme, the four NOWPAP Regional Activity Centres and the four member states. The outcomes of NOWPAP MALITA can be summarized as follows:

First, a NOWPAP marine litter database was established in 2006 (and regularly updated since then), which includes all marine litter-related data and information available in the region. In addition, Regional Overview on Marine Litter in the NOWPAP Region was published in 2007 (second edition in 2008).

Second, a Regional Overview on Legal Instruments, Institutional Arrangements and Programmes related to Marine Litter was published in October 2007, based on national summaries prepared by the four NOWPAP member states.

Third, guidelines for marine litter monitoring on beaches and shorelines as well as on seabed were developed.

Fourth, sectoral guidelines for fishing, shipping (commercial shipping, recreational activities and passenger ships) and tourism were developed. In addition, guidelines for improvement of port reception facilities and services were published as well as a report on recycling of plastic marine litter.

Fifth, a variety of brochures, leaflets and posters were published and distributed widely in order to increase public awareness on the marine litter problem. Some of them were translated into the national languages of the NOWPAP member states to facilitate further use by the general public, including school children.

Sixth, a series of marine litter workshops have been held which were of great use to exchange national data and information, including policies and good practices, and to build common understanding on marine litter issues in and beyond the region.

Seventh, four NOWPAP International Coastal Cleanup (ICC) campaigns were organized (one in each NOWPAP member state) with side events such as workshops, NGO meetings and exhibitions related to marine litter problem. Through a series of events held during 2006-2007, the member states demonstrated their strong ownership and financial support to MALITA while NOWPAP strengthened its cooperation with other regional organizations, programmes and projects (e.g., IMO, UNEP, COBSEA, YSLME, PEMSEA). NGOs also actively participated in all NOWPAP marine litter related events.

Finally, NOWPAP Regional Action Plan on Marine Litter (RAP MALI) was developed and adopted. RAP MALI is the second phase of the NOWPAP activities related to marine litter which was initiated in 2008 (after formal approval by member states).

Within RAP MALI, activities (with focus on national actions) are implemented under three major themes: 1) prevention of marine litter input to the marine and coastal environment; 2) monitoring of marine litter quantities and distribution; and 3) removing existing marine litter and its disposal. Sectoral guidelines developed during the MALITA implementation were translated into the national languages of the NOWPAP member states, in cooperation with the Regional Activity Centers and the Marine Litter National Focal Points, and distributed as widely as possible. Several NOWPAP ICC campaigns were organized in Dalian (China), Vladivostok (Russia), Hirado (Japan), and Jeju (Korea). Several workshops related to marine litter management were also held. In particular, in Vladivostok (Russia), a training workshop was organized on 26 September 2008 to illustrate how to organize the annual ICC campaigns, including data collection and management. Several technical reports and brochures were published by NOWPAP Regional Activity Centers and are available online. Of particular interest are reports on marine litter management in Incheon city (Korea); on model survey for removal of marine litter in Japan; and on technologies related to marine litter treatment available in NOWPAP member states.

National efforts and achievements of some NOWPAP member states deserve to be mentioned as follows.

In the People's Republic of China, several domestic laws and regulations related to the marine litter management were introduced (or revised): *Law on Prevention and Control of Water Pollution* (2008); *Regulations on Prevention of the Marine Environmental Pollution by the Coastal Construction* (2007); and *Regulations on Prevention of Marine Environmental Pollution by Marine Construction Projects* (2006). Providing free thin plastic bags in all shops was prohibited from 1 June 2008. The State Oceanic Administration initiated a National Marine Litter Monitoring Programme in 2006 and released annual reports since then.

In Japan, a Basic Plan on Establishing the Sound Material-Cycle Society, including marine litter issues, was revised in March 2008. The Law for the Promotion of Marine Litter Disposal was enacted in July 2009. The purpose of the law is to promote smooth disposal and reduction of generation of marine litter, in order to conserve the good landscape and environment of the coasts. To promote countermeasures pursuant to the law, the central government shall formulate a basic policy and prefectural governments formulate regional plans based upon the Basic Policy. The law puts emphasis on importance of the collaboration with private and public sectors as well as countermeasures in the remote islands. Market-based economic instruments (e.g., ban on free plastic bag) are being implemented by some local governments.

In the Republic of Korea, Marine Environmental Management Act came into force in January 2008 based on the earlier Marine Pollution Prevention Act. According to the Marine Environment Management Act, a Marine Litter Management Plan was developed and is being implemented since January 2009. The plan aims at establishing an advanced national marine litter management system and has four strategies: (1) preventing litter from entering the sea; (2) strengthening the marine litter removal and treatment capacity; (3) improving marine litter management system; and (4) encouraging public participation while also promoting international cooperation. Under the Marine Litter Management Plan, a variety of projects are being implemented. For sea-based marine litter, projects on the development of biodegradable and marked fishing gear, providing Styrofoam buoy compactors, and fishing farm cleanup are on-going. For land-based marine litter, projects on the river-basin management, installing trash-booms in major rivers and waterways, and providing waste treatment facilities for dams and estuaries are being undertaken. The ongoing projects also include the development of treatment and/or disposal systems, recycling technologies, beach cleanup campaigns, national marine litter monitoring activities, and public awareness raising.

PRIORITY ACTIONS

- Integrate garbage recycling (especially plastic) as a part of solid waste management plans.
- Prohibit free distribution of plastic shopping bags and use of polystyrene foam buoys in fishing and aquaculture.
- Introduce “no special fee” system for port reception facilities for garbage disposal, including abandoned/lost fishing gear.

7.c.1. Chemicals in marine plastics : global distributions and potential risk to marine ecosystem

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KEYWORDS
Plastic fragment, PCBs, PAHs, PBDEs, endocrine disrupting chemicals, EDCs, nonylphenol, bisphenol A, International Pellet Watch

BACKGROUND
Recently toxic organic contaminants such as polychlorinated biphenyls (PCBs) and nonylphenols have been detected in marine plastics (Mato et al., 2001). Ingestion of the plastics could be a significant exposure route of the toxicants to marine organisms and their adverse effects on the organisms and marine ecosystems are of concern. Concentrations and the spatial variations are essential information for the risk assessment of the chemicals associated with marine plastics. Marine plastics contain two types of chemicals: additive-derived chemicals and hydrophobic chemicals sorbed from surrounding seawater (Teuten et al., 2009). International Pellet Watch revealed concentration ranges and spatial variations of the hydrophobic chemicals such as PCBs and organochlorine pesticides in plastic resin pellets collected from beaches all over the world (Takada, 2006; Ogata et al., 2009). Resin pellets are significant, but minor components among the marine plastics compared with more abundant fragments of plastic products in marine environments (Law et al., 2010; Moret-Ferguson et al., 2010) and biota (Ryan et al., 2009). However, only limited information is available on the concentrations of organic micropollutants in marine plastic fragments and their spatial variations. Rios et al., (2007, 2010) demonstrated concentrations of HOCs including PCBs from central pacific gyre and California coast. In addition to the HOCs, plastic fragments contain additive-derived chemicals, too. However, very limited information is available on the additive-derived chemicals in plastic fragments from marine environments.

In the present study, we presents the results of the analysis of HOCs and additive-derived chemicals in plastic fragments and pellets from the open ocean including Central Pacific Gyre, Atlantic Ocean, remote beaches (Costa Rica and northern Vietnam) and urban beaches (Tokyo, Los Angeles).

METHODOLOGY

Plastic fragments were collected from open ocean and beaches in remote areas and urbanized areas. Samples from central pacific gyre were collected in July and August, 2005 on the cruise of ORV Alguita of Algalita Marine Research Foundation (AMRF). Further open ocean samples were collected during the cruises of SSV Robert C. Seamans and SSV Corwith Cramer (both vessels of the Sea Education Association) in the Pacific Ocean (S-217PP) and Atlantic ocean (C-216PE and C-216PP). The floating samples were collected by neuston net and plastics were sorted on board and stored in glass bottle or stainless steel containers and kept in a freezer or at ambient temperature until analysis. Stranded plastic fragments and resin pellets were collected from remote beaches at Marbella beach and Thinh Long, Tonking Bay (Vietnam) and urban beaches at Odaiba (Tokyo), Kugenuma (Kanagawa) and Seal Beach (USA). The plastic samples were picked up from stranded materials on high tide line of the beaches by using solvent-rinsed tweezers, wrapped with aluminum foil, sent to the laboratory in Tokyo at room temperature, and stored in freezer until analyses.

Plastic fragment samples were sorted by near infrared spectrometer (PlaScan-WTM OPT Research Inc, Tokyo, Japan) to select polyethylene (PE) and polypropylene (PP) fragments. PE and PP fragments varying in size from a few mm to a few cm were analyzed. Between three and five single plastic fragments were analyzed for individual locations to determine piece-to-piece variation. Plastic fragment samples were extracted with dichloromethane (DCM). The extracts were spiked with isotopically-labeled surrogate standards, purified and fractionated by silica gel column chromatography. Organic micropollutants in the fractions were analyzed by gas chromatography with mass spectrometer (GC-MS).

OUTCOMES

Polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), dichloro-diphenyl-trichloroethane and its metabolites (DDTs), polybrominated diphenyl ethers (PBDEs), alkylphenols and bisphenol A were detected in the fragments with concentration ranges from 1 ng/g to 10,000 ng/g. Hydrophobic organic compounds (HOCs) such as PCBs and PAHs were sorbed from seawater to the plastic fragments. PCBs are most probably derived from legacy pollution. PAHs in the plastic fragments showed petrogenic signature, suggesting sorption of PAHs from oil slicks. Nonylphenol, bisphenol A, and PBDEs in the plastic fragments were mainly from additives and detected at high concentrations in some fragments both from remote and urban beaches and open ocean. By using these data, magnitude of plastic-mediated transfer of chemicals to seabird was estimated below.

To assess the effects of plastic-derived-chemicals to marine biota, we have to consider that they are exposed to toxic chemicals also through food web. Due to biomagnifications, the prey contains considerable concentrations of the toxic chemicals. In the present study, we compared the amounts of chemicals derived from plastics with those from natural prey. As a model organisms, we selected short-tailed shearwater because it has been reported that this specie of oceanic seabird ingest marine plastic debris and they have been found in their stomach. Based on the daily energy consumption, the amount of daily prey intake was calculated. Based on the tissue concentrations of these chemicals reported in literature and our analytical data, we calculated the exposed amounts of pollutants to short-tailed shearwater through plastic ingestion and those from natural prey and compared (Table 1). Regarding PCBs, plastic-mediated exposure (1 – 86 ng/day) is estimated to be comparable or small to those from fish (7 – 51 ng/day). However, for PBDEs, plastic-mediated exposure (0.3 – 88 ng/day) is estimated to be greater than natural intake (8 – 10 ng/day). Furthermore, plastic-mediated expose of nonylphenol to the seabird (7 – 1100 ng/day) is estimated to dominate over the natural prey (~ 0.2 ng/day). The difference among compounds can be explained by the difference in degree of biomagnification. That is, PBDEs are less biomagnified than PCBs (Mizukawa et al., 2009). Furthermore, nonylphenol is easily metabolized through food web (Takeuchi et al., 2009) and minimal exposure through food web is expected. Thus, regarding nonylphenol and PBDEs, direct exposure from ingested plastics could be important source of these endocrine disrupting chemicals to the seabird. To assess the actual exposure of the chemicals to marine biota, bioavailability of these chemicals in plastics should be considered. Chemicals in plastics are thought to be less bioavailable due to diffused presence in plastic polymer matrix. However, chemical components in digestive tracts such as surfactants can enhance the bioavailability (i.e., leaching) of these chemical and uptake by organisms. Further studies are needed to address these issues of bioavailability and bioaccumulation for the chemicals associated with plastics.

PRIORITY ACTIONS

Our study and recent studies demonstrated the presence of toxic chemicals in marine plastic fragments and their transfer to marine organisms by their ingestion. Though there is a huge information gap to accurately assess the plastic-mediated transfer of chemicals to oceanic organisms, we should take preventive action to reduce this route of chemical exposure. We should reduce the usage of plastics on terrestrial environments. Also toxic additives should be replaced with safer ones.

FIGURES AND TABLES

Table 1. Estimation of exposure of pollutants to short-tailed shearwater through natural prey and marine plastics

	Prey			Open Ocean Plastics	
	Krill	Squid	Fish	Average	
Intake (g/day)	127	149	89	1.1	
Pollutants concentration (ng/g)				Average	Range
PCBs	0.057	0.348	0.573	21	1 - 78
PBDEs*	0.081	0.056		21	0.3 - 80
Nonylphenol			0.002	190	6 - 997
Daily buden of pollutants (ng/day)	Krill	Squid	Fish		
PCBs	7	52	51	23	1 - 86
PBDEs	10	8		23	0.3 - 88
Nonylphenol			0.16	209	7 - 1100

*Except for BDE209

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7.c.2. Surface properties of beached plastic pellets and the effect of salinity on their sorptive properties for phenanthrene and 1-naphthol.

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KEYWORDS
Phenanthrene, 1-naphthol, salinity, plastic pellets, point of zero charge (pzc), polyethylene (PE), polyvinylalcohol (PVA), sorption

BACKGROUND
Plastic pellets, mainly polyethylene (PE) and polypropylene (PP), are widely distributed in the beaches all over the world (Ogata et al., 2009). These plastic pellets are unintentionally released to the marine environment during manufacturing and transportation. By using beached plastic pellets as passive sampling media it is possible to identify pollution hot spots in a global map. Ogata et al. (2009) presents maps for the global distribution of persistent organic pollutants (POPs) in coastal waters through plastic pellet sampling. In another recent study (Karapanagioti et al., 2011), sampling from four beaches in Greece determined the concentration of PCBs, DDTs, HCHs, PAHs. To be able to use them as passive samplers and better understand their association with different toxic compounds, their surface properties and their sorptive behavior in the saline environment need to be studied in detail.

Batch studies are performed using phenanthrene as a hydrophobic organic model compound and 1-naphthpol as a hydrophilic organic model compound and hydrophilic and hydrophobic materials such as polyvinylalcohol (PVA), polyethylene (PE), polyoxymethylene (POM), and polypropylene (PP) were used in sorption equilibrium experiments. Kinetic studies for these materials are also performed. Since salinity affects sorption capacity, synthetic freshwater and synthetic saltwater are used to determine the effect of salinity on sorption capacity.

METHODOLOGY
Phenanthrene and 1-naphthpol (>99%) are used as model organic compounds and were obtained from FLUKA. These compounds often appear in polluted marine environments and are toxic to aquatic organisms. The plastic pellets that are tested as sorbent materials include polyethylene, polypropylene, and polyoxymethylene, (as hydrophobic polymers), and polyvinylalcohol (as hydrophilic polymer). PE and PP pellets were sampled from Greek beaches and were then sorted by near-infrared spectrometer (Plascan-WTM OPT Research Inc., Tokyo, Japan) into PE, PP, and other polymers by the Laboratory of Organic Geochemistry, Tokyo University of Agriculture and Technology, Tokyo, Japan. PVA pellets were provided by Kuraray Co., Tokyo, Japan.Polyoxymethylene were purchased from Aldrich (Milwaukee, WI).

Solutions used in batch studies were prepared in synthetic fresh water (FW) with 44 mg/L $CaCl_2*2H_2O$, 14mg/L $CaSO_4$, 17mg/L $NaHCO_3$ and 200mg/L NaN_3 and synthetic sea water (SW 36‰) with 31g/L NaCl, 19g/L $MgSO_4*7H_20$, 0.04g/L $NaHCO_3$ and 0.2g/L NaN_3. All sorption equilibrium experiments were contact in duplicate in 40 mL glass vials with Teflon coated septa. The initial aqueous sorbate concentration in the solutions was known. The solutions were mixed with a known sorbent mass. At certain sampling times, the aqueous sorbate concentration is measured and the loss is assumed to be due to sorption. Phenanthrene in the aqueous phase was measured with a Perkin Elmer LS - 50B fluorescence detector using a quartz cuvette at excitation wavelength 252nm and emission wavelength 347nm and 1-naphthol were measured with a Cary Varian UV-VIS Spectrophotometer using a quartz cuvette at wavelength 291nm. Blank samples with solution only and without the sorbents were also prepared to determine the initial concentrations. The amount sorbed was determined though a mass balance. The linear isotherm model was used to evaluate the experiment results. All sorption kinetic experiments were conducted in duplicate in 40mL glass vials with Teflon coated septa. The initial concentration for phenanthrene was 100 μg/L and for 1-naphthol was 10 mg/L. The vials were stored in dark place at room temperature (around 25 ^{0}C). Measurements of the sorbate solution concentration were taken at various time intervals. The surface properties such as surface area, porosity and pore average size were determined using BET methods, Micrometrics Tristar Analyzer. The point of zero charge was determined through titration potentiometric mass titration curves conducted using Radiometric Copenhagen analytical methods.

OUTCOMES

Erosion due to solar radiation and salinity is expected to change the surface properties of plastic pellets and thus, their sorptive properties (Mato et al., 2001). For this reason, experiments to characterize surface properties were performed as was described above. Figure 1 presents the titration curves of different eroded PE pellet masses. The point of zero charge corresponds to the intersect point of the different curves. In this case this point is found at pH equal to 6.2. For virgin PE similar titration curves were obtained but in this case, the curves were parallel and no intersect point was found (Sfaelou et al., 2011). For PVA the point of zero charge was determined to be above 9 (Sfaelou et al., 2011). These results suggest that at seawater pH (~8.3), virgin PE is neutral, eroded PE is negative and PVA is slightly positive. These differences suggest different sorptive behavior and different interaction with semi-polar and polar compounds. For example, positive ions would sorb to a negative surface through chemical sorption that is stronger than physical sorption and irreversible. Physical sorption would be more important for compounds and surfaces that are neutral or of the same charge. Once the surfaces demonstrate charges then, their interaction with water should also be considered.

PE, PP, and POM generally do not demonstrate high surface areas or porosity (Ahn et al., 2005). BET measurements for PP performed in the present study suggested that the surface area increased by a maximum of 10% for eroded PP. This suggests that erosion does not necessarily change the surface area significantly to affect sorption. On the other hand, PVA is highly porous containing 90% porosity causing it to swell in the presence of water (Bourikas et al., 2006).

Most of the isotherms performed with the materials and the sorbates described above are linear. Figure 2 presents kinetic curves for phenanthrene sorption into PE and 1-naphthol sorption into PVA. Based on previous studies (Karapanagioti and Klontza, 2008), phenanthrene reaches equilibrium into PE around ~100 days. Similar results are obtained in this study for on-going experiments. The same figure also presents the kinetic curve for 1-naphthol into PVA. In this case sorption equilibrium is much faster and is obtained around day 3. The sorption capacity is lower by almost 2 orders of magnitude compared to PE and phenanthrene. So, a polar compound sorbs into a polar polymer compared to a non-polar compound into a non-polar to slightly negative polymer: a) faster by 2 orders of magnitude and b) less by 2 orders of magnitude.

Such observations need to be considered, in order to understand the sorption behavior of different micropollutants into various polymers. Generalizing the sorption/desorption behavior of micropollutants into marine microplastics is not possible and careful data extrapolation should be performed based on experimental or field data.

PRIORITY ACTIONS

More studies are necessary to understand the desorption of organic chemicals from the different plastic materials under different environments e.g. in the body of seabirds, seaturtles, etc. and also when entering sensitive environments such as freshwater wetlands. It is also necessary to conduct field studies and monitoring in these sensitive environments where microplastics accumulate to verify the results observed in the laboratory.

FIGURES AND TABLES

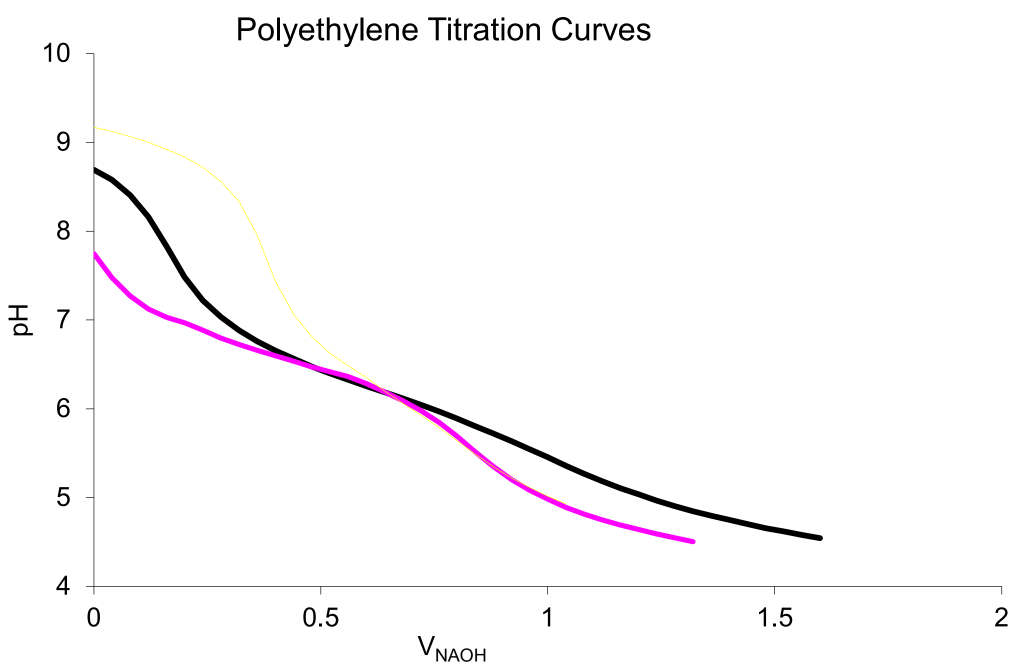

FIGURE 1: Beached polyethylene pellets titration curves show that the point of zero charge of polyethylene is 6.2. Three different masses were titrated in NaCl solution 0.1M.

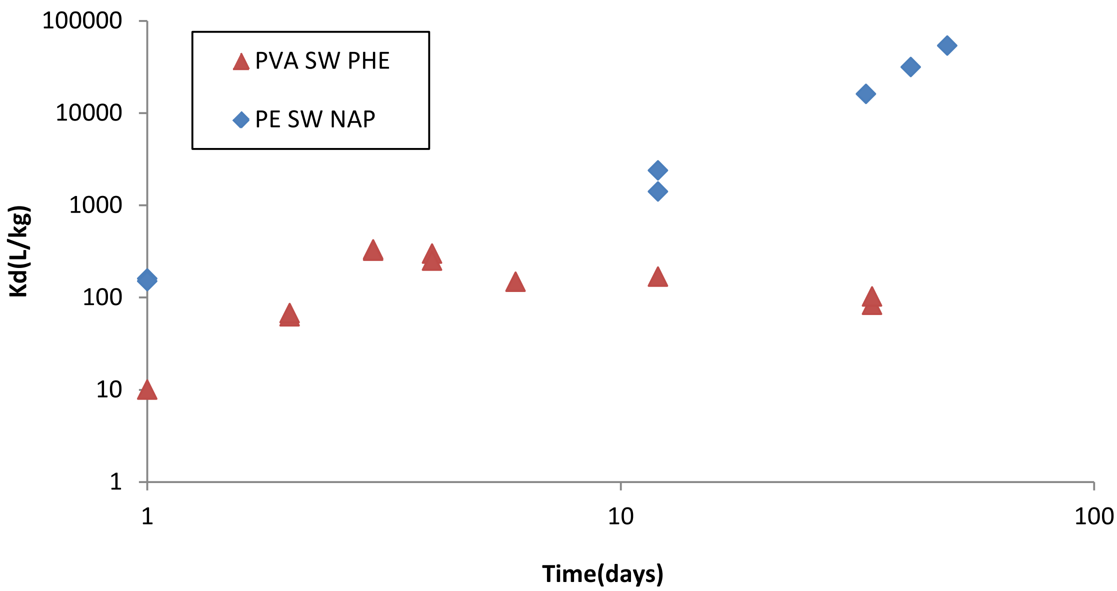

FIGURE 2: Kinetic diagram for polyvinylalcohol (PVA) (a hydrophilic material) in a phenanthrene (PHE) (a hydrophobic compound) solution and polyethylene (a hydrophobic material) in a napthpol (NAP) (a hydrophilic compound) solution in salt water (SW).

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7.c.3. Partitioning and bioavailability of persistent organic pollutants in marine plastic debris

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ABSTRACT
Plastics are known to accumulate hydrophobic organic compounds from the water phase. Microscopic plastic particles have been found to be widespread in pelagic and sediment environments since the 1970's and are known through field or laboratory observations to be ingested by many different classes of aquatic organisms, including deposit- and filter-feeding invertebrates. Recent research has identified a potential hazard to aquatic ecosystems from the transport and exposure of toxic chemicals associated with plastic debris; however, significant gaps exist in understanding the magnitude of this potential risk. In the present study, we measure the solid-water partitioning of PCBs to common marine debris materials, including polypropylene. Solid-water PCB partitioning coefficients for polypropylene were found to be on the same order of magnitude as partitioning coefficients cited in the literature for polyethylene, zooplankton and phytoplankton, and increased linearly with congener Kow. We also report the contaminant load on plastic pellets collected from a beach in the upper reaches of Chesapeake Bay. The concentration of total PCBs on plastic pellets collected in Fall 2009 was about 100 ng/g, which is comparable to PCBs on pellets found in other semi-rural locations reported by the International Pellet Watch program, a global effort to monitor concentrations of priority pollutants on plastic pellets collected along shorelines. Ongoing work is investigating the partitioning behavior of PCBs to other common plastic materials, the abundance of PCBs and pesticides on plastic collected from waterfronts in the Baltimore, MD area in summer 2010, and the digestive bioavailability of contaminants associated with plastics.

7.c.4. The role of plastic production pellets in the accumulation and transport of trace metals in the marine environment

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KEYWORDS
Plastic, pellet, microplastic, trace metal, marine,

BACKGROUND

Plastic production relies upon the transportation and processing of pellets, the raw material from which consumer items are formed. These pellets are most commonly cylinders and ovoids 1-5 mm in diameter, and may be released to the natural environment through careless handling during processing and transport [(1)].

Plastics are persistent in the natural environment, and have been shown by several studies to accumulate hydrophobic organic pollutants from natural waters [(2-5)]. Metal accumulation by plastic pellets has, however, not been considered despite the well known issue of metal loss to containers during sample storage and experiments involving spiking of trace metal standards [(6)]. In the present study we have shown polyethylene pellets to accumulate concentrations of trace metals from seawater, and have compared the behavior of virgin pellets and beached pellets.

METHODOLOGY

Laboratory based adsorption kinetics and equilibrium experiments were carried out using pellets collected from a beach in southwest England, and virgin pellets supplied by a plastics manufacturer. Kinetics of adsorption were investigated by agitating beached and virgin polyethylene pellets in filtered (0.45 μm) seawater spiked with 5 μg l^{-1} trace metals. Sub-samples of solid- and aqueous-phases were taken over a 168 hour period according to a pre-determined time series. Pellets were dried under laminar flow and subsequently extracted using dilute HCl to remove surface-bound metals. Aqueous- and solid-phase samples were analysed by inductively coupled plasma-mass spectrometry.

Adsorption equilibria were investigated by spiking seawater with a range of trace metal concentrations, and agitating for 48 hours. Following separation, trace metal concentrations were determined for solid- and aqueous-phases as above. Loss of analytes to container surfaces during incubations was also quantified.

OUTCOMES

Kinetics typically exhibited a period of rapid adsorption, followed by a more protracted increase to equilibrium. In most cases equilibrium was reached within 6 hours, while the longest time to equilibrium was 100 hours. Figure 1A shows Ni reaching equilibrium in 6 hours, and illustrates greater adsorption to beached pellets than virgin pellets. Adsorption isotherms are consistent with kinetics data, as Figure 1B shows equilibrium concentrations for Ni adsorbed to beached and virgin pellets of 0.07 and 0.008 μg g, respectively. This is presumably due to changes in pellet surface properties developed upon exposure to the natural environment, such as photo-oxidation and the accretion of biofilms on the polymer. Equilibrium concentrations of metals on beached pellets in the natural environment are likely to be greater than those predicted by these experiments, as hydrogenous metal precipitates and biofilms will progressively accumulate on pellet surfaces.

Plastics can be regarded in aquatic systems as a means of trace metal transport which has not previously been acknowledged. The mobility of plastics in the marine environment suggests that plastics may transport metals considerable distances and may afford a means for biological uptake as it is known invertebrates, fish and birds ingest plastic.

PRIORITY ACTIONS

It is important to understand the full range of environmental implications afforded by industrial plastic in the marine environment. The knowledge that plastic pellets accumulate trace metals serves to reinforce the argument for careful handling of industrial plastics.

FIGURES AND TABLES

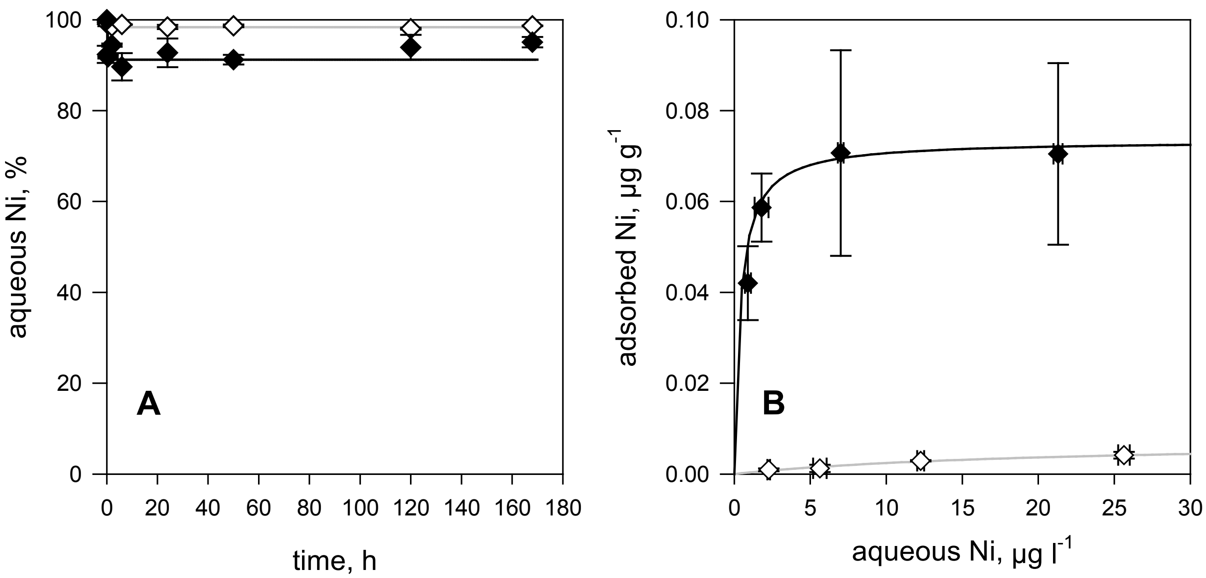

Figure 1: Time dependent adsorption (A) and isotherms (B) defining the adsorption of Ni to virgin (◊) and beached (♦) pellets. Aqueous Ni in A calculated as the aqueous % of total analytical Ni concentration. Error bars denote one standard deviation of the mean of three determinations.

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7.c.5. Understanding the occurrence of floating and beached plastics and the interaction between plastic pellets and organic micropollutants in the Mediterranean Sea

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KEYWORDS
Plastic pellets, floating plastics, microplastics, pollution, plastic fibers, organic micropollutants, Mediterranean Sea

BACKGROUND
Derraik (2002) presented a comprehensive review of studies conducted on plastic marine debris throughout the world. As reported by the author, a great deal of plastic is accumulating at the bottom of the sea but most floating plastics end on beaches. Although plastic production is increased, based on more recent observations, plastic accumulation on some beaches seems to be decreasing (Barnes et al. 2009). Since 1990, the dumping of rubbish at sea from ships has been prohibited under the international shipping regulation MARPOL Annex V. According to these authors, temporal trends of macroplastics on remote islands suggest that regulations to reduce dumping at sea have been successful to some extent. This is true for some beaches that have been surveyed on successive instances. The vast majority of the world's beaches have not been surveyed.

Most plastics break down slowly and gradually through mechanical action to result in the formation of microplastic pollution. Other plastics that contain biodegradable composites will eventually degrade but the nondegradable fraction will remain in the environment as microscopic plastic fragments. Hence, there is considerable potential for large-scale accumulation of microscopic plastic debris. Thompson et al. (2004) used Fourier Transform Infrared Spectroscopy (FTIR) to identify the plastic fibers within the sediments of 17 different beaches in the UK. Plastic fragments were present in 23 out of 30 samples from these beaches.
During their journey on the ocean surface, floating plastics are in contact with the ocean enriched surface layer or are found coated with tar (Shiber 1987; Karapanagioti and Klontza 2007). Being an organic medium they attract hydrophobic contaminants when these are present in the surrounding solution (Teuten et al. 2007; Karapanagioti and Klonta 2008). Plastics are carriers of toxic pollutants found on their journey from the release point to the sampling point (either on the sea or the beach surface) (Mato et al. 2001). Once the polluted plastic pellets are ingested, the contaminants might be transferred to the body of the organism (Ryan et al. 1988). A positive correlation between the mass of plastic pellet ingested and contaminants found in the organism fat tissue has been reported (Ryan et al. 1988; Bjorndal et al. 1994).

The Mediterranean is particularly vulnerable to floating plastic debris pollution, being a closed sea, surrounded by a large number of industrialized countries, and traversed by numerous busy shipping lanes. Also, it attracts tourists by the millions to its beaches, particularly from the northern European countries. Additionally, improper solid waste handling and disposal practices on land and also in the sea, leads to increased marine plastic pollution. The objectives of this presentation are as follows: a) to determine the presence of plastic on beaches throughout the Mediterranean Sea and b) to present the results of studies using plastic pellets as passive samplers for organic micropollutants throughout the Mediterranean Sea.

OUTCOMES

Limited studies counting floating plastics have been performed in the Mediterranean Sea. Tows were performed in Cretan Sea using an oceanographic vessel. Plastics were found in 90% of the tows at a density ranging from 1 to 1160 μg m-2, consisting primarily of fishing lines, cellophane and small plastic pieces as eroded fragments of larger items (Kornilios et al. 1998). Visual sightings of large floating debris were also performed in the Ligurian Sea, a sub-basin of the north-western Mediterranean Sea. Results for the 1997 data suggest a debris density of the order of 15–25 objects km-2, while for the 2000 data, a lower density of the order of 3–1.5 objects km-2 is found. Possible reasons for the observed variability include meteorological forcing, marine currents, and debris input variability (Aliani et al. 2003).

Shiber performed several of the early studies on plastic pellet occurrence on Mediterranean beaches in Lebanon and Spain. The occurrence of plastic pellets along the coast of Lebanon is reported for the first time in Shiber (1979). Although a variety of colours, shapes, and sizes was observed, most pellets seemed to be either an opaque-white or transparent amber colour, cylindrical to oval or round, and 2-5 mm in diameter. A random sampling was performed and the results of thermal analysis showed the pellets to be of either high density polyethylene (opaque-white pellets), polymethyl methacrylate (transparent), or polystyrene (amber). Eleven years later a follow up study demonstrated that plastic pollution in Lebanon beaches was even more pronounced than in 1977 (Shiber and Barrales-Rienda 1991). The entire of the Mediterranean coast of Spain was investigated by the same researcher (Shiber 1987). A correlation was found between the presence and number of plastic factories in the area and the abundance of plastic pellets on the beaches.

In another study, pellets collected on various beaches in Greece were mainly polyethylene and polypropylene with only a small percentage from different materials (Karapanagioti and Klontza 2007; Karapanagioti et al. 2009). Plastic pellet were present on all beaches that were investigated. In sandy beaches, it was easier to locate them since due to their lighter density than sand grains they are distributed on the top of the sand. In gravel beaches on the other hand, the pellets were mixed with the gravel and it was more difficult to locate them.

Information on the status of microplastic pollution in the Mediterranean Sea is very limited. A recent unpublished report provided by a private research institute in Greece called Archipelagos documents the presence of microscopic plastic fibers in sediments collected from various beaches of the Aegean Sea (Archipelagos 2010). The plastic fibers were separated through a density separation method that requires the suspension of the beach sediments in dense solutions. FTIR spectroscopy was used to identify and quantify the different plastic materials in the lighter fraction that was separated from the suspension. All beach sediments sampled were polluted with microplastic fibers. Mean concentration values of fibers range from 5 to 35 per 50 ml of sand sediment and maximum values of 70-75 were observed in Rhodes, Ikaria and Athens. On average, fine grained beach sediments were found to accumulate more fibers. Beaches with high accumulation of plastic litters regardless of their location demonstrated higher concentrations of plastic fibers. Sediments from beaches near developed areas and shipping lanes also showed higher concentrations of fibers.

In Mediterranean Sea, floating plastics are a significant problem in the sea and on beaches. In the last decade, a new form of plastic pollution is observed. Small fragments are observed and even worst microscopic fibers can be found in most beaches even in remote places. As plastic degrades the plastic fragments become smaller in size and that will facilitate their mobility in the food chain and also the mass transfer of the pollutants from the plastic to the organism that has ingested these fragments. Plastic pellets were successfully used as toxic organic pollutants passive samplers suggesting that in industrialized areas not only plastic pellets are present but they also carry toxic compounds.

A recent study conducted in the framework of the research program International Pellet Watch analyzed for persistent organic pollutants [PCBs, Dichloro-Diphenyl-Trichloroethane (DDTs), hexachlorohexane (HCHs)] in beached plastic pellets from three beaches in the Mediterranean Sea (Italy, Greece, and Turkey) among several other countries throughout the world (Ogata et al. 2009). For all three classes of pollutants, low to moderate pollution is observed for the three countries compared to other places in the world. In both Greece and Turkey, DDE is significantly higher than DDT suggesting that DDTs in this area originate from older applications. HCHs generally showed low concentrations without the predominance of any of the isomers. These observations reflect the worldwide ban of the usage of HCH pesticides. No current usage of the pesticide lindane can be suggested.

A more detailed study including sampling from four beaches throughout Greece determined the concentration of PCBs, DDTs, HCHs, and polycyclic aromatic hydrocarbons (PAHs) (Karapanagioti et al. 2011). The majority of the pellets collected in all four beaches were from polyethylene. Sampling was performed in a) Saronikos gulf, b) Aegena island c) Kato Achaia beach (the same beach presented in Ogata et al. 2009), and d) Lesvos island. Saronikos gulf and the Aegena island sampling points are both located close to Athens that demonstrates high industrialized activity and a production of large volume of municipal wastewater. Kato Achaia beach and Lesvos island are less industrialized areas.

The Table presents an overview of the results for the four sampling beaches and the four pollutant classes (Karapanagioti et al. 2011). PCB concentrations in Saronikos gulf and Aegena island were comparable to other industrialized areas in the world (California, Japan, etc.) whereas in the other two beaches the concentration values were two of the lowest in the world. DDTs and HCHs concentrations were four of the lowest in the world. DDT concentration values in Saronikos gulf and Aegena island suggest a recent application compared to the other two locations that the values suggest an older application (http://pelletwatchmap.web.fc2.com/). PAH concentrations in Saronikos gulf and Aegena island were significant (Table) and it was concluded that PAHs originate from pyrogenic processes (Karapanagioti et al. 2011). In the other two sampling sites, PAH concentrations in the beach pellets were not statistically different from the PAH concentrations measured in blank pellets.

PRIORITY ACTIONS

More surveillance is needed in identifying hot spots throughout the Mediterranean Sea where microplastics are accumulating. A careful study correlating microplastics transport and sea currents would help identify the sources that feed these hot spots and explain how they are formed. Also, the association of microplastics with toxic organic compounds should be better understood and a risk assessment study needs to be performed for the Mediterranean Sea that is a closed sea with sensitive ecosystem.

FIGURES AND TABLES

Table: Concentration of pollutants on the beached pellets from different sampling sites in Greece (Karapanagioti et al. 2011)

(ng/g-pellet)	Saronikos gulf	Aegena island	Kato Achaia beach	Lesvos island
∑13 PCBs	260	230	5	6
DDTs	18	42	12	1.1
HCHs	3.5	3.0	1.05	2.0
∑18 PAHs	500	180	160	100

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7.c.6. Environmental and health impacts of marine debris: plastic and chemical contaminants in juvenile yellowtail jacks (*Seriola lalandi*) from the North Pacific Gyre

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KEYWORDS
plastic, marine debris, contamination, food web, nonylphenol, ingestion, yellowtail, *Seriola*

BACKGROUND
Pollution by plastic debris is one of the major threats to marine life from human activities (Derraik, 2002). Notwithstanding the many benefits from the use of plastics, society's reliance on and failure to properly manage plastic materials has resulted in a proliferation of persistent synthetic trash in the environment (Moore, 2008). Carpenter and colleagues (1972) described polystyrene particles in the Atlantic Ocean and in fish and documented the occurrence of polychlorinated biphenyls (PCBs) on the polystyrene spherules almost 40 years ago. Further research on this subject lagged for many years, but considerable evidence now exists for the presence of various chemical contaminants in plastic resin pellets and plastic debris, including PCBs, dichlorodiphenyltrichloroethane and metabolites (DDTs), polyaromatic hydrocarbons, butyltins, hexachlorocyclohexanes, polybrominated diphenyl ethers, alkylphenols, and bisphenol A (Mato et al., 2001; Endo et al., 2005; Rios et al., 2007; Teuten et al., 2009; Colabuono et al., 2010; Karapanagioti et al., 2011). These contaminants may be adsorbed to the surface of plastic or added during manufacture and processing of plastic materials (Mato et al., 2001; Teuten et al., 2009; Thompson et al., 2009). Coupled with substantial evidence of ingestion of marine plastic debris by fish and other biota (Laist, 1997; Derraik, 2002; Gregory, 2009), the potential for marine plastic debris to be a transport mechanism and source of contamination of the food web has been suspected (Ryan et al., 1988; Mato et al., 2001; Teuten et al., 2007, 2009; Thompson et al., 2009; Frias et al., 2010).

While contaminants such as PCBs, DDTs, and others have been measured in fish from coastal waters and the deep sea (Harvey et al., 1974; Takahashi et al., 1998, 2000; de Brito et al., 2002; Ramu et al., 2006; Storelli et al., 2007), it has been difficult to establish the exact source of contamination or to link chemicals associated with marine debris to bioaccumulation in the food web. One problem is differentiating anthropogenic sources of pollutants from contaminated natural prey (Teuten et al., 2009). The objective of this study was to investigate the uptake of marine-debris associated contaminants by fish and hence into the food web.

METHODOLOGY

Nineteen juvenile yellowtail (*Seriola lalandi*) were collected by hook-and-line from the North Pacific Ocean, over 1800 km from the coast of California. The fish were caught at 34° 33.34′ N, 142° 22.80′ W on August 13 (1118 PST) and at 34° 40.61′ N, 142° 33.46′ W on August 15, 2009 (1500 PST) in the vicinity of large derelict fishing nets. Surface plankton tows conducted for one hour on the same sampling days, within ~10 km of the yellowtail locations consistently yielded samples of microplastics, fragments between 333 µm and 5 mm (NOAA, 2009). Whole body yellowtail samples were frozen at -20°C until analyzed. Fish ranged from 137 to 220 mm total length and weighed 25.5 to 100.5 g. The samples were dissected on March 18, 2010, while partially thawed, to separate digestive tracts and other organs from other body tissues. The remaining body tissues and digestive tracts were refrozen separately for future analysis. Digestive tract contents were examined with 25 x power and 8 x eyepieces with a stereoscopic dissecting microscope (Wild M5) on August 25, 2010. Prey items were only generally identified because the purpose was to determine presence or absence of plastic debris.

Body tissues were analyzed for phthalates and surfactants at the California Department of Fish and Game Water Pollution Control Laboratory. Six phthalates (bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, di-n-butylphthalate, diethyl phthalate, dimethyl phthalate, and di-n-octyl phthalate) were extracted from freeze-dried fish tissue using pressurized fluid extraction followed by gel permeation clean-up (GPC), and analysis by Gas Chromatography Tandem Mass Spectrometry (GC/MS/MS). Estimated method detection limits and reporting limits were high (200 and 500 ng/g dry weight, respectively) due to small amounts of tissue (0.5 g) available for analysis. Nonylphenol (NP, CAS# 84852-15-3) and nonylphenol ethoxylates (NPE, CAS# 9016-45-9) were extracted from freeze-dried fish tissue with methanol. High Performance Liquid Chromatography with Fluorescence Detection (HPLC-FLD) was used for identification and quantitation. Estimated method detection limits and reporting limits for NP and NPE were 100 and 200 ng/g dry weight, respectively, based on freeze-dried weight and limited sample size.

OUTCOMES

Of the 19 stomach samples, two contained plastic debris consisting of 1) a blue fragment ~ 0.5 x 1 mm and 2) synthetic filament ~ 6 mm in length. Prey items included mainly copepods and other crustaceans, and chaetognaths. Three individual yellowtail stomachs also contained fish remnants. The ingestion of plastic debris represents 10.5% exposure in this sample, with 95% confidence limits on the probability of exposure of 1.30% to 33.0%. The results of analysis of phthalates were inconclusive due to apparent contribution of phthalates from laboratory reagents, potential contamination of control tissues, and small sample mass. Six of 19 yellowtail samples had detectable concentrations of nonylphenol ranging from 435 to 1146 ng/g dry weight. None of the samples had detectable concentrations of nonylphenol ethoxylates.

Nonylphenol is produced in large volumes and is used in the production of nonionic surfactants, widely used as detergents, emulsifiers, and wetting agents in consumer and industrial products such as paints, plastics, cosmetics, lubricant oils, construction materials, and paper. Nonylphenol is the predominant environmental biodegradation product of the surfactants, and it is ubiquitous, moderately persistent and bioaccumulative, and extremely toxic to aquatic organisms (U.S. EPA, 2010). Nonylphenol can also leach from plastic where it is used as a stabilizer. The occurrence of nonylphenol in the environment is correlated with human activities such as wastewater treatment, land filling, and sewage sludge recycling (U.S. EPA, 2010), none of which is likely to impact ocean water over 1,800 km from these urban sources. Given their small size and age (Gillanders et al., 1999), it is equally unlikely that the juvenile yellowtail migrated from coastal areas. The findings reported here indicate exposure of juvenile yellowtail to marine plastic debris and to nonylphenol. Because there is no other apparent source of nonylphenol in the open ocean, its presence in yellowtail points to plastic debris as the source.

Nonylphenol in the environment has raised concerns because of its effects on the endocrine system. Experimental studies with fish exposed to waterborne nonylphenol suggested estrogenic and other reproductive effects. Further research is needed to assess effects on populations of yellowtail (and other marine species) from exposure to nonylphenol and other marine debris-associated chemicals. Food web contamination is indicated by these findings as yellowtail (and other small fishes in the surface layer where microplastics occur) can serve as prey for foraging seabirds. Furthermore, adult yellowtail is a popular human food. The detection of nonylphenol in these fish provides the first evidence for contamination of the food web (including human food) from chemicals associated with marine debris. While juvenile yellowtail might metabolize nonylphenol as they mature, the possibility exists that more persistent contaminants in plastic debris, such as PCBs, bioaccumulate and pose a risk to human health as well as other fish, birds, invertebrates, and marine mammals that prey on yellowtail.

PRIORITY ACTIONS

To reduce risk from exposure to chemicals associated with marine debris, dedicated research is needed to develop materials and products that are bio-based (derived from renewable sources) and biodegradable in marine and fresh waters as well as alternatives and safer substitutes for toxic chemicals currently in use in plastic production

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7.d.1. Aerial surveys and derelict fishing gear removal along main Hawaiian Island nearshore environments: a case study

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ABSTRACT
Throughout the main Hawaiian Islands (MHI), derelict fishing gear (DFG) poses both ecological and economic threats. Ecological threats include potentially lethal entanglement hazards to the endangered Hawaiian monk seal, the threatened green sea turtle and various bird species; damage to coral reefs; and a potential conduit for the accelerated introduction of alien species. Economic threats include hazards to boat navigation and fouling of beaches and coastal habitats where DFG poses pollution problems and creates visual blight, affecting recreation and tourism. In 2006, NOAA's Pacific Islands Fisheries Science Center conducted aerial DFG surveys along six main Hawaiian Islands to characterize the extent of DFG accumulation along nearshore environments. Data from these surveys indicated the widespread existence of DFG along MHI shores and provided insight into DFG accumulation patterns. These surveys resulted in a pilot DFG removal effort on O`ahu in 2006, where 16,745 kg of DFG were removed; DFG removal along the remote, northern shores of Lana`i in 2007 totaled 17,400 kg of DFG ; and aerial resurveys of seven MHI were conducted in 2008 with 5,941 kg of DFG removed on O`ahu. This project represents a case study of a large-scale DFG removal effort in both remote and non-remote shoreline locations. It also discusses the methods, tools and approaches utilized. We discuss logistical challenges met for operations in remote areas and varying coastal habitats, safety hazards, and disposal methods of removed DFG. Proper tools, resources and approaches were identified to maximize efficiency and safety to improve future DFG removal efforts.

7.d.2. Seven years "net" progress a.k.a. picking up the pieces on Hawai'i Island

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KEYWORDS
Community-based, volunteers, beach cleanups, derelict fishing net, marine debris, effective removal methods, Nets-to-Energy program

BACKGROUND
Hawai'i Wildlife Fund (HWF) regularly collects marine debris along nine miles of the southeast coast of Hawai'i Island. This lava-dominated stretch of coastline is highly susceptible to marine debris accumulation and is one of the largest "sinks" for marine debris within the main Hawaiian Islands. Initial debris collections began in 2003, and removal efforts continue with community-based volunteer events every other month. Cleanup efforts focus on protected coves, rocky shores, and two large sandy beaches; this coastline has an estimated accumulation rate of 15 -20 tons/year. Most of the marine debris weight recovered is large bundles of derelict fishing gear. However, smaller non-net materials make up most of the volume of debris collected.

HWF has developed efficient removal methods for marine debris on opposite ends of the size spectrum. Net bundles weighing up to two tons are removed and shipped to O'ahu as part of NOAA's Nets-to-Energy program. In addition, HWF uses simple sorting mechanisms to separate and remove small plastic pieces from beach sand. To date, HWF has collected over 130 tons of debris from this shoreline, and continues to investigate more efficient collection methods and new partnerships. This work is funded by the NOAA Marine Debris Program, with in-kind support from hundreds of volunteers, and numerous local businesses and organizations.

METHODOLOGY
In addition to the typical "bend-over-and-pick-it-up" method employed at most community beach cleanup events, HWF has incorporated several alternative techniques to their marine debris recovery arsenal. Derelict fishing gear (DFG) accounts for over 65% of the total marine debris (by weight) HWF has collected along the Ka'ū shoreline over the past seven years. Most DFG washes ashore as tangled bundles of nets and line that are impossible for people to lift, or too heavy to lift without risk of personal injury. For recovery of these bundles, HWF has mounted a four-ton capacity winch on a pipe rack over the cab of a pickup truck. The steel wire cable of the winch hooks to log-skidding tongs that easily grab the net bundles (see Figure 1). The pickup truck has been specially modified to dump, facilitating net loading and unloading with minimal human labor. We also use a military surplus 8' bed, ¾ ton trailer to enable extra DFG load recovery in a single trip to our remote sites.

At some shoreline locations, DFG is thoroughly tangled into large lava rocks and must be freed. Applying tension on the bundle with the winch allows easier cutting off the rocks with anvil-style pruning shears (or anvil razor blade). Anvil-style cutters are much more effective at cutting net and line than bypass tools, and knives with replaceable razor blades are preferable to fixed-blade tools since the latter dull quickly when cutting nets laden with sand and salt.

When approximately seven tons of DFG have been collected, nets are loaded into a 40' shipping container and transported by Matson to Honolulu as part of NOAA's Nets-to-Energy program. Upon arrival, Schnitzer Steel chops the nets and they are burned in Covanta Energy's H-Power Plant to produce electricity. Using these methods, specialized truck rigging, tools, and partnerships, a one-ton net can easily be removed from the coast and disposed of properly.

While net bundles are the largest debris objects removed, smaller plastic "confetti" is more troublesome to remove than typical debris items. These micro (<5mm) and small-sized (<20mm) objects are usually a mixture of nurdles and other miscellaneous fragmented plastic pieces. Core sample estimates found that 95% of this plastic confetti lies within the top 15cm of beach sand at Kamilo (Dr. Hank Carson, University of Hawai`i-Hilo, personal communication). While over 50% of manufactured plastics are negatively buoyant and will sink when submerged in water (US EPA 2006), all of the marine debris plastics found on Hawai'i Island's remote southeastern coast floated to shore. To recover this confetti, HWF has begun to "sift" through the top layer of beach "sand" using a large plastic tub (concrete mixing tray), shovel, seawater and a small aquarium net to skim off the surface of the water (see Figure 2). This technique enables volunteers to separate and remove plastic from the sandy beach. The large tubs are filled with seawater, and beach "sand" is added using a shovel. A sifting tray with 12mm mesh wire placed over the tub catches larger items (driftwood pieces, etc.), while the true beach sand (lava, basalt, coral) sinks and floating plastic is skimmed from the surface with small nets. This process is repeated, and remaining washed sand at the base of the tub is returned to the beach.

Two other sifting methods are employed to sort plastic from sand. Shovels perforated with small 8mm diameter holes (see Figure 2) are used to pick up and filter plastic from the sand. These shovels enable the sand and all objects smaller than 8mm to fall through the shovel. We also built sifting screens with 12mm mesh wire (see Figure 2) that are handled by two people while a third person shovels sand into the sifting tray (these sifters can also be used with the above floating tub method). Wire mesh size can be changed depending on desired sorting size.

OUTCOMES

HWF's Marine Debris Project leads community volunteer efforts to remove a broad size range of marine debris items, from massive net bundles to tiny nurdles. Few community-based volunteer beach cleanups attempt to remove large derelict fishing gear, perhaps in part because appropriate equipment for removal is not available and the partnerships for disposal are lacking. We've developed an efficient method for onshore removal of large DFG bundles that others could modify to suit their own DFG recovery needs.

We present a novel method for removing micro-plastics from sandy beaches. Some have used flotation of plastic pieces in scientific studies (Ryan & Moloney 1993, Ogi & Fukumoto 2000, McDermid & McMullen 2004, Thompson et al. 2004, Reddy et al. 2006), but we are unaware of others employing this method as part of any removal effort. At sites where sand contains a large fraction of plastic by volume, efficient removal of such plastic confetti should be addressed.

Since 2003, HWF and more than 750 volunteers have removed over 130 tons of marine debris from Hawai‘i Island’s southeast coast. Cleanup events take place about every other month and typically yield 65% (by weight) of DFG and the balance in miscellaneous marine debris. Compared to some ship-based removal efforts of entangled nets in Hawai‘i that can cost $25,000 per ton (Wiig 2005), HWF’s shore-based debris retrieval operations are relatively inexpensive at $589 per ton (plus volunteer time). If Hawai‘i is indeed the final destination for most North Pacific debris (Maximenko & Hafner 2010), stewards of debris “sinks” will shoulder the burden of removal and establishing more efficient cleanup methods will be crucial.

At this time community investment in the project is high, and continued action is required to maintain strong relationships with local stakeholders. Sustained volunteer effort encourages a much-needed sense of stewardship among community members in this region. Local fishermen and residents cooperate with HWF by pulling DFG above the tide line for later removal. Still, we sometimes observe net bundles washing back to sea before we can remove them. Prompt removal of DFG is necessary to ensure that nets do not refloat and endanger wildlife.

PRIORITY ACTIONS

HWF’s primary goal in attending this conference is to disseminate the lessons that we have learned over the years about shoreline marine debris removal to other small community groups and non-profits. Our secondary goal includes sharing the need for continued coastal management in southeast Hawai‘i, as debris accumulation rates will not likely decline in the near future. As such, we will continue to exchange information with users, to engage community support, to investigate more efficient collection methods, and to create alliances with other players in the marine-debris field to make all our concerted efforts more effective.

FIGURES AND TABLES

Figure 1. Net loading with winch and tongs.

Figure 2. Sifting and floating small debris.

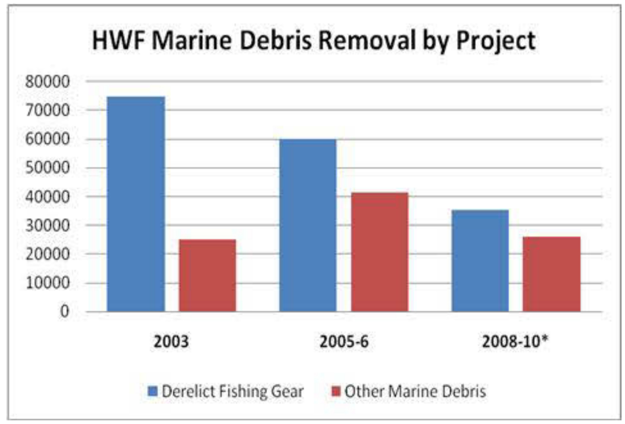

Chart 1. HWF Marine Debris Removal by Project. This bar graph shows the breakdown in marine debris weight (lbs.) by type and year. *These bars reflects project totals through early January, project ends June 2011.

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7.d.3. Using volunteer and professional crews to clean remote northern Gulf of Alaska beaches

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KEYWORDS
Insurance, injury, expertise, logistics, cost per pound, efficiency, volunteer, professional, liability waiver, safety

BACKGROUND
The problem statement is simply this: In a remote and potentially dangerous coastal environment, such as that found in the Gulf of Alaska, what are the relative benefits and disadvantages of using volunteer cleanup crews or experienced professional cleanup crews to remove marine debris.

This presentation will discuss the lessons learned from 9 years of volunteer cleanup projects and 5 years of professional cleanup projects.

OUTCOMES
Marine debris removal, disposal, recycling, and prevention in remote areas of the northern Gulf of Alaska are difficult and expensive, whether using volunteer or professional workers. From comparing nine years of volunteer and professional cleanups, it is clear that professional crews have many advantages, but in the right conditions, volunteer cleanups are worthwhile.

On remote dangerous coastlines, professional crews are more cost effective, safer, and more thorough than volunteers. However, on more easily accessible beaches, volunteers bring the advantages of numbers, large in-kind contributions, and valuable public outreach. Volunteer cleanups demand a significant amount of organizational effort and logistical support that professional cleanups do not.

PRIORITY ACTIONS
In remote, potentially dangerous cleanup sites, professional crews are safer, more thorough, and more cost effective than volunteer crews. However, volunteer cleanups provide an opportunity for large in-kind matching contributions, substantial public outreach, and in accessible areas, successful cleanups.

7.d.4. Removal and disposal methods used in Alaskan marine debris cleanups

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KEYWORDS
Alaska, marine debris, debris removal, debris disposal, debris recycling

BACKGROUND
Alaska has more than 33,000 miles of coastline, some of it is flat, sandy or pebble beach, but most is rugged and accessible only by boat or air. Commercial, subsistence and sport fishing occurs in all Alaskan marine waters. The fisheries are completely Americanized now but as recently as the 1960s and 1970s, the National Marine Fisheries Service reported an average of 697 Japanese vessels and 453 Soviet vessels fishing off of the coast up to the 12 mile limit. Now, more than 11,000 salmon permits are fished annually and hundreds more vessels participate in crab, shrimp, cod and Pollock fisheries in the Gulf of Alaska and Bering Sea. In addition to the fishing debris generated by fisheries in domestic waters, the current flow is such that debris from south and east of Alaska is also deposited on Alaskan shores. To date, more than 2 million pounds of debris have been removed by Marine Conservation Alliance Foundation (MCAF) projects since 2003 as well as additional debris removed by other projects covering only a fraction of the most accessible coastline. Debris depositions rates of up to 300 lbs per 100 yards have found.

Marine debris in Alaska is unlike that found along the remainder of the eastern Pacific coast. Although the ubiquitous plastic water bottles are found, a large part of it is fishing gear comprised of nets and lines which tend to be in large heavy pieces and wrap around objects such as logs and rocks on the beach or become partially buried. Along with the rugged coastline, the often cold and windy climate, the remoteness and lack of access to bring in mechanized tools, makes removing debris extremely difficult and sometimes dangerous.

METHODOLOGY
Beach Access To date, most of the projects have been in the vicinity of towns and villages where access has been via a road to a beach access point. Once on the beach, All Terrain Vehicles (ATVs), or trucks are used. The ATVs often have trailers in order to haul the debris to a staging area.

In some areas, vessels provide the only means of access and removal. In some cases the vessels leave and return on a daily basis. In other cases, the crews live aboard the vessel. They clean until the vessel is loaded at which time they steam to town to deliver the load of debris returning after the unloading. Often the most difficult and dangerous part is getting off of the beach with an inflatable raft or skiff full of debris. Some projects have used helicopters and lines to remove supersacks full of debris from the beach.

Debris cleanup Debris removal is primarily human labor. Crews walk the beach placing debris into plastic garbage bags. However, much of the debris is larger than what will fit into a plastic bag carried by a crew member. Nets in particular may require several crew members to work together. Often only hand tools including knives, shovels, come alongs and pry bars are available for extraction, however, in some cases vehicles may be used to free the debris.

If the beach is accessible for trucks and ATVs, the bags and nets are placed at the top of the beach and picked up by the vehicles. If not, each bag must be carried to a staging area where it will either be loaded onto a truck or ATV with a trailer or into an inflatable raft or skiff and taken to a vessel. Either way, the debris is then taken to a site where it is sorted, weighed and cataloged.

Disposal Ingenuity and resourcefulness has allowed many projects to successfully remove marine debris from Alaska's beaches. However, the remoteness of the beaches and communities and the general lack of facilities in Alaska make proper disposal impossible in many cases. If there is access to a road system, a larger town or a method of shipping, some of the debris may be recycled. We have worked with Skagit River Recycling in Washington to do this. In some cases we have also shipped debris to a proper landfill outside of Alaska. However, unfortunately, much of the debris goes into local landfills, many of which are filling up fast and have their own problems.

OUTCOMES

Through backbreaking physical work, more than 2.0 million pounds of debris has been removed from Alaska's beaches. We have developed many innovative means to access and remove marine debris from Alaska's beaches but now we need to look for new and innovative ways for the future. We have been able to recycle only a small fraction of the debris and to remove only a portion to proper landfills. We have done many of the easiest, most accessible beaches and one of the challenges will be to find ways to work in even more remote areas in an efficient and economic manner.

PRIORITY ACTIONS

Develop more efficient ways for accessing and working on beaches further from communities. Look for new means to recycle and properly dispose of marine debris.

7.e.1. The Lay of the land: single-use plastic pollution policy, regulatory and legislative approaches in California, the USA and beyond

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KEYWORDS
Bottle caps, California, Clean Seas Coalition, Extended Producer Responsibility, Nurdles,, Plastic Pollution, Polystyrene, Smoking ban, Target reductions of trash, Total Maximum Daily Loads (TMDLs)

BACKGROUND
Plastic pollution, the largest component of marine debris, is a global problem that threatens marine life, ocean environments and local economies. Single-use plastics such as cigarette butts, bottle caps, plastic bags and polystyrene pieces are frequently found during creek and beach clean-up events and are a large component of plastic pollution.

OUTCOMES
America has focused on "recycling," rather than the first "R"-- reduce. To date, state and national efforts have also been aimed at litter education and collection, not extended producer responsibility, or other means of source reduction. To stem the growing tide of trash, California and other states are now exploring a variety of policy, regulatory, and legislative approaches designed to reduce litter generation.

California has initiated policy efforts such as the Ocean Protection Counsel's Resolution on Reducing and Preventing Marine Debris (2007) and subsequent Implementation Strategy for Reducing Marine Litter (2008). These policies respectively call for target reductions of trash within a set timeline, and prioritize state efforts for source reduction of "worst offender" plastics like cigarette butts, plastic bottle caps, plastic bags and polystyrene. The Implementation Strategy also prioritizes extended producer responsibility for packaging waste, which has already been embraced in Canada, the EU and other countries. The Resolution and Implementation Strategy have yet to be fully implemented in California, or embraced by multi-state efforts to address plastic pollution, but remain critical templates for state, as well as national and international action.

California and Washington DC have also undertaken significant regulatory efforts like trash Total Maximum Daily Loads in NPDES permits under the Federal Clean Water Act. These regulations are effective means of controlling trash and should be replicated where possible, but can be limited in scope, and expensive to develop and implement. California is also considering additional state policies on trash that may be a path to more leveraged regulation of trash.

California has passed legislation on best management practices for pre-production resin pellets ("nurdles"). This law could be adopted elsewhere, and ideally would be further expanded to include places under federal inspection and enforcement jurisdiction, like ports and railroads. The California legislature is currently considering legislation for plastic bag bans and polystyrene bans (to date, 48 California jurisdictions have banned polystyrene containers), and has previously considered legislation for a smoking bans on beaches, and leashing plastic bottle caps to bottles. Moreover, California and other states are seeking to pass extended producer responsibility framework legislation as well as legislation for specific products. All are legislative efforts to consider replicating in other states and countries; all of these types of legislation can drive source reduction of plastic pollution.

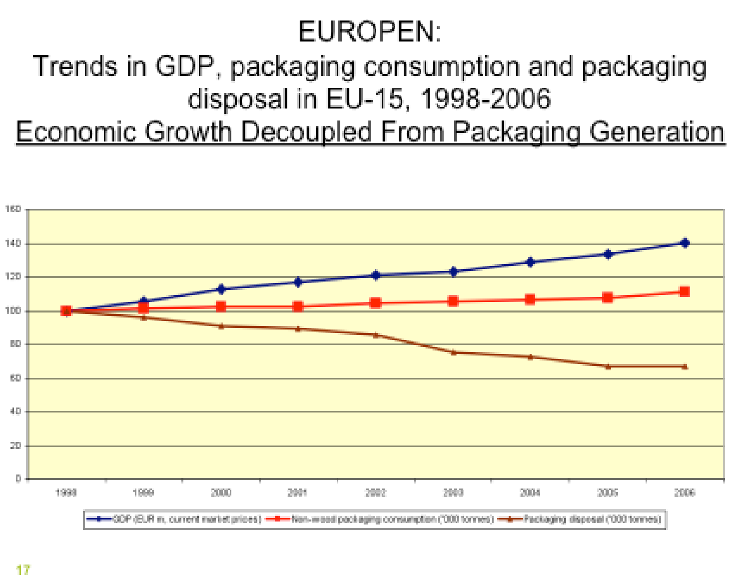
By exploring current policy, regulatory and legislative efforts, stakeholders can better understand the successes and challenges of the various approaches and move forward armed with critical knowledge.

PRIORITY ACTIONS

As in the California Marine Debris Resolution (2007), local municipalities, states, and nations should move to establish target reductions of plastic pollution within a specified time frame. Target reductions will allow all levels of government to choose from a full menu of policy, legislative and regulatory options to achieve targets, including regulations like trash TMDLs; legislation like best management practices for nurdles; bans for sustainability gateway bills like single-use plastic bags and polystyrene; and extended producer responsibility legislation like leashing bottle cap lids, and EPR framework legislation.

As the California Implementation Strategy (2008) recommends, implement Extended Producer Responsibility for packaging waste, and ban items that are likely to become plastic pollution and have readily available alternatives (such as reusable bags), and establish fees for those items that are likely to become plastic pollution and do not have readily available alternatives.

FIGURES AND TABLES



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7.e.2. Working to end plastic bag pollution in California.

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KEYWORDS
plastic pollution, plastic bags, paper bags, single-use bags, California, Clean Seas Coalition, American Chemistry Council, Total Maximum Daily Loads (TMDLs), Target reductions of trash

BACKGROUND
Plastic pollution, the largest component of marine debris, is a global problem that threatens marine life, ocean environments and local economies. Single-use plastics, such as plastic bags, bottle caps, and polystyrene pieces, are frequently found during creek and beach clean-up events and are a large component of plastic pollution. Plastic bags, in particular, have been a common target for policy-based approaches to pollution prevention at local, state and national levels.

Despite the buildup of the momentum in California, the last four years have demonstrated that it is not easy to pass single-use bag legislation at the state level. However, local policies continue to move forward at a fast pace. By exploring the policies already undertaken, stakeholders can better understand the successes and challenges of the various approaches and move forward with critical knowledge about how ensuing regulatory and legislative changes have fared.

OUTCOMES
Since 2005, the introduction of single-use bag legislation has been steady in the California legislature. In 2006, AB 2449 (Levine) was signed into law. This law created an in-store recycling program for the collection and recycling of plastic "carry out" bags, which has done little to reduce plastic bag pollution. Several bills in recent years have proposed placing a charge on single-use plastic, paper and compostable bags with the majority of the funds collected going back to local governments for single-use bag pollution abatement (AB 2869 [Levine]; AB 68 [Brownley]; AB 87 [Davis]). Not only have fee policies worked well in reducing bag usage in countries such as Ireland, but the funds generated can also help budget-strapped communities. However in part due to the economic downturn in recent years, the California legislature has not been willing to pass a bag bill that places a charge on the consumer. Most recently AB 1998 (Brownley) proposed a ban on single-use plastic and compostable bags and an at-cost charge on paper bags. Of note the California Ocean Protection Council's *Implementation Strategy to Reduce and Prevent Ocean Litter* recommends banning single-use items that are a significant ocean litter threat where there are readily available alternatives. This legislation garnered wide support from many unique stakeholders. However given heavy industry opposition from the American Chemistry Council and plastic bag manufacturers and distributors, the bill did not pass the California Senate. Single-use bag bills have also been introduced in California and other states this year.

Despite the slow action at the state level, local municipalities are moving forward single-use bag polices at a fast pace. In March 2007, the City of San Francisco became the first U.S. city to ban single-use plastic bags at large supermarkets and pharmacies. More recently Los Angeles County, City of San Jose, Marin County, City of Santa Monica and City of Calabasas moved forward ordinances that ban single-use plastic bags and place a charge on recycled paper bags. Los Angeles County adopted a Countywide Environmental Impact Report for their ordinance. It is designed to be used by any of the 88 cities in Los Angeles County that are interested in adopting similar ordinances and will hopefully streamline the process for these cities to move forward on policies.

Ideally, California will have a statewide policy that bans plastic and compostable single-use bags and bans or places a charge on paper bags at all large supermarkets, pharmacies, and convenience stores in the near future. This would lead to the greatest reduction in single-use bag pollution and would drive consumers toward reusable bags, the environmentally preferable alternative. Banning bags in California will also serve as a type of "gateway" bill for consumer education about sustainability. However in the meantime, local momentum on the issue is making significant headway that should help push the state to enact a statewide policy.

PRIORITY ACTIONS

In order to reduce single-use plastic bag pollution, local municipalities and state and national legislatures should move forward policies that ban or place a charge on single-use bags.

As in the California Ocean Protection Council Marine Debris Resolution (2007), local municipalities, states, and nations should move to establish target reductions of plastic pollution within a specified time frame. A call for reductions will allow all levels of government to choose from a full menu of policy, legislative and regulatory options to achieve targets, including bag bans.

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7.e.3. Plastics, litter, and the Precautionary Principle: carrots and sticks in San Francisco.

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BACKGROUND
San Francisco occupies the tip of a windy peninsula. Litter is expensive to clean up and can make its way into the bay and ocean.

San Francisco has implemented extensive zero waste, litter abatement and toxics reduction policies and programs. The oral presentation highlights some of these efforts, including the City's Plastic Bag Reduction, Food Service Waste Reduction and Mandatory Recycling & Composting ordinances.

OUTCOMES
San Francisco achieved 77% landfill diversion in 2008, exceeding its goal of 75% diversion by 2010. Its policies have reduced litter and marine debris, conserved resources and improved its nation-leading recycling and composting programs.

PRIORITY ACTIONS
Require producer takeback of products to internalize responsibility and recovery costs, and encourage redesign. Put deposits on products to ensure high capture rates and reduce litter (e.g., bottle bills). Institute charges, fees or taxes for items to reduce their use and provide program funding. Ban problem products, especially when entrenched interests oppose other regulatory options. Advocate for such measures with government, producers and publicly.

7.e.4. Surfrider Foundation law & policy advocating for local change: municipal ordinances addressing marine debris

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KEYWORDS
rise above plastics, advocacy, municipal ordinance, bag ban, polystyrene, legislation

BACKGROUND
This presentation will focus on the local education and advocacy initiatives of Surfrider Foundation's Rise Above Plastics ("RAP") program, with the mission to reduce the impacts of plastics in the marine environment by raising awareness about the dangers of plastic pollution and by advocating for a reduction of single-use plastics and the recycling of all plastics.

METHODOLOGY
The RAP program has helped to effect local change by first raising awareness of the harms of marine debris on our ocean environment, and then supporting sound and balanced local policy efforts to address these harms.

The talk will also present on Surfrider Foundation efforts through advocacy at the local state and region-wide levels and also through public-private partnerships, such as the giveaway of reusable bags and partnerships with local grocery stores (such as Ralph's and Safeway) to promote the utilization of reusable bags. Suggest local and state government tactics to address ocean litter include:

- Bans and fees on commonly littered items, such as cigarette butts, plastic bags, food wrappers, caps and lids, and beverage bottles. (ENDNOTE 1)
- Surcharges on products that easily become ocean litter that will both deter the unnecessary purchase of these items and generate funds to support clean up and prevention efforts.
- Stronger stormwater pollution controls and low impact development advancements. For instance, agencies can require best available technology for catch basins and stormwater controls. The California State Water Resources Control Board's Trash Policy that is currently being promulgated may be able to serve as a guide for these efforts.
- Stronger enforcement of existing litter laws.

OUTCOMES
The talk will present case studies from the Surfrider Foundation's successful and unsuccessful grassroots activism efforts geared at reducing land-based debris, including:

Bigger Better Bottle Bill in New York – In April of 2009, environmental groups across the state of New York, including the New York City Surfrider Chapter helped to pass this first major overhaul of the state's bottle deposit law since 1982. The law expanded the bottle return regulations to include water bottles, which comprised nearly a quarter of all beverages sold in New York. The law also required beverage vendors to return at least 80% of the unclaimed bottle and can deposits to the state, generating upwards of $115 million annually for the state General Fund.

Washington DC single-use bag fee - This 5-cent fee on single-use bags that was implemented in Washington, DC in January of 2010. Initial studies of this fee project that single-use bag usage was down 60% and the fee was put toward restoration of the local Anacostia river. The Surfrider Foundation DC Chapter garnered a major win in this case, after an integrated outreach and advocacy campaign to support the ordinance, entitled the Anacostia River Cleanup and Protection Act.

Seattle plastic bag regulation (failed) - Seattle City Council successfully imposed a 20¢ fee on single-use plastic bags in 2009, only to have the fee overturned through an industry-sponsored voter proposition. The proposition was the subject of a great deal of media and public lobbying efforts by those opposing the fee. There is currently no regulation on single-use plastics bags.

Expanded Polystyrene Bans in Santa Cruz County, CA - In March of 2009, Santa Cruz County went entirely foam-free with Watsonville as the final city in the county to ban foam. The ordinance bans expanded polystyrene take-out food containers at businesses selling food for immediate consumption. Santa Cruz City was first to pass an ordinance in April of 2008.

Expanded Polystyrene and Plastic Foodware Ban in Seattle, WA- In July of 2008, the Surfrider Seattle Chapter helped pass a foam ban that would be implemented in two stages. First, in January 2009, containers such as clamshell boxes at takeout restaurants were banned. In July 2010, the ban expanded to include plastic utensils and plastic food containers, requiring businesses to switch to compostable.

Plastic Bag Ban in Malibu, CA – In May of 2008, Surfrider Foundation along with support from Heal the Bay and the local Boys and Girls Club, successfully advocated before the Malibu City Council for a single-use plastic bag ban, including biodegradable bags, which do not break down in the ocean.

Plastic Bag Ban in Kauai, HI – Surfrider Foundation's Kauai Chapter worked for two years on a campaign to ban single-use plastic bags on their island and were successful in October of 2009. The successful advocacy was based on island-wide education efforts, including two radio commercials raising awareness regarding the threat to marine life posed by plastic bags.

San Diego Reusable Bag Giveaway – In promoting the reuse of common items such as grocery bags and water bottles, Surfrider Chapters frequently partner with local grocery stores and farmers markets to hand out reusable bags and inform the public of the advantages of bringing your own bag. . By way of example, our San Diego County Surfrider Foundation chapter has given away over 7,000 reusable bags in the past year. These bags were purchased with grant funding and were made in the United States from recycled cotton.

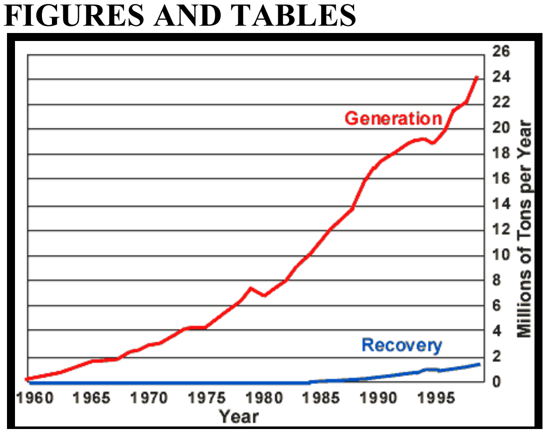
Statewide plastic bag efforts of California (failed) – For the past three years, there have been plastic bag reduction bills introduced in the California state legislature. The bills were in the form of fees (e.g. AB 68 for a 25 cent charge on plastic bags) or bans. For instance, most recently in 2010, AB 1998 was introduced by Assemblymember Julia Brownley and passed through the Assembly with approval. However, once the bill came to a final Senate floor vote, it narrowly failed to pass by a margin of 7 votes. It also had the pledged support of Governor Arnold Schwarzenegger to sign it, if it had reached his desk. The Governor was very disappointed in the failure of the bill and held a follow up press conference that encouraged cities to pass their own local legislation banning single-use bags.

The presentation will focus on our efforts to promote sustainable litter prevention policies (especially in relation to plastic bags and expanded polystyrene) at the city, county and state level throughout the United States. As Surfrider has learned from the above list of successes and failures in the advocacy arena, it is imperative that the locality has the public will to regulate marine debris items. This comes through the foundation of public education about the perils of single-use plastic and how it affects the ocean. For this reason, Surfrider's advocacy efforts are always closely tied to public education and awareness components of our campaigns. Even if an advocacy initiative fails to pass in the political arena, the purposes of our Rise Above Plastics program are served if more people understand and engage in protecting the coastal environment.

PRIORITY ACTIONS

To reduce the vast amount of land-based marine debris, implement bans and fees on easily littered items. Bans are more appropriate for items that are likely to become marine debris and have readily available alternatives (such as reusable bags). Fees are more appropriate for items that are likely to become marine debris and do not have readily available alternatives.
Establish target reduction or reduction requirements of plastic pollution within a specified time frame, such as the California Ocean Protection Council's Marine Debris Resolution of 2007.
Recommend a strong commitment from the marine debris community, including governmental agencies, to prioritize addressing land-based marine debris (over ocean-based debris) since this type of marine debris comprises up to 80% of the plastic in our ocean. (See ENDNOTE 2)

FIGURES AND TABLES



Graph located in California Integrated Waste Management Board's "Plastic White Paper" to illustrate the generation and recovery of plastic packaging in the solid waste stream in the United States. Data from 1999 U.S. EPA report. (ENDNOTE 3)

REFERENCES

ENDNOTE 1: Ocean Conservancy, "Trash Travels: 2010 international Coastal Cleanup Report" (2010), at p.11 (listing the top ten marine debris items).

ENDNOTE 2: California Ocean Protection Council, "An Implementation Strategy for the California Ocean Protection Council Resolution to Reduce and Prevent Ocean Litter," (November 20, 2008) at p. 3: *See also* http://blogs.discovermagazine.com/80beats/2009/08/03/ships-set-sail-to-examine-the-vast-patch-of-plastic-in-the-pacific-ocean/ and http://www.cleanupday.org/education.htm

ENDNOTE 3: *Municipal Solid Waste in the United States 1999,* prepared by Franklin and Associates, Ltd., Washington, D.C., 2000.

www.surfrider.org/wins

8.a.1. Engaging the fishing community through the Fishing for Energy partnership

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KEYWORDS
Derelict Fishing Gear, Fishing for Energy, Public-Private Partnership, Commercial Fishermen

BACKGROUND

When interviewed through efforts of the NOAA Marine Debris program fishermen identified significant barriers to their participation in voluntary derelict gear removal/prevention programs. One of the leading barriers was the high cost of disposal and, in some regions, the refusal of landfills to accept certain types of fishing gear. The *Fishing for Energy* program was created both to engage the commercial fishing industry and to remove this barrier to removal/prevention efforts. This program is a partnership consisting of Covanta Energy Corporation, the National Fish and Wildlife Foundation, the National Oceanic and Atmospheric Administration (NOAA) and Schnitzer Steel Industries. This unique public/private program partners with active fishing ports across the country to provide no-cost solutions to fishermen to dispose of old, derelict or unusable fishing gear and work to reduce the amount of derelict fishing gear in and around coastal waterways. The collected gear is then separated into metal recyclables taken by Schnitzer Steel and combustible materials converted into renewable energy by Covanta Energy.

By targeting active ports and placing bins in strategic locations, the *Fishing for Energy* partnership directly engages fishermen in disposal efforts. To date, fishermen have used *Fishing for Energy* bins to dispose of more than 1 million pounds of gear at twenty-four ports across the country, including lobster and crab pots, nets, dredges, and buoys. Fishermen Associations and boat captains have reached out and encouraged their colleagues to use the *Fishing for Energy* service to dispose of old and derelict gear. Any port, harbor, fish house, etc. that is associated with an active commercial fishing community and would like assistance in disposing of derelict, old, or unused gear, is eligible to participate in this program.

The partnership will work to enhance this relationship in 2011 by working with managers to remove further barriers to voluntary removal efforts; sponsoring community fishing for debris events; and highlighting the fishing community as a positive force in the partnership at mainstream venues in fishing communities.

METHODOLOGY

Several strategies have assisted the *Fishing for Energy* program in establishing a relationship with the fishing community: establishing the program through fisheries networks, fish houses and ports; careful messaging through documents and interviews that does not connect derelict gear as 'fault' of fishermen; and providing a service to the fishing community long before requesting their engagement in any removal activities. The partnership has had to work through challenges such as building trust in the program, providing bin security, and working within state derelict fishing gear removal laws while encouraging fishermen to participate in the program.

By targeting active ports and placing bins in accessible locations, the *Fishing for Energy* partnership directly engages fishermen in disposal efforts. Beginning in 2009, the *Fishing for Energy* program expanded to offer grants for removal projects that seek to directly engage fishermen in planning and implementation. Specifically, the funding is targeted to provide capacity and incentives to address old, abandoned or derelict fishing gear issues while building on the relationships and logistics that were established in the first phase of the program. All non-governmental organizations and state agencies are eligible to apply for funding but are required to work collaboratively with the fishing industry to meet goals of engaging fishermen in direct gear removal. By engaging fishermen in their areas of expertise (identification of known high density gear areas and in removal of gear) projects benefit from their knowledge, struggling fishermen are compensated for their efforts and are educated on the breadth of the problem in their area.

In 2011 the *Fishing for Energy* program will expand our efforts to include broader outreach and education efforts and to remove additional barriers to fishermen in partnering on gear removal projects and activities. Efforts are being made to publicly acknowledge the contributions of the industry to this program and announce milestones and successes through media and events that target this community. A workshop with state managers is also in development to remove the second most significant barrier to fishermen participation: the legalities of having someone else's gear on their vessel.

OUTCOMES

Since 2008, *Fishing for Energy* has placed bins in locations associated with 24 different ports in eight states within the continental United States. To date, fishermen have disposed of more than 1 million pounds of fishing gear in these bins. Coverage of the efforts of the partnership and participating fishermen has been extensive. Area newspapers, fishermen associations, and academic blogs have written articles about the *Fishing for Energy* program. Local news and radio stations have also covered the efforts of the partnership, sending reporters to interview partners and participating fishermen at a variety of program events. Finally, two television programs: the Sundance Channel's *Big Ideas for a Small Planet* and PBS' *Curiosity Quest* have run programs focusing on the *Fishing for Energy* program in Oregon and Massachusetts.

The first projects to receive funding were: Cornell Cooperative Extension of Suffolk County (CCE) in Western Long Island Sound, Stellwagen Alive (SA) in the Stellwagen Marine Sanctuary and the Provincetown Harbormaster in Provincetown, MA. All three projects will directly engage fishermen to identify and remove marine debris from designated marine areas. In total, the three projects are estimated to engage close to 100 fishermen and collect more than 90 tons of fishing gear from coastal waters. At the time of this conference, a second round of applications are being considered for funding.

Through bin placement and grants projects the program has had a number of unanticipated benefits to marine debris conservation. For example, a CCE employed fisherman has modified a grappling hook to remove twice as much gear from coastal waters and recyclers have reached out to the program to reduce waste in other aspects of the industry.

PRIORITY ACTIONS

- Provide easily accessible opportunities for fishermen to properly dispose of retired gear.
- Remove barriers to voluntary removal of derelict gear by the fishing industry.
- Create a trusting relationship with fishermen by providing needed services and offering opportunities for engagement and compensation for use of their expertise.

8.a.2. Measuring the cost of marine debris to Hawaii's longline fishery

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KEYWORDS
Hawaii; Marine Debris; Economics; Hawaii Longline

BACKGROUND

Marine debris is a global problem and its effects, such as entanglement and habitat degradation, can be easily seen throughout the Hawaiian Archipelago. Extensive research has quantified the amount of marine debris affecting the marine environment; however, estimates of the economic impacts of marine debris have proven elusive. In 2006, a partnership project was initiated among various NOAA offices in Hawaii to study and quantify rates of interaction and the subsequent economic impact of marine debris within Hawaii's longline fishery. This effort is being achieved through data collected in cooperation with the NOAA Fisheries Pacific Islands Regional Office Hawaii Longline Observer Program and its new comprehensive Marine Debris Encounter Report.

In the North Pacific Ocean, derelict fishing gear (mainly lost or discarded nets from other fishing fleets) is often found drifting within areas heavily fished by the Hawaii longline fleet. Derelict fishing gear (DFG) impacts the longline fishery through active gear entanglement, vessel interactions, and catch interaction. The debris poses a safety hazard for crew to disentangle the vessel and impacts the fishery economically by the occurrence of immobilized or slowed fishing operations and may induce behavioral responses within the fishery. The main objectives of this partnership project are to gain a better understanding of the overall impacts of DFG and to quantify the economic impact of marine debris to the Hawaii-based longline fishing industry. This presentation will detail the Hawaii project and give an introductory analysis of the economic implications of marine debris interactions in the Hawaii longline fishery.

METHODOLOGY

In December of 2007, collaboration began between the NOAA Marine Debris Program and the NOAA Observer Program to explore the prevalence and make attempts at quantifying at-sea marine debris encountered on Hawaii longline trips. Marine debris interactions range from at-sea marine debris entanglement with active fishing gear, interactions with fishery resources and protected species, and interactions with the vessel and navigational equipment. A Marine Debris Encounter Report form was developed and observers trained to collect these data. The Marine Debris Encounter Report (Figure 1) is not an official NOAA Observer Program data form. This form is used by the Observer only when the longline vessel, its gear, or hauled species are noted as having interacted with or encountered marine debris. The sections of the form are filled out and photos are typically taken and noted. Data collected include observer trip number, spatial location of debris, date, time, incident type (gear, vessel, species), debris type (net, rope, monofilament line, plastic, floats, etc.), biota present, estimated weight, photos, whether debris was brought on board, and an estimated length of downtime. The data collected are run through simple analyses to determine most common debris interaction and type.

In order to begin economic analysis of the data, an integrated database was developed that linked Hawaii longline logbook reports, State of Hawaii dealer reports of fish sold, and US Coast Guard records of vessel characteristics with marine debris encounter reports and economic information (trip costs) collected by on-board observers. Using data from 2008 and 2009, we describe characteristics of longline fishing in the context of marine debris encounters using statistical tests to explore the role of at-sea marine debris.

OUTCOMES

This research makes a first effort to describe the role of marine debris in fishing operations for the Hawaii longline fleet. During 2008 and 2009, approximately 20% of longline trips encountered some form of at-sea marine debris with interaction rates differing by fishery. We find that the Hawaii shallow-set fishery (swordfish) is especially susceptible to at-sea marine debris encounters with interaction reports associated with 38% of trips during 2008 and 2009. The deep-set fishery (tuna) experienced lower rates of interactions with 14% of trips encountering marine debris. Additionally, while a disproportionate amount of marine debris encounters are occurring on fishing trips that straddle the 150 degree line and trips extending into the eastern-Pacific, these differences are not statistically different.

Overall, during 2008 and 2009, 396 encounter reports were submitted. The most common type of interaction with marine debris for Hawaii's longline fishermen was gear interaction (331 reported incidents) (Figure 2). Similar to anecdotal information gathered at the onset of this project, encounters with marine debris entangled on the longline fishing gear is indeed fairly common. The most common type of debris that fishermen encounter while at sea is derelict fishing nets (63% of all reported incidents) (Figure 3). From reports, this varied in size from a very small (<1 lb.) to 8,000 lbs. (maximum reported). Visually represented on a map (Figure 4), the areas with an increased number of encounter reports submitted seem to coincide with the approximate area of the North Pacific Subtropical Convergence Zone, an area known to concentrate marine debris and at the same time is high in biota (Pichel et al., 2007).

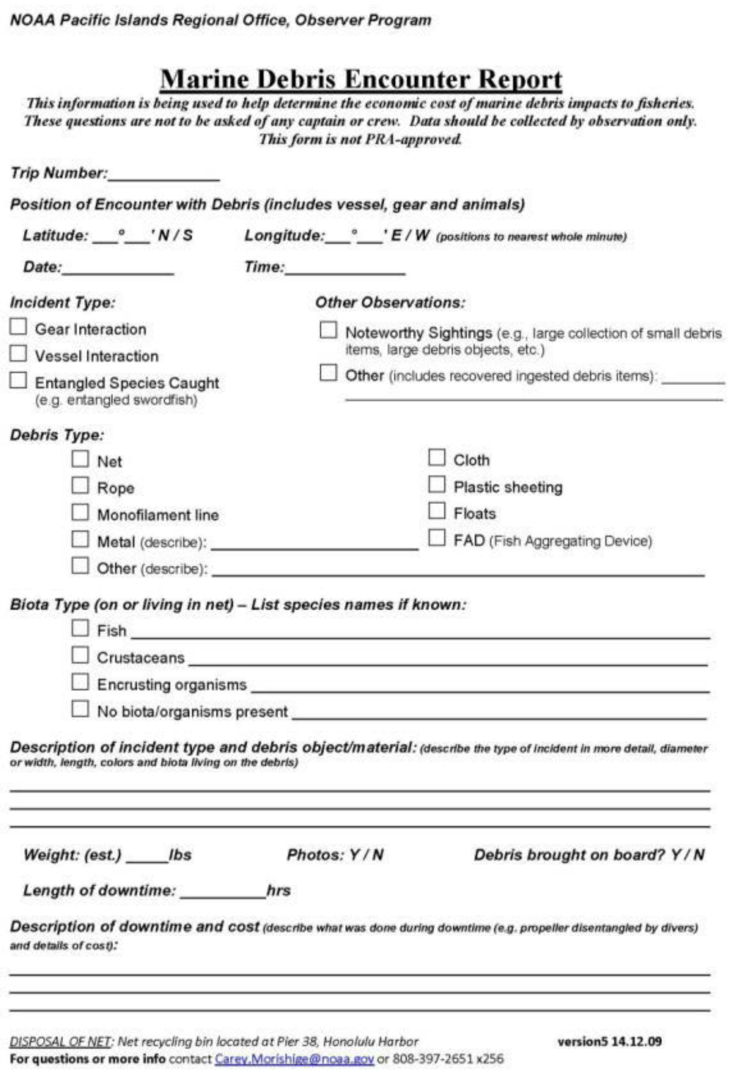
While the number of reports was much higher than anticipated, marine debris does not appear to be significantly affecting basic trip characteristics for the Hawaii longline fleet. In fact, trips encountering at-sea marine debris appear to be nominally more profitable, perhaps capturing benefits from the fish aggregating characteristics of most at-sea debris encountered. However, we do find nominally higher trip costs associated with trips encountering marine debris, suggesting the need for further research into the implications of marine debris on vessel efficiency.

PRIORITY ACTIONS

Positively engaging the fishing industry is important in moving towards the ultimate goal of reducing the amount and impacts of marine debris.

The Hawaii marine debris encounter report is a unique program that offers invaluable information that allows us to better understand the implications of at-sea marine debris for our fisheries and should be promoted (nationally and internationally) as a valuable tool towards quantifying debris in our oceans.

FIGURES AND TABLES



NOAA Pacific Islands Regional Office, Observer Program

Marine Debris Encounter Report

This information is being used to help determine the economic cost of marine debris impacts to fisheries. These questions are not to be asked of any captain or crew. Data should be collected by observation only. This form is not PRA-approved.

*Trip Number:*____________

Position of Encounter with Debris (includes vessel, gear and animals)

Latitude: ___°___' *N / S* *Longitude:*___°___' *E / W* *(positions to nearest whole minute)*

*Date:*____________ *Time:*____________

Incident Type:

☐ Gear Interaction
☐ Vessel Interaction
☐ Entangled Species Caught (e.g. entangled swordfish)

Other Observations:

☐ Noteworthy Sightings (e.g., large collection of small debris items, large debris objects, etc.)
☐ Other (includes recovered ingested debris items): ________

Debris Type:

☐ Net
☐ Rope
☐ Monofilament line
☐ Metal (describe): ____________________
☐ Other (describe): ____________________
☐ Cloth
☐ Plastic sheeting
☐ Floats
☐ FAD (Fish Aggregating Device)

Biota Type (on or living in net) – List species names if known:

☐ Fish ____________________
☐ Crustaceans ____________________
☐ Encrusting organisms ____________________
☐ No biota/organisms present ____________________

Description of incident type and debris object/material: (describe the type of incident in more detail, diameter or width, length, colors and biota living on the debris)

Weight: (est.) _____*lbs* *Photos: Y / N* *Debris brought on board? Y / N*

Length of downtime: __________*hrs*

Description of downtime and cost (describe what was done during downtime (e.g. propeller disentangled by divers) and details of cost):

DISPOSAL OF NET: Net recycling bin located at Pier 38, Honolulu Harbor **version5 14.12.09**

For questions or more info contact Carey.Morishige@noaa.gov or 808-397-2651 x256

Figure 1. Marine Debris Encounter Report Form

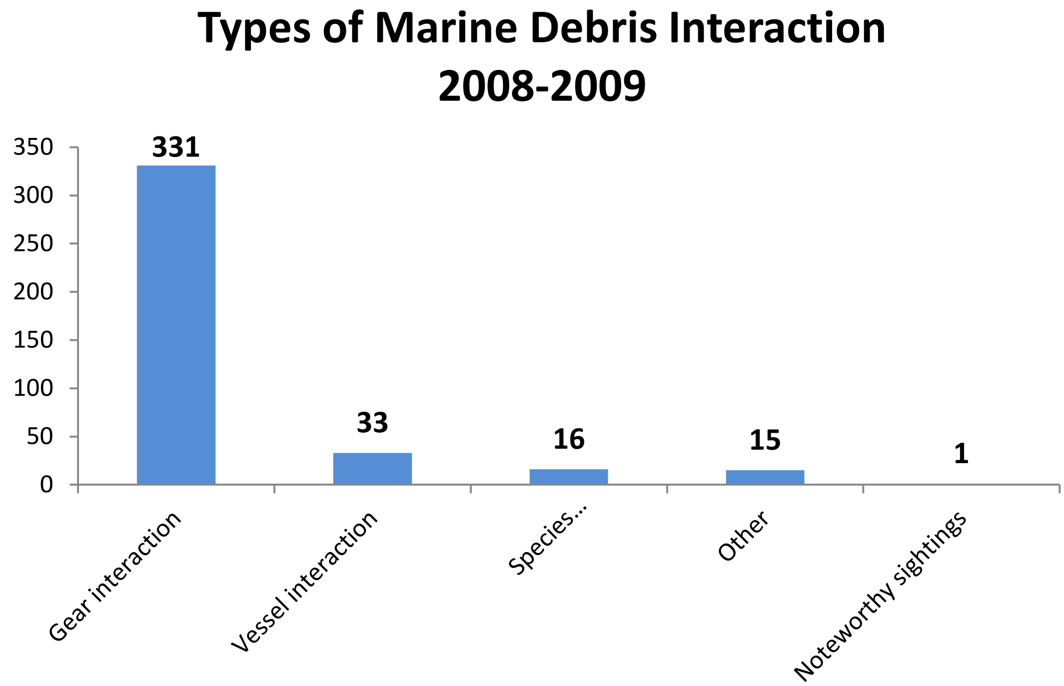


Figure 2. Total number of each type of interaction with marine debris by Hawaii longline fishermen from 2008-2009.

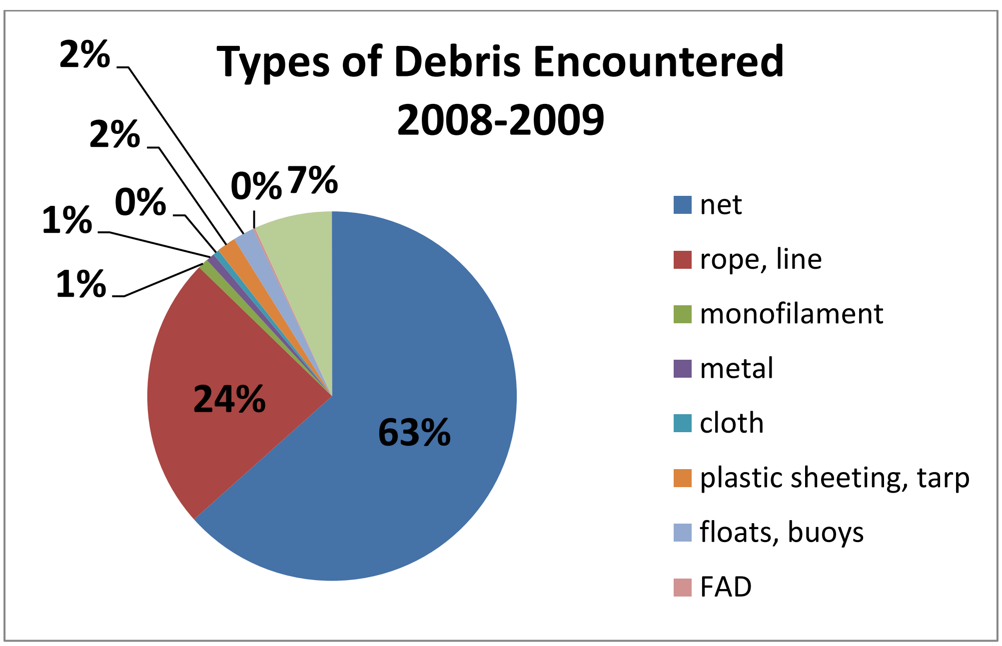


Figure 3. Percentage incidence of various debris types enountered by Hawaii longliners at sea from 2008-2009.

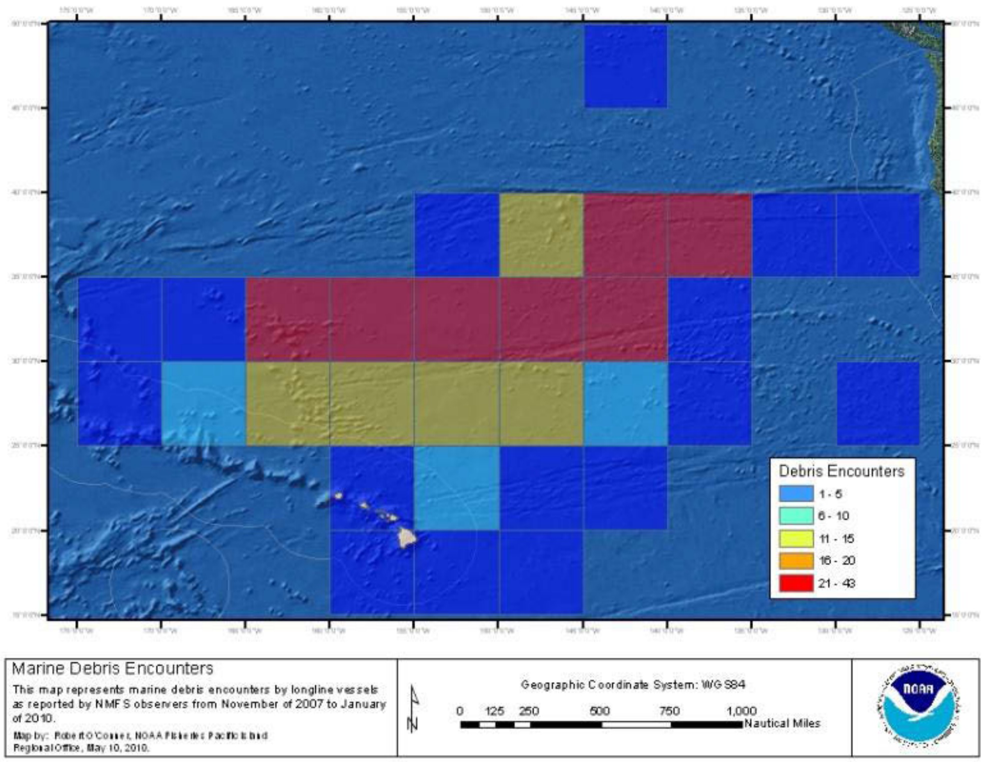


Figure 4. Spatial Distribution of Marine Debris Encounters, November 2007 – January 2010

REFERENCES

Pichel, W., J. Churnside, T. Veenstra, D. Foley, K. Friedman, R. Brainard, J. Nicoll, Q. Zheng, and P. Clemente-Colon. 2007. Marine debris collects within the North Pacific Subtropical Convergence Zone. Marine Pollution Bulletin 54: 1207-1211

8.a.3. Fishermen-led derelict gear recovery in California

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KEYWORDS
Fishing gear, entanglement, diver, fishermen, recovery, crab fishery, California.

BACKGROUND

Derelict commercial and recreational fishing gear in California's coastal ocean impacts both ecologically and economically important living marine resources. Lost gear continues to catch harvestable species, and abandoned nets drown fish, birds and mammals. Hundreds of coastal birds and marine mammals suffer injury when they become entangled in fishing line or when they ingest hooks (Dau et al, 2009). Lost fishing gear artificially alters seafloor and rocky reef habitats and may thereby affect local biodiversity. Furthermore, lost fishing gear impacts people, including boaters, surfers, divers, and especially fishermen, because derelict gear clutters legal fishing grounds, affecting their ability to safely and effectively deploy legal gear. Derelict gear leads to financial losses for fishermen in the form of lost catch opportunity as well as repair and replacement costs for nets and traps damaged due to derelict gear entanglement.

To ameliorate the problem of derelict fishing gear in California, the California Lost Fishing Gear Recovery Project (www.lostfishinggear.org) of the UC Davis Wildlife Health Center's SeaDoc Society has been conducting derelict fishing gear location and removal since June 2005. Gear recovery has been conducted by commercial fishermen (sea urchin harvesters and crab fishermen) and by volunteer scientific divers. The project has removed 45 tons of derelict fishing gear and other marine debris from Southern California coastal waters, including hundreds of nets and traps, over 1 million feet of monofilament fishing line, and even hundreds of automobile tires and toilets from a proposed marine protected area. The California Lost Fishing Gear Recovery Project's strategy to date has been to contract with fishermen to remove lost or abandoned fishing gear on a case-by-case basis. While this is an effective and efficient way to get the gear out of the water quickly, it does not lead to a long-term sustainable solution that promotes larger-scale involvement of the fishing community. Ultimately, the California Lost Fishing Gear Recovery Project envisions derelict fishing gear recovery in California as a more financially self-sustaining endeavor that is "owned" by local fishing communities.

METHODOLOGY

Working jointly with the Humboldt Fishermen's Marketing Association (HFMA), the local commercial fishing trade group in Eureka, CA, we have engaged commercial crab fishermen in Eureka, Trinidad, and Crescent City, CA who are willing and able to conduct gear recovery work in the field, using their vessels with adequate desk space for storage of recovered pots and with essential equipment on board. As well, we have signed up fishermen who give permission to the participating fishermen to recover their gear. In order to address the fact that it would be otherwise illegal for participating fishermen to have the cooperating fishermen's gear on board, in consultation with the California Department of Fish and Game Legal and Marine Enforcement departments, we drafted a form letter that is signed by all cooperating fishermen. A project staff person on board collects data on gear ownership, to ensure the transparency of the participating fishermen's efforts in removing only cooperating fishermen's crab gear (and not gear belonging to non-cooperating fishermen). Commercial gear is identifiable to owner by the permit number painted on the marker buoy, a tag attached to the pot itself, as well as by the particular design and construction of the pot, which is often unique to individual fishermen. Data on gear ownership are held by the HFMA, not by the California Lost Fishing Gear Recovery Project, and are not shared with the California Department of Fish and Game.

Participating fishermen realize financial benefits from their involvement in this project in two ways: 1) Once the gear is recovered, participating fishermen have the option to either give or sell the recovered gear back to the cooperating fisherman who is the rightful owner of the gear; gear that is not given or sold back to the original owner is stored in a secure location by the HFMA and sold at auction at a later date, with three-quarters of auction proceeds going to the participating fisherman who collected the gear, and one-quarter of the proceeds going into a HFMA-held fund that is used to sustain the program in the future; and/or 2) A portion of California Lost Fishing Gear Recovery Project grant funds are utilized to cover participating fishermen's out-of-pocket expenses for conducting the recovery work, i.e. costs for fuel, equipment that experiences wear and tear (e.g. blocks, pumps), and expendable supplies (e.g rope, wire, hoses). The selling of recovered gear back to fellow fishermen, which provides gear retrievers with a financial reward for their effort, is made all the more profitable because significant real costs in conducting the work will be reimbursed to participating fishermen through the Project. Methods for recovering derelict crab gear have been well worked out by the fishermen themselves.

OUTCOMES

We estimate that there are thousands of derelict commercial crab pots lying in coastal waters across the commercial crab fishing grounds in Northern California, from Del Norte to Mendocino Counties. Pots were lost during past commercial crab seasons due to the high-energy ocean environment off the North Coast. Most of these abandoned pots are in 200- 600' of water, and if their rot-cords have failed (i.e. have not yet disintegrated), may continue to "ghostfish" crab and other non-target species. Therefore, the ecological benefits of this project are measured according to the number and total weight of retrieved pots, the number of trapped crabs returned to the ocean, the area of seafloor restored, the number of participating fishermen, and volunteer hours. To date, we have removed 350 crab pots from Northern California's coastal ocean.

As well, although not measured specifically for this project, anticipated outcomes include considerable financial benefits to participating and cooperating fishermen: e.g. participating fishermen earn up to $35-50/pot by selling retrieved pots back to their rightful owners; and cooperating fishermen can realize considerable savings in either receiving their pots back for free, or paying just $35-50/pot instead of $100-200 to replace them.

Ultimately, while the removal of impediments to commercial fishing in the form of derelict gear that ensnares or entangles legally deployed gear is of huge benefit to the fishery, it is the closer involvement of commercial fishermen in achieving project goals in ways that provide ownership of ocean restoration and income that is the true outcome of this project. By implementing this derelict fishing gear recovery project in close collaboration with a local commercial fishing organization in ways that incentivizes participation by commercial crab fishermen, lost fishing gear recovery is becoming a routine endeavor of the crab fishery in this community. We envision that with time, this project will be able to keep up with ongoing gear losses that will be of a magnitude easily handled and financed by the Humboldt Fishermen's Marketing Association on its own, utilizing the financial model implemented by this project.

PRIORITY ACTIONS

Fully engage commercial fishing communities in derelict fishing gear recovery.

Facilitate local leadership of derelict fishing gear recovery by commercial fishing communities through enabling legislation and innovative financial frameworks.

REFERENCES

Dau, B.K., Gilardi, K.V.K. et al. 2009. Fishing-gear Related Injury in California Marine Wildlife. Journal of Wildlife Disease 45(2): 355-362.

8.a.4. Mobilizing fishermen to recover derelict lobster gear – overcoming misgivings and mistrust

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KEYWORDS
Lobster, Maine, fishermen, industry, derelict fishing traps, outreach, communication

BACKGROUND
Engaging commercial fishermen in recovering and disposing of derelict fishing traps generated by their industry is challenging on many fronts. In Maine, where the commercial lobster fishery is a 150-year-old tradition pursued by over 5500 individuals, there are logistical, political, jurisdictional and even emotional hurdles which arise, where handling another fisherman's gear – derelict or otherwise – is concerned. Decades-old statutes exist to protect the property of the individual, but also stymie 21st-century clean-up efforts. An "out of sight, out of mind" attitude pervades the industry, while lost plastic-coated wire traps now in common use collect on the ocean floor. In an industry hammered by state and federal regulations governing everything from the number of traps they can fish to the type of rope they must use, fear of reprisal conflicts with the desire to address the issue head-on.

In an effort to engage the industry in a vested manner and obtain more information about the scope of the issue, a two-year project to recover, document and dispose properly of traps lost at sea was initiated in 2009 by the Gulf of Maine Lobster Foundation (GOMLF), in conjunction with the Maine Department of Marine Resources (Maine DMR) with private funding through the National Fish and Wildlife Foundation. Central to the project is the enlistment of 70 fishermen – and crucial to the success of the program is overcoming the industry's fear of public backlash that such attention to the issue might bring. GOMLF has developed a close relationship with the lobster industry through collaborative research and gear exchange programs, and effective outreach to the industry has helped the gear recovery program's success.

METHODOLOGY
GOMLF collaborated with Maine DMR on the design of a program to recruit commercial fishing captains and their vessels to locate and retrieve traps lost at sea. Because the coast of Maine is extensive (over 3000 miles of shoreline), the project was divided into two years and crafted to engage volunteering fishermen in state waters during the winter months, so as to avoid actively-fished gear and employ fishermen during a slower season. The Project Director held informational meetings in all seven of the Maine lobster management zones (LMZ) (see Figure 1) and attended lobster association meetings and Maine DMR Lobster Advisory Council meetings to present the project. Focus meetings in the three easternmost LMZ during January 2010 were announced through industry association newsletters and with posters at buying

stations and co-ops. Phone calls were made to anyone not able to attend the meetings, and vessel applications were mailed to all interested parties.

Careful attention was paid to the involvement of media at the early stages (*e.g.*, ads were not placed in traditional newspapers), in deference to the sensitivities of the industry. In-depth interviews and invitations to key media to attend gear recovery events helped convey the project's "no-fault" approach. GOMLF met regularly with officers of the Maine Bureau of Marine Patrol (Maine BMP) to review protocols for handling gear and to design a streamlined system for processing a considerable number of unclaimed traps. Throughout both the outreach and implementation phases, direct and constant communication with the individual fishermen was paramount, particularly in the arenas of justifying the project and planning the field work.

OUTCOMES

Many fishermen voiced initial opposition to the project, as it could potentially draw negative attention to an issue they were quite aware of, but that had not been in the public eye. Extensive outreach to lobstermen and drag fishermen by the Project Director, describing the project's intent to be pro-active, understated and industry-friendly, resulted in a shift of opinion to support the program. During the first year of the program, 25 different vessels and captains were contracted to grapple back gear in the three eastern-most LMZ (Zones A,B,C). A total of 1130 traps were recovered; approximately 50% were salvageable.

Participating fishermen were interested in the data about lobster bycatch, as well as recovering fishable traps; draggermen were eager to clean up tow areas that had been lost to fishing due to the navigational hazards presented by the lost traps; and all participants were pleased at receiving a fuel stipend during an otherwise slow part of the year (winter). Key to the success of involving the lobster industry in the project was an understanding by project staff of the many and varied means by which traps can be lost (most of them beyond the control of the fisherman), and the metered way the recovery effort was conveyed to media and the public. Positive press coverage clinched the success of the program's first year.

The project was designed to involve the Maine BMP in processing the gear to abide by existing regulations. The enforcement arm of Maine DMR was obliged to commit to the somewhat labor-intensive final step of the program, which involved storing the unclaimed traps for a six-month period before auctioning them off.

PRIORITY ACTIONS

Given the potential scope of the issue of derelict fishing traps and the ensuing efforts to address it, a revision of the state's regulations regarding trap possession and salvage rights is important in the near future. Concurrently, a long-term program involving the full lobster industry should be considered, where a condition for annual license renewal could include trap clean-ups, and where structured disposal mechanisms are established.

FIGURES AND TABLES

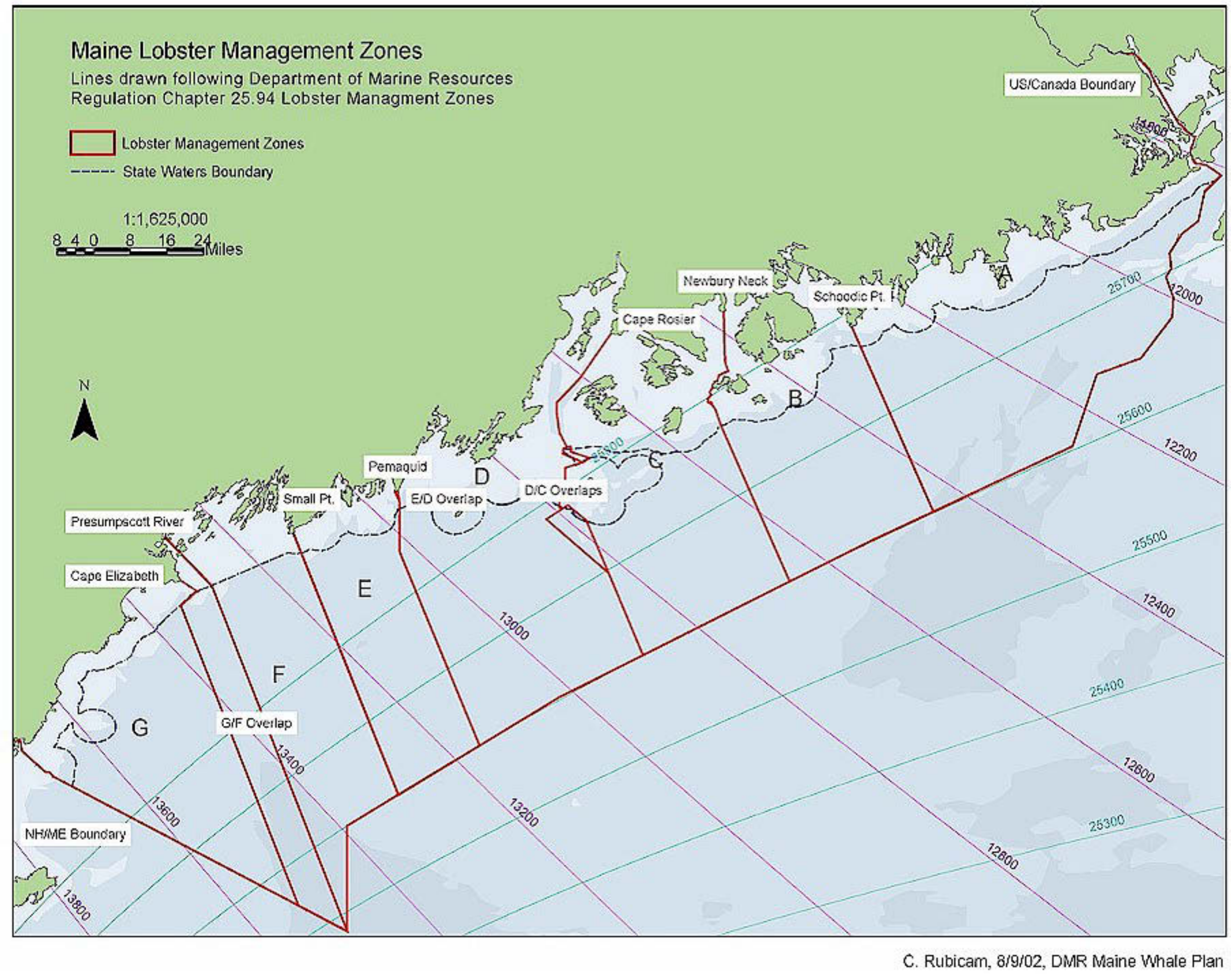

Figure 1 – The seven Maine Lobster Management Zones (A-G), denoting the state waters boundary (black dotted line 3 miles from shore)

8.a.5. Rule changes and partnerships with commercial fishermen increases impact of derelict crab trap clean ups in Florida

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KEYWORDS
Blue crab, derelict traps, commercial fishermen, gear removal

BACKGROUND
Various groups, including the commercial fishing industry, have identified lost and abandoned blue crab traps as a problem in Florida's marine environment. Once traps become lost or abandoned, they may spark user conflicts because they "ghost fish," continuing to trap marine organisms until traps degrade enough to allow escape. They also visually pollute, damage sensitive habitats and become hazards to navigation. Previous programs to address this problem were hampered by rules which restricted which traps could be legally removed. Traps had to meet very specific criteria to be considered derelict which often led to traps being left in the environment that had clearly been lost or abandoned.

Efforts to remove derelict traps in Florida waters received a major boost in 2009 when the Florida Fish and Wildlife Conservation Commission (FWC) passed a new rule to systematically close the commercial fishery around the state in an effort retrieve derelict traps and more readily identify and preemptively remove abandoned traps before they become derelict and hard to find.

This project presented a unique opportunity for the Charlotte and Lee county Sea Grant Agents who have established relationships with the blue crab commercial industry to work in partnership with FWC, the agency regulating the blue crab industry. Our project objectives were: to conduct in cooperation with the area's commercial fishermen a volunteer blue crab trap removal exercise and training; work in partnership with Florida Fish and Wildlife Conservation Commission (FWC) to develop guidelines for conducting volunteer blue crab trap clean up events; develop outreach materials to educate the public about marine debris, explain the role of commercial fisheries in marine resource stewardship, and outline clean up procedures.

METHODOLOGY
Training materials were developed to guide event organizers in implementing volunteer cleanup events. The materials were ground-truthed during a trap removal exercise that was organized in partnership with area commercial fishers. The training exercise was planned several months in advance of the systematic closures in order to provide sufficient time for changes and also to allow for the development of additional materials, including a training video and PSA, which was filmed during the cleanup exercise. We recruited commercial fishers, statewide agency staff

and Sea Grant faculty to participate in the exercise. Commercial fishers provided vessels for the cleanup and agency staff/Sea Grant faculty assisted vessel captains with trap removal and data collection. Agency and Sea Grant personnel were selected because they would likely initiate future cleanup efforts and because commercial fishers sought to build positive relations with resource managers and educators. Each vessel team participating in the cleanup exercise received a package of materials, which included event authorization, trap removal guidelines, data sheets, maps and contact numbers. All participants received training on derelict trap rules, removal protocol, data requirements and trap disposal procedures. Following the cleanup exercise, a train the trainer workshop was held to increase participants' ability to organize or become resources for clean ups in their region. A second train the trainer was held in the Florida panhandle. Based on these events, a document entitled "Steps to Organizing a Local Derelict Crab Trap Removal Event" was produced. It along with a "How To" video provide basic guidance for event coordinators. These materials are electronically available on both the Florida Sea Grant and Florida Fish and Wildlife Conservation Commission websites.

OUTCOMES

As a direct result of this project, 6 clean up events were held around the state in 2009, removing a total of 450 derelict crab traps from a marine environment encompassing 50,000 acres. The removal of traps restored diversity, function and productivity of coastal and marine ecosystems, and improved navigational safety and aesthetics of shallow water resources. Further, commercial fishermen were able to demonstrate their role in marine resource stewardship.

The project resulted in strengthened partnerships between Florida Sea Grant, FWC and commercial fishermen as well as enhancing the marine environment. Future clean ups can be conducted by trainees, increasing the benefit to partners and the environment.

PRIORITY ACTIONS

Although the establishment of systematic closures has facilitated the removal of derelict trap gear, volunteer groups may still only conduct cleanups for sanctioned events with state approval. A mechanism is needed to allow for the timely removal of traps throughout the year. Additionally, the rule as is it currently written, prevents the removal of some traps, which are clearly abandoned, but do not meet the definition of derelict. Finally, steps are needed to identify and implement gear modifications that will reduce ghost fishing.

8.a.6. Engaging unemployed commercial fishers to retrieve lost blue crab pots in the Chesapeake Bay, USA.

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KEYWORDS
Marine debris, derelict fishing gear, blue crab, crab pot, ghost fishing, co-management, commercial fishers, watermen.

BACKGROUND

The blue crab, *Callinectes sapidus*, is a significant economic and ecologic driver in the Chesapeake Bay. The prominent capture method is a wire trap usually referred to as a crab pot and designed to be deployed and recovered by a line and buoy system. Pots become lost when buoy lines are severed by vessel propellers, lines break because of age, pots are abandoned or are vandalized, or storms roll pots pulling the buoy below the water surface. It is estimated that 10% to 30% of deployed commercial pots are lost annually (Havens et al. 2008; Morison and Murphy, 2009). Once lost, pots can continue to capture both crabs and other animals, particularly fish, and contribute to a self-baiting phenomenon. Depending on pot type and location, pots can take up to four years to degrade to the point of no longer capturing animals (Havens et al. 2008; Havens et al. unpublished data).

In recent years the harvest of blue crabs has dipped to historic lows (VMRC, 2009). In response to the reduced harvest the states of Virginia and Maryland enacted a series of conservation measures designed to boost the blue crab populations. In Virginia, the practice of dredging for crabs during the winter months was prohibited. Closure of the winter crab dredge fishery affected 73 commercial fishers who held current dredge licenses.

METHODOLOGY

The determination of a commercial fishery failure by the US Department of Commerce allowed for federal assistance to Maryland and Virginia. Virginia developed a Blue Crab Fishery Resource Disaster Relief Plan in which one component provided for the employment of those commercial fishers directly affected by the closure of the winter crab dredge fishery. These commercial fishers were employed to locate and remove lost or derelict crab pots from Virginia waters (Havens et al. in press).

Commercial fishers were provided Humminbird side-imaging units, instructed on their use, and located and removed pots in the winter off-season (December to mid March) of 2008, 2009, and 2010. Commercial fishers were consulted in determining survey areas. The side-imaging units recorded participant track lines, GPS coordinates of pots, and a sonar image of each pot. In addition, each participant was provided a waterproof digital camera for cataloging a photographic record of bycatch and pot condition and a datasheet for each retrieved item, including recording oyster growth on pots. Every other week data from the units, digital photographs, and datasheets were collected. After each data download, quality assurance evaluations were conducted to ensure participants were following protocol and using technologies correctly. Participant vessel track lines were used for auditing and accountability purposes, as well as quantification of the areal extent surveyed. A spatial database was created of derelict crab pot information to visualize distribution and patterns of items collected and marked.

At the end of each season, participants were asked to provide input on the program and suggested changes were discussed and implemented where appropriate.

OUTCOMES

As of the middle of January 2011, around 25,000 derelict crab pots have been removed from the Virginia portion of the Chesapeake Bay Blue crab and other bycatch from the Virginia removal program was 19,632 and 4,105, respectively

Loss rate of commercial pots reported by watermen was 20% (SE 2.1%). Average loss rate from a four year York River tributary study was 21% (Havens et al. 2008; Havens et al. unpublished data)

Participation in the Virginia program in the first year was 58, the second year 66, and the third year 70. Seventy six percent and 68% of participants responded to the first and second year surveys, respectively. Most commented that they would make no changes in the following year protocols. Participant suggested changes and the corresponding agency responses are listed in Table 1. Over 40% of the respondents added comments to the survey expressing that the program allowed them to participate in helping “clean the bay”. A number of participants actively sought additional opportunities to collaborate on future research projects involving the bay and fishery (i.e. testing of biodegradable panels for crab pots – see Stanhope et al., 2011, these proceedings).

PRIORITY ACTIONS

- Engage stakeholders in program plans.
- Provide mechanisms that allow input from stakeholders to adaptively manage programs.
- Provide regular communications to allow participants and citizens to track progress.

FIGURES AND TABLES

Table 1. Participant comments and agency response.

Participants Comments	VIMS/VMRC Response
Would change nothing	NA
Change start date to December 1st	Implemented
Allow 6 day work weeks	Implemented
Allow money for oil and propane for boat	Implemented – shifted money from disposal costs
Allow 9 hour work days	Implemented - to make up time

	due to inclement weather
Add more days to the program	No change – due to financial constraints
Provide money for mates on boat	No change – due to financial constraints
Provide money for winches to pull up pots	No change – due to financial constraints
Keep sonar units at end of program	No change – State property restrictions but provided opportunity to keep units if working on a research project
Limit program to Virginia crabbers	NA – all hold VA commercial licenses
Extend program beyond 3 years	Implemented – abbreviated 4th year added
Allow removal of old duck blinds/pilings	No change
Allow more participants in program	Implemented – 5 additional participants
Check sonar machines on boat	Case by case basis
Pick up data in afternoons rather than mornings	Case by case basis

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8.b.1. “Clean Coast” Program – leverage for a long-time change

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KEYWORDS
Marine litter, Clean Coast Program, Clean Coast Index (CCI), plastic debris, beach, cleanliness.

BACKGROUND
190 km of Israeli coastline suffer from accumulation of marine litter. Approximately 130 km, are open to the public for leisure activities and serve as nature reserves, recreational beaches, etc. As a result of the accumulation of marine litter, the quality of Israel's coast has declined[1,2,3]. There are three main litter sources: current and wind regimes are responsible for the deposition of significant quantities of waste from the eastern Mediterranean basin on the Israeli coast[4]; Flash floods in winter carry waste accumulated along dry riverbanks during the summer; Yet, over 50% of total litter mass accumulated on the beaches is the result of recreational activities by vacationers and bathers[5,6,7,8].
For years, various activities were conducted in an attempt to solve the marine litter problem. These activities included clean-up campaigns with volunteers by NGO's, beach cleaning by contractors hired by the Ministry of the Environmental Protection (MoEP), education and public awareness campaigns and more of that sort. Authorities such as the Ministry of the Environment, Ministry of Interior, Nature and Parks Authority (NPA), as well as several municipalities and NGOs have each undertaken specific local initiatives over time. Unfortunately, each body had limited responsibilities and resources. Until 2005, no single organization was completely committed to dealing with marine coast line litter. The operations mounted were short-term and therefore, had no lasting impact.

METHODOLOGY
In 2005, the Israeli MoEP launched a 3-year program entitled "Clean Coast" in cooperation with the NPA. It has been updated and renewed several times since.
The “Clean Coast” program aims to achieve and ensure clean beaches at all times. The program seeks to improve beach cleanliness by using a combination of tools and overall coordination of participating bodies and activities. The program focuses on the unauthorized beaches.

The “Clean Coast” program implements several measures simultaneously:

- Routine cleanup of unauthorized beaches by local authorities.
- Educational activities in the country’s schools, work places and community centers in conjunction with the Ministry of Education and relevant NGO's.
- Enforcement against polluters of coasts and non-cooperative municipalities.
- Information and public relations activities.

Budget requirements amounted to US$ 800,000 per annum. The budget was distributed roughly as follows: cleaning (60%), educational activities (20%), advertising and enforcement (20%).
In order to assess cleanliness levels, and thus the eventual success of the program, a Clean Coast Index (CCI) was developed[9]. CCI measurement of the quantity of plastic debris is an easy way to preclude bias by the assessor. Measurements are still being conducted on a biweekly basis and outcomes are publicized on the Ministry's web site.

OUTCOMES

Over time, all the local authorities along the Israeli coastline enlisted in the "Clean Coast" program, and adapted cleanup operation in their jurisdictions on a regular basis.
The CCI demonstrates very vividly the improvement in beach cleanliness achieved by each municipality since entering the program (fig.1).

Ga'ash beach provides a good example of the importance of cleaning efforts made by local authorities (fig 2). Another example is demonstrated by comparison of CCI results for Nahariya with those for Acre (fig 3). Aside from routine beach cleanup, Nahariya municipality initiated several informational and educational activities, eliciting positive reactions from the public. Since June 2005, just after the first CCI measurement was made, Nahariya beaches have constantly been "clean" or even "very clean". Acre municipality did not join the program at the beginning. CCI measurements, taken until mid-August 2005, showed Acre beach to be "dirty" to "extremely dirty". As a response to the failure of Acre municipality to maintain coastal cleanliness, the MoEP initiated enforcement activities. As a result, the municipality of Acre joined the program and started to clean its beaches in August 2005. It immediately received very positive feedback from the local media.

Within the framework of the "Clean Coast" program, educational programs were included in the environmental studies curriculum, mainly in the elementary schools of several coastal municipalities and education centers of NPA. Children who participated in this program confirmed that the message concerning the importance of beach cleanliness was delivered.
Enforcement activities have been less effective, due to operational difficulties. Nevertheless weekly presence of inspectors, and particularly volunteers, on beaches over summer weekends (July-September) has made a major contribution to awareness of the public regarding the importance of beach cleanliness.

During the summer months of 2005-2006, the following media coverage was

and efforts to raise public awareness, we are not getting better results and we see clear evidences that the public is still littering.
Though at times we are tempted to give up on this generation of 'litterers' and focus on basic education of the next generation, we are painfully aware of the fact we do not have such a privilege. We think a holistic approach is needed though costly both in budget and in time. The main components are: education, legal enforcement, maintaining basic cleaning standards, involving NGO's and promoting public awareness through extensive use of the media.

PRIORITY ACTIONS

Our conclusion was that an ongoing 360^0 approach was necessary to achieve Clean Coast goals. In Israel this entails: local municipal involvement, ongoing cleanup efforts, national media coverage, national educational efforts and enforcement at municipal levels as well as a physical presence on the beach itself.

FIGURES AND TABLES

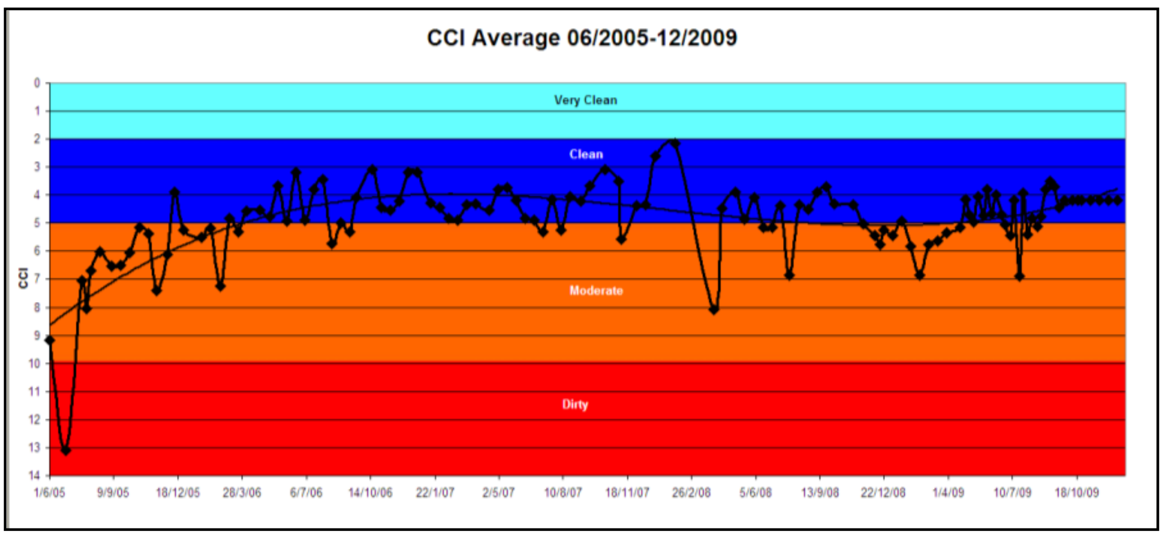

Fig. 1 National CCI averages from the beginning of the program to the end of 2009

Fig 2. Ga'ash coast at the beginning of the program, and after 2 month.

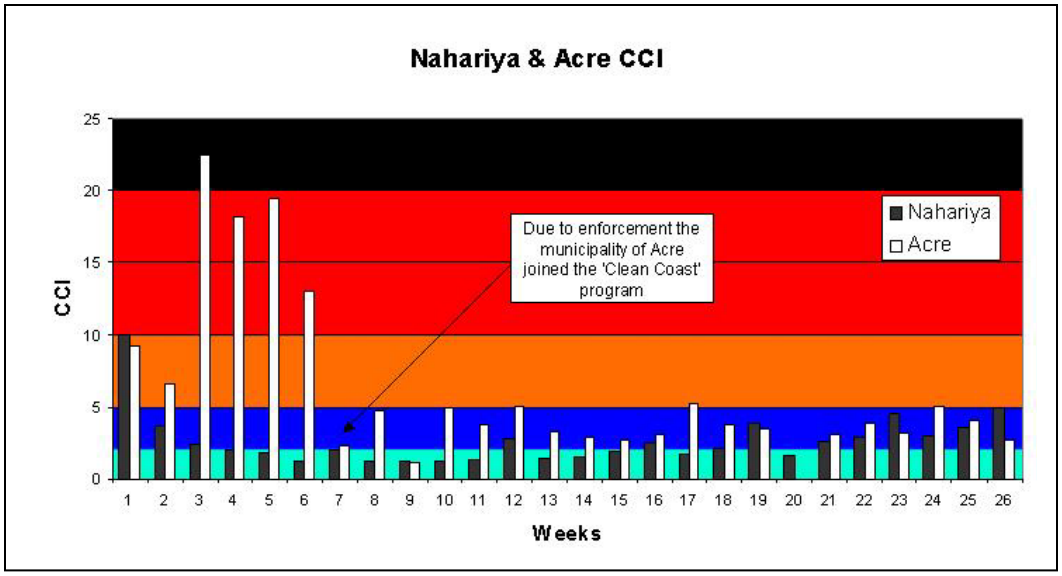

Fig 3. CCI of Nahariya and Acre beaches, June-December 2005

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8.b.2. Waitemata Harbour Clean-Up Trust video presentation

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ABSTRACT
Formed in 2002, the Waitemata Harbour Clean-Up Trust is a charitable organization that oversees the removal of litter from Auckland's Waitemata Harbour and inner gulf islands, and promotes the concept of clean, clear rubbish-free waterways.

The idea to form a trust to deal with rubbish entering the Waitemata Harbour was the brainchild of boating enthusiasts Waitakere City Mayor, Bob Harvey and Mr. Hayden Smith. They observed increasing amounts of rubbish making its way to sea via roadways and storm water channels often clogging up streams and estuaries along the way.

With the support of local councils and corporate sponsorship, funding was obtained to raise awareness about litter issues and to carry out litter removal in the inner gulf. The Ports of Auckland provided a 7 meter boat, the Phil Warren, for litter retrieval and removal. The boat was named in recognition of the environmental initiatives led by the late Phil Warren while he was chairperson of the Auckland Regional Council.

Removing rubbish manually from the coast is very labour intensive, the best way to achieve a cleaner harbour is preventing rubbish from entering the environment in the first place.
The Trusts board members include:
- -Peter Drummond, Professional Director (Chairman)
- -Mayor Bob Harvey, Waitakere City (Deputy Chairman)
- -Mayor Andrew Williams, North Shore City
- -Mayor Len Brown, Manukau City
- -Mayor John Banks, Auckland City
- -Mike Lee, Chairman of the Auckland Regional Council
- -Gary Swift, CFO Watercare
- -Penny Whiting, Professional Yachtswoman

The WHCT is funded by charitable donations from our sponsors which include;

Auckland City Council	Manukau City Council
Waitakere City Council	North Shore City Council
Auckland Regional Council	Watercare Services Ltd

100% of funding is made available for operational costs associated with cleaning up the Harbour.

Since the Trusts inception we have now removed over 2.5 million liters of waste from the waterways of Auckland. That's the equivalent of 70 twenty foot shipping containers, full of loose litter, consisting mainly of plastic products (bottles, bags, utensils, straws etc…), polystyrene,

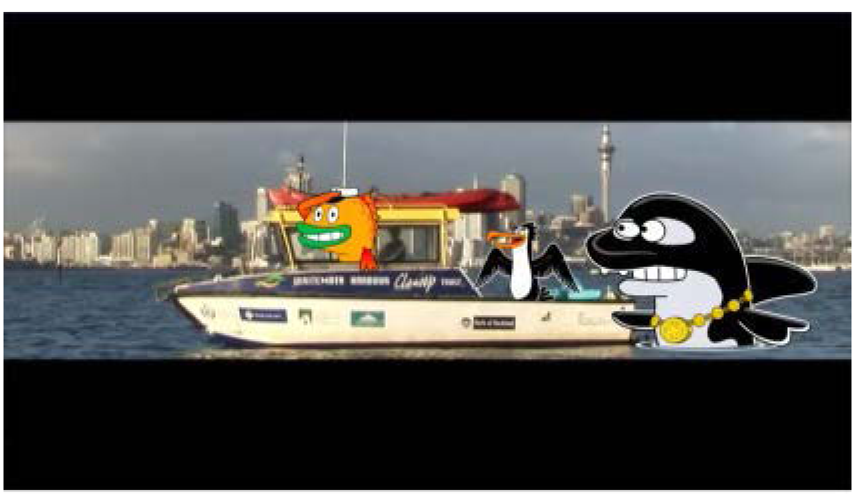
aluminum cans, glass bottles, sports balls etc… Most of our time is spent cleaning up the coastline of Auckland’s Waitemata Harbour, and actively involving ourselves in the communities across the region at a grass roots level.

The WHCT has been instrumental with the co-ordination of volunteers who are willing to help clean-up the ocean. Our vessel and the full time crew aboard the “Phil Warren” has now had over five and a half thousand volunteers assisting on the coast with rubbish removal, and the Waitemata Harbour and Hauraki Gulf Islands are much cleaner because of this service.

Children have always been an integral part of the trusts environmental crusade; the trust understands that emphasizing the work with kids will see a new generation of environmental protectors acting as caretakers for a sustainable, cleaner future.

School groups often seek the trusts assistance with education on marine debris matters. We organize beach clean-up days with whole schools or classes as requested. We will meet on site and demonstrate the effects of litter being dropped on the street, and how they can help stop the rising tide of grime on the coast. After a formal Health and Safety briefing, we clean up the designated beach. We then engage the participating students by asking them to write a short brief on what they have learnt.

The trusts representatives make many presentations outside of operational time, volunteering their personal time to local community boards, councils and community groups, to raise the awareness for the marine debris issues that they are working with on a day to day basis.
The trust has produced an educational film clip. An outreach animation called “Shag Force – Episode 1: Waste Warriors” The film clip follows the journey of a typical plastic bottle cap that has been carelessly dropped on the street, and tracks its journey down through the storm water network to the sea. Through the medium of animation the film clip identifies and exposes the harmful effects that a singular bottle cap can have on the marine creatures and the environment over a typical ten year period. To view it, visit;
http://www.youtube.com/watch?v=1zUuEA8s9qE



8.b.3. Marine debris pollution along the coasts of Korea: results from a nationwide monitoring and clean-up campaign

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KEYWORDS
Marine debris, Beach monitoring, Public participation, International Coastal Cleanup, Fishing debris

BACKGROUND
Many coastal countries are suffering from serious impacts due to marine debris. In Korea, marine debris has received much attention since 1999. The first nationwide beach monitoring was carried out from 2000 to 2003. Plastic debris (including expanded polystyrene) dominated the debris in number collected during the monitoring, which agreed with numerous other studies. Participation in International Coastal Cleanup (ICC) since 2001 has played a crucial role in understanding sources of debris found in the Korean coast. Five-year Korea National Marine Debris Monitoring Program (KNMDMP) was launched in 2008 to obtain more information on accumulation rate, distribution and sources of marine debris. Monitoring data from KNMDMP and International Coastal Cleanup Korea were analyzed to provide policy perspectives on the marine debris management in Korea.

METHODOLOGY
Monitoring sites for KNMDMP were selected along eastern, western and southern coasts. Twenty sandy or pebble beaches with a gentle slope were located in the range of 33°18′38.68″N~38°12′03.18″N and 26°4′16.70″E~129°26′24.79″E. The areas with regular cleanup were avoided. Marine debris on the twenty beaches were first cleaned in January 2008 and monitored every two months between March 2008 and January 2009. All debris larger than 2.5cm on a 100-meter survey line on each beach was counted from the low tide line to the base of dunes or vegetation. Their weights and volumes were measured and they were classified according to their composition and source activities.

<u>ICC in Korea</u>

International Coastal Cleanup in Korea followed the protocol provided by Ocean Conservancy. For nine years since 2001, volunteers participated in the cleanup campaigns on the third Saturday of September on 266 beaches with a total length of 313 km (15~54 sites/yr, land only).

OUTCOMES

Surveyors collected a total of 60,363 items with a combined weight of 11,348.2kg and a volume of 36,652.9ℓ from 20 beaches for KNMDMP between March 2008 and January 2009. Average annual count of marine debris was 3,018 pieces/100m, with an average count at 503 pieces/100m for each survey (accumulation rate of 251.5 pieces/100m·month). The southern coast showed the highest debris occurrence at an average of 4,197.7 pieces/100m/yr (Fig. 1). Commercial fisheries accounted for 31.1% of debris collected by KNMDMP with the highest fraction in the southern coast. EPS buoys used for aquaculture were the most frequent debris found on the beaches (12.8%), followed by ropes at 8.1% (Table 1).

In the International Coastal Cleanup activities from 2001 through 2009, ocean/waterway-related debris occupied an average of 27.5±4.9% (21.6~34.1%) of the total debris. This is much higher ratio than their international average during the same period (6.4±0.8%) (Fig. 2), mostly due to buoys/floats and ropes as shown in Table 1.

Even though the Korean fishing population occupied only 0.2% (56,000 persons) of the employed persons in 2007, ocean and waterway activities, especially commercial fishing and aquaculture, were one of major marine debris sources. This suggests that a management priority should be given to reducing commercial fishing and aquaculture-related marine debris.
The Korean government has been implementing measures to reduce ocean/waterway-related debris such as installation of reception barges for debris trapped in fishing nets, development of biodegradable nets, standardization of EPS buoys, and the like. The results of marine debris monitoring have also provided objective and quantitative data to be used in enhancing the awareness of the fishing communities on marine debris.

PRIORITY ACTIONS

- Development of alternative material for EPS buoys
- Fishermen education
- Development of source identification method

FIGURES AND TABLES

Table 1. Top 10 debris items collected in Korea National Marine Debris Monitoring Program (KNMDMP) (2008, n=60,363) and International Coastal Cleanup (2001~2009, n=377,768) in Korea.

Rank	KNMDMP		ICC Korea (land only)	
	Item	%	Item	%
1	Expanded Polystyrene Buoy	12.8	Cigarettes/Cigarette Filters	18.3
2	Ropes	8.1	Bags	8.3
3	Food Wrappers/Containers	6.6	Caps, Lids	7.2
4	Strapping Bands	5.7	Beverage Bottles (Plastic) 2 liters or less	7.0
5	Plastic bags, Shopping bags	5.3	Buoys/Floats	6.6
6	Beverage Bottles (Plastic)	5.0	Beverage Bottles (Glass)	6.1

	2 liters or less			
7	Caps, Lids	5.0	Beverage Cans	5.1
8	Beverage Bottles (Glass)	4.8	Food Wrappers/Containers	4.2
9	Miscellaneous Plastic products	4.6	Strapping Bands	4.0
10	Building timber	3.3	Rope	3.8
	Total	61.2	Total	70.5

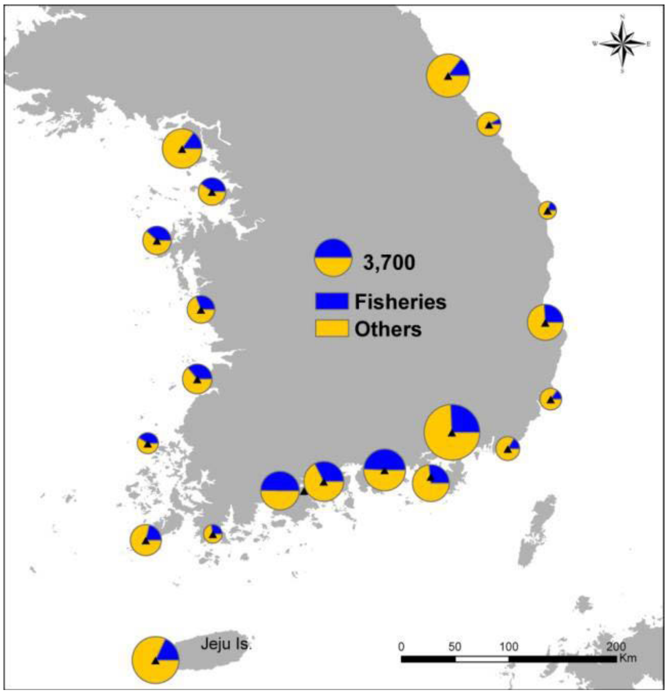

Fig. 1. Spatial distribution of marine debris collected by the Korea National Marine Debris Monitoring Program (KNMDMP) in 2008, with the average debris count at 3,018 pieces/100m·yr. The size of circles represents the quantity of debris found on each beach, with the blue color showing the ratio of fishing-related debris on each site.

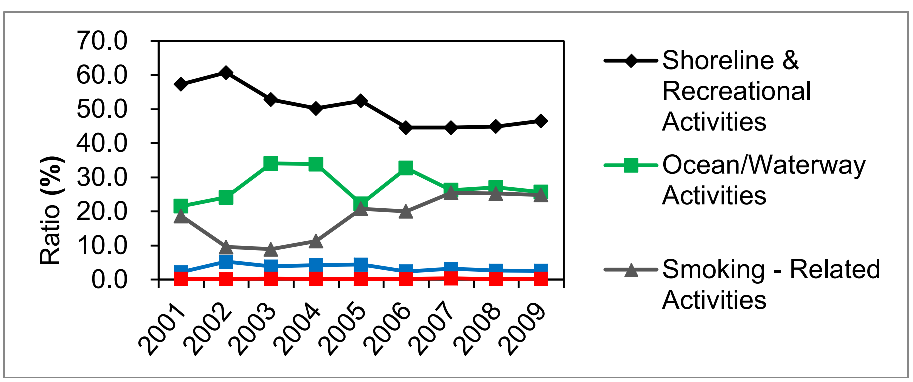

Fig. 2. Sources of marine debris collected by volunteers in the International Coastal Cleanup Korea from 2001 through 2009. Ocean/Waterway activities accounted for 27.5% (±4.9) that is much higher than their fraction in the international results during the same period (6.4±0.8%).

8.b.4. How addressing symptoms can lead to a solution to the problem

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ABSTRACT
It could be expected that Northern Australia, being very remote and removed from large population centres, would have pristine shores. However, due to its proximity to multi jurisdictional fishing grounds in adjacent seas this coastline has a very high incidence of marine debris, 80% of which is ghost nets. Since 2004, GhostNets Australia has been assisting the local indigenous people to remove nets, record data and rescue animals, particularly marine turtles entangled in the nets. Although we continue to work towards achieving change in the behaviour of the international fishers who create the problem, other more indirect outcomes are beginning to be seen.

8.b.5. Laying a path to solve the marine litter problem

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KEYWORDS
marine litter, International Coastal Cleanup (ICC), data, lobbying activity, "Law for the Promotion of Marine Litter Disposal", consistency, long-term monitoring, societal background

BACKGROUND
The problem of marine litter is recognized as a serious global environmental problem nowadays. Marine litter found in oceans and beaches is generated from human activity and industrial sites. It harms both nature and human society in many ways. After responding to the invitation to participate from Ocean Conservancy's International Coastal Cleanup (ICC) in 1990, JEAN (Japan Environmental Action Network) joined the ICC, started marine litter survey activities in Japan, and has gathered data on litter commonly found on water shores and underwater ever since. JEAN uses the data to address the problem of marine litter not only for public enlightenment, but to make changes in national governmental policies on prevention and control of marine litter.

The long-term marine litter survey data shows trends of increase or decrease in certain trash items. Shifts in the trends may be observed when changes occur in any aspect of society, such as inventions and innovations of materials, processes or fabrications; enactment of laws and ordinances; and even individual preferences. When survey data is compiled, we can use it as evidence of what is occurring and to address how to prevent undesirable outcomes caused by marine litter. For the first ten years since its inception, JEAN put its efforts into raising awareness of the Japanese public on the issue of marine litter. The next ten years up to the present, JEAN endeavored to make use of the compiled data as a tool to influence government policy. For the next ten years, JEAN plans to use the compiled data, which shows various trends, to press administrative bodies to make swift moves towards solving the problem, since the issue has never seemed subsided from global concern.

METHODOLOGY
This presentation introduces the activities of JEAN, which is a non-government/non-profit organization, formed voluntarily in 1991, after members first participated in ICC in 1990 (JEAN became a general incorporated association in 2010). After twenty years of coordinating the ICC in Japan, JEAN has earned credibility for expertise regarding the marine litter problem. The twenty years of addressing the marine litter problem will be examined – how a small voluntary networking group conducted trash surveys with the help of thousands of citizen volunteers throughout the country; how it used the gathered data and information related to marine litter; and how the "Law for Promotion of Marine Litter Deposal", a bill sponsored by a cross-party group of lawmakers, was enacted. To consider more speedy and effective solutions to this problem, one workable means may be to superimpose the marine litter data on related events in

the history of innovations, laws and regulations, and even on changes in people's preferences. By analyzing the changes in trends of certain trash items in this way, hints to solving the marine litter problem can be seen.

OUTCOMES

The first ICC in Japan was held in September 1990 at 80 sites with 800 volunteer participants. Now, it has grown to an activity involving around 20,000 volunteers at 200 sites. JEAN has carried out biannual cleanup campaigns in spring and autumn from 1991 to the present. During the autumn campaign, which is held from September to December, ICC marine litter surveys are taken to encourage participants to become involved in the international effort to investigate and collect data of trash scattered on water shores, as well as to collect trash from the area where they do the survey. In the 2010 ICC, the number of sites was 162 and the number of participants was 10,441. Although over the years, there have been some variances in the numbers of sites and participants, the trends show a slight decline after a sudden increase in both numbers in 2003. ICC's trash survey itself is not a scientific program, as non-professional people record the number of certain trash items in different periods and numbers of participants. It can reveal, however, some particular characteristics in the composition of trash found at shores and underwater. JEAN has compiled and disclosed the data publicly in the form of a "Cleanup Campaign Report". The participants in the ICC will experience first-hand the state of the marine litter. This will lead people to become aware of their behaviors regarding using goods and disposing trash, and hopefully, become a force toward reducing marine litter. Meanwhile, by presenting organized data and recommendations based on the data, the report is a tool for educating and urging all tiers of the society to recognize the problem and seek a solution. This was the first phase (first ten years since the start) of ICC in Japan – to address the seriousness of the problem and urge the Japanese society to take responsible action to solve it. The increase in participation indicated the positive public response to the new method for a solution.

Although the second phase of another ten years did not bring about a dramatic rise in participation, stable, constant and organized data collection has been secured by volunteer investigators. The marine litter situation, however, apparently worsened despite the volunteers' efforts. Marine litter accumulation in particular Japanese beaches is a serious problem, since in most of these places, driftage is severe and both financial and human resources to collect and properly dispose the trash are lacking. JEAN regarded apprising information and building awareness among people was important but fell short of reaching the goal – to solve the problem forthwith. By then, JEAN had gained supportive members with background in many different fields, which helped networking groups and individuals in the issue of marine litter. JEAN started hosting forums and gatherings including persons of responsibility from relevant government offices, and others related to the marine litter issue such as researchers and individuals from NGOs and the business sector. It also actively amplified lobbying activities, and as a result, the "Law for the Promotion of Marine Litter Disposal", which was legislation initiated by Diet members, was passed in 2009. The law strengthens imperatives and cooperation among the national government, local authorities, businesses and citizens, not excluding areas without coasts. Based on this law, many local governments have received budget allowances for cleanup measures. The specifications of the law, however, lack in collaboration between the government, NGOs and other groups, and many issues have arisen. Shortcomings of the law may be corrected in the course of a review in 2012.

Enactment of the law, despite its imperfections, will lead to changing the mindset of people on the issue of marine litter. Furthermore, for concerned groups and individuals such as JEAN, the law can be a premise upon which to urge government offices to promptly tackle the problem. For example, interesting correlations can be observed from the data that JEAN has compiled. In Japan, as in other countries, the ICC trash item “cigarette butts and cigarette filters” has been listed as the most abundant trash. The number of cigarette butts and filters collected, however, has been declining since the late 1990s. In October 2002, Chiyoda Ward in Tokyo enforced the "Living Environment Ordinance", which prohibits smoking and littering on streets in specific area and imposes a correctional fine. Motivated by this action, other local bodies followed Chiyoda Ward’s case. In addition, the power balance changed rapidly between smokers and non-smokers in Japanese society. Now, non-smokers can say "No" to smoking, more places like restaurants, offices and vehicles have restrictions on smoking, and the manner of smokers seems to have improved. Year-to-year differences in the cleanup participants’ way of picking up trash at their discretion may have had an effect on the data, but it can be surmised that changes in the laws and people’s behavior may have influenced the trends in amount of trash collected at the beaches. Another example of a declining marine litter item is “pull tabs” on beverage cans (Figure 1). After 1992, there was a sudden decline in the number of pull tabs collected, especially at non-shore areas. The cause of this decrease was public reaction to the proliferation of littered pull tabs, manufacturers’ quick response in innovating “stay-on-tabs” as a solution in the early 1980s, and change from pull tabs to stay-on-tabs by early 1990. An example of an increase in a collected item can be seen in the case of PET (Polyethylene terephthalate) bottles, which started to be used in the late 1960s. With the development of recycling technology, PET bottles smaller than 500 ml became popular in Japan (Figure 2). In 1997, The Law for Promotion of Sorted Collection and Recycling of Containers and Packaging applied to PET bottles in Japan. After that year, collection of PET bottles at the ICC survey has been increasing. This type of correlation can only be observed by continuing long-term monitoring of the marine litter. Careful consideration from these results can bring about effective methods to reduce marine litter.

PRIORITY ACTIONS

It is necessary to cleanup beaches, and vital to make the public aware of the problem of marine litter and educate not to litter. In addition, it is important to conduct research and study the trends. To solve the problem more efficiently, however, we must understand the mechanisms of changes in trends in marine litter items in order to explore every avenue to stop generating litter that ends up in our oceans.

FIGURES AND TABLES

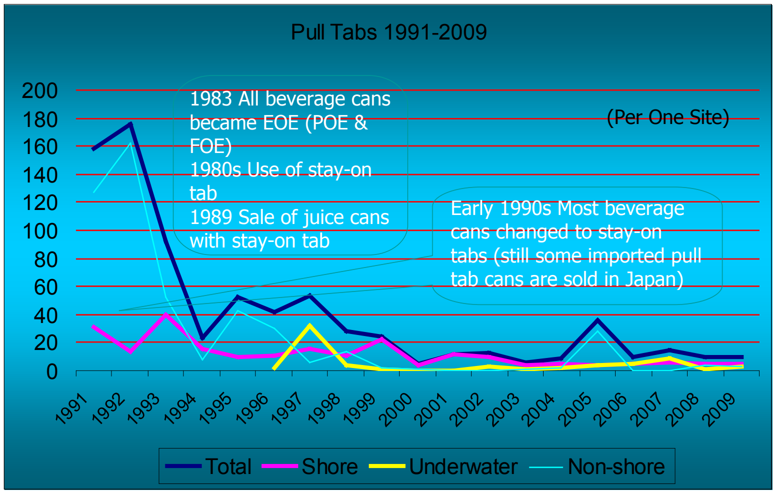

Fig. 1 Pull Tabs Collected in the ICC Events and Related Background Events
(EOE: Easy-open-end, POE: Partial-open-end, FOE: Full-open-end)
Source: Data obtained from JEAN ICC results from 1991 to 2009

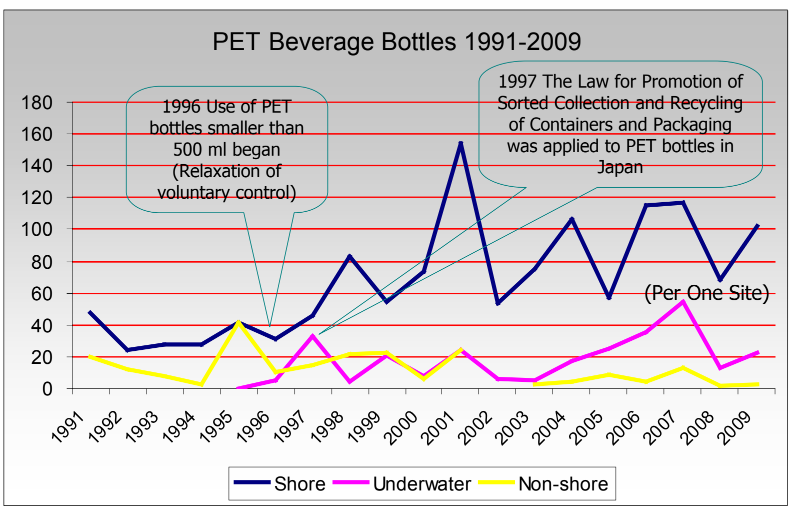

Fig. 2 PET Beverage Bottles Collected in the ICC Events and Related Background Events
Source: Data obtained from JEAN ICC results from 1991 to 2009

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Cleanup Campaign Report 1991 to 2009, JEAN (in Japanese)

8.b.6. Marine debris data tracking: methods and uses

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BACKGROUND
Save Our Shores (SOS) is a 501c3 organization with a recognized presence on California's Central Coast. SOS was founded in 1978 and was instrumental in establishing the Monterey Bay National Marine Sanctuary (MBNMS), of which it continues to protect today. One of the most significant threats to the health of the MBNMS is marine debris, and more specifically, plastic pollution.

While SOS had been conducting beach and inland cleanups for over 30 years, it became clear that without data, SOS could not effectively launch litter prevention efforts including advocacy and education programs. In 2007, SOS worked with the California Coastal Commission and other partner agencies throughout the State to develop a data card so that they could most effectively track the type and quantity of items collected. SOS has been tracking data at every cleanup for the past several years and is using this information to successfully identify data trends to help guide policy and outreach decisions on the local level. SOS is striving to encourage and support other agencies to adopt their data card in order to provide a more comprehensive look at the marine debris problem on a statewide, national and international level.

METHODOLOGY
In 2007, SOS received funding from the California State Coastal Conservancy to develop a Marine Debris Data Card that could be used throughout California. SOS worked with the California Coastal Commission and other statewide partner agencies to develop a Data Card that was both comprehensive and easy to use.

SOS created a database to enter and track all of the collected data, which allows SOS to track data by month, by location and by type of cleanup (inland or beach). Additionally, SOS established routine publishing deadlines so that data was made available to the public through the Sanctuary Integrated Monitoring Network (SIMoN) website as well as the SOS website.

OUTCOMES
Due to the marine debris data collected over the last several years, SOS has been able to advocate for local bans and provide more targeted outreach and education to community members. Regarding local policy issues and bans, SOS was instrumental in pushing for a ban on polystyrene take-out containers for Santa Cruz County. SOS was able to provide valuable information on the prevalence of polystyrene take-out containers on local beaches and waterways, which helped convince local officials of the scope of the problem. In 2009, the entire county of Santa Cruz including its four cities adopted a ban on polystyrene take-out containers.

SOS has been working to bring similar bans to cities within Monterey County and Coastside San Mateo County. Additionally, SOS has been able to show how polystyrene take-out containers decreased by 37% the first year the local bans were instituted, which provided evidence that this type of action is effective when combating marine debris issues.

Early in 2009 it became evident that plastic bag litter along with cigarette butts represented two of the most collected items during SOS beach and river cleanups. SOS therefore launched a targeted campaign to bring a single-use plastic bag ban to Santa Cruz. SOS presented to the Santa Cruz Board of Supervisors in 2009 on the scope of the plastic bag problem. SOS was able to show the Board that volunteers had collected over 14,000 bags in the short time they had been collecting data, which provided the impetus for the Board to move forward on a single-use plastic bag ban. Data trends suggested that plastic bag litter was not just a problem on the beach but that many bags were washing down creeks and rivers from more inland sources, which influenced SOS' decision to press for a countywide effort that targeted the more inland cities as well as all types of stores. SOS continues to use their data on plastic bags to support a uniform bag ban effort for Santa Cruz County, Monterey County, and Coastside San Mateo County.

SOS' cigarette butt data follows statewide and national Coastal Cleanup Day data trends in that they represent the number one item collected during cleanups. Since the Spring of 2007, SOS volunteers have collected over 190,000 cigarette butts from local beaches and waterways. Data trends suggested that specific locations, particularly along transition points, yielded much higher levels of cigarette butts. With this information, SOS was able to convince the Coastal Conservancy in June 2010 to fund a pilot project in which SOS would provide cigarette butt receptacles in high impact locations, coupled with data monitoring and a targeted community outreach program aimed at educating people about the harm butts cause to marine life and the proper way to dispose of them. SOS worked with a private company to create receptacles that were both functional and educational and a total of 18 receptacles were installed in the cities of Santa Cruz and Capitola. Continued monitoring of these locations before and after installation has shown that this particular approach has reduced cigarette butt litter by at least 60%. Due to the success of this pilot project, SOS has been working with the city of Monterey, the City of Morro Bay, the City of Half Moon Bay and other locations who are interested in using our findings and recommendations to address cigarette butt litter in their own community.

PRIORITY ACTIONS

It would be extremely effective to have a uniform data set across California as well as nationally and internationally where organizations, city officials, and members of the public could better understand the types of materials that are posing the biggest threat as well as allow partner groups to propose and create more uniform approaches to addressing these types of litter such as uniform single-use plastic bag bans. In order for this to happen, SOS recommends groups adopt their Marine Debris Data Card so that everyone will have the same data set and that we establish a database where all groups collecting data publish periodic data reports so that data trends and results can be shared.

FIGURES AND TABLES

Save Our Shores Cleanup Data Card.

Save Our Shores
Cleanup Data Card

Group Name:

City/County:

Beach/Site:

Date:

Area Covered (miles):

# of Volunteers x Hours = Total Volunteer Hours

Pounds of Recyclables: Pounds of Trash:

Cleanup Instructions

1. Leave dead animals, kelp, drift wood and all other naturally occuring items. They are an important part of the ecosystem you are preserving.
2. Collect everything else, even the small pieces which are easily mistaken for food by animals.
3. Tell your site leader if you find a syringe or any other dangerous materials. They will dispose of these items.
4. Help us prevent ocean pollution by collecting data!

Data is being collected across California and will be used to tackle the ocean pollution issue with legislation at the local and statewide level. Keep a count of the trash items that you find using tally marks. When you are finished, enter the item total in the box. Example:

[8] Bags (grocery, shopping, trash) 卌 III

Do not write words such as "Lots" or "Many"
Only numbers are useful data.

PLASTIC ITEMS

- [ ] Bags (grocery, shopping, trash)
- [ ] Bags (ziplock, snack)
- [ ] Food Wrappers (ie chips or candy)
- [ ] Bottles
- [ ] Cups, Lids, Plates, Utensils
- [ ] Bottle Caps or Rings
- [ ] 6-Pack Rings
- [ ] Straws or Stirrers
- [ ] Fishing Line, Nets, Lures, Floats
- [ ] Motor Oil Bottles
- [ ] Balloons or Ribbons
- [ ] Pieces

STYROFOAM ITEMS (foamed plastic)

- [ ] Food Containers, Cups, Plates
- [ ] Buoys or Floats
- [ ] Peanuts or Packing Materials
- [ ] Pieces

SMOKING RELATED ITEMS

- [ ] Cigarette Butts

GLASS ITEMS

- [ ] Bottles
- [ ] Pieces

PAPER ITEMS

- [ ] Bags
- [ ] Food Containers, Cups, Plates
- [ ] Cardboard, Newspapers, Magazines
- [ ] Pieces

METAL ITEMS

- [ ] Bottle Caps or Can Pulls
- [ ] Beverage Cans
- [ ] Aluminum Foil
- [ ] Nails
- [ ] Batteries
- [ ] Fishing Hooks or Lures
- [ ] Crab Pots

BEACH USERS

- [ ] Fireworks
- [ ] Pallets or Wood
- [ ] Beach Chairs, Toys, Umbrellas
- [ ] Shoes
- [ ] Clothes or Towels

MEDICAL AND PERSONAL HYGIENE

- [ ] Syringes or Needles
- [ ] Diapers
- [ ] Condoms
- [ ] Feminine Products
- [ ] Bandaids or Bandages

LARGE ITEMS

- [ ] Shopping Carts
- [ ] Appliances
- [ ] Car Parts
- [ ] Bikes/Bike Parts
- [ ] Tires
- [ ] Car Batteries

OTHER

(please write in anything else you have found)

- [ ] i.e. Rope
- [ ]
- [ ]
- [ ]

Please return this data card to your cleanup leader.

Thank you for helping to stop ocean pollution!

Save Our Shores

For more information contact our Cleanup Coordinator at:
Phone: (831) 462-5660
Fax: (831) 462-6070
http://saveourshores.org

8.c.1. Microbial biofouling of plastic marine debris

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KEYWORDS
Microplastic, marine debris, microbial, bacteria, biofouling, degradation, density

BACKGROUND
The fate of plastic marine debris in the open ocean is largely unknown. The long-term dataset compiled by Sea Education Association in the North Atlantic suggests that the measurable amount (>335um) of plastic debris in the North Atlantic has not kept pace with rise of consumption and production on land over the past 25 years. Assuming that the supply of plastic to the ocean has risen along with production/consumption, this finding suggests that there is a sink of plastic in the ocean. A likely candidate for this "sink" the deterioration of microplastic fragments to size classes smaller than the mesh size of the collection nets (335um). How does plastic breakdown in the environment? Is it all photo- and mechanical degradation? Or is there a biological driver as well? These are important questions, and ones that we are just begining to answer.

In this study we examined the physical characteristics of the plastic for signs of microbial growth, and examined the microbial content using microscopy and gene sequencing techniques.

METHODOLOGY
Moret-Ferguson et al (2010) analyzed the physical properties of 748 individual particles for mass, size, form and density. This sample set represents a subset of more than 18,000 archived plastic samples collected in the western North Atlantic Ocean by Sea Education Association (SEA, Woods Hole, MA, USA) over the past 24 years. All samples were collected with a neuston tow, using a surface net-tow protocol that has been uniformly employed on SEA vessels for the past three decades. A neuston net (335 lm mesh and 0.5 m x 1.0 m opening) was towed along the sea surface (nominally 0.25 m of the net is submerged beneath the surface) for approximately one nautical mile at a speed of two knots and the contents of the net are strained over a 335 lm mesh sieve. All plastic particles were visually identified, hand-separated from plankton and tar, air-dried, stored in plastic bags, and archived in darkness at room temperature.

Density determination was modified from Kolb and Kolb (1991), utilizing ethanol and strontium chloride solutions to construct a solution of the same density as the plastic fragment, determined by suspending the fragment in solution at neutral buoyancy. The density of the resultant solution was measured by weighing a known volume on an analytical balance.

Scanning Electron Microscopy (SEM) was performed at the Marine Biological Laboratory. The genetic framework was provided by V6-V4 rRNA gene hypervarible region pyrotag sequencing, conducted at the Marine Biological Laboratory Josephine Bay Paul Center for Comparative Molecular Biology and Evolution.

OUTCOMES

There is a distinct difference in the density distribution of "fresh" plastic found on the beach and plastic marine debris in the open ocean (Moret-Ferguson et al., 2010). The most common plastic type (polyethylene) in the open ocean is more dense than virgin polyethylene or polyethylene from beach samples, suggesting that the density of plastic marine debris increases during residence in the open ocean. The C:H:N ratios of 20 plastic fragments from the open ocean reveal a nitrogen content that is consistent with an addition of biomass. The amount of biomass predicted by the increased nitrogen content would result in a density increase of the fragment matching the observed increase.

High throughput gene sequencing of microbial biomass recovered from open ocean plastic fragments revealed a very complex structure of microbial communities. Microbial communitikes associated with polyethylene plastic are distinct from communities in the surrounding seawater, and distinct from communities associated with polypropylene and natural substrates (*Sargassum*). SEM images of the surface of various plastic types show an abundant diversity of microorganisms including prokaryotes and eukaryotes. Several images confirm microbial utilization and degradation of the plastic substrate.

PRIORITY ACTIONS

This study demonstrates that abundant and diverse microbial life is supported on plastic substrates floating in an oligotrophic oceanic region. The microbial contribution to the fate of plastic marine debris is largely unknown. We have captured images that clearly show degradation of plastic associated with the presence of bacteria. Our findings highlight the need to better understand the community structure and impact of microbial populations on the "plastisphere" in our oceans.

FIGURES AND TABLES

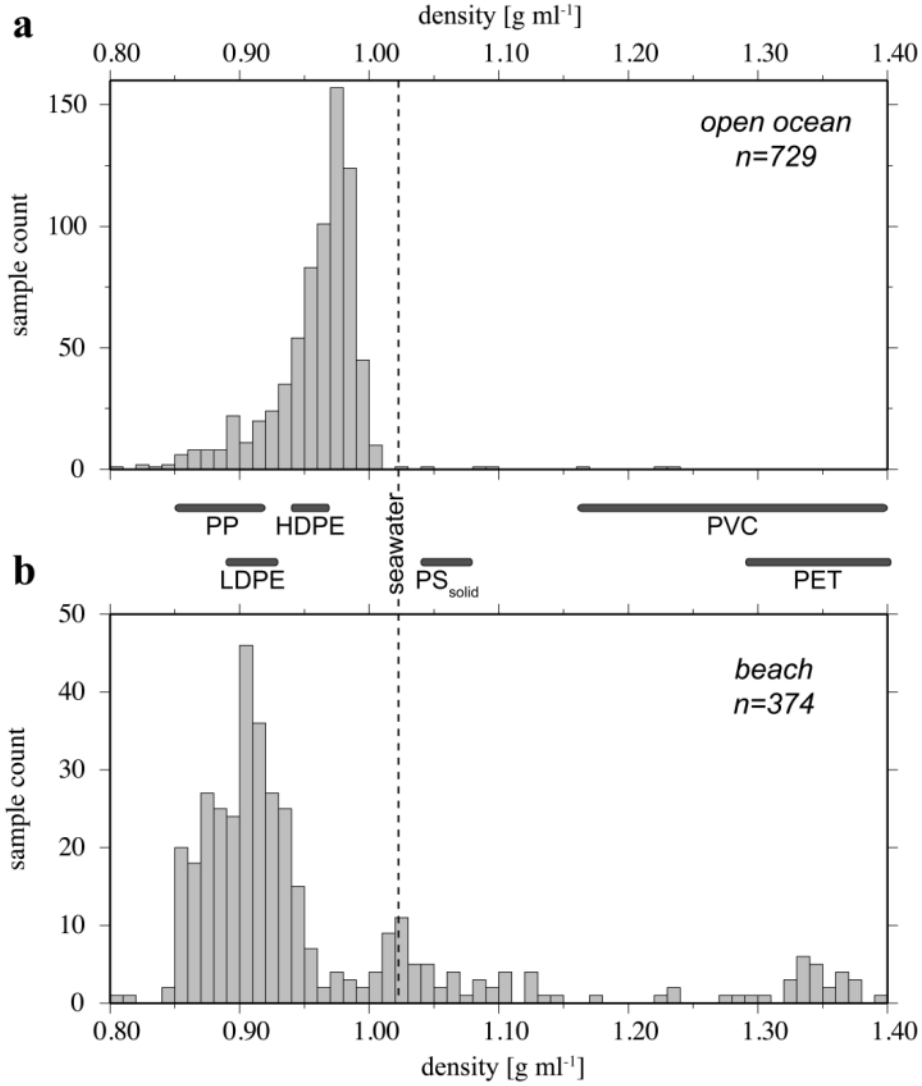

Figure 1. From Moret-Ferguson et al. (2010). Plastic density histograms of (a) open ocean and (b) beach samples, not including polystyrene foam. Horizontal bars indicate known densities of major consumer plastics. Dashed line represents measured mean western North Atlantic surface seawater density. Note that only six pelagic samples have densities greater than seawater, and that beach plastic values are consistent with the densities of common consumer plastics. The increase in the most frequent density in open ocean samples is hypothesized to be due to bioaccumulation on the plastic fragments.

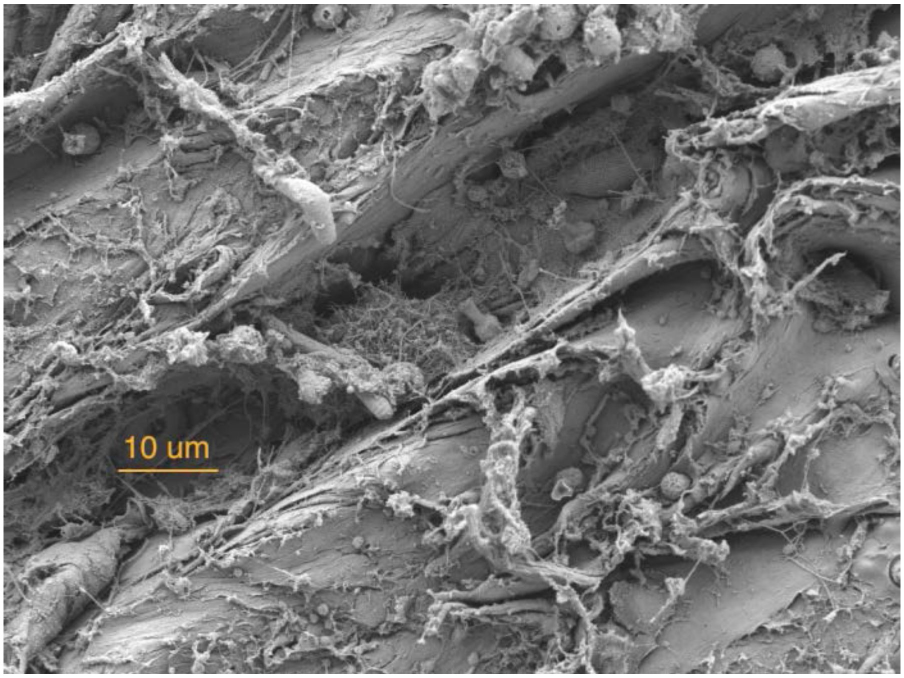

Figure 2. SEM image of a polyethylene sheet collected from the western North Atlantic in 2009. An abundance of microorganisms is depicted, including prokaryotes and eukaryotes. Presence of microbes in the deep gouges of the plastic surface suggests a habitat provided by protective refuge, but does not indicate active degradation of substrate.

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8.c.2. Adsorption of POPs to different types of plastic pellets deployed in San Diego Bay, California

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ABSTRACT
Plastic pollution in the ocean not only carries toxins such as Bisphenol A and phthalates from the manufacturing process, but also adsorbs and accumulates Persistent Organic Pollutants (POPs) such as PCBs, organochlorine pesticides, and PAHs among others present in surrounding waters. In addition, many marine organisms have been shown to ingest plastic debris directly. Plastics may serve as another mechanism for these contaminants to enter marine foodwebs. The objective of this study is to better understand how marine plastic debris adsorbs POPs from the ocean. In this study, 6 types of plastic (Polyethylene terephthalate, High-density polyethylene, Polyvinyl chloride, Low-density polyethylene, Polypropylene, Polystyrene) were deployed at six different locations in the San Diego Bay. These plastics were collected at 1-, 3-, 6-, 9-, and 12- months post exposure to the ocean water and are analyzed for the rate of adsorbtion and equilibrium concentrations of PAHs, PCBs, and organochlorine pesticides. Data from HDPE, PP, and PS will be presented. We found that HDPE adsorbs significantly higher concentrations of PAHs than PP ($p<0.001$), but that there is an opposite trend for PCBs. We found that PP adsorbs significantly higher concentrations of PCBs than HDPE ($p=0.015$). We also found different patterns of POPs across the San Diego Bay. In general PAHs were 2-3 orders of magnitude higher in concentration than PCBs and organochlorine pesticides. During a beach survey, we found that PS foam contained very high concentrations of PAHs. To further investigate, we compared environmental samples of polystyrene foam to unexposed polystyrene foam and virgin polystyrene pellets. Unexposed PS foam samples were found to have 2 to 3 orders of magnitude greater total PAHs than virgin polystyrene pellets. These results lead us to believe that the manufacturing process of polystyrene foam produces PAHs as byproducts, raising the issue of polystyrene foam as a source of PAHs to seawater.

8.c.3. Quantifying phthalates and bisphenol A in marine organisms

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KEYWORDS
Phthalates, Bisphenol A, Dispersive solid phase extraction, blank contamination, SPE cartridges, Teflon, contaminated solvents, marine organisms.

BACKGROUND
Marine debris accumulated from around the world on certain beaches and locations in the ocean has been the focus of recent studies because of the threat it poses to the marine environment. About 90% of the floating wastes are plastics in all sizes which can exist in the marine ecosystem without biodegrading for hundreds of years (USEPA, 2003). The quantity present is recognized to be harmful for marine organisms and wildlife species. Many of the wildlife ingest micro plastics (< 5 mm) mistakenly as food particles which do not metabolize in their system and are harmful for their health and survival. Another harmful threat of plastic is the potential leaching of their toxic additives such as bisphenol A, phthalates, styrene, vinyl chloride and flame retardants in the marine environment. Uptake of these compounds by adsorption or absorption through the skin or binding to proteins and lipids poses a hazard to marine organisms throughout all trophic levels. Many of the marine bird species and sea turtles are found dead on the shores of Hawaii and Northern California due to ingestion of micro plastics but only little work has been done to determine the level of toxic plastic additives in the tissue and organs of these organisms. The focus of this research was to determine the levels of six common phthalates and bisphenol A in different trophic levels found in the coastal regions of Alaska, a location with one of the largest marine plastic debris accumulation. Tissues from marine birds, Alaskan salmon, halibut and clams were analyzed using liquid chromatography tandem mass spectrometry (LC MS/MS) with atmospheric pressure photo-ionization (APPI) and electrospray ionization (ESI) to detect trace levels of six common phthalates and bisphenol A. Significant levels of two of the most common phthalates were seen in the clam and bird tissue samples. These compounds are toxic to higher trophic levels and have already been banned in most of the European Nations and the United States.

METHODOLOGY
Since phthalates are ubiquitous in nature, the most difficult part in the analysis was lowering the background contamination. Lots of different solvents were analyzed to check for phthalate and bisphenol A contamination. All of the solid phase extraction cartridges (florisil and C18) were analyzed for the presence of phthalates and bisphenol A. Preferred method of tissue extraction in

the beginning of this project was accelerated solvent extraction system (Dionex,ASE 200) but after the extractions of the blanks, it was determined that another method would have to be developed or refined where limited contact of solvents were allowed with the Teflon tubing. Analysis of Teflon septa showed significant levels of two of the common phthalates, dibutyl phthalate and diethylhexyl phthalate. The method of extraction in this analysis was dispersive solid phase extraction (DSPE). Approximately 1 gram of homogenized sample was first extracted with 2 ml of acetonitrile in the presence of $MgSO_4$ and NaCl. The mixture was vortexed for 1 minute and centrifuged for 10 minutes at 3460 x g. After centrifugation, the organic layer was removed and further cleaned with super clean primary secondary amine (PSA) by centrifugation. The supernatant was removed, filtered and analysed using LC MS/MS triple quad.

OUTCOMES

The standard calibration curves were linear for all the analytes over the concentration range of 1-30 ng/ml and the correlation coefficients ranged from 0.9978 to 0.9997. The accuracy was evaluated by measuring the recovery from the deuterated spiked samples. Method blanks were significantly low with dispersive solid phase extraction thereby enabling the method to be used successfully in the analysis of phthalates and bisphenol A. The results with tissues samples varied from clams, to fish to birds. The following table and graphs gives an overview of the levels of phthalates and bisphenol A found to be present in the four different trophic levels.

PRIORITY ACTIONS

More studies should be conducted on the marine organisms from the lakes and rivers surrounding the Gulf of Alaska to see the effects the chemical components of marine debris over a period of time.

FIGURES AND TABLES

Table 1. Concentration range of the compound of interest in four trophic levels broken down by tissue sampled.

Sample	DMP conc. ppb	DEP conc. ppb	DBP conc. ppb	BBP conc. ppb	DEHP conc. ppb	DNOP conc. ppb	BPA conc. ppb
Clams	3 - 37	0.3 – 1.5	6.3 - 333	0.1 -2.4	5 - 342	0.5 – 3.3	5 - 45
Halibut muscle	<LOD	<LOD	0.6 - 256	0.1 – 4.1	3 - 13	0.3 – 0.5	2 - 5
Halibut liver	<LOD	<LOD	2.3 - 199	0.1 – 2.8	1 – 9.4	<LOD	8 - 25
Salmon muscle	<LOD	<LOD	1.3 – 1.5	<LOD	0.3 – 9.5	<LOD	0.2 - 10
Salmon liver	1.8 – 7.3	0.1 – 1.1	1.7 - 297	<LOD	0.4 – 1.2	<LOD	6 - 8
Bird	<LOD	<LOD	0.6 - 427	0.2 – 3.8	0.6 - 27	<LOD	0.8-1.3

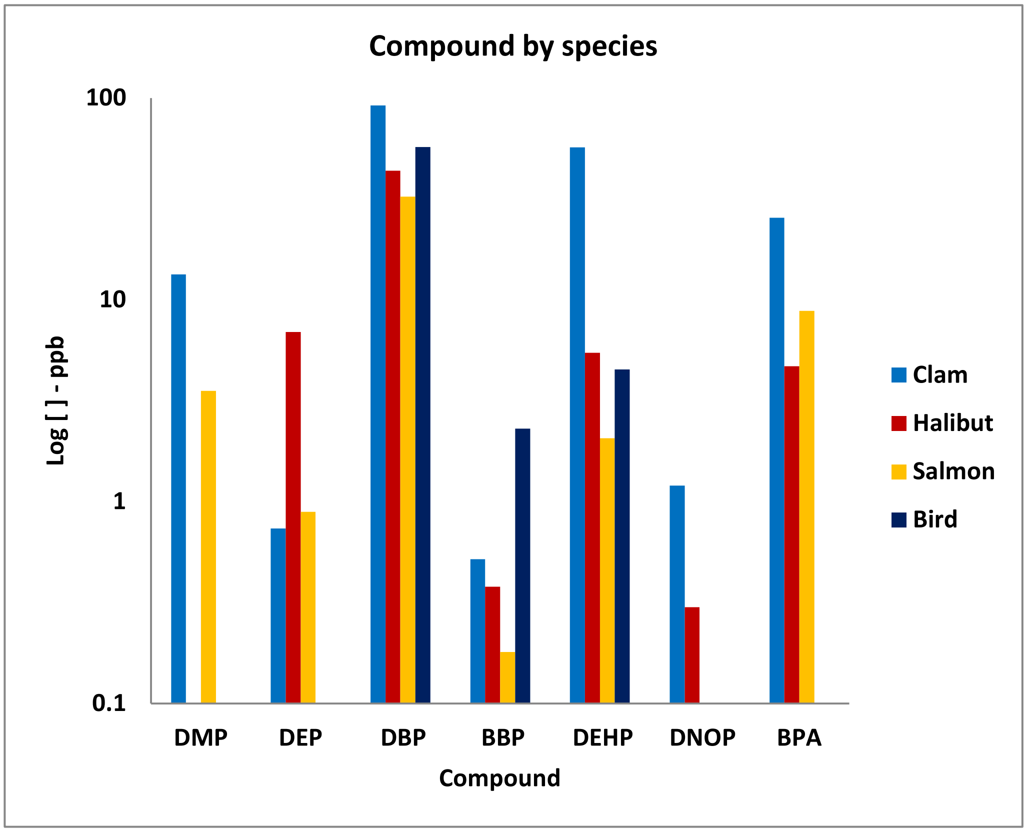

Fig 1: Average concentration of compound of interest in four trophic levels.

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8.c.4. Chemicals in marine plastics and potential risks for a seabird like the northern fulmar (*Fulmarus glacialis*).

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KEYWORDS
Plastic; Ingestion; *Fulmarus-glacialis*; North-Sea; mass-mortality; seabird-wreck; POP; effect; hormonal disturbance

BACKGROUND
Some seabird species consume major quantities of different types of marine plastic debris. In addition to direct physical effects, there is a growing concern on the potential effects from chemicals built in or adsorbed to the plastics that are ingested. Under natural conditions it will be extremely difficult to firmly demonstrate effects. Observations in relation to a mass mortality of Northern Fulmars (*Fulmarus glacialis*) in the North Sea in 2004 do suggest that such effects may occur, and that effects can be sudden and severe.

METHODOLOGY
In the North Sea area, a monitoring system of the amount of plastics ingested by Fulmars is in place (van Franeker et al. 5IMDC abstract 0054). In March 2004, beach surveyors of the project in the southern North Sea encountered exceptionally large numbers of dead Fulmars on the beaches, and many were collected and processed according to the standard protocol in the project (van Franeker 2004a), which includes a range of variables on age, sex, condition, origin, death cause etc. These records allow a closer analysis of backgrounds of the mass mortality incident.

OUTCOMES
Even if the Fulmar mortality in March 2004 was perceived as a sudden event, survey data and details from dissections showed that the wreck had its origin in autumn 2003 and continued until the start of the breeding season 2004 (Van Franeker 2004b).

Patterns of molt of primaries and tail feathers of the March victims showed that most of them had suffered food shortage in the previous autumn that had caused them to slow down or even fully arrest the renewal of their feathers. Apparently this situation had continued over the full winter until March and even into June 2004, thus preventing that molt was resumed. June showed unusual mortality of birds in extremely poor plumage. In many birds, feathers had degraded to a level that must have affected waterproofing, flying capacities and insulation (Fig.1). Less conspicuous, but possibly even more important, was the fact that a considerable proportion of the dead birds had very poor to no down plumage, and thus suffered from poor insulation, increasing energy demands and thus exacerbating the apparent shortage of food. The most serious aspect however, was that a large majority of birds that died were adult females, which is highly unusual as most mass mortalities of seabirds concern young and inexperienced birds, and are not normally strongly sex-biased (Table 1). Such age and sex bias continued into the June mortality and even showed mortality among several egg carrying females at large distances from colonies. The normal strategy in long-lived seabirds like the Northern Fulmar is that reproduction is not started or aborted if well-being or survival of the adult is threatened by e.g. poor food conditions.

Many aspects of feather growth and reproductive decisions are hormonally regulated. The serious aberrations in down plumage, the highly abnormal sex and age ratio in mortality, and the illogical reproductive individual decisions all create heavy suspicion towards a disturbed endocrine hormonal system.

Disruption of the endocrine hormonal system may occur as a consequence of the various types of chemicals built into plastics, or adsorbed onto them in sea water. As a top level consumer of the marine system, Fulmars already accumulate considerable amounts of toxic substances via the normal bioaccumulation in the food chain (Knudsen et al. 2007). However, in addition to that, Fulmars are among the most serious plastic consumers among seabirds (5IMDC abstract 0054) and grind down plastics in their gizzard (5IMDC abstracts 0056) which is likely to maximize uptake of plastic related chemicals known to be linked to plastics (Teuten et al. 2009).

The question is why this mortality occurred now. In principle, the effects of pollutants become apparent when birds utilize their fat reserves and the contaminants start circulating in blood in higher concentrations. However, that is a situation that happens frequently in a normal annual cycle. What made the 2004 wreck different, is that apparently low body condition persisted over a very long period from autumn throughout winter. It is well possible that only under prolonged periods of reduced body condition, that endocrine hormone disruptors can take their full effect, and then bring the animal in a spiral of ever increasing energy demands that cannot be met.

This means that chemical loads related to plastic ingestion can be latent for a long time, but then under unfavorable conditions may pass a threshold level triggering serious population consequences. Excessive mortality of adult females will have an exceptionally heavy impact on a seabird population.

Over the years the proportion of industrial plastic granules ingested by Fulmars has been reduced, but unfortunately increased amounts of user plastics took their place. Virgin industrial pellets contain relatively little added chemicals in comparison to user plastics. Also, the particle size of ingested consumer plastics has decreased, which increases the surface to volume ratio. The changes in type of plastics and in particle size may both have enhanced chemical transfer of chemicals from plastics to Fulmars in comparison to earlier years. However, as long as food availability is in order, the effects of such pollutants remains latent, but represents a threat of irreversible events once started.

The interpretation of events during the 2004 mass mortality is of course speculative. No funds were available to test details of pollutants and hormones in these birds. But also with more detailed research, it will always be possible to question actual causes and effects in complicated ecosystem events like those seen in 2004. Evaluations of consequences of plastic pollution on natural populations and ecosystems will inevitably remain difficult and a case of common sense.

PRIORITY ACTIONS

In the marine plastic pollution issue, postponing policy decisions until full scientific proof of effects on species or ecosystems is given, is not an option. Effects may not be gradual but could show sudden high impacts in relation to unpredictable triggers or thresholds.

FIGURES AND TABLES

Table 1. The unusual sex and age composition of Fulmars in the 2004 wreck, illustrated by comparison of different periods in the full Fulmar EcoQO dataset for the Netherlands.

Sex-age composition of Fulmars in the Netherlans

	n	FEMALE ADULT	female imm-juv	MALE ADULT	male imm-juv
1980s	*363*	22%	29%	25%	23%
1990s	*232*	29%	29%	23%	19%
2000-03	*187*	30%	30%	20%	19%
2004	*134*	67%	11%	13%	8%
total NL	*916*	32%	27%	22%	19%

Figure 1. Postponed or arrested molt caused excessive wear of plumage of many Fulmars in the 2004 wreck in the Southern North Sea to an extent that must have affected their insulation, waterproofing and flying capacity.

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8.c.5. Effects of plastic debris ingestion on PCBs in seabirds

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ABSTRACT
The ingestion of plastic debris by seabirds has become widespread during the last five decades. However, limited number of studies have been conducted on the effects of ingested plastics, especially, adverse effects caused by toxic chemicals (e.g. polychlorinated biphenyls; PCBs) associated with ingested plastics. To address the ecotoxicological questions, the present study conducted field observation and feeding experiments. Stomach contents and PCBs in abdominal adipose of seabirds accidentally caught during experimental fishing in the North Pacific in 2005 were determined. Among the 55 individual seabirds inspected, 41 were found to have ingested plastics. The mass of ingested plastic correlated positively with tissue concentration of lower chlorinated biphenyls (e.g. CB#8; r=0.66, p=0.018; n=12) but not significantly with those of total PCB and higher chlorinated congeners (e.g. CB#132; r= 0.33, p=0.31). This was probably due to transfer of lower chlorinated biphenyls which are more abundant in marine plastics compared to natural prey of the bird (e.g. fish). Further evidence of the transfer of PCBs was obtained through feeding experiments where contaminated polyethylene resin pellets (40 particles, ~1 g) were fed to seabirds' chicks (40 day old) at the beginning of the experiment and their preen gland oil was collected periodically to monitor PCB concentrations. The Japanese sand lance (*Ammodytes personatus*) was fed to each chick daily (~10 to 120 g-wet). Slight but significant increase in PCBs concentrations was observed in the preen gland oil form specimen fed with contaminated plastics in comparison to control, suggesting transfer of PCBs from the plastics to internal organ of the seabird.

8.c.6. Marine debris and heavy metal contamination in Flesh-footed Shearwaters (*Puffinus carneipes*)

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ABSTRACT
In Australia, the Flesh-footed Shearwater (*Puffinus carneipes*) is widely regarded as the species most at risk from the ingestion of marine debris, with up to 90% of fledglings containing significant quantities of plastic. Because marine plastics accumulate contaminants in the ocean environment, an assessment of metal and metalloid contaminants in Flesh-footed Shearwaters was initiated. We sampled feathers from Kauwahaia (n = 18) and Lady Alice Island, New Zealand (n = 30), Lord Howe Island (n = 24) and Western Australia (n = 33) during the 2008 austral summer, making this the most complete assessment of metal and metalloid contamination of any shearwater. We found colony differences in all elements except lead and thallium. Samples from Western Australia had higher silver, aluminium, cadmium, and copper concentrations, while shearwaters from Lord Howe Island (eastern Australia) had elevated concentrations of mercury (11221ppb ± 5612SD). Analysis of plastic debris recovered from inside Flesh-footed Shearwaters on Lord Howe Island produced relatively high levels of these and other elements such as arsenic (1.15ppm) and lead (6.23ppm). We conclude that plastic debris is a likely source of contamination with mercury, and potentially arsenic and cadmium representing toxicological concerns for this declining species.

9.b.1. Volunteer beach cleanup data collection: sources of error and responses to the challenge

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KEYWORDS
Cleanup data, data errors, plastic pollution, volunteer data, volunteers, shoreline debris,

BACKGROUND
San Diego Coastkeeper coordinates twice-monthly volunteer beach cleanups for nearly 10,000 volunteers at different beaches across San Diego County in Southern California. Volunteers collect data following protocol similar to that which is used by the Ocean Conservancy for International Coastal Cleanup Day. Important information from this data set is used in communicating with local decision makers and the public by displaying this data on an online wiki. There are weaknesses in the data set which are often not addressed in our outreach materials or the materials of cleanup coordinators from different organizations. This presentation describes some of the sources of error in volunteer beach data collection and weaknesses in the resultant data set, as well as a discussion of why we continue to collect this information.

METHODOLOGY
The main data in discussion is totaled from volunteer collected data cards at our twice-monthly cleanups we do in partnership with the Surfrider Foundation of San Diego. We also compiled observations from cleanup coordinators in the San Diego region as well as local scientists. The analysis of the sources of error in the data collected by volunteers fall into three main categories: errors in volunteer training, errors based on human nature, and uncertainties or variables affecting results.

OUTCOMES
Errors in volunteer training: Oftentimes, first time volunteers have little to no training in data logging or categorizing pieces of debris. Different organizations may train differently and this may lead to bias in the way or extent to which volunteers record information. Sometimes, they don't even know how to properly tally and total their marks. If volunteers go alone, rather than in pairs as instructed, it's understandably difficult to handle collection and recording of debris pieces.

Errors based on human nature: If volunteers are not told reasons why to collect the data, or perhaps are simply filling volunteer hours, they may only partially complete the form or not complete it at all. Some volunteers may record data focusing on one type of litter (i.e. cigarette butts) and this information is amplified when other volunteers don't collect any data at all.

Uncertainties or variables affecting the results: Volunteers are not limited to the beach for their collection, and sidewalks alleys and streets contain different litter than the shoreline. The cleanup may have extenuating circumstances around the time of cleanup; it may appear cleaner or dirtier based on previous days activities (i.e. beach grooming reducing the large pieces of debris, parties or special events, major storms bringing larger, heavier pieces to shore and downstream, and rain saturating debris and making it heavier). Abnormally large items, such as pieces of derelict vessels, greatly increase the total weight of trash collected, but only count as one item on a data card.

Considerations must be made to reduce error as much as possible in data collected at volunteer cleanup events, primarily through training, education, and proper recording of variables affecting data. Other solutions are possible, including having a controlled collection site for more robust monitoring at each cleanup by dedicated and trained volunteers.

While the data set may not be scientifically robust, it has value. It is important to collect information before beach debris is collected and disposed of. We educate the public with this outreach data collection, and this information is important for local decision making and regional data sets.

PRIORITY ACTIONS

- Properly train and communicate with volunteers at cleanups to ensure the best possible dataset, explaining why we need the data.
- Record and report any factors which may affect the overall quality of data for volunteer cleanups.
- Continue to collect data at all volunteer cleanups, regardless of the scientific robustness of the dataset, as it is essential for education and tracking purposes.

9.b.2. Engaging ocean-going sailors to observe and record marine debris data in the North Pacific Gyre.

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ABSTRACT
The Pilot Marine Debris Visual Survey Project collaborated with ocean going sailors to record visual observations of marine debris and wildlife at sea. Each year sailing vessels race from California to Hawaii in one of two biannual ocean races, the Transpac and the Pacific Cup. Since 2008, the project collaborated with both Pacific Cup and Transpac Yacht Clubs to educate and recruit ocean-going sailors travelling through the eastern lobe of the North Pacific Gyre, more popularly coined the Great Pacific Garbage Patch. Volunteer sailors made visual recordings of marine debris types, location, wildlife, and environmental conditions. Data was mailed back to Hawaii and shared with the National Oceanic and Atmospheric Administration (NOAA) researchers. The project worked with sailors and scientists to develop procedures and data collecting requirements that were conducive to supporting research as well as crews managing the needs of a 40ft sailboat. As a result, this project has demonstrated that open ocean marine debris can be researched with volunteer sailors. Future implications of the project include: ongoing awareness and education through sailors to the public; standardization of data for long term storage; and the development of an ontology for marine debris visual observations.

9.b.3. Bringing together the marine debris community using "ships of opportunity" and a Federal marine debris information clearinghouse

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KEYWORDS
marine debris, ships of opportunity, clearinghouse, volunteers, pelagic, plastics, visual surveys, database

BACKGROUND
Marine debris surveys at sea have been conducted typically as an add-on to infrequent research cruises. In recognition of these limitations, "ships of opportunity" (i.e., vessels already at sea, such as fishing vessels) may assist researchers in learning more about the location, amount, and types of marine debris at sea as well as the behavior and movement of debris in the open ocean. Underscoring the value of "ships of opportunity" is the ability to link citizen scientists to standard monitoring and assessment protocols as well as enhance cross-communication among citizen scientist groups. Another tool for linking these groups is the U.S. Federal Information Clearinghouse, a product under development by the NOAA Marine Debris Division (MDD) to fill the communication gap in the growing field of marine debris research.

METHODOLOGY
A pilot project, begun in 2009, is currently underway to collect data on marine debris observations at sea. This project is being coordinated by the NOAA Marine Debris Division, in partnership with James Callahan, the Pacific Cup Yacht Club, TransPacific Yacht Race and experts on marine debris observations at sea.

An initial Shipboard Observation Form for Floating Marine Debris was created based on methods used in studies of floating marine debris (Thiel *et al.*, 2003, Shiomoto and Kameda, 2005, and Matsumura and Nasu, 1997), previous shipboard observational studies conducted at sea by NOAA, and the experience and input of the yacht sailors (Figure 1). The goal of this observation form is to be able to calculate the density of marine debris within the transect area using a slightly modified version of the formula used by Thiel *et al.*, (2003), Shiomoto and Kameda (2005), and Matsumura and Nasu (1997):

$$D = n/((w/1000) \times L)$$

- n = # of debris observed

- w = maximum distance perpendicular to the transect
- L = total length (in km) of the transect

**The original formula was modified because observations will only be noted from one side of the vessel at a time.*

The observation form was reviewed by researchers and others with experience and expertise in marine debris data collection at sea. Reviewer suggestions and comments were used to modify the form and instructions.

Copies of the observation form were printed on waterproof paper and sent with 2009 TransPac yacht racers heading to California and with 2010 Pacific Cup yacht racers returning to California. Completed observation forms and comments were mailed to and compiled by James Callahan. Scans of the observation forms were provided to the MDD and we then compiled the data and conducted simple data analysis. A website was created to share the results of the project each year (www.mdsurvey.wordpress.com).

This website and the data it provides is an example of the importance of using technology to distribute current and relevant information to the broad community interested in the issue of marine debris. In the future, the Clearinghouse will serve as a central point of reference for these types of data. The clearinghouse will initially be populated with project data gathered by the NOAA Marine Debris Program and its partners, with the intent that over time it will grow to include project information from a wide range of organizations.

OUTCOMES

In 2009, a total of 10 Trans Pac yachts participated; however only six returned observation forms. Those yachts are: *Cazador, Far Niente , Grand Illusion, J World, Lynx, and Medicine Man* The majority of the sighted marine debris was plastic (69%) followed by derelict fishing or boat-related gear (25%) (Figure 2). Of the plastic debris, plastic fragments were sighted most often with an average of 13 pieces (±3.07) (Figure 3). Of the fishing/boating gear, buoys and floats were sighted most often with an average of 5 pieces (±0.98) (Figure 3).

In 2010, a total of 20 Trans Pac yachts participated; however only nine returned observation forms. Those yachts are: *Cinnabar, Coyote, Jamani, Nozomi, Pangaea, Rhum Boogie, Scaramouche, Tiki J, and Whistler V*. Data analysis showed a similar trend to 2009 data. The majority of sighted marine debris was plastic (80%) followed by derelict fishing or boat-related gear (17%). Of the plastic debris, plastic fragments were sighted most often with an average of 0.92 pieces (±0.11). Differing from 2009, bouys and floats were sighted most often with an average of 0.34 pieces (±0.10).

The data collected by these volunteer yacht racers helps codify other anecdotal information on marine debris in the North Pacific in the area in or near the “eastern Pacific garbage patch” or the North Pacific Subtropical High. Concentrations of marine debris have been noted (published studies (e.g., Moore et al., 2001) and anecdotally) in an area midway between Hawaii and California within the North Pacific Subtropical High. Due to limited marine debris samples collected in the Pacific it is still difficult to predict the content, size, and location of these areas of debris concentration. Because the rare nature of research cruises to this area, and areas like it in other oceans, taking advantage of “ships of opportunity” like these yacht racers is one way to continue to learn more about the amounts, types, behavior, and movement of marine debris in the open ocean.

As ocean users, yacht racers are knowledgeable about the problem of marine debris and in many cases their expertise lends a depth of understanding that exceeds what research has been able to quantify or model thus far. Each racer that the authors spoke with had encountered marine debris while at sea, much of the time in the form of a propeller entanglement. The authors have found that yacht racers are willing to participate as citizen scientists in this data collection effort if the process is simple, it costs nothing, and they are able to see results. Most racers participated to help the environment. They know the costs of marine debris and how dangerous it can be out in the open ocean and want to share their knowledge to add to the understanding of marine debris at sea.

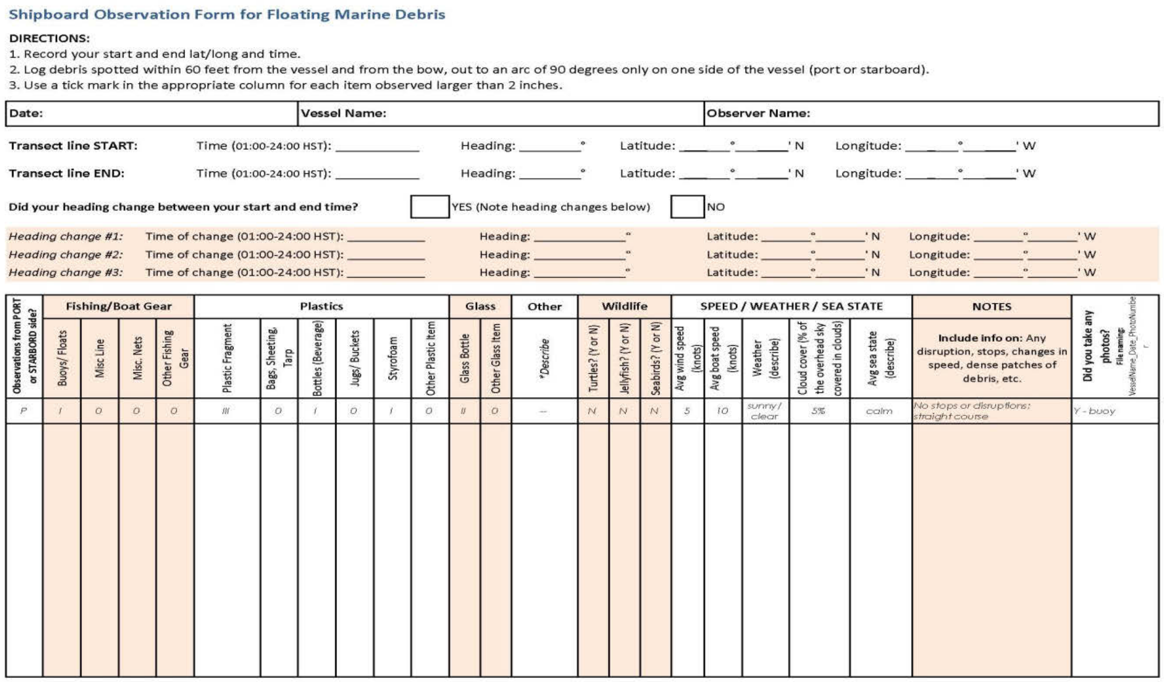
The overall goal of the clearinghouse is to facilitate and promote this type of information sharing and data transfer among researchers, scientists, removal experts and the interested general public. This goal was mandated by the legislation that formalized the NOAA Marine Debris Program. Workshops, interviews, and conversations verified this mandate as a clear need within the marine debris community. The clearinghouse will work to make connections throughout the marine debris community, allowing for sharing of lessons learned as well as adoption of common best practices. Bridging shared experiences is a principal goal of the clearinghouse. Given the global nature of marine debris, sharing the knowledge we gain on where it is, what it goes, and what it impact it has will help researchers and citizens take the best actions for dealing with the problem.

PRIORITY ACTIONS

Actions to reduce marine debris include the following top priorities relating to citizen science:

- Better sharing of standardized data is crucial to awareness of debris hotspots. This could be achieved through the proposed FICH.
- Engaging the ocean community is crucial to filling gaps in knowledge. Communication is a key factor in this, as is quality control of any data obtained.

FIGURES AND TABLES



Shipboard Observation Form for Floating Marine Debris

DIRECTIONS:
1. Record your start and end lat/long and time.
2. Log debris spotted within 60 feet from the vessel and from the bow, out to an arc of 90 degrees only on one side of the vessel (port or starboard).
3. Use a tick mark in the appropriate column for each item observed larger than 2 inches.

Date:	Vessel Name:	Observer Name:

Transect line START: Time (01:00-24:00 HST): ____________ Heading: ________° Latitude: ______°______' N Longitude: ______°______' W

Transect line END: Time (01:00-24:00 HST): ____________ Heading: ________° Latitude: ______°______' N Longitude: ______°______' W

Did your heading change between your start and end time? ☐ YES (Note heading changes below) ☐ NO

Heading change #1: Time of change (01:00-24:00 HST): ____________ Heading: ____________° Latitude: _______°_______' N Longitude: _______°_______' W
Heading change #2: Time of change (01:00-24:00 HST): ____________ Heading: ____________° Latitude: _______°_______' N Longitude: _______°_______' W
Heading change #3: Time of change (01:00-24:00 HST): ____________ Heading: ____________° Latitude: _______°_______' N Longitude: _______°_______' W

Observations from PORT or STARBORD side?	Fishing/Boat Gear				Plastics						Glass		Other	Wildlife			SPEED / WEATHER / SEA STATE					NOTES	Did you take any photos? File naming: VesselName_Date_PhotoNumber
	Buoys/ Floats	Misc Line	Misc. Nets	Other Fishing Gear	Plastic Fragment	Bags, Sheeting, Tarp	Bottles (Beverage)	Jugs/ Buckets	Styrofoam	Other Plastic Item	Glass Bottle	Other Glass Item	*Describe	Turtles? (Y or N)	Jellyfish? (Y or N)	Seabirds? (Y or N)	Avg wind speed (knots)	Avg boat speed (knots)	Weather (describe)	Cloud cover (% of the overhead sky covered in clouds)	Avg sea state (describe)	**Include info on:** Any disruption, stops, changes in speed, dense patches of debris, etc.	
P	*I*	*O*	*O*	*O*	*III*	*O*	*I*	*O*	*I*	*O*	*II*	*O*	*–*	*N*	*N*	*N*	*5*	*10*	*sunny / clear*	*5%*	*calm*	*No stops or disruptions; straight course*	*Y - buoy*

Figure 1. Shipboard Observation Form for Floating Marine Debris.

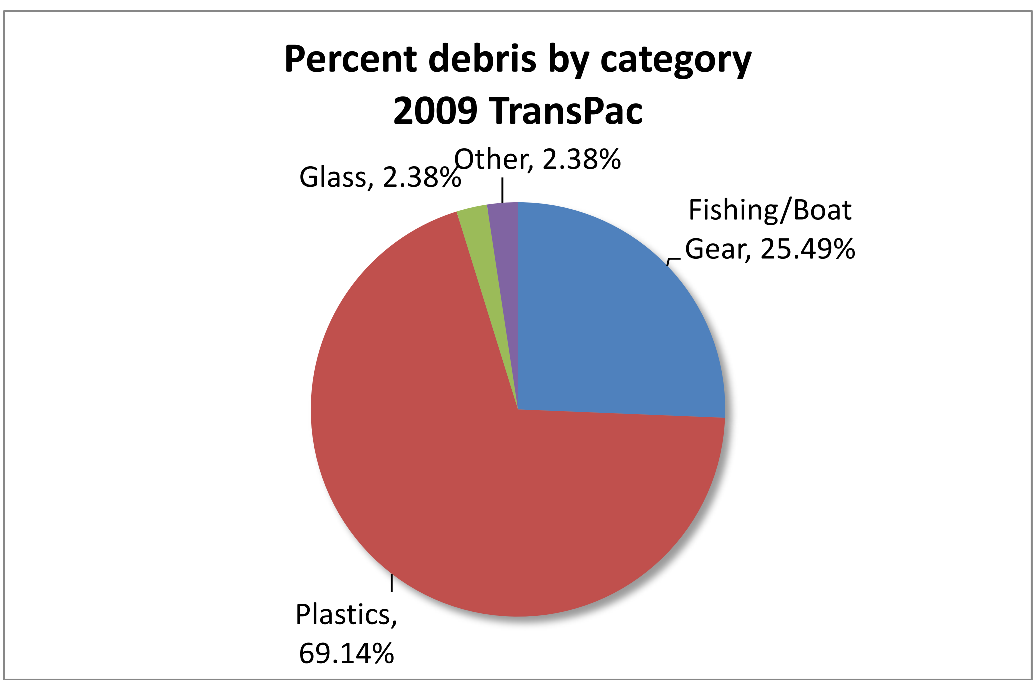


Figure 2. Percent debris by category sighted at sea during the return trip (Hawaii to California) after the 2009 TransPac yacht race.

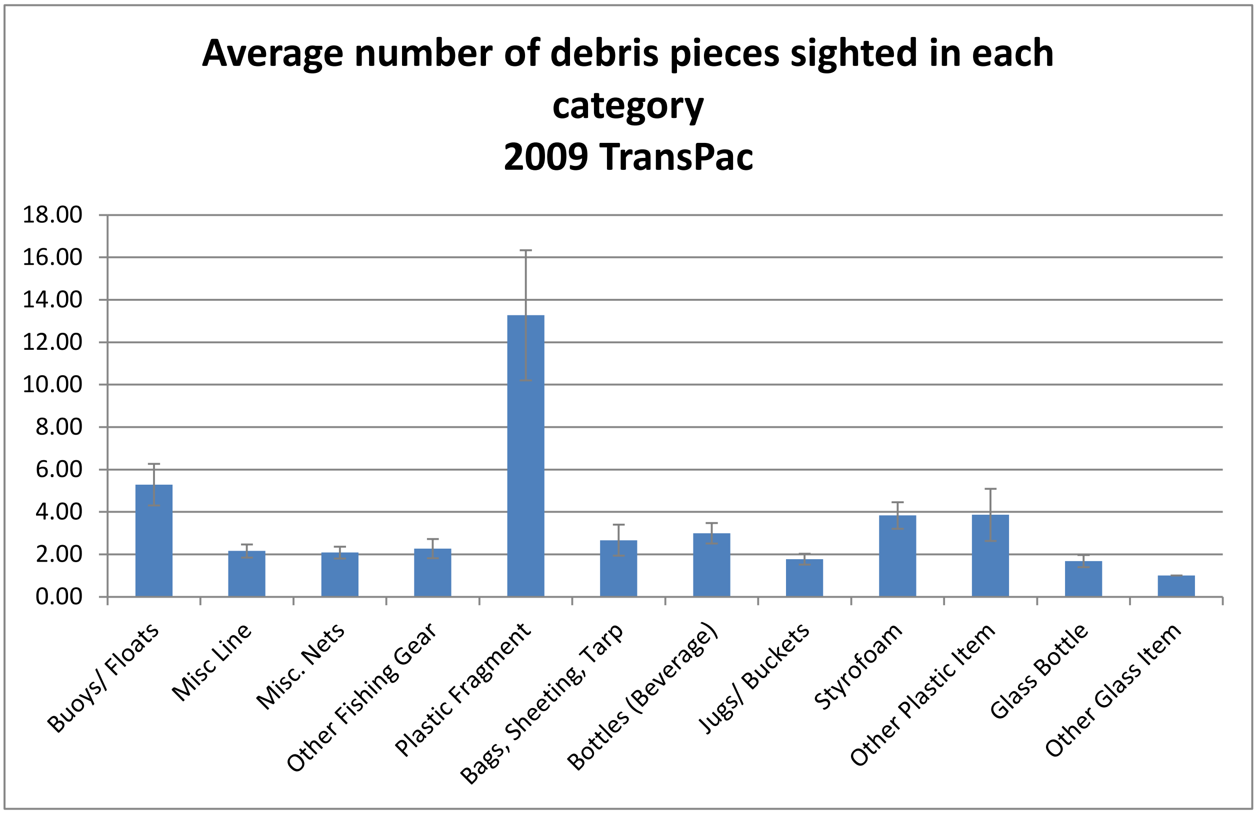


Figure 3. Mean number of marine debris items (including standard error of the mean) sighted at sea during the return trip (Hawaii to California) after the 2009 TransPac yacht race.

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9.b.4. A mobile application for marine debris data collection and mapping

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KEYWORDS
Mobile Application, iPhone, Android, Marine Debris Tracker, Collection, GPS, Mapping

BACKGROUND

As a part of the Southeast Atlantic Marine Debris Initiative (SEA-MDI) partnership with NOAA, a mobile application was developed for the Android and iPhone platforms called ***Marine Debris Tracker***. One of the goals of SEA-MDI is to use innovative technologies and unique expertise to add culturally relevant outreach tools and information to the current NOAA Marine Debris Program and to marine debris monitoring and education throughout the world.

Mobile Applications have become synonymous with modern communications, and this ever growing tool was used for its convenience, popularity, and cost efficiency. The widespread nature of mobile applications (or "Apps") in today's world provides an innovative yet simple tool for development and use. The ***Marine Debris Tracker*** App provides an opportunity for individuals to record location and description of marine debris items on their Smartphone (instead of logging using a data card). The flexibility in the App allows a casual beachgoer to record debris they find, or for an organized cleanup group to keep track of debris in beach cleanups. Data is posted on a publically available web portal, with the most recent five items are shown in a dynamic and engaging "feed" that updates every time a debris item is recorded. Data is also viewable on a map and available for download. Users of the website may observe and download data to use in curriculum development, classroom teaching, and as examples of the pervasiveness of marine debris throughout the world for education purposes. The ***Marine Debris Tracker*** App, database, and website have the potential to develop the mission of marine debris prevention into a regional, national, and global agenda.

METHODOLOGY

The database behind the App is a MySQL database, housed at the University of Georgia, providing security, structured storage, efficient access, and back-up of data. A flexible PHP-based web-service allows for any programmable internet capable device to securely log marine debris items. A user may register from their phone to use the app (available in the Android and iPhone App stores) and begin to record marine debris items immediately (Figure 1). No password is needed to view the data on the web portal located at http://www.marinedebris.engr.uga.edu/ (Figure 2). This allows for maximum outreach, education engagement with the public. All data (except usernames) is available for one-touch download as a .CSV file (default opens with MS Excel). Data can then be used in any program, e.g., Arc-GIS or Google Earth.

Eventually, a passkey to each individual's data will be provided so that data may be filtered by this passkey to: 1) to keep individual data sets private and 2) to allow users to download only their data (passkey acts as a filter). The App requires the user's current location, obtained through either GPS, cell-tower triangulation, or known wifi-hotspot location. Items are currently logged in real time through a network, e.g., 3G or wifi; however, an off-line logging mode is under development so that the data will be stored and then uploaded once the phone is back in network range (recognizing that many debris monitoring locations may not be within cell phone networks). A web-based map, developed with Google Map API, is available with pin point locations color coded to the category of each item recorded. The categories and item list of marine debris for the App is adopted from a draft shoreline assessment guide developed by the NOAA Marine Debris Program. The categories, along with their color code developed into an emblem for the website, are: plastic (blue), glass (brown), metal (red), fishing gear (purple), processed lumber (yellow), rubber (black) and cloth (orange). The public interface also includes directions on how to get the App for Android and iPhone, a page "About" the App and NOAA Partnership, links to the NOAAMarine Debris Program and Marine Debris 101, a link to SEA-MDI and a Twitter feed from Debris Tracker, a Twitter account operated in cooperation with SEA-MDI and ***Marine Debris Tracker*** (Figure 2). Google Analytics was placed on the page to track numbers of visitors and page views.

OUTCOMES

The mobile application was designed to enable those currently engaged with marine debris efforts, as well as a new demographic of people (i.e., those that carry their mobile device everywhere) to become more aware of marine debris (even just to notice debris on the beach) and potentially join in cleanup and management efforts. The App should appeal to the masses and provide a new excitement and engagement over marine debris cleanup and prevention. Moreover, the web portal, with available data and visualizations, can provide education to any person viewing the page, even if they do not have or use the mobile application. Finally, the mobile application and web portal offers the potential for marine debris data collection, analysis, as well as outreach documentation at a speed and efficiency not available previously.

PRIORITY ACTIONS

This project illustrates how technology can be used in ways to engage and involve the public. It is important to use culturally relevant tools, i.e., *materials/methods that teach to the learner's knowledge base in a way they are familiar with* so as to maximize engagement with the public. The ***Marine Debris Tracker*** App will continue to evolve to serve the needs of marine debris prevention and the users.

FIGURES AND TABLES

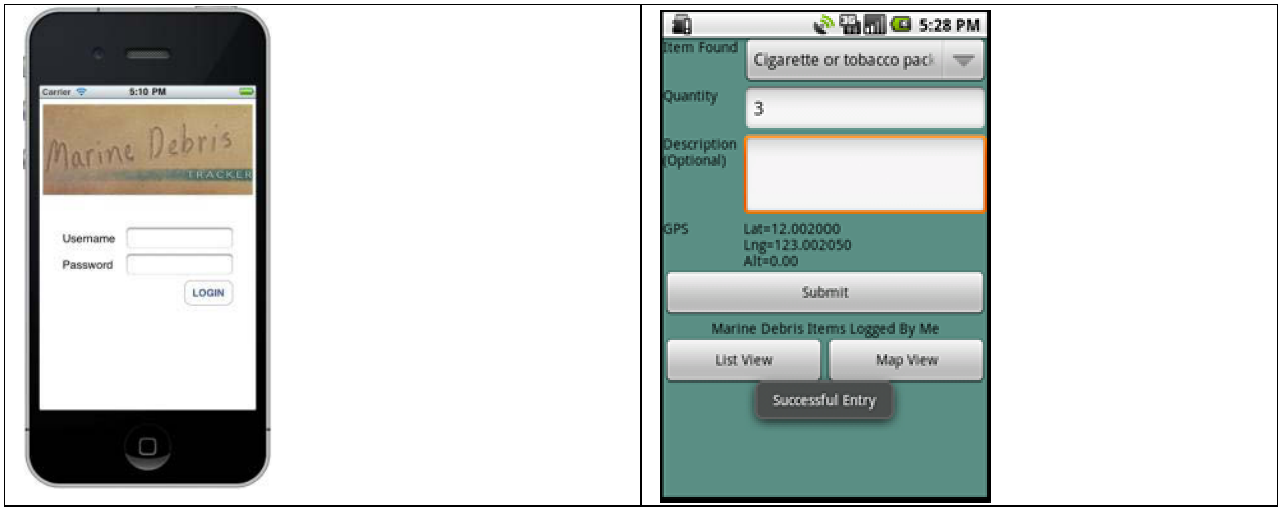

Figure 1. Marine Debris Tracker App: iPhone log-in screen and Android debris item entry form

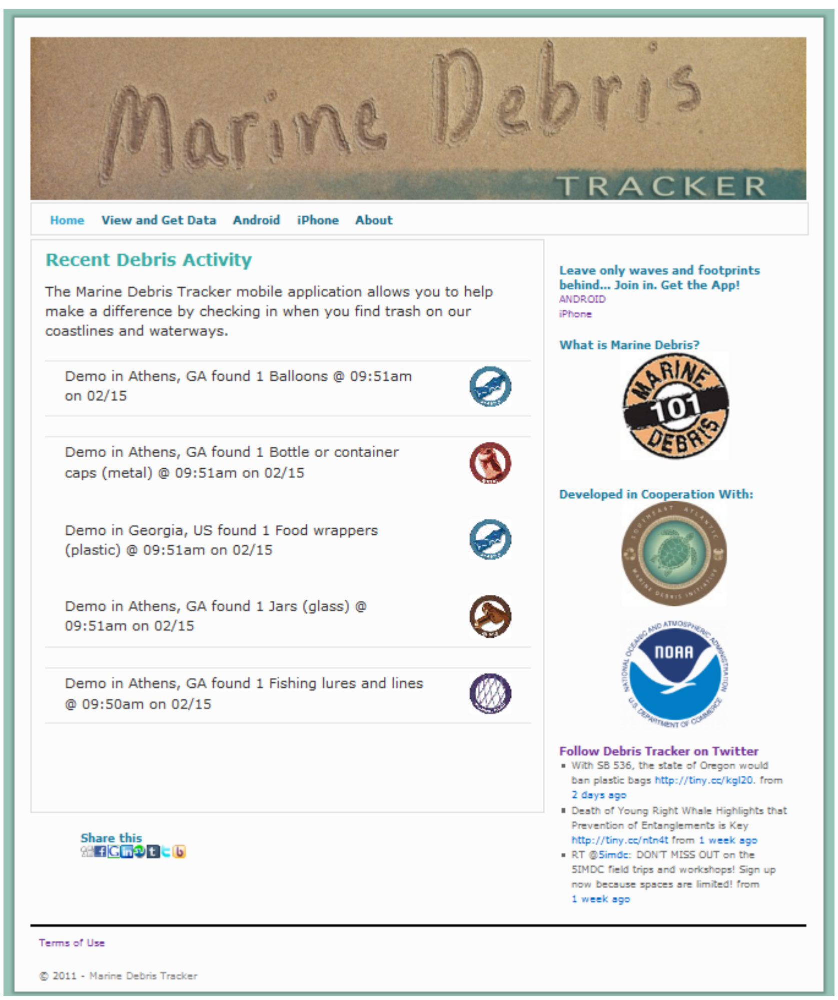

Figure 2. The public web portal interface with dynamic "feed" of most recent debris items shown

9.b.5. Technology in the tropics: reinforcing community based science

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KEYWORDS
Ghost nets; data; electronic; CyberTracker™; hand held PDA devices

BACKGROUND
Along the remote and sparsely populated north Australian coastline, large amounts of marine debris and ghost nets wash ashore each year. Since 2004, GhostNets Australia (GNA) has removed and recorded over 7000 ghost nets from this region, with the data collected making it possible to map the probable countries the nets were manufactured in, as well as their type of fishery. Interpreting these patterns may assist efforts to develop management strategies to reduce the likelihood of ghost nets entering the marine environment.

Due to the remote nature of the region, GNA relies on the work of local Indigenous Rangers and enthusiastic community volunteers to collect this valuable data. In general, these participants are not scientifically trained and many have low literacy and numeracy levels so it was necessary to incorporate these factors into the design of monitoring and data collection methodologies. After a considerable period of traditional paper based record collection, GNA has transitioned its partners to an electronic survey method called CyberTracker™ which uses touch-screen technology and picture-based questions that help to overcome problems of low literacy and numeracy by keeping the need for handwriting and extensive reading to a minimum. In this way, it is expected that the accuracy and consistency of data collection will be maintained at a high level.

METHODOLOGY
When a net is found, Rangers use hand held PDA devices with a tailored GhostNets Australia Microsoft™ ‘application’ operating in the CyberTracker™ programme. The application requires users to log GPS coordinates, photograph the net and record net descriptors, particularly colour, knot type, mesh and twine size and an estimate of volume. This information is then used to identify the likely country of manufacture and fishery. Currently, the primary tool used to identify nets found on the north Australian coast is the ‘WWF Net Kit’, developed in 2002 by the World Wide Fund for Nature. The net type and probable country of manufacture is then added to the existing GNA database of nets collected by Indigenous Ranger groups across northern Australia since 2004.

PDA and CyberTracker™ technology incorporates much of the equipment needed for ghost net surveys into one unit. This includes a GPS, camera, tape measure and survey sheets and means that Rangers are able to carry fewer pieces of equipment on patrol. Each data point is linked to a GPS location, allowing data to be mapped. Further, the PDA is automated to take GPS points at frequent regular intervals, making it possible to create clearly mapped patrol tracks that are useful when reporting activities and results. The hand held PDA unit used by the Rangers is robust and resistant to water and dust damage as well as being reliable in both hot and cold climates. Using an electronic data collection method eliminates the need for doubling handling of data by translating data collected into the field directly into a Microsoft™ Excel spreadsheet and in this way, reduces the risk of human error when transcribing field collected information to electronic format.

OUTCOMES

Using CyberTracker™ to collect ghost net data has allowed GNA to simplify and standardize data collection for use by a participant base with a broad range of abilities, literacy skills and experience. Employing data collection technologies that streamline and simplify the process is an important step towards achieving effective and long term management programs.

The development of a long term database allows patterns in the data to be highlighted including the most likely countries of net manufacture, the most common fisheries experiencing the loss of nets in the region, and dominant hot spots for ghost net and marine debris accumulation along the north Australian coast. Examination of these patterns allows GNA to respond in a targeted and effective way by removing the nets from heavily affected regions of the coast and raising awareness using accurate and constructive information. By knowing the country of manufacture of ghost nets arriving in Australian waters, GNA will be in a strong position to develop international partnerships to collaboratively manage this problem. As a community driven, grassroots organisation responding to a large and international issue, GNA relies on accurate information to best guide our actions and make every approach as effective as possible.

PRIORITY ACTIONS

Standardise ghost net data collection methods across all agencies in Northern Australia and incorporate the data into a uniform format to be analysed and shared across agencies.
Use the existing database to constantly review data collection methodologies and inform our partners, as well as use the information collected to inform the development of new partnerships.
Develop an accurate, constantly updated and easily accessed database of net type and probable country of manufacture for a global audience.

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9.b.6. Citizen scientists and marine debris monitoring worldwide: materials, methods, and protocols

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KEYWORDS
Plastic Marine Pollution, Citizen Science, Neuston Net, Methodology, Algalita Marine Research Foundation, 5 Gyres Institute, Trawl net, Ocean Plastic, Plastic pollution monitoring, Marine monitoring

BACKGROUND
The enormous spatial extent of plastic marine pollution presents challenges for quantitative monitoring of this emerging pollutant. Citizen scientists have demonstrated their ability to collect and process samples for water monitoring in coastal environments over the last two decades. As high levels of bacterial contamination began forcing beach closures near population centers, municipalities sought to supplement sample collection by public health authorities.

The Traveling Trawl Program, developed by 5 Gyres and the Algalita Marine Research Foundation, (AMRF) invites citizen scientists to collect useful data on plastic pollution in the world's oceans. Three different trawl designs are available for loan, and include easy-to-use protocols for sample collection and analysis, and simple steps to post data into an online GIS database, which is being developed by AMRF and the Environmental Systems Research Institute (Esri). Similar to other citizen science programs like Reef Check and Ocean Conservancy's "Coastal Cleanup Day", the Traveling Trawl Program intends to engage the public in the science of plastic marine pollution, while providing citizen's groups, small organizations and legislative bodies with basic quantitative data on the spatial distribution of plastic pollution in their regional marine environment and beyond.

METHODOLOGY
There are three trawl designs available for loan or purchase through AMRF's Traveling Trawl Program. The Suitcase Manta Trawl, the Folding Manta Trawl and the Hi-Speed trawl. The suitcase manta and folding manta trawls are both designed to capture a volumetric measure of the sea surface using wings to keep the trawls on top of the water, and using a splash guard to knock the crests of waves into the net. These are deployed at slow speeds, typically less than 3 knots. The Suitcase Manta Trawl has a net aperture of 60cm x 25cm, whereas the Folding trawl is 50cm x 25cm. Their 2-meter nets have a 333 micron mesh, and a detachable cod end. The manta design was first used by the California Cooperative Oceanic Fisheries Investigations during their 1977-78 cruises. (NOAA-TM-NMFS-SWFSC-392)
The Hi-speed Trawl measures surface abundance of marine debris, rather than a quantified volume of seawater. The Hi-speed Trawl has a vertical net aperture, rather than the horizontal net

aperture common to the manta design. At tow speeds of 8-10 knots there is tremendous turbulence on the sea surface. The vertical net aperture allows for a 45cm. range of vertical movement, therefore capturing the sea surface at all times, but not a known volume. This allows for a measure of surface abundance rather than density of marine debris. The net aperture is 45cm x 14cm. The 3-meter net has a 500 micron mesh and a detachable cod end. This net length and mesh size allows for large volumes of water to be sieved as the trawl travels at relatively high speeds. This design is similar in several respects to the Sameoto sampler, as well as the Marine Resources Monitoring, Assessment, and Prediction Program neuston array (MARMAP), in that they are all designed to fish with part of the aperture out of the water. The three designs, Manta, Sameoto and MARMAP were compared in a paper by Jump et al., for their ability to collect larval fishes in the Gulf of Alaska. (Jump et al., 2007). AMRF is currently analyzing samples collected for the purpose of comparing the three designs available through the Traveling Trawl Program for their ability to collect neuston plastics.

These three designs are portable, of solid aluminum construction, and easy to store on any vessel. When disassembled, both the Suitcase and Folding Manta trawls fit in a standard suitcase. The citizen scientist must sign an “Equipment Responsibility” agreement, which includes a recovery and repair policy, and requires significant contributions of data garnered from samples over the contract time.

OUTCOMES

The protocols for sample collection are modified from those used by the Algalita Marine Research Foundation, and based on recommendations from NOAA’s marine debris program.(see http://swfsc.noaa.gov/textblock.aspx?Division=frd&id=1342) Citizen scientists use the traveling trawls to conduct short tows at the sea and air interface (neuston). Without a flowmeter, the surface area is determined by the width of the net multiplied by the tow distance measured by the GPS start and stop locations. Samples are collected in a cod end attached to the end of the net, and then transferred to a collection jar or dish for analysis. Sample analysis begins with splitting the sample into two size classes, one greater than 5.0mm and one less than 5.0mm, representing the divide between micro and macro debris. Plastic fragments and objects in these separate groups are then counted and weighed. If samples need to be preserved for later analysis, alcohol can be used, or the samples can be dried and stored.

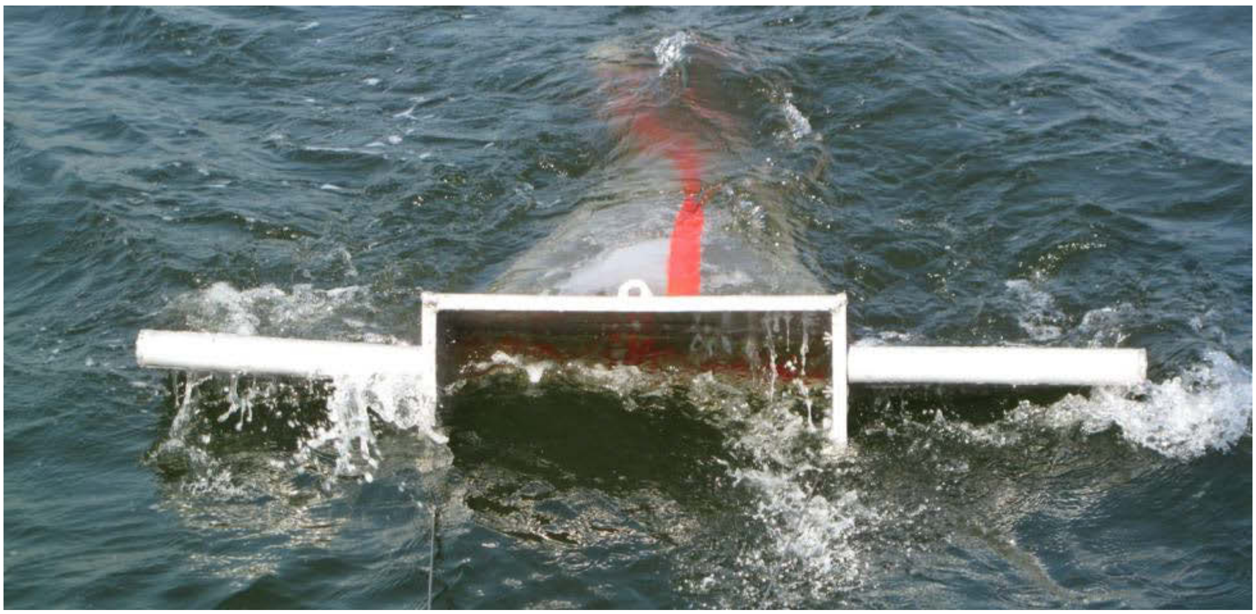
Challenges have included the engineering of these trawls for ease of deployment by solo citizen scientists, deployment from small sailing vessels, and the development of easy-to-use protocols. Simplicity is perhaps the most important variable that influences participation. By reducing the complexity of trawl set up, deployment and retrieval, storage of the trawl and collected samples, and ultimate analysis of samples, the citizen scientists is more motivated to use the equipment and provide meaningful data.

With these challenges overcome, and data coming in, we are now in the process of creating a GIS database where results can be shared online. Data will be imported directly onto the website, which will be kept separate from a website where rigorously quantitative data from qualified sources will be posted. After a short period of review, the data will be posted to a map created by Esri, and include a brief description of the contributor, and other selected meta data.

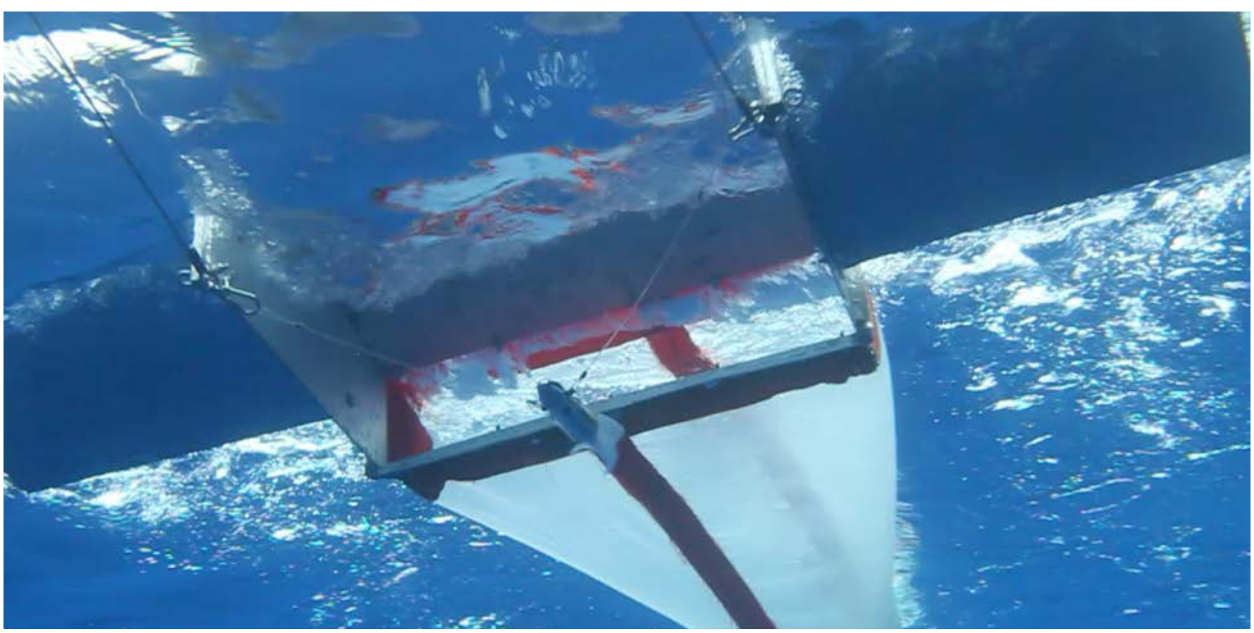
PRIORITY ACTIONS

The Traveling Trawl Program will allow sailors, marine scientists, and organizations worldwide to participate in geospatial data gathering and make valuable contributions to understanding impacts of plastic marine pollution. Given the enormous spatial extent of plastic pollution of the world ocean, it is necessary to enlist citizen scientists to help extend the reach of academic and governmental responses worldwide. AMRF and the Five Gyres Institute will continue to respond to the needs of citizen scientists for equipment and data management, so that they can monitor and develop strategies to remediate the ocean's plastic load.

FIGURES AND TABLES



Suitcase Manta Trawl under tow



Suitcase Manta under tow as seen from below


High Speed Trawl under tow

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9.c.1. Economics + marine debris: a review of economic instruments

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KEYWORDS
Economics, market-based instruments, MBIs, Polluter pays principal, incentives

BACKGROUND
There is great potential to reduce and prevent marine debris through the use of tools including public outreach to increase awareness, technological advancements, collaborations, and voluntary efforts. There are also economic tools that can be employed to help reduce the sources of litter and marine debris. Economic instruments (also called "market-based instruments" or MBIs) can be applied by local, regional and national governments to encourage waste reduction from the source as well as promote remedial removal efforts at sea. The aim is to use market forces – through price signals – as a key part of the solution to the marine debris problem. There is increased support for the MBI tool as it has moved from the 'vanguard' to become a commonly used policy tool.

Economic instruments are designed to change the cost or price of our actions. Some have an *incentive effect* (to encourage a change of behavior), while others have a *revenue raising effect*. Economic instruments include:

- Taxes, charges, fees
- Fines, penalties
- Liability and compensation schemes
- Subsidies and incentives
- Tradable permit schemes.

If it changes the cost or price of a good (e.g., plastic bags), service (e.g., waste collection), activity (e.g., waste dumping), input (e.g., materials), or output (e.g., pollution) then it is a market-based instrument.

Some MBIs are fairly common (such as deposit-refund programs for beverage bottles, fines for littering, etc.) while others are less common, using more complicated and integrated approaches (such as recycling tons of fishing nets and converting those materials into electricity).
The basic economic principles behind these economic tools are:

- Polluter pays principle (PPP)
- User/beneficiary pays principle
- Principle of full-cost recovery

Making the economic cost (the price) of an item or service reflect the true cost of pollution reflects the "polluter pays principle." "Getting the prices right" and ensuring that the economic cost (the price) reflects the resource cost or cost of pollution impacts reflects the principles of "full-cost recovery" or the "user pays principle."

METHODOLOGY

Decision makers, policy makers and relevant organizations can select, apply and implement economic tools to address problems with marine litter. There is not one solution that will fix every marine litter problem. Selecting an effective MBI or a combination of MBIs requires careful consideration and analysis as well as an understanding that the up-front costs associated with pollution prevention (including supporting the development of an adequate solid waste management infrastructure) are less than the long-term costs of pollution to the environmental and marine-related industries. A first step in this process is to determine whether the conditions are favorable and which economic tools could potentially be effective.

Policy makers also need to determine their goals for using an MBI: is it to provide an incentive to change people's behavior, is it to raise revenue or is a combination? Revenue generated by MBIs can be large (e.g., fuel taxes) or small (e.g., selective product taxes), and can be relatively stable (e.g., fuel taxes) or volatile (e.g., fines and fees, liability, and in certain cases taxes where consumer can move away from the taxed good). The revenues can go to the government, or channeled to specific constructive uses (e.g., earmarked to pay for port waste facilities). Revenues can also be used to strengthen monitoring and enforcement activities.

Selecting the most appropriate economic instrument (or instrument package) requires careful consideration and depends on several factors including:

- The type of marine debris
- The MBI should be relevant to the local problem whether it is nets, fishing lines, floating debris, etc.
- The sources of marine debris
- Land-based or ocean-based; many sources contributing to the problem versus just a few contributing sources; domestic source, or international sources.
- Economic and environmental impact of the marine debris
- Available waste management infrastructure
- Political will
- Possible opposition
- The capacities to design, implement, monitor and enforce the MBI
- Which MBIs are cost-effective, practical, affordable, fair, consistent with other polices in place, and offers the most environmental benefits.
- Which MBIs are politically and publicly acceptable, understood and will avoid unacceptable social impacts and perverse incentives, such illegal dumping

For simple problems with a few obvious potential solutions, the process will be faster and easier. The process will also be simpler when there is clear institutional authority for action. Policy makers need to understand the pros and cons of each MBI; lessons from other countries help build this understanding and reduce the risk inherent in policy innovation. In some cases, the pollution-reduction results from other countries or regions can serve as benchmarks.
Selecting appropriate MBIs is part of a larger policy-making process that includes the following steps: (1) problem recognition, (2) investigating the problem, (3) identification of possible

solutions, (4) analysis of policy proposals, (5) selection of policy options, (6) implementation, (7) monitoring and (8) evaluation and potential revision.

OUTCOMES

The following sample MBIs have various merits, and are suitable for use to combat different marine debris problems. While most of these policy tools have targeted the proper/legal disposal of solid waste on land and at sea, there are potential innovative uses of MBIs that can more precisely target some of the more damaging forms of marine litter. Note that some of these MBIs may also generate revenues:

Deposit-refund programs on plastic and glass bottles. These programs increase the incentive to reuse the bottles and reduce the temptation to litter. These have been proven to reduce roadside litter and are applicable in most countries.

Plastic bag tax. Taxes such as these increase the incentive to reduce the use of plastic bags. More and more countries and regional governments are applying MBIs of this type, while other communities are pursuing outright bans on some packaging types. It should be noted that bans may have other unintended impacts from the replacement products and should be thoroughly reviewed before implementation.

Other product charges. Extra charges can also be applied to the sale, distribution or use of other products such as fishing line, fishing floats and foamed plastic food containers in order to reduce the incentive to litter and to raise funds that can be made available for cleanup activities or to improve coastal waste management infrastructures.

Liability for pollution/marine litter. The liability is linked to cost of the cleanup and linked to a compensation scheme for those whose livelihood is compromised by the impacts of marine litter. This is a non-trivial scheme to set up and requires a certain legal system and capacity to make it work. It is likely to not be possible for certain international sources of marine pollution and it is operationally difficult, especially in developing countries.

Fines for litter and illegal disposal of waste items. Many communities impose fines aimed at discouraging anti-social behaviors including the improper discarding of waste and trash. Revenues can be used to help with awareness campaigns or to provide additional waste receptacles and other infrastructure.

Charging for waste services including landfills. Taxes and fees can be charged to cover the costs of collection and environmentally-sound disposal of waste. These revenues can help pay for landfills, their operation and maintenance. More and more countries are looking for methods to cover the full cost of waste management (full-cost recovery). Such fees and taxes also offer an incentive to consumers to reduce the amount of waste they are creating. This has to be done carefully to avoid perverse incentives to dump waste elsewhere, and hence actually lead to more litter that could end in marine environments.

Port reception, ship berthing, and commercial and recreational fishing fees. Portions of these fees can be designated to improve waste management infrastructure and start innovative programs that remove marine litter from the ocean.

Tourist taxes, car park fees (e.g., near waterfronts)**, and waterfront business charges**. Taxes and fees paid by coastal tourists could be earmarked for beach cleaning, waste infrastructure and awareness-raising programs. In this "user pays" plan, tourists (the beneficiaries of clean beaches) contribute to the maintenance of the beaches. This is a *de facto* payment for an environmental service.

Award-based incentives for coastal villages with Integrated Waste Management systems. These programs incorporate all the policies, programs, and technologies that are necessary to manage the entire waste stream. The mix and emphasis of approaches that are taken generally varies from region-to-region.

Incentives to fishermen for reporting on and the removal of debris.

Financial and technical support for the installation of waste management systems on board fishing vessels, leisure crafts and larger ships that have inadequate facilities.

PRIORITY ACTIONS

The issue of marine litter is complex due to the myriad of sources producing it, compounded by the challenges of monitoring and enforcement of existing controls for its abatement. Nonetheless, MBIs including environmental charges, taxes, fines, and deposit-refund programs, have become commonplace and understood. They should be considered by local, regional and national governments as important tools to reduce and control marine debris in the world's oceans. They should also be seen as part of an integrated strategy that includes education, outreach, laws and policies, enforcement and adequate infrastructure.

Reducing and controlling marine litter in the world's oceans is a significant – but achievable challenge. The economic aspects of the global marine litter problem need to be fully explored if we are to be successful in effectively addressing this issue.

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9.c.2. You can't put a price on that*:* a market-based solution to marine debris

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KEYWORDS
marine, debris, alaska, economics, industry, pilot, kodiak, island, trails, network

BACKGROUND
This presentation uses an Alaska case study to propose solutions to the limited volunteer resources and excessive cost of marine debris clean-up and removal.

A 2007 Marine Debris survey conducted by Island Trails Network (ITN) in partnership with the Marine Conservation Alliance Foundation (MCAF) showed significant accumulations of marine debris near commercial salmon fishing set net sites along the western and southern shores of Kodiak island.

In 2009 a marine debris collection pilot program was offered to fisherman on Kodiak island. Six participating fish sites conducted clean-ups during fishing closures and delivered marine debris to a participating tender vessel in conjunction with regular salmon offloads. ITN negotiated a nominal price per lb of $0.50 per lb with these sites and agreed to hold the program open until the season ended or the quota of 10,000 lbs was met.

OUTCOMES
A review of past volunteer clean-ups organized by ITN on other parts of Kodiak island showed costs of marine debris removal, from the time it is picked up off the beach to its arrival at a recycling facility, to average $2.40 per lb. Mobilization alone may account for up to 40% of such a project's budget (Fig 1). These high costs are due to an unfavorable economy of scale for small operations and compounded by the high costs of operating in remote areas.

The six participating fish sites in the 2009 set net pilot project delivered a total of 3700 lbs of marine debris. The adjusted cost of marine debris under this program was $1.62 per lb (Fig 2). This adjusted figure includes the $.50/lb contract fee, cost of clean-up materials, outreach and recruitment of participants, shipping costs from Kodiak to Seattle, grant reporting and administration. Some of these initial expenses (outreach, materials) were budgeted for a 10,000-lb project and will not increase with increased participation. We are resuming the program in 2011 and project that modest growth of the program this year could drive costs down to under $1.25 per lb and expansion of the program to include all set netters could reduce costs of marine debris clean-up and removal to less than a dollar per lb.

Despite the low costs and opportunity growth and short-term gains in efficiency, the set net project is geographically limited by the location of the fishing grounds and because of the small and widely dispersed crews may not be effective in areas of high marine debris density. It is useful in complementing volunteer efforts and addressing marine debris issues in a particular region of Kodiak that is moderately impacted by marine debris. The marine debris/commercial fishing analogy provides a useful model to identify efficient ways to move commodities from the field to market. Finally, the set net project symbolizes an emerging partnership with the commercial fishing industry, a major contributor to the marine debris problem.

PRIORITY ACTIONS

Organizers of marine debris clean-ups should consider market-based solutions as well as volunteer efforts in addressing the marine debris problem.

Organizers of marine debris clean-ups should look for synergies with maritime industries to capitalize on the economy of scale of seafood production and maritime shipping.

Government agencies should conduct research, publish data and provide guidance on determining the true costs of marine debris recovery, recycling, and energy conversion to facilitate discussions between clean-up organizers and potential buyers in the private and non-profit sectors.

FIGURES AND TABLES

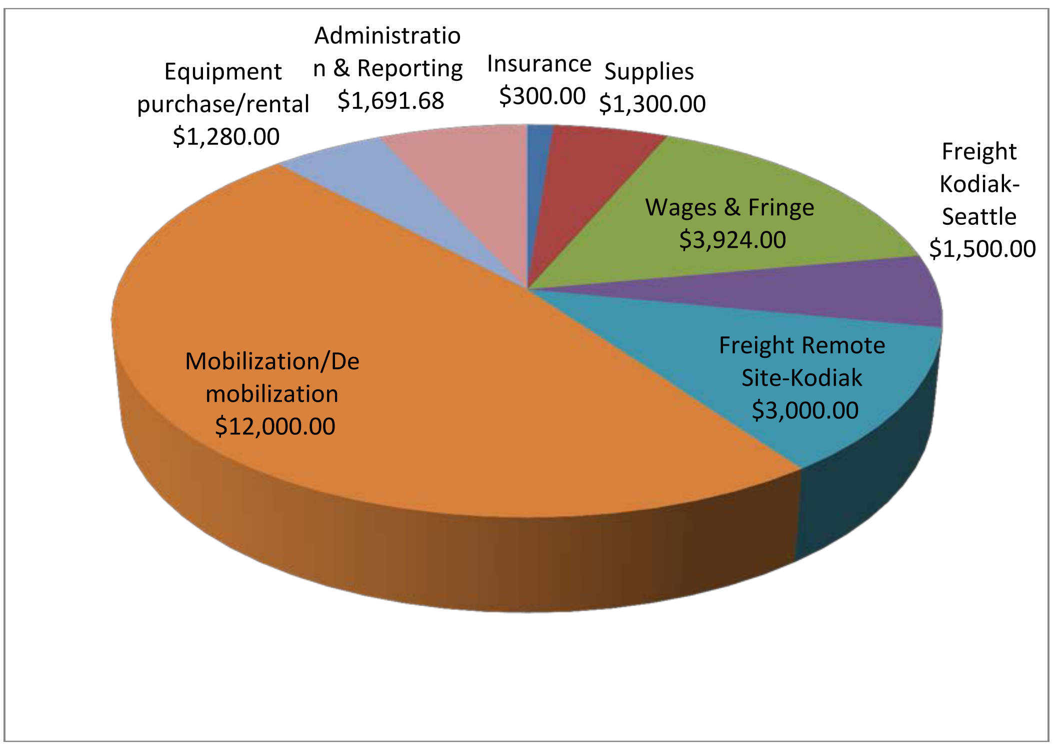

Figure 1: Depiction of a typical volunteer-based marine debris clean-up by expense type. Mobilization of volunteers and equipment at these sites constitutes the majority of the cost. A project of this size should produce about 15,000 lbs of marine debris.

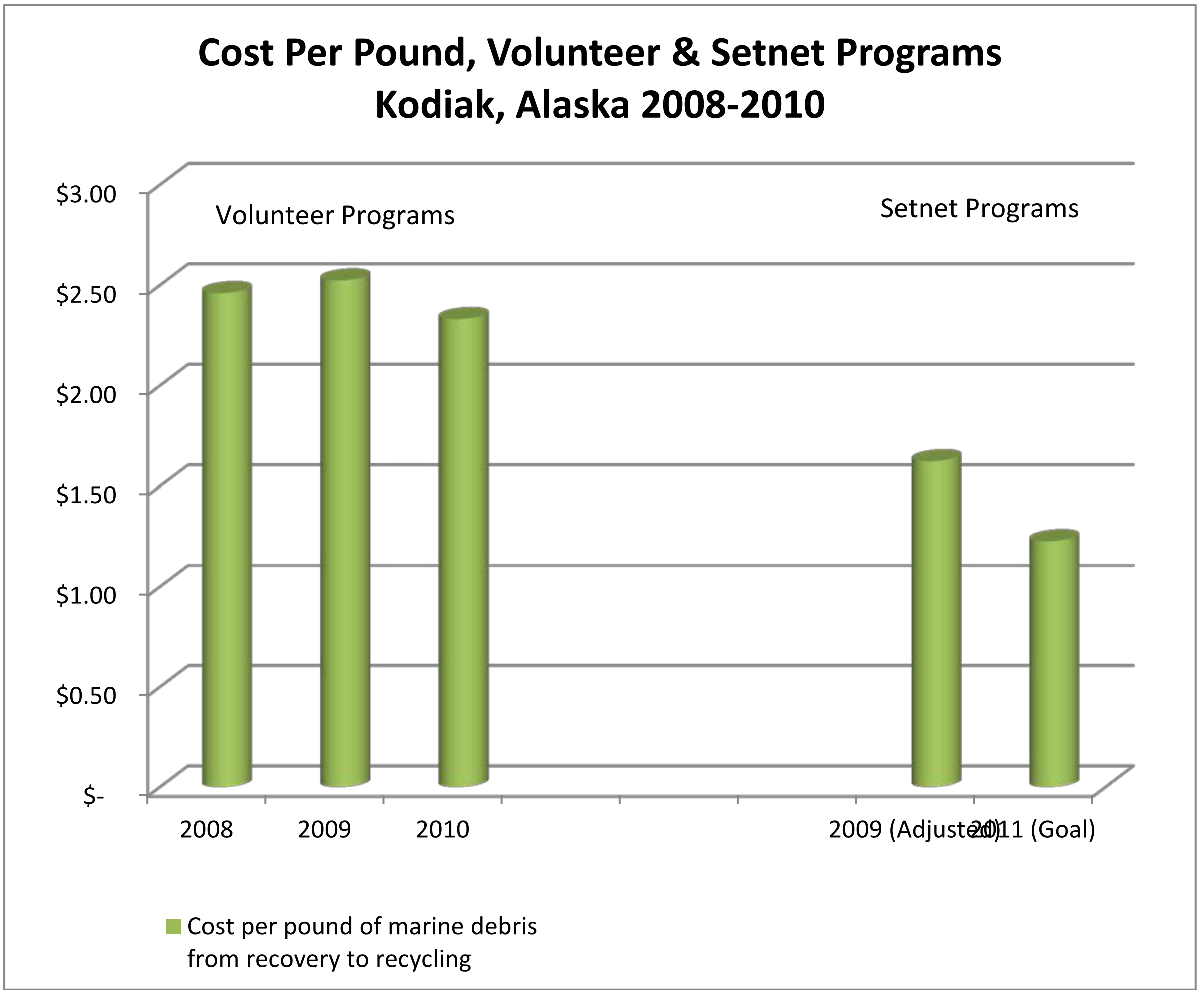

Figure 2: This graph depicts the costs per lb of marine debris from initial collection at a remote site in Kodiak to recycling facilities in Seattle. Combined volunteer programs of various years are depicted at left, and the results and projections of the set net program at right.

9.c.3. Open Source Legislative Database and the Global Map Project

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KEYWORDS
plastic pollution, marine debris, legislation actions, global map

BACKGROUND
A major thrust of the movement to end plastic pollution around the globe is borne by individual communities, working to limit their use of disposable plastic. In some instances the efforts is to ban, or tax the use of plastic bags, polystyrene containers or plastic bottles - major contributors to plastic pollution. While every community has unique needs, there are considerable similarities in how they approach the problem, as well as in the challenges they face, as the opponents of the movement are often the same and use similar approaches.

The open source legislative database addresses a key problem in the community based movement to end plastic pollution - it connects individual community efforts to the global database of resources; it offers access to environmental impact reports, as well as to model legislation; it puts the resources of the global movement in the hands of the local communities.

METHODOLOGY
The Open Source Legislative Database and the Global Map Project is developed as a webbased portal, with open access to members of the Plastic Pollution Coalition. Each member has access to the database to contribute, collaborate or use as needed. The project combines social networking techniques with easy access to aggregated, curated news regarding plastic pollution, and a rich database of research and peer-reviewed science on the topic.

OUTCOMES
The key goal of the project is to connect communities round the globe working to end plastic pollution to each other and to resources. By creating these connections, communities around the globe will:

- gain a sense of the unique value of their efforts;
- understand how their contribution adds to addressing this global problem;
- celebrate the successes of the global community, this strengthening the sense of support and collaboration between the members;
- become stronger and more dedicated contributor to the movement.

PRIORITY ACTIONS

- Populate the database with peer-reviewed scientific data
- Maintain integrity and currency of database
- Deliver and monitor member access to database

9.c.4. Using the Clean Water Act to address land-based sources of marine debris

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KEYWORDS
Clean Water Act, trash reduction, stormwater permits, TMDLs

BACKGROUND

Marine debris degrades ocean habitats, endangers marine and coastal wildlife, interferes with navigation, results in economic losses, and threatens human health and safety. Generally, the sources of marine debris relate to improper waste disposal or management of trash and manufacturing products (e.g., litter, illegal dumping)[1]. It has been estimated that as much as 80% of marine debris is derived from land-based sources although the relative percentage of land-based versus ocean-based varies by region and is difficult to identify since trash and debris can travel long distances before sinking or be deposited on shorelines[2,3]. In urban areas, trash accumulates in streets and parking lots and is flushed by rainfall events into storm drains, which empty into streams, bays and harbors, and onto beaches. Addressing trash associated with stormwater runoff is critical to reducing marine debris. The Federal Water Pollution Control Act (33 U.S.C. §1251 et seq.)[4], otherwise known as the Clean Water Act (CWA), is one mechanism to initiate actions to address land-based sources of trash.

METHODOLOGY

The CWA established the basic structure for regulating discharges of pollutants into the waters of the United States and regulating water quality standards for surface waters. The U.S. Environmental Protection Agency (EPA) and its state partners are responsible for implementation of the Clean Water Act. EPA delegates authority to operate many federal environmental programs, including the CWA, to the States. Delegation usually includes permitting, inspections, monitoring and enforcement, and standards setting.

The CWA calls for the development of water quality standards with three components: designated uses; numeric or narrative criteria; and an antidegradation policy. States are required to develop integrated water quality reports every two years to summarize the assessment of water bodies relative to water quality standards and designated uses. These reports include an assessment of all waters, where there is available data, and characterize waters as either fully supporting appropriate standards and designated uses, partially supporting, or not supporting. Partially and non-supporting waters are considered ‘impaired’ and comprise a State’s CWA Section 303(d) list of impaired waters. Impaired waters require restoration to meet water quality standards and designated uses. Approaches to restoration vary depending upon the waterbody, pollutant and location but may include: development of Total Maximum Daily Loads (TMDLs), specific requirements associated with regulatory permits, and/or voluntary approaches utilizing different funding sources.

Integrated water quality reports for California, Hawaii, Maryland, District of Columbia and Alaska have identified waters as impaired for trash or debris. The consideration of trash as a pollutant is related to narrative water quality standards (e.g., “Waters shall not contain floating materials, including solids, liquids, foams, and scum, in concentrations that cause nuisance or adversely affect beneficial uses”.). The assessment methods to establish trash impairment include a combination of quantitative data as well as visual assessments and consider trash impacts on aquatic and human uses associated with waters.

The states of California and Maryland/District of Columbia have recognized voluntary measures are not adequate to keep trash out of waterways. These states have developed a limited number of TMDLs to address trash discharges to specific waters. TMDLs are a pollution budget for the amount of a particular pollutant that can be discharged to a waterbody and still meet appropriate water quality standards. Trash TMDLs have established endpoints as either zero trash discharge or equal to 100% removal of the baseline load of trash.

TMDLs assign pollutant loads to a wasteload allocation (WLA), which pertains to point sources regulated by CWA permit, and a load allocation (LA), which pertains to nonpoint sources generally not regulated by the CWA. The National Pollutant Discharge Elimination System (NPDES) Stormwater Program regulates stormwater discharges from three potential sources: municipal separate storm sewer systems (MS4s), construction activities, and industrial activities. If a TMDL has been established for an impaired water and includes a WLA for stormwater discharges then stormwater permits must be consistent with the WLA.

CWA Section 319 established the Nonpoint Source Management Program to help focus state and local efforts to address nonpoint sources of pollution. States receive funding to support a variety of activities including technical and financial assistance, education, technology transfer, demonstration projects and monitoring. Section 319 funding has been used to support efforts to reduce trash, including: public education and outreach such as anti-litter campaigns, assessment of the extent and magnitude of trash affecting surface waters, purchase/strategic placement of trash receptacles as well as riparian and beach cleanups.

OUTCOMES

Four brief examples are provided to highlight the opportunities CWA tools and authorities provide in addressing land-based sources of marine debris.

Los Angeles (LA) River, California[5]

Trash impairments of several segments of the Los Angeles (LA) River were originally identified as part of California’s 1998 CWA Section 303(d) list and a Trash TMDL for the LA River watershed was developed in 2001. The TMDL established an endpoint of zero trash discharge. Incremental load reductions were incorporated into the LA MS4 stormwater permit with zero discharge required by 2016. Zero discharge can be achieved by following one of the approved actions for trash reduction. These actions include: full capture systems with annual maintenance, partial capture systems and/or institutional controls. Full capture systems are those which trap allparticles greater than 5mm and treat a minimum peak flow rate resulting from a 1-year, 1-hour storm. To date, the City of LA has achieved over 60 percent trash reduction by installing more than 32,000 new catch screens and inserts in the storm drain system at a cost of approximately $50 million. The City expects to meet the goal of zero trash discharge three years before the mandated 2016 deadline at a total cost of $80 million.

Santa Monica Bay, California[6]
The waters of the Santa Monica Bay have been included on the CA CWA Section 303(d) lists of impaired waterbodies for debris, including trash and plastic pellets. A tentative TMDL has been developed to address this impairment and proposes incremental reductions of trash from municipal stormwater discharges as well as plastic pellet-related industries. The approach for addressing municipal stormwater is similar to LA with permits requiring phased trash reductions and zero discharge within an 8 year compliance period. This TMDL is unique in that it specifically addresses the discharge of plastic pellets. The principal source of plastic pellets is discharges through storm drains from industry that manufacture, handle, or transport plastic pellets. The zero discharge requirements for plastic pellets will likely be incorporated into industrial stormwater general permits. Potential methods suggested by the Los Angeles Regional Water Quality Control Board for compliance with these reductions include the use of best management practices such as appropriate containment systems, sealed containers, vacuum devices for cleaning, and frequent inspection and cleaning at operational areas as well as outlets of water discharge.

Anacostia River, Maryland (MD)/District of Columbia (D.C.)[7]
The Anacostia River watershed is an interstate watershed with its headwaters in MD and extends to its confluence with the Potomac River in D.C. Efforts to address trash in the Anacostia River are part of the 'Potomac River Watershed Trash Treaty' an agreement among political leaders from the D.C. metropolitan area to reduce trash and increase recycling throughout the region. In their respective 2006 Section 303(d) lists, MD and D.C. designated their portions of the Anacostia River as impaired for trash. Accordingly, a trash TMDL was developed in 2010 to establish trash reductions in the watershed which will meet the water quality criteria and support designated uses. MD and D.C. identified a TMDL endpoint of 100 percent removal or capture of the baseline trash load as an instream condition that will attain the water quality criteria. The next step is to incorporate appropriate trash limits into municipal stormwater discharge permits in the region.

San Francisco Bay, California[8]
The San Francisco Bay Region municipal stormwater permit covers five counties and three cities surrounding San Francisco Bay. This permit requires compliance with trash discharge prohibitions and receiving water limitations through the implementation of trash reduction plans. These trash reduction requirements were established to address San Francisco Bay area waters impaired by trash without diverting limited resources for TMDL development. Permittees must conduct a prescribed level of trash capture, cleanup/monitor a minimum number of trash hot spots, and implement best management practices to meet trash reduction goals. Incremental reductions in trash loads are required with 100% reduction by 2022.

PRIORITY ACTIONS

- Expand and institutionalize the use of Clean Water Act tools and authorities throughout the United States to specifically identify and address land-based trash discharges to surface waters.
- Identify and share the most promising technologies and/or approaches for reducing land-based trash discharges to surface waters as a result of Clean Water Act stormwater permitting requirements.
- Ensure compliance assistance and/or enforcement actions to address regulatory requirements for trash reductions.

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9.c.5. Marine debris emergency response and preparedness: lessons from the September 29, 2009 tsunami in American Samoa

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KEYWORDS
marine debris, emergency response, tsunami, American Samoa, national response framework

BACKGROUND
Following the 8.1-magnitude earthquake on September 29, 2009, a destructive tsunami was generated, which struck the island of Tutuila in the U.S. territory of American Samoa. Villages were destroyed and the resulting wreckage was dragged into nearshore waters as the waves receded. NOAA's response, outlined in another paper at this conference (Manuel and Koyanagi, 2011), focused on the marine debris damage to Tutuila's coral reefs, which was mitigated through assessment and debris removal. Tutuila is the largest island in American Samoa and is home to about 95 percent of the population. Working for 19 days on site, NOAA program offices coordinated with territorial agencies, surveyed roughly one-third of the coastline of Tutuila for marine debris and coral damage, and removed over four metric tons of tsunami-generated marine debris that threatened coral reefs. This response was beneficial, but much remained to address tsunami-generated marine debris impacts and to increase the hazard resiliency of American Samoa communities (NOAA, 2010). Similarly, this tsunami event pointed out areas for improvement in federal responses to future disaster events that create marine debris. This presentation will discuss the management and policy implications of tsunami and other severe wave and weather events that may generate marine debris. It is important to comprehensively respond to and mitigate the impacts of disasters across inland, coastal, and in-water environments.

The National Response Framework (dated January 2008) includes American Samoa as a "state" and thus, eligible for assistance through the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The same day as the tsunami, the President declared that federal disaster assistance would be available to help the territory respond and recover from the earthquake, tsunami, and flooding. One of the significant challenges in this situation, however, was determining the application of the Stafford Act as it specifically supports activities related to the marine debris that was generated. Across the U.S. federal government, it remains unclear which agency, if any, is responsible to address marine debris in an emergency recovery situation (immediately following an event). What is clear, however, is the need for sustained, long-term planning and preparedness education efforts, including evacuation and land use planning. A timely and coordinated response can mitigate the existing damage and minimize the ongoing damage caused by marine debris generated by a tsunami or other severe wave and weather events. Response efforts, particularly in ocean-dependent communities, must take place both on land and in the water.

METHODOLOGY
While the field operations following the September 29, 2009 tsunami were limited by available resources, conversations with American Samoa's Governor, territorial agency staff, NOAA staff from a variety of offices, and FEMA's on-scene coordinator provoked the discussion on policy gaps that are outlined here. In addition, this thinking was informed by lessons learned from responses to Hurricane Olaf, which struck American Samoa in 2005 and Hurricanes Katrina and Rita, which struck the Gulf of Mexico in 2005. A discussion among U.S. territorial and federal agency and Pacific Islands nation representatives at the Pacific Risk Management 'Ohana 2008 annual meeting generated a better understanding of existing mandates and restrictions on federal assistance.

OUTCOMES
NOAA has identified potential actions to build on the assessment and removal work that was initially conducted to assist the territory with long-term recovery (NOAA, 2010). These actions are grouped within the following topics: surveys and assessments, debris removal, logistics, increasing community resilience, outreach and education, and data and modeling. NOAA has been an active partner with the American Samoa government before and since the tsunami in several areas, including coral reef monitoring, coastal zone management, weather service products, hazard preparedness and mitigation, community resiliency, and marine protected areas. For example, NOAA program offices have worked on tsunami preparedness and public awareness; biennial Reef Assessment and Monitoring Program (RAMP) cruises, which could provide baseline information against which to measure coral damage; and through regional coordination related to risk management, NOAA has developed decision support tools for permitting and land use planning.

No single federal agency can currently undertake marine debris removal following natural disasters using annually appropriated funds; the very nature of disasters means that the timing and amount of assistance are unpredictable. Improved communication in planning and response is required, as is strengthened coordination and mobilization of assets to swiftly and strategically provide critical assistance unavailable at the local level. At present, the term "marine debris" is not included in either the National Response Framework or the National Disaster Recovery Framework. Federal agencies must collaborate not only at the national level with one another to provide technical assistance and operational resources, but in partnership with local entities to empower development of their own action plans and priorities to address the needs of their people.

PRIORITY ACTIONS
Community resilience planning, while not focusing solely on marine debris generated by extreme events like tsunamis, should acknowledge that materials located in the inundation zone have the potential to become marine debris and cause negative impacts that must be addressed.

Local and national organizations should cooperate to ensure that authorities and funding for rapid response to marine debris generated by extreme events exist and are widely understood; this should include the consideration by emergency planners of disaster-generated marine debris and its impacts on economies and public safety.

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9.d.1. Forty years of at-sea marine debris data collection

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ABSTRACT
Sea Education Association (SEA) has studied the distribution of tar balls and plastic debris in the North Atlantic and Caribbean Sea for over 30 years, and in the North and Central Pacific the past eight. These data have been collected by more than seven thousand undergraduate students participating in independent research projects as part of SEA's academic programs.
Marine debris data is collected in surface neuston nets from sailing school vessels on long, open-ocean voyages over annually repeated cruise tracks. Most sampling stations have additional data including surface temperature, salinity, meteorological data and water column physical and chemical data.

The length of the data set allows SEA scientists to examine changes in plastic concentration in the North Atlantic over the past four decades, a period in which the production and disposal of plastic waste have significantly increased. SEA's long-term tar ball data set provides an important baseline against which the impacts of spills and leaks resulting from petroleum extraction accidents can be evaluated relative to background levels due to natural sources.

9.d.2. SUPER HI-CAT: survey of underwater plastic and ecosystem response between Hawaii and California

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KEYWORDS
Marine microbes, micro plastics, biogeochemistry, Pacific Ocean,

BACKGROUND
Microbes are the most abundant organisms in the oceans and are vital to the Earth's habitability. Marine microbes produce the oxygen we breathe, form the base of the marine food web and help regulate the Earth's climate. Marine debris has become a serious issue concerning the health of today's oceans. Plastic debris in particular is known to have negative impacts on marine organisms through ingestion and entanglement by seabirds and large marine fauna; however, little is known about its influence on microbial communities. The objective of the SUPER HI-CAT cruise was to locate and sample microbial communities and biogeochemical properties associated with the so-called "Pacific plastic patch" between Honolulu, HI and Port Hueneme, CA.

METHODOLOGY
Sampling was conducted from the R/V *Kilo Moana,* between August 25th - Sept. 5th, 2008. During the transit a total of 15 CTD/Trawl/Optics stations and 15 underway (UW) stations were occupied. Hydrographic and biogeochemical data were collected to characterize the upper 150m water column at discrete depths (5m, 15m, 25m, 45m, 75m, and Deep Chlorophyll Maxima or DCM) using a CTD rosette sampler. UW stations were sampled using the ships uncontaminated seawater system. A Manta Trawl was used to map the surface horizontal distribution of plastic. Plastic samples were then size fractionated into the following size classes; 5mm and larger, 2 - <5 mm and 0.2 - <2mm. All three size fractions were then sub-sampled to measure Chlorophyll *a* and ATP concentrations, to estimate Gross Primary Production (GPP) and Respiration (R) and to preserve samples for subsequent genomic analyses. A LISST and HYPERPRO radiometer were used to characterize particle size distribution and optical properties of the upper water column.

OUTCOMES

Plastic samples were size fractionated into the following classes; 5mm and larger, 2-<5mm and 0.2-<2mm. Plastic particles in the 2-<5mm and > 5mm size classes ranged from 0.35-3.71 pieces m^{-3} across all sampling stations (Figure 1.). Integrated over the top 0.5m of the ocean, plastic concentrations along the transect ranged from $0.17\text{-}1.85 \times 10^6$ plastic fragments km^{-2}. Total microbial biomass, as measured by ATP content and Chlorophyll were measured for a range of plastic types and size categories. ATP and Chlorophyll concentrations were highly variable across the transect (100 to 20 fold range, respectively), but provided proof that microorganisms colonized the plastic particles and occasionally achieved significant enrichments relative to their distributions in seawater. Characterization of the microbial communities using PCR-based techniques demonstrated distinct differences in bacterial assemblages associated with plastic compared to assemblages from whole seawater and attached to naturally-occurring marine aggregates. Total particle abundance and particle size distributions, as determined by a forward scattering measurement, were not correlated with measured abundance of size-fractionated plastic in the surface waters along our transect. Rather total particle distributions tracked phytoplankton biomass, as chlorophyll or particulate carbon. Measurements of Gross Primary Production (GPP), Net Community Production (NCP) and Respiration (R) revealed high community metabolic rates on plastic particles in the two larger size classes. More importantly, whereas rates of NCP in the seawater were close to zero (GPP=R), microbial assemblages associated with the plastic debris were demonstrably net auto-trophic suggesting the presence of phytoplankton enriched biofilms.

PRIORITY ACTIONS

Marine plastics have become a serious issue concerning the health of today's oceans. There is growing interest in removing plastic from the ocean. However, the high spatial and temporal variability of marine plastics concentrations in the ocean and the limited number of samples that have been collected lead to a lot of unknowns. Removing plastics from the ocean could be costly, inefficient and have unforeseen consequences on the marine organisms such as phytoplankton, zooplankton and small surface dwelling creatures. Perhaps our efforts are best put towards preventing plastics from entering the ocean in the first place. Some key priority actions to reduce marine debris should include reducing the amount to plastic we use. Making concerted efforts to ensure that plastics don't end up in marine waterways though beach cleanups, education and outreach and by making people aware of how much plastic they use in their daily lives.

FIGURES AND TABLES

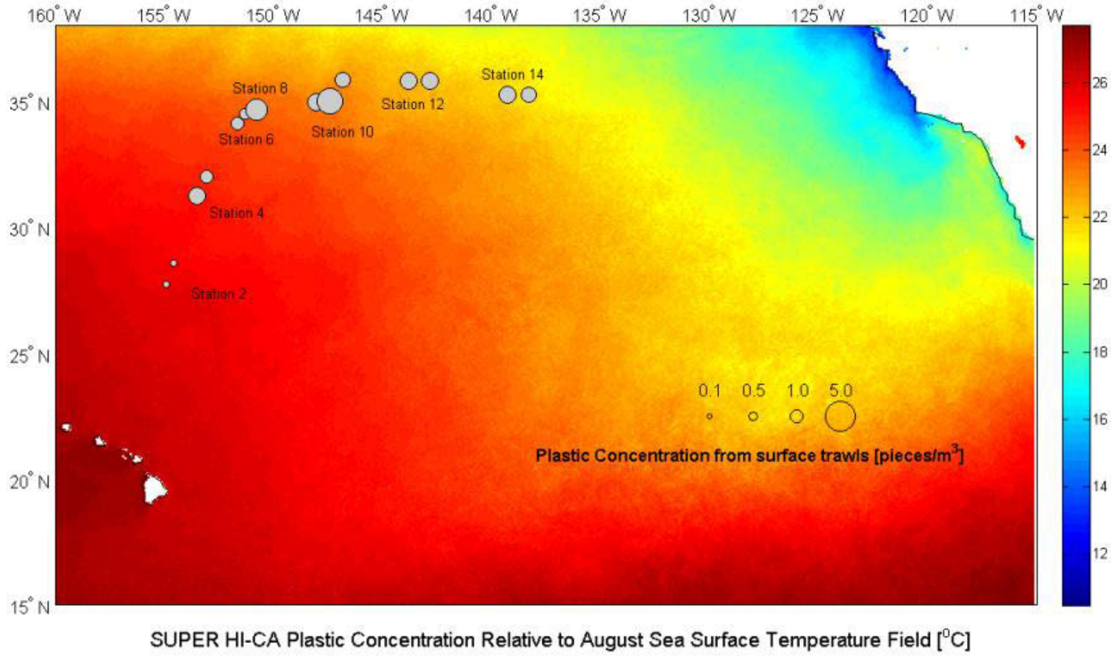

Figure 1. Super HI-CAT plastic concentrations from surface Manta trawls (pieces/m^3) relative to the August sea surface temperature field (C˚).

9.d.3. Quantifying concurrent distributions of marine debris and oceanic birds in the North Pacific Ocean using visual surveys

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ABSTRACT
Plastic debris and seabird prey accumulate in regions characterized by the convergence of surface waters and the retention of buoyant material. While many surface-foraging seabirds ingest plastic at-sea, little is known about when and where these far-ranging marine predators collect this material. Thus, quantifying the habitats of marine birds and debris is key to interpreting plastic ingestion by these oceanic predators. To this end, we conducted visual surveys and surface net tows during two summer cruises onboard the Sea Education Association vessel R.V. Robert C. Seamans. Our goals were: (1) to develop standardized methods for concurrent surveys of marine debris and oceanic bird distributions, and (2) to characterize the association of surface-feeding seabirds with areas of plastic concentration.

In June-July 2008 we surveyed 1556 km of survey effort during a cruise from Honolulu to San Francisco, and conducted 43 neuston tows. In June 2010 we surveyed 484 km along the Hawaiian archipelago, spanning from the Big Island to French Frigate Shoals, and conducted 10 neuston tows. The region of highest debris concentration was associated with the North Pacific subtropical gyre, and the seabirds were most abundant close to their colonies in Hawaii and California. While we documented marine debris both inside and outside of the Papahānaumokuākea Marine National Monument, the observed debris densities in the Hawaiian archipelago were substantially lower than in the subtropical gyre.

Our cruises did not detect small-scale (10s km) relationships between seabird and plastic concentrations, but revealed large-scale (100s km) associations with water masses. In particular, several surface-foraging seabird species occupied the same subtropical gyre waters where plastic debris concentrates. Studying these biogeographic associations is key to interpreting plastic ingestion by these far-ranging predators, and can be easily accomplished using standardized visual surveys from vessels of opportunity.

9.d.4. The Lone Ranger Mission: testing the latest advances of marine debris monitoring techniques, new methodologies, and environmental sensing technologies

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ABSTRACT
In January 2011,the *Blue Ocean Sciences* (BOS) team and our *National Aeronautics and Space Administration* (NASA) partners crossed the Atlantic on The Schmidt Foundation Research Group *R/V Lone Ranger* to explore the North Atlantic Gyre and the Sargasso Sea. This expedition covered approximately 3,000 nautical miles of critical ocean environments looking at environmental impacts of marine debris. Marine debris is a multi-faceted problem that includes interactions with everything from environmental toxins, the world's carbon cycling systems, ocean surface chemistry, fine minerals deposition, and nano-particles. However, research on this significant environmental pollution problem has not been able to keep up with the scope of the issue since some of the first studies published in *Science* in 1972 by Edward Carpenter. During the Lone Ranger Mission, eight senior level scientists from NASA and BOS tested out the latest advances in remote sensing systems, imaging technologies, and monitoring methodologies, and compared these to traditional sampling techniques. These studies will help in the development of our understanding of marine debris interactions and development of new techniques for assessment of marine debris accumulation.

10.a.1. PLASTIC OCEANS - A unique documentary that will challenge our addiction to plastic

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KEYWORDS
Plastic, Oceans, Gyres, wildlife, film, solutions

BACKGROUND
The biggest problem with making an environmental film, on any topic, is attracting an audience that has no interest in the issue. Consequently the people who end up watching them already care and the film ends up 'preaching to the converted'. Our biggest challenge therefore, is to entertain whilst educating our audience, but how can we make a film that is essentially about plastic pollution, interesting?

When people sit down to be entertained at home or at the cinema, they do not want to hear bad news, nor that they are powerless to make changes. Often the hard facts are enough to make them switch channels, or walk out of the movie theatre.

METHODOLOGY
With an issue as big and as important as marine debris, we have to reach beyond the 'converted' to capture the hearts and minds of a global audience. We can best achieve this by producing and distributing a high-end, High Definition documentary that has a clear message, stunning marine wildlife images and compelling human stories. But to truly inspire and empower people to make permanent changes to the way they use and dispose of their plastic waste, we must offer hope – hope in the guise of tangible solutions, be they remarkably simple or technologically groundbreaking.

The 'Plastic Oceans' film will investigate both marine and land-based solutions: from looking at the feasibility of using passive collection devices to remove plastic particulates from the ocean's surface, to testing river nets as a means to stem the flow of plastic debris into our oceans. The film will reveal how valuable a resource plastic waste is and look at the recycling of plastic fishing nets into electricity in Hawaii and the conversion of plastics into diesel and gas in Ireland. It will question our need to use so much plastic, look at the advantages of re-designing for end-life and investigate organic alternatives to packaging. And, ultimately, 'Plastic Oceans' will unveil the latest cutting-edge solution that could revolutionize plastic waste disposal forever. Have taken out the bit about it vanishing into thin air – I am sure the press will be there and don't want to have to answer questions about this to them or during the presentation.

As ocean filmmakers, we must look at every possible means to maximize our audience and influence. We will tell well constructed stories with charismatic wildlife and use well-known personalities to bring the stories to life. We are working with the world's top ocean and marine debris scientists and we can guarantee the film's international appeal and scientific integrity. Finally, 'Plastic Oceans' lies at the heart of a multi-media, multi-platform network that has the potential to move and motivate hundreds of millions of people worldwide into becoming part of the solution to marine debris

OUTCOMES

"With knowing comes caring. The 'Plastic Oceans' film will make a difference, first of all by getting people to know – and then to care." Dr Sylvia Earle.

Humans respond to visual images much more than audio stimulus. And we all know that *'a picture tells a thousand words'*. Our aim is to provide not only stunning images but to construct stimulating stories to entice the public to watch and learn without even realizing they are being educated. We are aware of the massive impact that Al Gore's '*An Inconvenient Truth'* had on a global audience and that was based on a simple Powerpoint Presentation. We are working with the world's top wildlife cameramen and the production team has many years of experience making films for the BBC's world-class Natural History Unit. We are confident that the film will be both powerful and entertaining – enough to make people start talking, to seek it out and to watch with intrigue.

Our work will not stop once the film is produced, it will become a tool for the whole Plastic Oceans project and the work of the Plastic Oceans Foundation. It will be available as a DVD and online for schools, tertiary educational institutions, government bodies and the public to access. During the filming we will be making a series of short films which will be updated on our website and the intention is to continue making these as solutions develop. The funding generated by the film release will be ploughed back into the Foundation so that they can help to fund new research, educational campaigns and more filming projects.

PRIORITY ACTIONS

Unlike the scientific presentations is this conference; this presentation is about spreading the awareness of solutions. The film in itself is a solution and our priority, is to stick to our production schedule and make the film, the only actions we can engender are to start people anticipating it and encouraging others to see it.

10.a.2. Filmmaking in the North Atlantic Gyre: into the vortex of research and education

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KEYWORDS
SEA, Education, Association, gyre, plastic, pollution, sailboat, research, Atlantic, video, documentary, film.

BACKGROUND

On a 35-day, 4,000 nautical mile voyage to the center of the North Atlantic gyre aboard a 135 foot square rig sailing research vessel, two filmmakers worked 18-hour days to produce a revealing and accurate depiction of oceanic plastic debris research.

In the summer of 2010, Sea Education Association (SEA) conducted the first federally funded research expedition dedicated to studying the accumulation of plastic debris in the North Atlantic Ocean. This expedition is a natural extension of the more than two-decade-long effort to measure plastic debris by SEA students and staff. Floating plastic debris has been collected by several thousand undergraduate students who hand pick, count, and archive tiny pieces of plastic collected in neuston nets, amassing an unrivaled dataset describing the extent of plastic pollution in the area known as the North Atlantic subtropical gyre. The expedition followed a 3,800 nautical mile saw-toothed cruise track east of Bermuda in an attempt to map the easternmost extent of the gyre.

The crew on the voyage was comprised of professional mariners, current SEA scientists, SEA alumni, a microbiologist, a professional photographer and writer and two professional documentary filmmakers. One of the primary goals of the cruise was to create a vibrant website that would educate the public about the cruise and the problem of plastic pollution in our oceans. My role as the producer and director of the web-video series was to create bi-weekly web videos.

As someone who does not have a background in science, my immediate challenge was that what I was seeing in the North Atlantic subtropical gyre wasn't at all what I expected. When one conducts a cursory Google search of "ocean garbage patch," – which is what the media has dubbed the Pacific gyre – one finds patently false images. We see images of coastlines and rivers stuffed full of piles of garbage. Problems, certainly, but very different problems from plastic pollution found in any of the five oceanic gyres. In reality, what we saw was very few pieces of macro plastic (more than 5 cm), but a great deal of microplastic (less than 5 cm). This microplastic is nearly impossible to see in the water, it's abundant presence only revealed in the neuston net results. So my challenge became, how to accurately film and document what we were seeing in the Atlantic subtropical gyre? If I was tasked with educating the public with an accurate view and description of pollution on our oceans, how to raise the alarm when the images are not as visually "horrible" as the public has been led to believe?

METHODOLOGY

There were multiple goals we hoped to achieve through the videos:

To show an accurate description of what the gyre looked like and what plastic actually looked like when it was collected in a scientifically rigorous manner.
To show the scientific methodology we were using to accurately count and map the plastic distribution in the gyre.
To discuss some of the other scientific goals of the expedition, most importantly looking at microbial activity on the plastic. This research was mostly done later, at WHOI, but the processing and storing of the microbes on plastic was a large part of the voyage.
And finally – and I think this is was incredibly important for educational outreach – to create a sense of wonder and awe of the study of the ocean, especially research conducted on a scientific sailing vessel.

OUTCOMES

Throughout the five-week voyage, we produced thirteen 2-4 minute videos. The videos were roughly divided into two categories. Science and Profiles. The science videos included videos on microbiology, the use of the neuston net to capture plastic debris and microorganisms, processing the neuston results, the use of a Tucker trawl to measure plastic below the surface, and the purpose of twice-daily Conductivity, Temperature and Depth measurements. The science-based videos were aimed at a layperson.

The rest of the videos profiled a number of the crew, scientists, and SEA alumni and students who were participating in the expedition. Often, the profiles didn't even mention plastic pollution. But in my mind, showing a profile of one of the sailors talking about the history and science of, say, celestial navigation enabled our viewers to learn incredibly interesting things about our ocean. Another example: profiling the ships' engineer and cook show the type of person who is willing to live for months on end at sea. In essence, it was my hope that increasing the viewer's love and wonder of the ocean through the eyes people who work around it might propel them to take action on pollution; to see that by not working harder to curb pollution, we are forever altering our oceans.

On June 25th, during a normal neuston tow, we captured 23,000 pieces of plastic, which is the equivalent of 26 million pieces per square kilometer. According to chief scientist Giora Proskurowski, this was likely the largest amount of plastic sampled in one tow by anyone ever in any ocean. While there were some notable large macroplastic pieces in the tow, most of the 23,000 plastic pieces were microplastic, so "seeing" this vast number on video was still very difficult. However, we also caught two triggerfish and a red plastic bucket. When we cut open the triggerfish, their stomachs were filled with plastic. The video of the plastic being squeezed out of the fish has become the iconic image of the expedition. It has been linked to by countless media outlets and has hundreds more hits than any of the other videos on YouTube. It is an incredibly disgusting and at the same time poignant image that brings together what these tiny pieces of plastic are doing to our ocean in a visceral way. I would posit that images like this and Chris Jordan's striking photographs of dead birds filled will with plastic pollution are vital to the public truly understanding and *caring* about plastic pollution. I don't want to get into a discussion of "truth" in photography and film, but we need to see more imagery like this and less false images pushed by unscrupulous media outlets about what oceanic pollution looks like.

The filmmakers are currently involved in producing an hour-long documentary that will be pitched to US and international cable television channels and play at international film festivals.

PRIORITY ACTIONS
Set the visual record straight on what oceanic gyres are and look like.

Develop education strategies that use "difficult" still and video imagery to make people care about the effects of marine pollution on our oceans.

Rigorous dissemination of oceanic plastic video across many different platforms – Internet, the classroom, meetings, conferences, and television – often repurposing material for different distribution formats.

FIGURES AND TABLES
While my talk will not have figures or tables, I will be showing short excerpts from two of the videos I produced. Links:

http://www.youtube.com/watch?v=XU995OR_lRc&feature=player_embedded&hd=1

http://www.youtube.com/watch?v=WdhIEG-Q2hk&feature=player_embedded#at=11&hd=1

10.a.3. Highlighting marine debris clean up success through educational film making

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KEYWORDS
Marine debris, environmental education, sustainable development, lifestyle, clean up, ecotourism, volunteer, film making.

BACKGROUND
This presentation focuses on the problem of effectively communicating to the public the severity of marine debris worldwide. Marine debris is considered a major form of marine pollution and is one of the main challenges for coastal managers (Santos et al. 2005) and decision makers. Diminishing waste pollution of our seas, oceans and shores is a serious challenge that needs to be addressed systematically.

We act on this line by producing an educational tool, a film on costal clean up’s efforts, which will present data and civic engagement highlighting the scope of the debris problem, as well as the possible positive local community response to marine debris problems. The film will also address the tourism sector, including the built environment, related infrastructure, and tourism activities, since tourists are considered one of the most important target group due to its considerable footprint in coastal locations.

The increasing shift toward sustainability is reflected in the growth of ecotourism, which is evaluated as a tool of environmental education and an awareness raising activity. Since the educational level strongly determines the behavior of people in relation to litter generation and disposal (Santos et al. 2005), we take the standpoint that an effective way to address marine debris problematic is to invest in environmental education and awareness raising activities, which have been identified as significant in reducing marine litter (Storrier and McGlashan, 2006).

METHODOLOGY
The project was initiated among a team of marine scientists, videographers, and environmental activists in coastal waters of Slovenia in 2008. The club of energetic ecologists - Eco Vitae started a project Clean coast (In Slovenian: Čista obala) in 2008 with the main goal to organize clean ups of Slovenian coast and improve monitoring of collected marine debris. The idea for this project came from the Israel colleagues who originally started the Clean Coast Index Project in 2005.

The onetime event has grown into a project in which ecologists, students of Environmental Sciences from the University of Nova Gorica and volunteers join their forces to clean the coast monthly with National Service for Protection of Marine Coastal Waters which operates under the Environmental Agency of the Republic of Slovenia.
In the research on pollution of Slovenian coast with solid waste the project leader argues that informative and awareness raising activities are needed as well as organized volunteer help in clean up events (Palatinus, 2008; Palatinus, 2009). The filming will take place in April 2011 during the Eco Vitae spring clean up event. Regarding the marine debris problematic in Slovenia we will interview representatives of marine scientists, marine mammals research and conservatory society, National Service for Protection of Marine Coastal Waters, fishermen, tourism sector, local inhabitants, national and international tourists. According to Storrier and McGlashan (2006) coastal clean ups are excellent opportunities for community involvement, focusing the public's attention on the issue of marine debris and creating a sense of environmental responsibility. Free work force e.i. volunteers proved to be very successful in various conservation projects including marine debris surveys (Bravo et al. 2009). Volunteer ecotourism is becoming a niche success (Wearing, 2004; Gray and Campbell, 2007; Brightsmith et al., 2008) and might be a possibility for marine debris clean up events.

OUTCOMES
The project aims to produce a 30 minutes non-commercial film that raises awareness and informs the public of behavioral shifts that lead to sustainable lifestyles (Barr and Gilg, 2006). By emphasizing prevention of marine debris pollution it will focus on enhanced ecosystem services for coastal communities and adjacent watersheds.

We aim to motivate people into getting involved in monthly marine debris clean ups of Slovenian coast as volunteers. One of the film main messages is to try to implement “5Re eco-lifestyle strategies” (refuse, reuse, reduce, repair, recycle) into everyday life and consequently generate less litter locally, that potentially ends up in our seas and on the coasts. Since 80 % of marine debris found on beaches and waters comes from land based sources (The encyclopedia of Earth, 2011), we hope to make a significant change within the following years. Finally we try to provoke local tourism industry into becoming more environmentally friendly in all its aspects by improving coastal ecotourism offer. According to Stubelj Ars and Bohanec (2010) proper management strategy and regime must be implemented in order to achieve quality ecotourism, since positive tourism impact on natural resources can be expected as noted by Li et al. (2006). Therefore we will suggest various activities and small coastal investments to improve ecotourism offer on the Slovenian coast.

At the end of summer 2011 we plan to release the film that will motivate people to join us on the International Coastal Cleanup 2011, an action that has been held in Slovenia since 2008 within the project Clean Coast. The educational film will be available for use in schools and in outreach educational actions and we hope to promote it on the National TV station that deals mainly with Slovenian coastal life. By the end of the year 2011 the web for promotion of Slovenian coastal clean ups, literature, data and ecotourism coastal offer will be set up with the possibility of free film watching. The film will have English subtitles, in Picture 1 the expected influence of the film on the local society is shown.

PRIORITY ACTIONS

The main goal of the film is to inform the public on marine debris problem, to show the pollution prevention personal strategy and contribute to the behavioral shift towards more sustainable lifestyles. We wish to trigger the increase in ecotourism offer and more sustainable practices in tourism industry. Finally we hope to get more volunteers involved into the clean coast project and therefore increase the number of activists who not only systematically clean our coast, but spread the idea of caring for it and thus contribute to the quality of our beaches and the marine environment.

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10.b.1. Australian Marine Debris Project – the value of community data in a national database

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KEYWORDS
Marine, Debris, Community, Data, Plastics, Cleanup, Signature, Litter, Index, Site

BACKGROUND

In an overpopulated world explosive growth and turnover of consumer goods and packaging has led to dangerous levels of marine debris. Beaches are the one place where the average citizen can directly experience this problem. Many citizens are ready to act to protect their local coastal environments and by encouraging them to identify and record their findings the overall experience can be broadened and valuable data and information obtained.

Community based data does not usually conform to strict scientific protocol but we argue that it can provide important and relevant information. This can be achieved by developing marine debris identification resources and developing collection protocols for volunteers, by organizing ongoing coastal cleanups and reviewing and refining the whole process over time. Resulting data (count of items) is stored in a relational database system and this system enables a range of descriptive statistics to be developed.

METHODOLOGY

Our Marine Debris Identification Manual and data collection sheet are regularly updated to make individual item identification accurate and consistent for entry into the database. Beach cleanup data comes from annual events, regular monitoring projects and submitted data from individuals and other organizations.

From this data we have developed a "litter and local source" index which gives a guide to the proportion of beach debris generated from littering or other local inputs at or near a site by taking into account the buoyancy, form and other factors of each item as well as the demographics and geographic nature of the site itself. The litter index is expressed as a decimal fraction or a percentage. An offshore index is 1 (or 100%) minus the litter index. We have also developed a "cleanup signature" which simply shows the proportion of the total of items in each of our seven marine debris categories which are end user items, packaging items, industrial and commercial items (farming, fishing, and shipping), linear items, sundry items, oil and tar, and remnants of any item made of plastic. We mention these tools as examples of how community based data can be used to identify what is impacting each cleanup site and then to find solutions to these issues.

OUTCOMES

Community willingness to participate in coastal cleanups is amply demonstrated internationally e.g. the International Coastal Cleanup and in our own experiences in Australia. In the process of collecting large volumes of data from multiple sources spread around a large coastline we are identifying problems and issues within the process itself and also in regards to having the data recognized and used by relevant authorities and government organizations.

Our litter index records shows the degree to which a site is directly impacted by human activity and over time the index will show the highs and lows of site usage by people as well as changing seasonal factors affecting the beaching of offshore debris.

The cleanup signature performs in the same manner, but additionally shows the dominant category/s of debris affecting a given site. Our litter index and cleanup signature collectively show that where there is littering and local impact, packaging and end user items are predominant. Using these tools together with statistics showing the volumes of debris within sites over time can be used to direct resources, review policy and procedure, and target enforcement and education activities across areas and regions.

Being able to demonstrate the escalating levels of single use plastic packaging and consumer goods found as marine debris allows attention to be focused on related issues such as the fate of those plastic items and the prolific loss of plastic resins which are now distributed universally to produce throw away plastic items.

PRIORITY ACTIONS

We recommend the recording of community based marine debris data at a national level with possible links to an international level.

We further recommend that academic institutions explore the development and usage of community based beach cleanup data. Data and resulting reports and studies should be freely accessible to the community. Community, industry and government bodies need also to be encouraged to use this data in their planning, enforcement and mitigation activities.

We recommend the phasing out of single use plastic packaging and consumer items as a matter of urgency.

FIGURES AND TABLES

Table 1: Example of a Litter Index and Percentage of Plastic Items From Selected Sites

Location	Total Items	Litter Index	Percentage Plastic	Description
Quarry Bay West Australia	2751.47	0.14	97%	Quarry Bay is a small 300m, remote bay head beach with low visitation which receives mostly offshore debris. Data collected from 12 clean ups during 2009.
Marmion Marine Park West Australia	1472	0.39	77%	Marmion Marine Park is a 17 km stretch of small beaches within the metropolitan area of Perth. This example is from one clean up event in October2009 when beach usage is moderate and some offshore debris is still coming ashore.
Far North Queensland	58835.35	0.54	71%	This is a coastal region adjacent to the Great Barrier Reef with most data from Port Douglas where high tourist numbers occur. The data was collected from 24 sites during 109 clean ups, covering 274km of coastline.

Table 2: Examples of Cleanup Signatures for Various Data Groupings

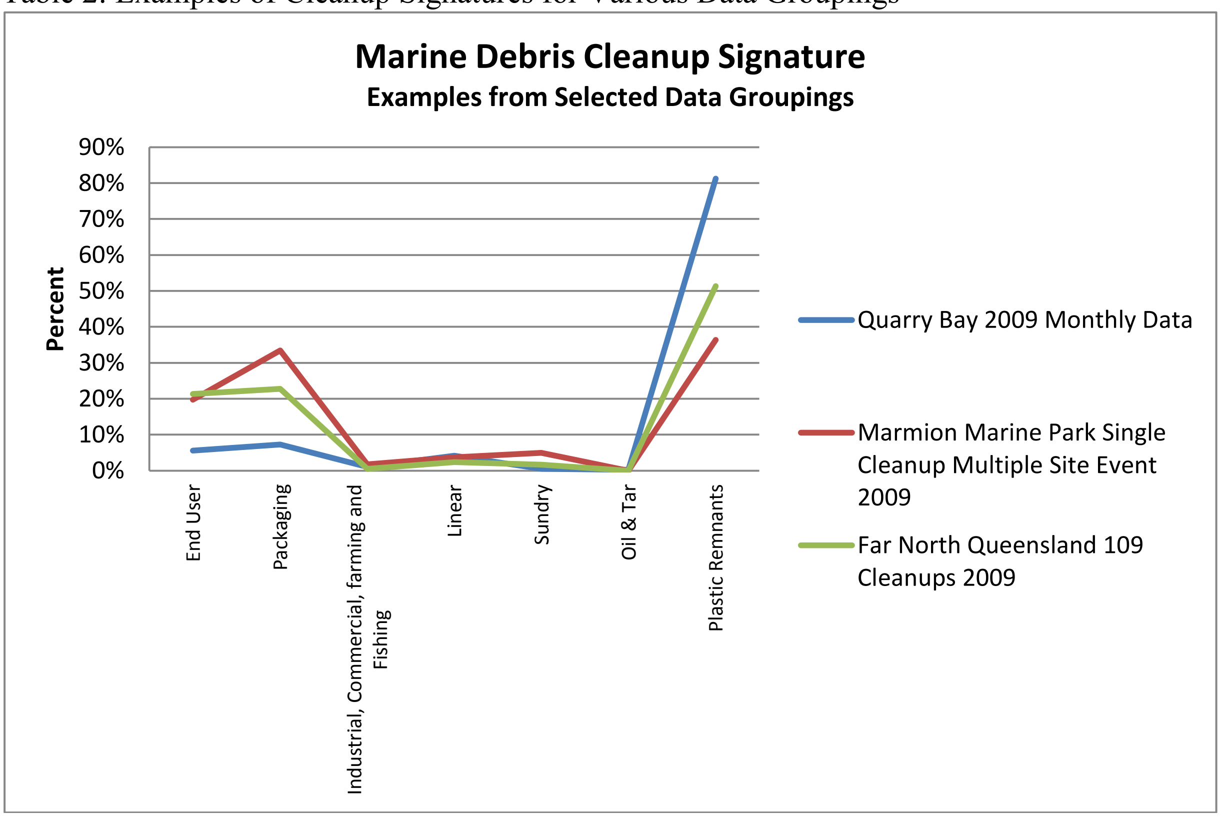


Table 3: Comparison of long term litter index and debris density (items per meter of beach) trends

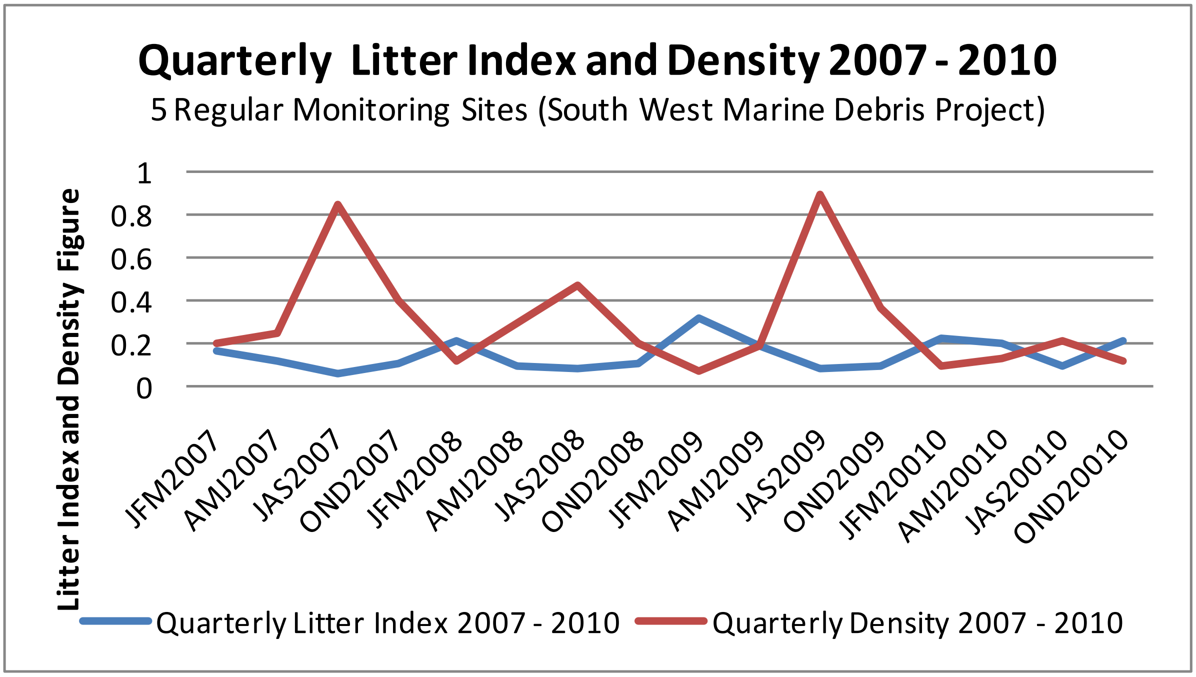
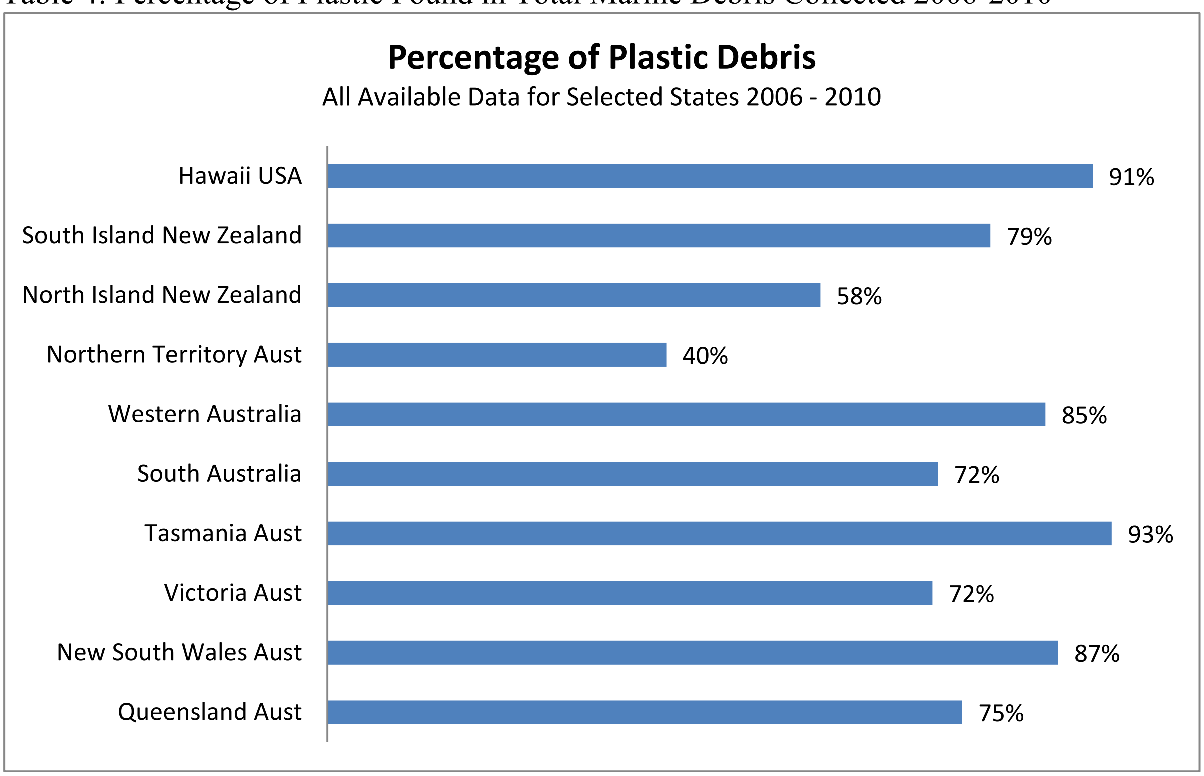


Table 4: Percentage of Plastic Found in Total Marine Debris Collected 2006-2010



10.b.2. Prince William Sound Alaska Marine Debris Monitoring Program

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KEYWORDS
Monitoring, volunteers, debris pulses, legacy gear, trends, high seas driftnet floats, mid-water trawl floats, accumulation, beverage bottles, Styrofoam

BACKGROUND
The problem statement is: Long-term marine-debris monitoring provides useful information regarding MD accumulation rates and changing trends in MD types. Monitoring information can help identify the parties responsible for the MD and it is useful for determining where to concentrate MD removal resources and effort.

Marine debris deposition in Prince William Sound appears to be changing from primarily legacy and derelict commercial fishing gear to general plastic detritus. More plastic debris is in our immediate future…not less.

METHODOLOGY
Gulf of Alaska Keeper uses carefully selected volunteers with an experienced professional to re-clean selected MD monitoring sites on an annual basis. Approximately 130 categories of debris are currently tracked by number and weight. Each monitoring plot is thoroughly cleaned, the items sorted into categories, counted, and weighed.

OUTCOMES
MD monitoring is a useful and valuable activity. The trend in foreign-origin MD in Prince William Sound appears to be up. The trend in beverage bottles is markedly up. Styrofoam MD deposition tracks very closely with the overall poundage of MD deposition in Prince William Sound. MD monitoring is useful for discovering unreported coast-wide MD events, such as spills from cargo ships. Onshore winter storms directly influence how much debris is deposited annually on Gulf of Alaska beaches.

10.b.3. A baseline study of marine debris in Central California: assessing the abundance and types of beach litter in Monterey Bay, CA

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KEYWORDS
Beach litter, beach survey, citizen science, AIC, *mixed effects*

BACKGROUND

Existing efforts to clean up beaches within the Monterey Bay region (Save Our Shores and The Surfrider Foundation) lack scientific monitoring and assessment of stranded marine debris and beach surveys serve to address this problem. In Watters et al. 2010, boat based researchers mapped the categories and distribution of underwater benthic debris (mostly fisheries related items) within the Monterey Bay (Watters et al. 2010). Their effort marked the first published marine debris study on the Central Coast (Watters et al. 2010). However, in effort to lessen the expense of boat-based research, beach surveys on land are a common method used to assess the scale of the distribution of both terrestrial and oceanic marine debris (Ribic 1992; Moore et al. 2001). Beach surveys can help identify the distribution and changes in debris quantity through aggregate spatial and temporal beach monitoring (Rees and Pond 1995; Kusui and Noda 2003; Edyvane et al. 2004; Oigmann-Pszczol and Creed 2007). Beach surveys also allow for the efficient collection of accurate and statistically comparable data, using trained volunteers and inexpensive equipment (Rees and Pond 1995). The objectives of this study are: 1) Assess presence, type, and quantity of macro and meso-scale beach litter in the Monterey Bay by sampling surface and sub-surface beach substrate, 2) To better understand the relationship between litter abundance and temporal or spatial factors, and 3) Involve citizens in science-based research.

METHODOLOGY

Monthly samples were repeatedly collected by trained volunteers at the same site over the course of one year. Volunteers went through 2 hours of mandatory training, involving a 30 minute explanation about the importance of scientifically quantifying marine debris and the method for beach surveying. Immediately following the lecture, volunteers participated in a demonstration of the survey protocol. A total of twelve beaches were surveyed monthly in tandem throughout the Monterey Bay region (Figure 1). Surveys occurred semi-monthly from July through September 2009 and monthly from September 2009 through June 2010. Data collected in months that were surveyed twice were averaged. Per Ribic's (1992) recommendations regarding volunteer effort, six teams comprised of at least two volunteers each conducted surveys, and each team surveyed two beaches per event. This simultaneous multi-team approach increased efficiency and possibly increased accuracy in measurements otherwise thwarted by the daily variation in litter deposition. All surveying was conducted at low tide, providing optimal beach surface area to be sampled. The first of two transects occurred within the strandline as previous studies have shown this region as a deposition zone for plastics (Velander and Mocogni 1998, 1999; Corcoran et al. 2008; Ryan et al. 2009). Similar to Cunningham and Wilson (2003), the second transect was positioned 5m above the first transect line. A pin flag demarcated the start of each transect. Five 4 m^2 quadrats were randomly placed along both transect lines for the purposes of sampling meso and macro-scale beach litter (Velander and Mocogni 1999; McDermid and McMullen 2004). Prepared random numbers designated the number of volunteer paces taken along each transect line for quadrat position (one through five). Volunteers demarcated each sequential sampling plot by reusing a 4m^2 PVC quadrat as they progressed along line. All anthropogenic debris was collected from each quadrat, tallied on the data sheet, and placed into labeled sealable Ziploc bags. Spatial and temporal relationships were analyzed using mixed effect modeling and best fit was ascertained using AIC model comparison.

OUTCOMES

Following Styrofoam, fragmented plastics (< 2 cm) were the second most frequently occurring items found. Beach clean-ups most likely miss meso-scale plastics, consequently these items may accumulate on or underneath the sand surface. Using scientific survey techniques, this study was able to identify the quantity and distribution of fragmented plastics, and this evidence suggests these items have a long lasting nature in the coastal environment. The presence of this synthetic waste could pose significant threats to seabirds which are known to forage in the waters of the Monterey Bay. Species of seabirds may mistake small pieces of plastic for food items (Ryan 2008). Other notable items found included; resin pellets, food wrappers, and fertilizer pellets.

Larger litter loads clearly produced the increased variance in abundance in the winter and early spring months (January February, March, and April) (Figure 2). In contrast, summer months and late spring (July, August, September, May, and June) experienced fairly uniform distribution of litter abundance (Figure 2). Mean litter abundance in the summer, fall, winter, and spring months was 1.40, 1.47, 5.88, and 3.50 items m^{-2} respectively. Based on the data collected and analyzed in this study seasonality instead of beach location affects abundance and type of litter. In support of this finding, I found that heavily visited beaches do not necessarily accrue more litter than remote beaches, findings which may be due to storm events or proximity to rivers. Akaike's Information Criterion (AIC) has been used in model selection for generating hypothesis testing on various environmental drivers effecting amounts of debris (Ribic et al. 2010). In this study, AIC was used to identify and explore likely relationships between litter abundance over space and time which were driven by anthropogenic and environmental factors. The use of mixed effects and AIC model comparison was non-experimental, and helped to generate hypothesis about the causality of beach litter rather than test hypothesis (Tudor and Williams 2004). Utilizing survey methods that incorporate collecting large and small debris has allowed me to provide categorical and litter abundance benchmarks for ongoing beach litter monitoring as well as for public education, outreach efforts, and legislative action.

PRIORITY ACTIONS

Incorporate beach survey methodology into Sanctuary citizen monitoring programs (Urban Watch and BeachCombers); Future data can be used to educate public about the connections between their local watershed and the Monterey Bay.

FIGURES AND TABLES

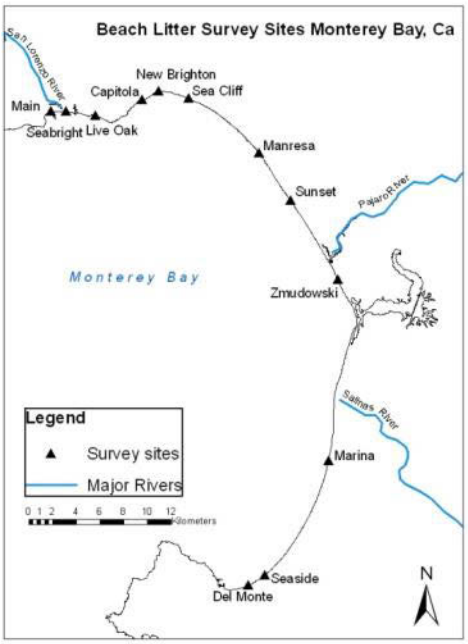

Figure 1. Map of beach survey sites.

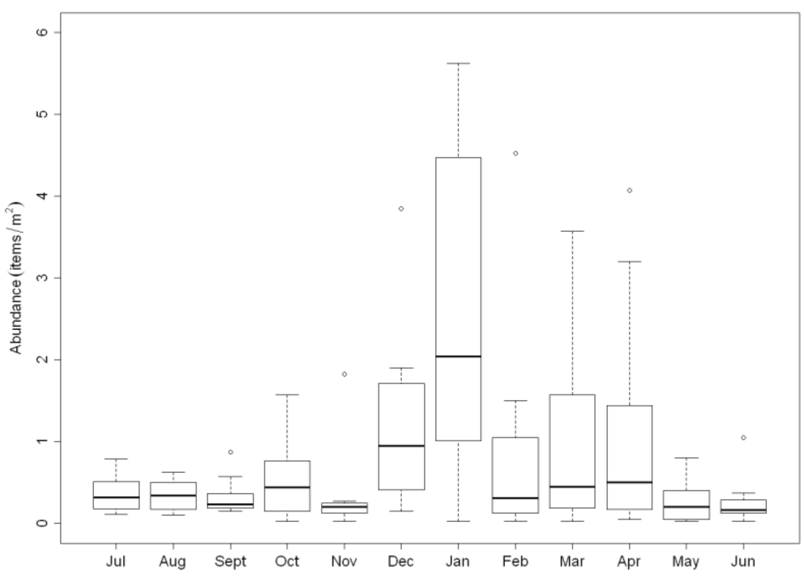

Figure 2. The distribution and variation in litter abundance across month from July 2009 to June 2010. Three outliers are not shown, one for each month in Jan, Feb, and Mar of 2010.

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10.b.4. The Clean Coast Index – 5 years of data collection along 65 beaches in the Mediterranean and the Red Sea.

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KEYWORDS
Marine litter, Clean Coast Index (CCI), plastic debris, beach, cleanliness, assessment.

BACKGROUND

In 2005 the Ministry of the Environmental Protection launched a long-term program entitled "Clean Coast". The aim of the program is to maintain beach cleanliness at all times, while generating public awareness of the importance of the subject of coastal cleanliness.
An index which measures the actual cleanliness of the beach was required in order to evaluate the success of the program. In seeking such an index, we found that conventional methods rely on the amount of waste removed from the beach during cleaning operations, as measured by tonnage or volume[1,2]. These parameters are comparable and easily measured although they do emphasize the cleanup operation, rather than the actual cleanliness of the beach. Other methods analyzed the type of debris found on the beach referring mainly to its origin[3,4].

METHODOLOGY

Plastic debris represents by far the majority of litter on the beaches [5,6,7,8,]. According to preliminary studies conducted throughout the winter of 2004-2005, plastics represented 90% of the litter found on the Israeli coast, at that time, as shown in fig. 1. In our study, the term ‘plastic’ refers to any artificial waste made, or partly made, of plastic. We decided to ignore other waste items, like wood, for instance, that can be counted by some surveyors as waste while others regard it as a natural item. By choosing plastic alone as a numerator, we reasoned that this was similar to the choice of e-coli as a marker for human pathogen pollution. Plastic particles 2 cm in size and above (a bottle cap) were chosen as the index numerator, on the basis of practical and measuring convenience as in previous studies [8,9].
Study area: The Israeli coast stretches for about 190 kilometers and is not homogeneous. It varies from long sandy beaches, surrounded by sand dunes, to narrow rocky shores with beach rocks and pebbled coasts covered by seashells or kurkarite fragments.
Since the litter distribution on a given beach is not constant, transects are performed from the water’s edge at the measuring moment, to the border of the coast, represented by any obstacle – sand dune, cliff, vegetation, road or fence. The preliminary study demonstrated that several 10 meters transects, performed on a single beach gave similar results. To facilitate the counting procedure, transects were divided into 5 strips of 2 meters in width. To eliminate bias, the exact measurement location was selected randomly.
All the unauthorized beaches were morphologically defined as 42 segments, each characterized by the same coastal conditions (sandy/graveled, narrow/wide, open/bordered by cliffs, etc.)

Depending on the length of the beach, the number of measurements varied from 1-3, giving us a total of 65 CCI measurements along the Mediterranean and the Red Sea coasts of Israel.
The calculation of the CCI is presented in the following equation:

$$\frac{\text{Total plastic parts counted in Z lines}}{Z * 2[m] * \text{beach width } [m]} = \text{Plastic parts} / m^2$$

For statistical reasons, as well as for convenience, a coefficient of K=20 was inserted into the equation, thus the ICC represents the amount of plastic particles found in $20m^2$. In order to make the picture clearer for the public, results for the presence of litter on the coasts were graded as follows:

0-2 : Very clean – No litter is seen,
2-5 : Clean – No litter is seen over a large area
5-10 : Moderate – few pieces of litter can be detected
10-20: Dirty – A lot of debris on the shore
20 + : Extremely dirty – most of the beach is covered with plastic debris.

Coast Index	Very Clean	Clean	Moderate	Dirty	Extremely dirty
Numeric Index	0-2	2-5	5-10	10-20	20 +

OUTCOMES

The CCI is measured every two weeks, by more than 60 people: inspectors, paid students and volunteers of different backgrounds and ages. The assessors reported that each measurement took as long as 10-20 minutes and was easily performed. CCI results accorded with beach appearance. To verify results obtained from different assessors, we conducted parallel measurements.
Publication of the CCI by the media raised public awareness and encouraged local municipalities to increase their efforts to maintain cleaner beaches (Fig.2). The CCI has been published regularly in the website of the Ministry for Environmental Protection (www.environment.gov.il) as well as in national and local Israeli newspapers since June 2005. The CCI facilitates better control and regulation of the "Clean Coast" budget that funds most of the cleaning activities conducted by local authorities. The program established a set of rules determining that in cases where a beach is found to be dirty once a month or in moderate condition twice a month, its cleanup will not be covered by the "Clean Coast" program. The CCI supported initiation of enforcement activities, in case of failure to maintain coast cleanliness in accordance with contracts between local authorities and the "Clean Coast" program.
The CCI is used for scientific research at different education levels. By performing the measurements, students are exposed to the marine debris issue and the way it is dealt with in Israel and around the world (fig.3). The CCI was published[10] and has been tested in various countries such as Brazil[11], Slovenia and the Republic of Korea, and found suitable for assessment of their beach cleanliness.

PRIORITY ACTIONS

The CCI is a handy tool for evaluation of the success of the "Clean Coast" program, and can be very useful for implementation, with minor adaptation, in other countries.
Beach cleanliness assessment is a powerful tool in motivating the stake holders and authorities to clean their coasts, and finding solutions for the marine debris problem. Performing the CCI and

publishing its results, promote public awareness of the cleanliness of the coast in their vicinity, and produces a sense of responsibility and commitment in the young generation.

FIGURES AND TABLES

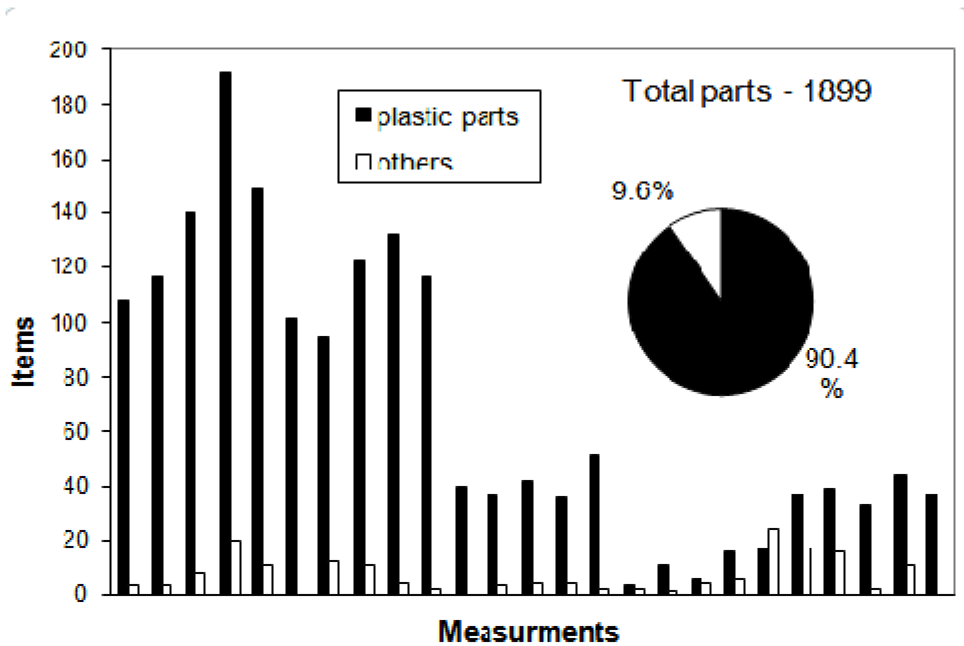

Figure 1: Plastics and other items counted on 25 beaches at 5 geographical locations.

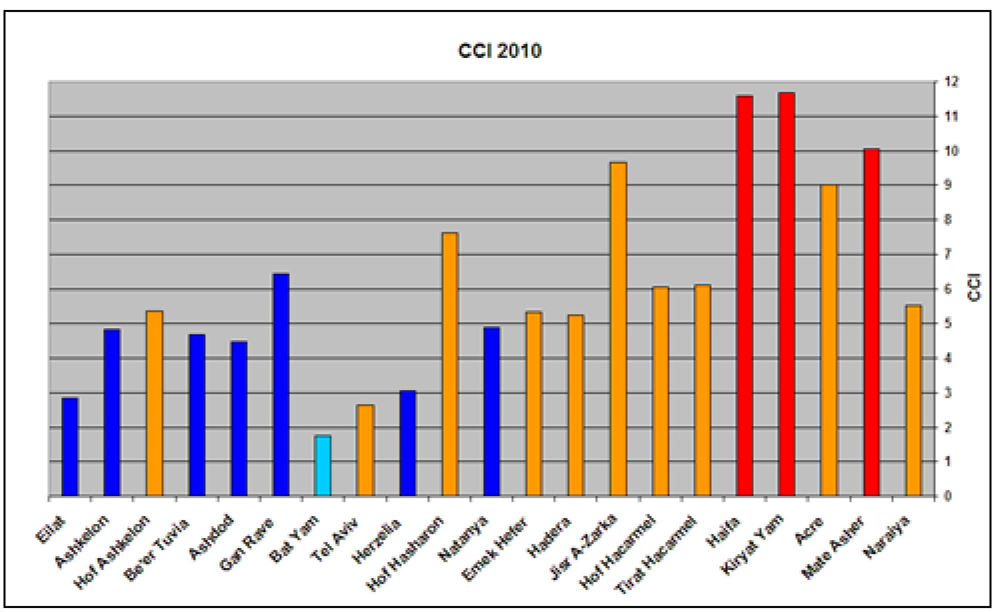

Figure 2: The ICC average of the local authorities for 2010.


Figure 3: College Students performing the CCI, in the framework of environment studies.

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10.b.5. 25 years of global trash: 8.7 million people, 144 million pounds of trash, 291,000 miles of coastline

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KEYWORDS
Ocean Conservancy, International Coastal Cleanup, data collection, data set, volunteers Industry solutions, plastics

BACKGROUND
Trash and other manufactured items in the ocean represent a serious pollution problem. The ocean is the planet's life support system, providing much of the food, water, and oxygen we need to survive. It also drives our climate. Trash in the ocean isn't just an eyesore; it threatens the health of our ocean as a whole, along with that of humans, wildlife and their habitats, and economies. One common charge is that inroads must be made to assess the extent of the problem, triage marine debris items of concern and engage in formulating solutions which tackle these items.

The collection of marine debris data is one of the best ways to accomplish these objectives. One of the best available data sets to provide a snap shot of the problem, the Ocean Trash Index, comes from Ocean Conservancy's International Coastal Cleanup (ICC). For 25 years volunteers have collected information on specific items of concern. This year's annual report entitled Tracking Trash: 25 Years of Action for the Ocean, brings a tally of all the items collected during 25 years of ICC event's (Ocean Conservancy, 2011). Given the volunteer nature and global scope of the Cleanup, the methodology, while not rigorously scientific, provides useful information for non-governmental organizations, policy makers and industry to forge solutions.

METHODOLOGY
The Ocean Trash Index presents state-by-state and country-by-country data about ocean trash collected and tallied by volunteers around the world on one day within the months of September and October during Ocean Conservancy's International Coastal Cleanup. Volunteers have collected data since 1986 and internationally since 1989. Debris items are tallied on standardized data cards were developed and provided by Ocean Conservancy. From 1986 through 2000 debris was categorized by the type of material, such as wood, rubber, plastic, glass, paper, and metal. In 2001, Ocean Conservancy revised and simplified the data card to include 42 specific debris items and groupings related to five debris-producing activities and sources such as Smoking-Related Activities and Shoreline & Recreational Activities. The new groupings identify the behavior

associated with the presence of debris. In 2008, Ocean Conservancy decided to tally paper and plastic bags separately, for a total of 43 items listed.
Currently, data cards are available in nine languages: English, Spanish, French, Portuguese, Chinese, Russian, Thai, Swahili and Arabic.
The volunteer coordinator for a country, location, or US state enters totals for each site into Ocean Conservancy's secure Online Data Collection and Reporting Tool by the Cleanup Coordinator for the country, location, or US state. Coordinators may also mail, email, or fax totals to Ocean Conservancy. All data sent to Ocean Conservancy and not entered by the Coordinator are entered by Ocean Conservancy staff. Country, location, and US state geographic designations are made using the CIA World Factbook, https://www.cia.gov/library/publications/theworldfactbook/geos/uk.html. Data is also analyzed by regions determined using the UN Statistical Division, http://unstats.un.org/unsd/methods/m49/m49regin.htm

OUTCOMES
Trash is covering our beaches and accumulating in gyres in the middle of the ocean. We have a clear picture of the specific products involved, and can now ramp up efforts to stop these items from ever reaching the ocean.

Considering the twenty-five-year body of Cleanup data, there's no question that a wide variety of manufactured items are causing a major ocean pollution problem. In 25 years 166,244,420 items have been collected and tallied by 8,763,377 volunteers. Volunteers removed 144,606,491 pounds from 291,514 mile of shoreline from over 152 countries (Fig. 1).

The data provide the most comprehensive and measureable global snapshot of the world's marine debris, as well as a breakdown of sources and debris items found in US states, countries, locations, and regions of the world. Due to the large sample and nature of the collection, the data also provide a base for other studies. The top ten items collected, over the last 25 years of the International Coastal Cleanup (Fig. 2), provide a useful roadmap to tackling items of most concern.

This valuable information is an effective tool for educating the public, business, industry, and government officials about the presence of marine debris, and how and where to take specific actions to prevent it. For example, the Cleanup data have been cited in numerous reports, including a 2009 United Nations Environment Programme/Ocean Conservancy publication entitled, Marine Litter: A Global Challenge. Cleanup data informed passage of the 2006 Marine Debris Research, Reduction, and Prevention Act, as well as California's state marine debris action plan. Also over the past twenty-five years, items reported by Cleanup volunteers have helped inspire industry to make changes to protect the ocean. One example is Morton's "Ship 'n Shore" salt. In 1990, Cleanup data analysts noted that many volunteers in the Gulf of Mexico reported finding blue plastic bags of Morton's "Ship 'n Shore" salt, used by commercial shrimpers to keep their catch fresh. Morton wasn't responsible for the improper disposal of their packaging, yet they took action when the Cleanup data highlighted the problem. First, they encouraged people to take advantage of the option to purchase the salt in paper bags that degrade relatively quickly in the water, rather than the long-lasting plastic package. And they took the additional step of adding messages reminding shrimpers to take care: "Don't be a Litter Boat" and "Stow It, Don't Throw It."

Going forward, we need many strategies working in concert to significantly reduce the trash winding up in our ocean and waterways. The Ocean Conservancy's International Coastal Cleanup is one of those strategies, by providing guidance and support to local and regional organizations as they tackle the marine debris problem in their own backyards. Many volunteers have been inspired to form their own organizations while other large and distinguished organizations in their own right have developed and grown along with the International Coastal Cleanup. The following organizations comprise a small part of the entire worldwide network that is the data collecting engine of the International Coastal Cleanup, all deserve a great of deal of our gratitude:

Alliance for the Great Lakes
California Coastal Commission
Center for Alaskan Coastal Studies
Clean Virginia Waterways
Coastsweep
Great Canadian Shoreline Cleanup
Indian Maritime Foundation
Japan Environmental Action Network
Our Sea of East Asia Network

PRIORITY ACTIONS

Based on our data, Ocean Conservancy, with the help of other non-government organizations, industry leaders, government officials, and volunteers from around the world propose the following priority actions to rid the world of trash in the ocean.

- Change bad habits and champion policy initiatives to **Reduce** the amount of single-use materials and manufactured debris that are improperly discarded
- Continue to expand initiatives such as the International Coastal Cleanup to **Remove** marine debris for trash free seas.
- Engage industry to **Reinvent** products so that they are safer for the environment and humans.

FIGURES AND TABLES

Figure 1. 25-year total of people, pounds, miles and countries part of Ocean Conservancy's International Coastal Cleanup

Top Ten Items Over 25 Years

RANK	DEBRIS ITEM	NUMBER OF DEBRIS ITEMS	PERCENTAGE OF TOTAL DEBRIS ITEMS
1	CIGARETTES / CIGARETTE FILTERS	52,907,756	32%
2	FOOD WRAPPERS/CONTAINERS	14,766,533	9%
3	CAPS / LIDS	13,585,425	8%
4	CUPS, PLATES, FORKS, KNIVES, SPOONS	10,112,038	6%
5	BEVERAGE BOTTLES (PLASTIC)	9,549,156	6%
6	BAGS (PLASTIC)	7,825,319	5%
7	BEVERAGE BOTTLES (GLASS)	7,062,199	4%
8	BEVERAGE CANS	6,753,260	4%
9	STRAWS / STIRRERS	6,263,453	4%
10	ROPE	3,251,948	2%
	TOP TEN TOTAL DEBRIS ITEMS	**132,077,087**	**80%**
	TOTAL DEBRIS ITEMS WORLDWIDE	**166,144,420**	**100%**

SOURCE: OCEAN CONSERVANCY/INTERNATIONAL COASTAL CLEANUP

Figure.2. Top Ten items based on 25-year total of debris items collected worldwide by volunteers during Ocean Conservancy's International Coastal Cleanup.

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10.b.6. Quantification of plastic marine debris balance using data collected by citizen scientists

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KEYWORDS
microplastic, trawl, quantification, model, mass balance

BACKGROUND
Problem statement: Existing observations of marine debris are commonly qualitative. Neither the accuracy nor the amount of available data are sufficient to understand the entire global dynamics of the debris. This problem is due to complex, heterogeneous properties of the debris distribution, complexity of its measurements, lack of remote tools for its mass tracking, and intrinsic noise of observations, caused by many different factors. The global view and guiding concepts of the marine debris problem could be provided by models, whose skills allow today to successfully describe many oceanic processes. This paper discusses the gap between the available data and available models that needs to be filled up.

METHODOLOGY
Solution of the statistical model, developed using historical trajectories of Lagrangian drifters [Maximenko et al., 2011a, 2011b] has been compared with the data of a number of regional observational programs, including the SEA Semester® program [Law et al., 2010], "5 Gyres" voyages and ocean cleaning efforts by Kaisei/Ocean Voyages Institute. In addition, samples were collected with the help of a volunteer sailor.

OUTCOMES
Five maxima in Figure 1 have been validated against observations. The North Pacific Great Garbage Patch, located between Hawaii and California, is the best documented patch in the ocean [e.g., Ryan et al, 2009]. It is adequately reproduced in the statistical model solution. Interannual variations of the patch, detected during the 2010 Kaisei/Ocean Voyages cleaning operation and not described by the statistical model, were explained by the diagnostic SCUD model [Hafner et al., 2011; Maximenko and Hafner, 2010]. The pattern of density of microplastic, sampled by the 22-year program of the SEA, agrees well with the model solution in the western subtropical North Atlantic [Law et al., 2010; Law et al., 2011]. The "5 Gyres", created with the goal to document plastic in the subtropical gyres, not covered by previous surveys, found good correspondence between changes in the amount of plastic along sections across the patches in the South Atlantic and South Indian Oceans and Figure 1. Finally, the

volunteer sailor James Mackey, who started his navigation from Azores in 2009 [IPRC'2009], despite of two major boat repairs (in Cape Town and New Zealand), succeeded to reach the region of the South Pacific patch and has reported (Fig.2) microplastic in the samples collected southeast of Easter Island, close to the model patch center.

PRIORITY ACTIONS

To make the model and the data to better complement each other, observations should aim at estimates of the integral (integrated in vertical or in three dimensions) mass of plastic, while models should include processes (such as wind mixing) that affect in situ observations. Better instruments for debris observations should be designed and observational system should be put in place to address the global problem of marine debris in general and microplastic in particular.

FIGURES AND TABLES

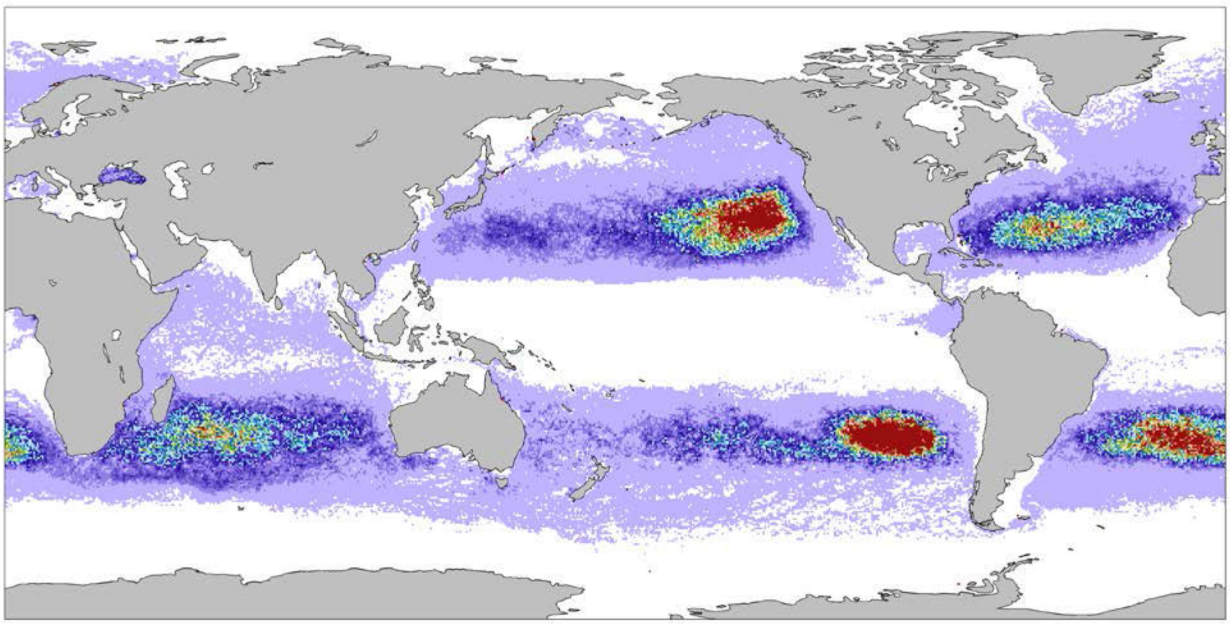

Figure 1. Density of model tracer, integrated from the initially homogeneous condition for 10 years, predicts locations of five main patches of long-living marine debris, floating at the sea surface.

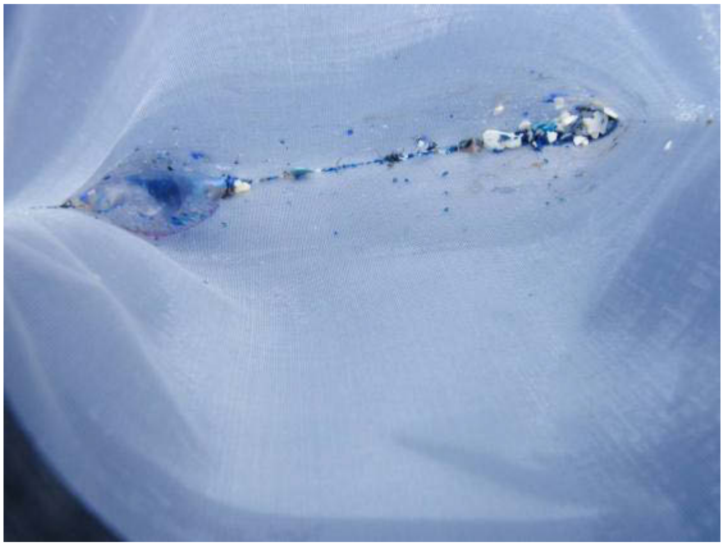

Figure 2. A photo of the sample, collected in January 2011 southeast of Easter Island (eastern South Pacific) by a volunteer sailor James Mackey. The sample, collected with the Manta trawl, may well be the first sighting of microplastic in the area, validating the pattern in Figure 1 and reconfirming the global nature of the marine plastic debris.

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10.c.1. Derelict fishing gear: addressing the management vacuum

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KEYWORDS
Derelict Fishing Gear, Fish Aggregating Devices, Jurisdiction, Enforcement, International Law

BACKGROUND
Each year, staggering amounts of plastic waste are introduced into the world's oceans. Much of the waste consists of abandoned or lost fishing nets and other commercial fishing equipment used by many of the world's fishing fleets. Once abandoned, derelict fishing gear (DFG) continues to ensnare fish, marine mammals, and birds. Other types of abandoned fishing equipment injure wildlife by being ingested. Any individual abandoned device can entangle and injure wildlife indefinitely because the marine environment cannot break down the plastic fibers used to make this equipment.

While DFG and fish aggregating devices (FADs) have been identified as having a significant negative effect on the marine environment and on fisheries, very little has been accomplished in addressing the problem. Despite initial voluntary measures by some in the fishing industry to begin to address the so-called "ghost net" problem, a lack of clear legal jurisdiction and enforcement capability has led to a regulatory vacuum. Domestic laws generally do not apply beyond a country's exclusive economic zone. Many Regional Fisheries Management Organizations (RFMOs) lack the authority to develop policies and rules to address DFG, and those that have developed such policies or rules lack the capacity to monitor compliance Likewise, the U.N. Food and Agriculture Organization (FAO) has produced information and identified concerns about the effects of DFG, but it also lacks legal jurisdiction to monitor compliance with recommendations. Into this jurisdictional vacuum have arrived recommendations that the U.N. International Maritime Organization (IMO) address DFG through Annex V of MARPOL (the International Convention for the Prevention of Pollution from Ships, as modified in 1978 by the Protocol on marine pollution).

METHODOLOGY
This presentation will examine both the extent of the problem of DFG and FADs and discuss the current legal regime. Because of the lack of jurisdiction and the inability to enforce current laws and regulations, this presentation will also discuss potential changes to international and domestic laws that could be used to address the problem, including stronger use of MARPOL Annex V. The institution of a comprehensive derelict gear control system will be proposed and examined. Such a program would include a method of tracking nets so that liability for abandoned equipment can be assessed. Incentive systems to decrease both intentional and unintentional loss of netting will also be discussed.

OUTCOMES
A vacuum exists in the management of derelict fishing gear due to both a lack of clear legal jurisdiction and international enforcement capability.

Under international law, both coastal states and flag states have an obligation to prevent the release of DFG by providing adequate disposal facilities at fishery ports and enforcing regulations requiring proper disposal of waste fishing gear. More specifically, the international community is guided by MARPOL and the United Nations Convention on the Law of the Seas (UNCLOS), two legally binding regimes that have attempted to address marine pollution. Neither of these treaties has proved to be adequate at addressing the problem of DFG, however. Existing non-binding declarations, like the United Nations Global Program of Action and the Washington Declaration, are more comprehensive in terms of addressing specific pollution activities, but they are merely declarations and lack legal effect and enforcement power.

Additionally, domestic laws generally do not apply beyond a country's exclusive economic zone. As a result, even where an individual nation has passed laws regulating DFG, those laws would only apply within that nation's EEZ and to ships flagged in that country. Activity in international waters and in the waters of other nations would not be affected by domestic regulation. DGF is both a pollution problem and fishery management problem, leading to potential conflicts among agencies. Additionally, even domestic regulatory regimes can be stymied by confusion between regulatory agencies over authority.

Prevention and reduction of DFG is clearly a part of sustainable and responsible fisheries management. For that reason, international fisheries agreements—including commitments made by nations to manage fisheries under RFMOs such as the Inter-American Tropical Tuna Commission (IATTC) and the Western and Central Pacific Fisheries Commission (WCPFC)—should play a large role in preventing and reducing DFG. These commitments could include measures to reduce the loss of fishing gear, but not all RFMOs have the authority to develop policies and rules to address DFG. One RFMO that has attempted to address the problem is the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), which has an active program to combat marine debris from fishing activities. For example, the CCAMLR requires that all fishing and fishing research vessels have identifying marks on each item of fishing gear, post placards illustrating that fishing net disposal is prohibited, carry observers, and distribute educational materials explaining marine debris regulations. But RFMOs that have developed such policies or rules lack the capacity to monitor compliance.

The FAO similarly lacks legal jurisdiction to monitor compliance with its recommendations and policies. The FAO has adopted an international Code of Conduct for Responsible Fisheries, which provides that nations, RFMOs, and other international organizations should adopt appropriate measures to minimize DFG and its impact on nontarget species, in particular endangered species. The FAO has also encouraged the use of gear identification systems, so that gear may be traced to its source. Due to its lack of monitoring and enforcement capabilities, however, neither practice has become widespread.

Because of the limitations and shortcomings of attempts by RFMOs and the FAO to impose binding rules, it has been recommended that the IMO pursue stronger regulation of DFG through

Annex V of MARPOL. MARPOL is one of the few multilateral treaties that specifically addresses the problem of ocean pollution. MARPOL's Annex V prohibits the disposal of all plastics at sea, which includes waste fishing gear.
There are currently a number of difficulties in relying on MARPOL to address DFG, however. Enacted by the IMO, Regulation 3 prohibits the disposal of all plastics, including synthetic fishing nets, and a similar ban applies to special areas under Regulation 5. Regulation 6, however, exempts the release of fishing gear from this general prohibition if the release involves an "accidental loss," provided that "all reasonable precautions have been taken to prevent" the loss. Consequently, if fishing gear breaks off or falls overboard due to damage, or is intentionally released in order to secure the safety of the vessel, it is not a violation of MARPOL.

In addition to these exceptions, another difficulty in implementing MARPOL arises from the international nature of high-seas fishing. That is, Annex V's lack of success to date is due in large part to the difficulty of enforcement. The IMO's regulations are difficult to implement, largely because the IMO relies on coastal and port states to enforce them. A country that a fishing vessel visits can conduct its own examination to verify the vessel's compliance with international standards and can detain the ship if it finds significant noncompliance. When incidents occur outside the country's jurisdiction or jurisdiction cannot be determined, the country refers cases to the vessel's flag state, in accordance with MARPOL. However, a report by the U.S. Government Accountability Office (GAO) in 2000 documented that, even when referrals have been made, the response rate from flag states has been quite poor.

The IMO has recognized that compliance with MARPOL Annex V has been incomplete and that marine debris from fishing operations continues to be a substantial threat. In 2006, the IMO's Marine Environmental Protection Committee (MEPC) began a review of Annex V and its implementing guidelines. The IMO's review has identified a number of fisheries-related problems and options to rectify them. These options include: (1) better defining the exceptions for the prohibition on releasing fishing gear and limiting the application of that exception; (2) expanding the application of the IMO's Regulation 9, which requires reporting lost fishing gear, to more vessels; (3) including a requirement to mark gear so that it can be identified and traced to its source; (4) ensuring that the information contained in the IMO's implementing guidelines is more accessible to fisheries management organizations and stakeholders.

Stronger regulation of DFG by the IMO through MARPOL Annex 5 would be a significant step in addressing the problem of DFG, and it would also assist RFMOs in their attempts to confront this problem. Nevertheless, because of the need for domestic implementation of Annex 5 by member nations, and because the IMO relies on self-reporting by coastal and flag nations, the efficacy of this approach is limited.

Any regulatory regime, whether established by the IMO, individual nations, or other bodies, should include the following elements:

- An inventory of net types and other gear used by fisheries under each nation's jurisdiction.
- A clearinghouse mechanism to facilitate the sharing of information on fishing net types and other gear used in international fisheries.

- A requirement to mark and track gear so that it can be identified and traced to its source in order to establish liability.
- An international network of regular, long-term monitoring of DFG and other fishing-related debris.
- Additional research through targeted studies to determine factors motivating the loss and disposal of fishing gear at sea. Information gained from these studies would be used to develop additional measures to prevent loss and promote the appropriate disposal of fishing gear.
- An incentive system, including financial credit or fee exemptions, in addition to enforcement and liability.
- Outreach and education to ensure that information about regulations and guidelines is more accessible to fisheries management organizations and stakeholders.

PRIORITY ACTIONS

Stronger regulation by the IMO through MARPOL Annex is essential to addressing DFG. The IMO should require the institution of a comprehensive derelict gear control system, including a method of tracking nets so that liability for abandoned equipment can be assessed. Incentive systems to decrease both intentional and unintentional loss of gear, such as financial credit or fee exemptions, are also necessary.

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10.c.2. Regional fisheries management organizations and derelict fishing gear: current efforts and future needs

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ABSTRACT
Derelict fishing gear (DFG) has potentially significant adverse impacts on the marine environment, including damage to sensitive habitats, unaccounted mortality of target and protected species, and dangers to vessel navigation. A number of international instruments address the discharge of persistent fishing gear and fishing gear fragments into the marine environment. The International Convention on the Prevention of Pollution from Ships (MARPOL 73/78) Annex V prohibits the deliberate disposal of all plastics at sea, including synthetic ropes and fishing nets; however, there is an exception if the gear is lost accidentally provided that all reasonable precautions have been taken. The 1993 FAO Code of Conduct of Responsible Fisheries and the 1995 United Nations Fish Stocks Agreement both call for States to take appropriate measures to minimize waste, discards, and catch by lost or abandoned gear. The 2005 United Nations General Assembly Resolution 60/31 called upon States, individually and collectively, to develop mechanisms for the regular, long-term collection, collation and dissemination of information on DFG. Conventions of two Regional Fisheries Management Organizations (RFMOs) contain specific obligations to minimize ghost fishing by lost and abandoned gear. Despite these mandates, experts contend that the rates of loss or abandonment of fishing gear on the high seas and within coastal waters has not decreased.

This oral presentation will examine the current international framework to reduce derelict fishing gear, focusing on the role of Regional Fisheries Management Organization. Further, it will explore potential solutions to improve understanding of the impacts of DFG on the marine environment and reduce the incidences of DFG, including developing and implementing cost effective and efficient prevention and, if appropriate, recovery of derelict and lost fishing gear.

Marine Debris, including derelict fishing gear, has been recognized as a problem at the highest levels in the United States. NOAA Fisheries' Office of International Affairs' has actively promoted prevention, mitigation and outreach in bilateral, regional and global fora, in partnership and coordination with other NOAA offices and the State Department.

10.c.3. Strengthening the global governance and regulatory framework to combat abandoned, lost or otherwise discarded fishing gear (ALDFG)

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KEYWORDS
Abandoned, lost or otherwise discarded fishing gear (ALDFG); Areas beyond national jurisdiction (ABNJ); Marine debris; Governance and regulatory framework; International cooperation; Code of Conduct for Responsible Fisheries (CCRF); Food and Agriculture Organization of the United Nations (FAO); International Maritime Organization (IMO); United Nations Environment Programmes (UNEP); General Assembly of the United Nations (UNGA).

BACKGROUND
ALDFG is an insidious problematic aspect of the marine debris issue that undermines fisheries management and threatens biodiversity. ALDFG can have negative economic, ecological and public health effects including habitat destruction through abrasion or smothering, macrofaunal entanglement, ingestion, and ghost fishing. Aesthetically, ALDFG can be unsightly and can discourage tourism and coastal recreation. Increases in the scale of fishing operations and pervasive use of synthetic materials and expansion of fishing into the high seas and deep-seas have increased these impacts. ALDFG has been recognized internationally as a major problem. Proposals for addressing the problem have been made at the level of the United Nations General Assembly (UNGA) and its specialized agencies and programmes namely the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), the International Maritime Organization (IMO), and the Conference of the Parties of the Convention on Biological Diversity (CBD COP). There have also been regional calls to address ALDFG. However, there has not been up to now a global initiative to address the problem in a coordinated and cohesive manner under an international governance and regulatory framework which requires the participation by major stakeholders to deal with ALDFG. A coordinated and coherent global approach that is guided by an agreed global governance and regulatory framework will yield better results. Such framework should establish clear objectives and the means to address gaps in information and technology, identify the key actors and recommend specific measures that seek to prevent, mitigate and cure the ALDFG issue. Partnership and participation by major stakeholders in implementation of the specified measures is crucial. In this respect the means to ensure effective partnership and broad participation should also be identified.

METHODOLOGY

Literature review, in particular the analyses by recent studies of the global action and findings on the adequacy of these actions will be presented. The result of a comparison between how similar or related global problems such as dealing with illegal, unreported and unregulated fishing and their relative effectiveness to identify useful approaches that seek to address ALDFG will also be presented. Emphasis will be placed on ALDFG in areas beyond national jurisdiction (ABNJ) highlighting the lack of a common governance and regulatory framework in that area and the pivotal role regional fisheries management organizations and arrangements (RFMO/A's) could play in addressing this issue. Emerging and other interesting trends and specific aspects of ALDFG that may require attention will be highlighted. The presentation will also identify the potential components of a proposed global governance and regulatory framework to address ALDFGs and the next steps to realize this.

OUTCOMES

The presentation will make the proposal for a dedicated global cooperative mechanism for action on ALDFG in the form of a governance and regulatory framework. Whatever the form (*e.g* Best practices Guideline, International or Technical Guideline, International Plan of action) and regardless of whether it is binding or not, the framework should focus on preventing, mitigating and curing ALDFG and its impacts. Such framework should set out, as a minimum, the following components:

- The lead stakeholders and their responsibilities namely States and competent national authorities, inter-governmental organizations including FAO, IMO, UNEP and CBD COP and regional bodies or arrangements including RFMO/A's, fishers etc;
- The specific measures (prevention, mitigation and curative) and the entities (States, RFMO/A'S, international organizations and civil society) that will implement these measures;
- Specific recommendations on research to address the gap in information, knowledge and technology required to deal with ALDFG;
- Programs and actions to address capacity building needs for effective implementation including transfer or sharing of knowledge;
- How to address special needs of developing countries; and,
- A review and monitoring mechanism for implementation of the framework.

PRIORITY ACTIONS

A renewed call for coordinated and coherent action at a global level to address ALDFG and its impacts through urging the Conference, individuals, groups and civil society to convince their Governments and States to demand action at the highest global fora including the UNGA, FAO, IMO, UNEP and CBD COP to address ALDFG. Recommendations, resolutions or decisions should be specific and directive. They should, inter alia:

- Specify that States and international fora/entities including the UNGA, FAO and FAO's Committee on Fisheries, IMO and UNEP should collaborate to address ALDFG;
- Call for a cooperative and global governance and regulatory mechanism to be developed to ensure coordinated and cohesive action on addressing ALDFG
- Designate competent IGO's (*e.g* FAO) to lead, discuss and identify options for cooperative global action;

- Urge FAO, IMO and other UN agencies to continue their work on Annex V of MARPOL and report on their work to their members;
- Regular reporting on actions taken at the national level;
- International and national campaigns to raise awareness.

FIGURES AND TABLES

Stakeholder	Relationship to the issue of ALDFG	Potential impact	Potential influence in addressing ALDFG
United Nations General Assembly	Provides a mandate through its Resolutions for the issue to be addressed globally, and for specific international organizations to address the issue	+	High, if Resolutions are acted upon, due to global influence
FAO	Mandated by member countries and the UNGA as the leading international fisheries organization to conduct research, make technical recommendations, support RFBs, and provide an advocacy role	+	High, due to extent to which people look to FAO for leadership on fisheries issues, and due to ability to feed solutions back to member countries through COFI and other structures/activities
IMO	Adopts legally binding and non-legally binding instruments pertinent to international shipping. Oversees MARPOL Annex V which addresses ship-generated garbage and prohibits the disposal of plastics, including synthetic fishing nets	+	High, especially due to ongoing MARPOL Annex V review
UNEP	Advocate, educator, catalyst and facilitator for sustainable development. Sees ALDFG importance in the context of wide marine litter and its Regional Seas Program	+	High, due to extent to which people look to UNEP for leadership on environmental issues, and due to ability to feed solutions back to member countries and to regional programs
Regional Fisheries Bodies (RFBs)	May have a management, scientific or advisory role.	+	High, as can either legislate for, or encourage preventative/curative measures. And because RFBs provide for Government to act in a coherent manner

Stakeholder	Relationship to the issue of ALDFG	Potential impact	Potential influence in addressing ALDFG
Regional Fisheries Management Organizations (RFMOs)	RFMOs have the potential to pass Resolutions which are binding on signatory parties	+	High, as can directly influence cooperating member fleet activities and practices
Regional Seas Conventions and Action Plans (UNEP and non-UNEP)	Facilitate, assists and provide financial support for activities on marine litter in 12 Regional Seas, as well as several activities at the global level. The ALDFG is considered as one of the major issues in such work.	+	High, the work of RSP in Regional Seas and at the global level is considered as the only systematic work on the marine litter problem at the regional and supra-regional level.
Regional Economic Groupings (e.g. APEC)	May chose to pick up the issue of ALDFG as important within working groups established to address the issue.	+	Medium, due to potential ability to make recommendations to governments on a regional level, but fact that many such grouping will not view ALDFG as a priority issue
National governments	Often bear the costs of clean up. Important role in legislating for, and supporting voluntary measures to reduce ALDFG. May also support/fund research	+	High

Table 3: Stakeholder analysis (adapted version), Source: Food and Agriculture Organization of the United Nations, *Abandoned, lost or otherwise discarded fishing gear, Rome, 2009*, FAO Fisheries and Aquaculture technical paper No. 523- UNEP Regional Seas Report and Studies No. 185, by Graeme Macfadyen , Tim Huntington and Rod Cappell- FAO Consultants, Lymington, United Kingdom of Great Britain and Northern Ireland.

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10.c.4. Which governance for plastic-free seas and oceans? A view from Europe

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KEYWORDS
Governance; European seas; EU Marine directive; awareness raising; education; prevention; production; research and monitoring; remediation; coordination.

BACKGROUND
Marine litter is a growing problem which imposes an increasingly serious threat to the environment in EU Marine waters and elsewhere. Marine litter consists of items that have been deliberately discarded, unintentionally lost, or transported by winds and rivers, into the sea and on beaches. Land-based sources account for up to 80% of marine litter and include tourism, sewage and illegal or poorly managed landfills. The main sea-based sources are shipping and fishing.

Statistics about packaging waste generated by countries such as Germany, Italy, France or UK range between 2 and 2.7 mio tons of plastic a year each. EU Member States (+ Norway and Switzerland) represent 25% of the global plastic production.

Marine plastic/litter threatens biodiversity, our health and our economy. Its multiple causes, sources, forms and impacts call for global coordination, extensive research, creative, collaborative approaches and urgent action. If we want to rid our seas and coasts of marine litter it is high time for all players – scientists, NGOs, industry, policymakers to sit around the table and come up with innovative solutions. This is therefore a governance challenge.

METHODOLOGY
Within the European Union, the Marine Strategy Framework Directive (MSFD), adopted in 2008, is a binding instrument which aims at reaching Good Environmental Status (GES) of the marine waters in 2020. With regard to marine litter, the aim is that properties and quantities of marine litter do not cause harm to the coastal and marine environment. The 22 coastal Member States of the European Union are obliged to develop a strategy to address the pressures of the marine environment. As part of this strategy, Member States have to deliver in 2012 an Initial Assessment of the state of the marine environment, the existing pressures and the cost of degradation. They have to define what is GES, which targets they will set (also in 2012), to have a monitor programme which will be able to measure progress towards achieving GES (2014) and to take measures (2016 latest).

Prior to the development of these strategies by Member States, the European Commission took the initiative to already stimulate the development of actions, and cooperates with the Regional

Seas Conventions aiming at the protection of the marine environment in the North East Atlantic, the Baltic sea, the Black Sea and the Mediterranean.

A recent workshop (November 2010) at the European Commission underlined the need to address both sources of marine litter: litter or waste which comes from the land and waste which originates from the sea-users. At the workshop a wide variety of stakeholders participated: industry, local and national governments, NGO's, scientists, policy makers, politicians. They agreed that partnerships with stakeholders need to be established whereby short term and long term objectives have to be set. There will be a large number of problems to overcome when developing activities to achieve those objectives. How to make more use of the market forces? How can incentives be developed and used, also for the consumers? Or should the focus be more on the development of sanctions? The 'polluter pays' principle is difficult to apply in this context. And there are, unfortunately, also examples of non-coherence between different policies and legislations.

OUTCOMES

Within Regional Seas Conventions of European waters (North East Atlantic, Baltic, Mediterranean, Black Sea) there are action programmes under development of addressing this emerging issue of marine litter. Within OSPAR there is the Fishing for Litter initiative. Within the Black Sea region national waste strategies and coastal zone management plans are amended with the aim of coastal and marine litter minimisation and to develop regional and national monitoring and assessment methodologies. Research and monitoring is strengthened through the framework or the MSFD. Marine litter has at the moment also political attention and commitment. The European Commission is making an overview of all the relevant actions it can contribute to. They are listed below:

- change the production of plastic products through taking the whole life-cycle of the product into account
- increase the prevention of litter by increasing the recycle and re-use rate (i.e. through setting binding reduction targets) or to develop and strengthen policies (i.e. obligations with regard to Port Reception Facilities or Waste legislation)
- focus the research on the impacts of micro-plastics and the toxicity of plastics and the potential of bio-degradable plastics
- establish standards for monitoring marine litter in the water column and at the sea bed
- raise more awareness and educate school youth, consumers, fisherman, port authorities, producers, etc, for instance through the introduction of an eco-label or 'plastic footprint' or through the exchange of best practices and success stories
- stimulate the development of local actions and find loopholes in the plastic cycle through pilot studies, as requested and approved by the European Parliament)
- take remediation actions such as 'Fishing for Litter' activities and beach clean-ups
- cooperate with the different stakeholders and coordinate the different actions at local, national, regional and global level

PRIORITY ACTIONS

- A better <u>monitoring</u> of plastic litter in the seas is needed in order to know better, to understand better and to act.

- A comprehensive approach is necessary; legislation is one option, but cooperation with industry is necessary and behavioral changes from consumers should be aimed at through educative programmes.
- The local, national, regional and international levels have each a specific part to play, reducing plastic litter is largely a governance issue.

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http://ec.europa.eu/environment/water/marine/pollution.htm

10.c.5. Policies and implementation of the integrated marine debris management in Republic of Korea

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KEYWORDS
marine debris, management, cost sharing, buy-back, South Korea, NOWPAP

BACKGROUND
Korea faces serious marine debris problems due to increasing industrial activities and population growth. Enormous amounts of domestic and industrial waste and other pollutants are discharged into the sea, directly or indirectly. Especially, a great deal of debris enters the sea via river during rainy and stormy season. As a result, Korea has suffered from economic losses, and decreased tourism and recreational activities due to ecological alterations and marine species decline.

METHODOLOGY
Since early 1990s, Korean government has tried to solve marine debris problems under an integrated national management plan. Ministry of Land, Transport and Maritime Affairs (MLTM), in co-operation with local government and related organizations, tried to solve marine debris problems by several efforts. Monitoring is conducted at about 20 sites to understand marine debris distribution in coastal and marine environment in Korea. Based on the annual nationwide monitoring results, Korean Government has developed National Integrated Management Strategy for Marine Litter. These included applying an advanced ocean cleaning vessel to collect marine debris, encouraging fishermen to bring entangled marine debris back to a designated place, installing adequate disposal systems to treat generated marine debris, and etc.

OUTCOMES
National Integrated Management Strategy for Marine Litter of Korea covers minimization of marine debris generation, enhancing technical capability for removal of marine debris, building the scientific database and information for efficient marine debris management, and increasing public participation and international co-operation to respond to the marine debris problems.

Cost-sharing programme to fund-raise for implementation of marine debris policies has been applied for 5 main river watersheds in Korea, Han River (2001), Geum River (March 2009), Nakdong River (April 2009), and Youngsan River/Seomjin River (May 2009). Sharing the treatment cost of marine debris takes into account the polluters, beneficiaries, area of the basin, population, and the estimated volume of the marine debris. Cost-sharing programme is a good method to fund raise but also to prevent marine debris generation.

Buy-back programme encourages fishermen to bring entangled derelict fishing gear back to port ing by paying a small incentive fee for marine debris. Sacks are provided in three sizes: 40 L, 100 L, and 200 L. When they are returned full, the government pays the fishermen 4,000 won ($4 USD), 10,000 won ($10 USD), 20,000 won ($20 USD) respectively (Table 1). During 2005-2010, 41,627 tons of marine debris was collected through the buyback programme.

Removal of beach and seabed marine debris was also implemented. Coastal cleanup is conducted to remove generated marine debris at the coast. For example, a total of 6,328 tons of marine debris was collected in 2009. Removal of seabed marine debris has launched since 1999, and this project was carried out in 19 sea areas, such as Koeje and Gosung In 2009.

For sound disposal of marine debris, Korean Government has developed treating- and incinerating and recycling technologies of collected marine debris. Especially, a high amount of waste polystyrene fishing buoys thermal volume reduction system is an environmentally friendly method of treating and recycling polystyrene fishing buoys (Fig. 1). The system thermally reduces the waste polystyrene buoys to ingots, 100% of which can be recycled to produce other plastic products, and therefore produces subsidiary income. This system successfully dedicates to improve the coastal environment.

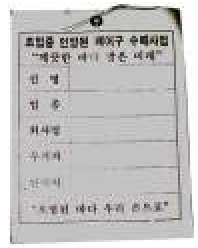
Increasing public awareness programmes on marine debris are also implemented. A coastal cleanup campaign is held annually on 31st May in cooperation with NGOs. International Coastal Cleanup event is also annually held on the third Saturday of September. The One Beach, One Company campaign is another example to raise public awareness on marine debris. The campaign is to remove coastal beach by volunteer group of fishery-related corporations, local organizations, and communities.

PRIORITY ACTIONS

The marine environment of Korea has been immensely improved compared to the past. These kinds of integrated management could be applied at the other part of the sea over the world. This study could provide a good example to other cities, nations, and regions, and help to improve the global ocean environment.

FIGURES AND TABLES

Table 1. Sacks provided to fishermen for buy-back programme

Size	40 L	100 L	200 L	Tag	trap
Picture					 (eel trap: 150 won)  (shell and crab trap: 250 won)
Purchasing Price	4,000 won	10,000 won	20,000 won	250 won/kg	150/250 won per each

(a)

(b)

(c)

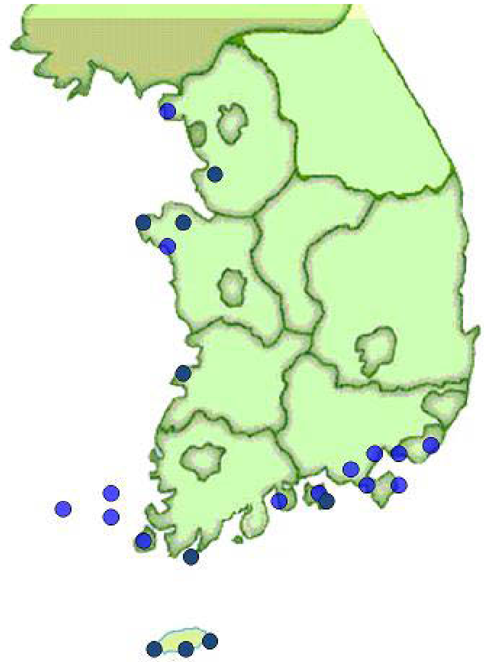


Figure 1. (a) Fixed type, (b) portable type, and (c) location of polystyrene buoy thermal volume reduction system in Korea.

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10.c.6. An integrated coastal zone management plan: a panacea for tackling environmental impacts from land-based sources of marine debris in Nigeria

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ABSTRACT
Drasic changes have been observed along the Nigerian Gulf of Guinea coastline arising from anthropogenic perturbations. The growing coastal population of 300-500,000 residents is bound to double within the next 10 years due to the increasing awareness of the socio-economic benefits to be derived from the natural attributes of beaches as recreation, commerce and tourism sites. This therefore enhances the vulnerability of the beaches to marine debris scourge from off-shore and land based sources. Despite the outcry from relevant environmental regulatory agencies in Nigeria such as the Federal Ministry of Education and Department Resources, there are still undefined pollution from point and non-point land-based sources emanating from principally from domestic and industrial sectors including deforestation of coastal vegetation, inadequate solid waste management facilities and ineffective legislation. An integrated coastal zone management plan has therefore been proposed to tackle transient and stable coastal zone problems by emphasizing community participation as the core environmental tool in the implementation.

10.d.1. Cleaning Kanapou, Kahoʻolawe: the challenges of marine debris removal from a remote Hawaiian Island that was once a military bombing range

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KEYWORDS
Kahoʻolawe, Hawaiʻi, ingestion, turtle, shark, plastics, sharkastics, ordnance, helicopter removal

BACKGROUND
Kahoʻolawe, the smallest of the eight Main Hawaiian Islands (USA), is located ~7 miles southwest of the island of Maui. The rich cultural and natural resources within this island-wide reserve (surrounding the island 2 nautical miles) are managed by the Kahoʻolawe Island Reserve Commission (KIRC), which is holding the island in trust until a native Hawaiian sovereign entity can be established.

Due to its geographic location and prominent current patterns around the island, Kahoʻolawe is a sink for marine debris accumulation. Similarly to other Main Hawaiian Islands' marine debris hot spots, this ʻōpala (rubbish) is both Hawaiian and international in origin. It's a rather shocking aggregation of materials: a snapshot of our throwaway society that disregards the serious impacts of discarding rubbish inappropriately. And since it takes decades for these materials to break down, we're stuck with it for the duration of our lives, and beyond. The often-toxic properties of the wide range of debris that exist are contributing to rising pollution levels in our oceans and coastal lands. Marine debris poses serious entanglement and ingestion hazards for all marine life, from coral polyps to whales, and is responsible for an unknown number of negative impacts/deaths to these creatures.

Kanapou Bay, which spans over eight kilometers (five miles), is located on the eastern side of the island and is especially heavily concentrated with marine debris. Since 2003, this has been the site of KIRC-coordinated large-scale annual cleanups. The shear expense of these cleanups has unfortunately limited their frequencies, making the desired thorough cleanup of the beach unattainable with the constant influx of debris. KIRC is very grateful for receiving a 2010 NOAA Community-based Marine Debris Removal Project Grant. The funded project focuses on the bay's 4.5-acre Keoneuli Beach, which is approximately 800 meters (0.5 miles) long. During the course of this 18 month project, the KIRC plans to remove an estimated 15 tons of debris from this beach and rocky coastline, effectively providing a clean slate for monitoring Kanapou's re-accumulation rate.

The most efficient removal method is by helicopter, although this is very costly so we also bring back bags of sorted recyclables back with us aboard our vessel when conditions warrant. The goal is to reuse and recycle what we can so that we are not simply using valuable resources to remove debris from one island to fill the landfill of another. The nets that are collected off the reef using SCUBA gear and lift bags and the nets that are cut free from rocks on the shoreline are going to be utilized for novel inland erosion control techniques. Non-recyclable plastics are staged for hopeful transfer to O'ahu's H-Power facility to be burned for energy (pending additional funding and partnerships).

METHODOLOGY

The "Complete Cleanup of Kanapou" project will clean the entire length of Keoneuli Beach, removing an estimated 15 tons of debris from the marine environment. The shore-based removal techniques typically used by other islands are hindered by Kaho'olawe's limited access, often rough ocean conditions along that coastline, murky "shark-infested" waters, and especially the presence of unexploded ordnance (Kaho'olawe was used for live-fire military operations from 1941-1990). Due to these explosive hazards, these cleanup events are the only time Kaho'olawe's "If you didn't drop it, don't pick it up!" mantra slackens slightly. These dangerous factors limit what staff and volunteers can do and add to the expense of the project, but with extra safety precautions, these cleanup events proved very educational, rewarding experiences for all who attend.

Specific project tasks include: pre- and post-cleanup aerial surveys of Kaho'olawe's nearshore habitats to assess animal interactions (Fig 3), marine debris accumulation and monitor project effectiveness; pre-cleanup educational orientations for volunteers; at least five cleanups at Kanapou utilizing approximately 150 volunteers; record the quantity and type of marine debris; quantify the sharkastics issue; sort and divert as much as possible from the Maui landfill by recycling or re-using the applicable diverted marine debris in upland Kaho`olawe erosion control efforts; remove the debris by helicopter sling loads and KIRC's landing craft (Fig 1); feature the project in public outreach events, presentations, workshops and conferences; create a permanent educational display; prepare a short video to be used in presentations and as a public service announcement; and highlight the project on KIRC's website and newsletters.

OUTCOMES

This KIRC project began on July 1, 2010 and will be completed by December 31, 2011. Four cleanups have been completed so far, in which ~5 tons of marine debris have been removed from Keoneuli Beach. We've made very noticeable progress so far, but debris remains so more upcoming cleanups are planned. We've found that we've been limited in our efforts due to especially rough afternoon ocean conditions, so we've been camping to gain more cleanup time, which also adds to the experience for our volunteers.

As a part of the International "Get the Drift & Bag It" campaign (9/25/2010), twenty-four adults cleaned approximately ½ an acre of the southernmost end of Kanapou bay. The ~2 tons of (predominantly plastic) rubbish collected were tallied and sorted by type, with the recyclables and other reusable items separated by category (Fig 4). This provides a quality snapshot of what kinds of marine debris accumulates on Kaho'olawe. Due to time constraints, all of the tiny pieces of broken plastics could not be picked up, but all of the larger items were which left a "clean slate". Surprising even to us, upon our return to Kanapou for the next cleanups (11/4/2010 & 12/20/2010), debris had already re-accumulated as if we had never cleaned it (Fig 2). We are leaving this section to be monitored so haven't cleaned there again and rubbish is still piling up there. After focusing on the more northerly sections similarly over a course of three cleanups, rubbish has not washed ashore in those sections nearly as much as it has in the southernmost corner. This provides some insight as to how Kanapou currents and dispersal rates work, although it is unclear at this point whether the accumulations are brand new debris drifting in or just the re-dispersion of more northerly debris washing to the south corner, or both. This will become clearer as we remove more rubbish from the environment.

Certain items of interest that we collected have been saved for educational purposes (namely for the student art projects that are decorating this conference venue). Some plastic items that show evidence of being bitten by marine creatures have been saved for research and educational purposes. We've given them the term "sharkastics", and King is in the process of creating a large collage out of the collected pieces. KIRC has a display at the Maui Ocean Center and we are working on our marine debris video. Also, we have been spreading the word when attending outreach events and by our website: http://kahoolawe.hawaii.gov. Our cleanup efforts have made local newspapers and have been featured on two television news stations so far. Cleaning Kanapou will benefit many marine species, educate and inspire volunteers, and help heal Kaho'olawe.

Please see 5IMDC Poster 52 for more information: What's Eating Kaho'olawe's Marine Debris? "Sharkastics" Are Providing Many Clues, and it's Not Fantastic News…

PRIORITY ACTIONS

Despite simply keeping up with the removal of the debris from the marine environment, this project has the most impact in an educational way: through volunteer experiences, outreach efforts, displays, video, and website, although we may be preaching to the choir and not the rest of the over-consumptive, throwaway society... Since the "Refuse, Reduce, Reuse, Recycle" lifestyle hasn't caught on yet in the majority of the world, major advances in clean green recycling technology need to be made, especially burning rubbish for energy like H-Power currently does.

FIGURES AND TABLES

Fig 1. Kanapou marine debris removal methods.

Fig 2. Kanapou debris re-accumulation.

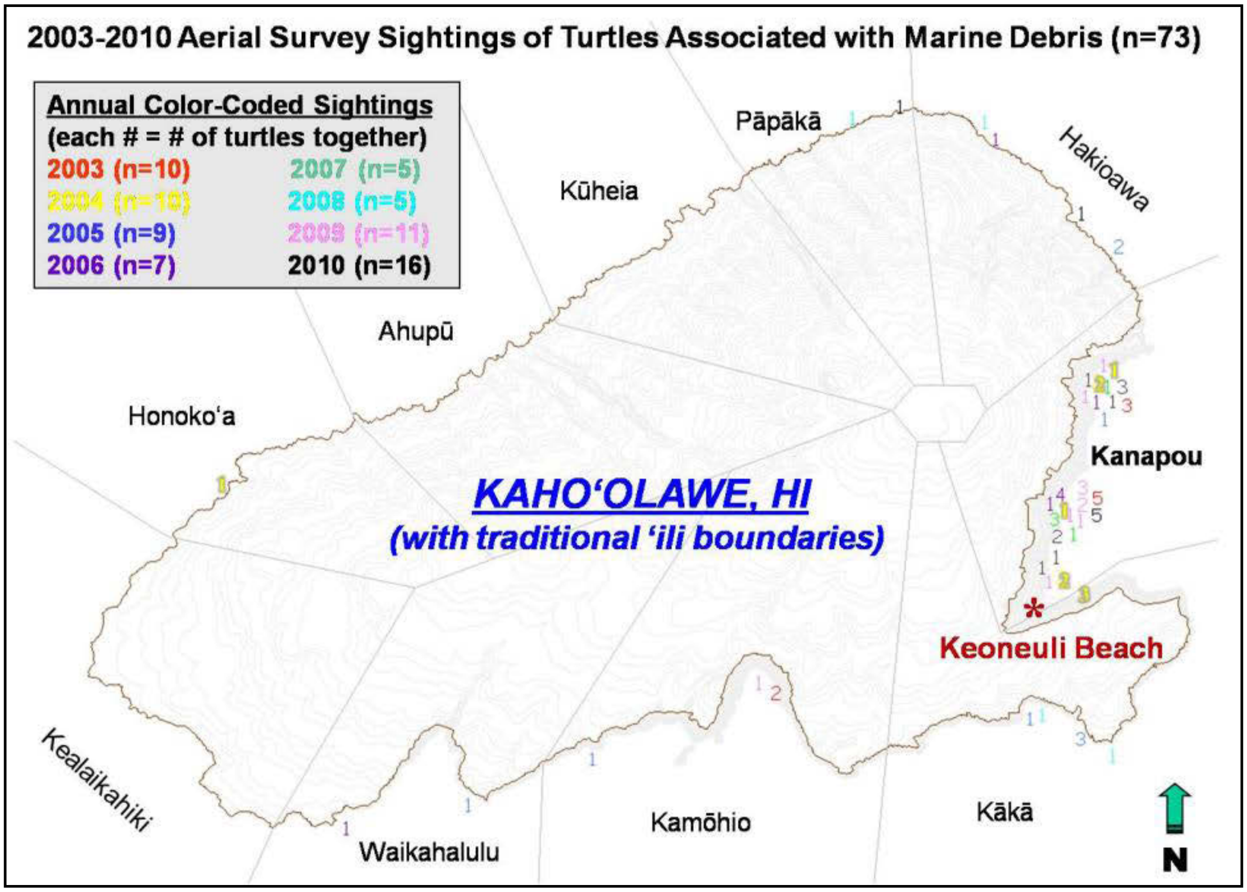

Fig 3. 2003-2010 Aerial survey sightings of turtles associated with marine debris.

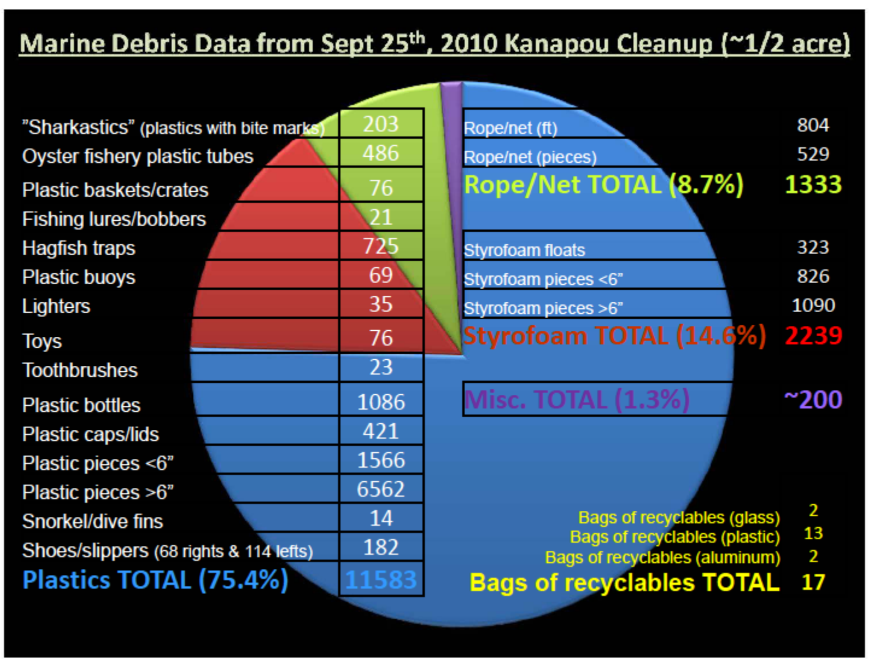

Fig 4. Marine debris data from Sept 25th, 2010 Kanapou cleanup (~1/2 acre).

10.d.2. The challenges of marine debris removal and disposal on St. Paul Island

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KEYWORDS
St. Paul Island, Pribilof Islands, Alaska, Northern Fur Seals, marine debris, debris removal, debris disposal, debris recycling, Phillip A. Zavadil

BACKGROUND
St. Paul Island, Alaska (Figures 1 and 2) is located in the middle of the Bering Sea approximately 800 air miles from Anchorage, Alaska, 300 mile west of mainland Alaska, and 280 miles north of the Aleutian Chain. St. Paul Island is the largest of the Pribilof Islands, a five-island archipelago in the Bering Sea that supports astonishingly high concentrations of marine mammals, seabirds, fish, and invertebrates. This biodiversity and biological productivity results from the proximity of the island to the continental shelf break, particularly the Pribilof and Zemchug Canyons, along with the general ecological complexity of the isolated island habitat. The terrain on St. Paul Island is quite diverse. The island is surrounded by 42 miles of shoreline, including high bedrock cliffs, low bluffs, rock platforms, and gravel, rocky and sandy beaches. Boulder beaches and basalt shelves often are present at the base of cliffs and bluffs.

Unangan (Aleuts) of the Pribilof Islands are working in collaboration with Marine Conservation Alliance Foundation (MCAF), partners in the fishing industry, management agencies and environmental community, to mitigate the damaging effects of marine debris. For 17 years, community members have removed marine debris from the shores of St. Paul Island. Removal and disposal of marine debris on a remote island in the Bering Sea poses many challenges. Along with the island terrain, some of these challenges include working in the sub-arctic environment and inclement marine weather. One of the main challenges is timing the marine debris removal efforts between the retreat of sea ice from shoreline and the arrival of nesting sea birds and northern fur seals. This window of opportunity to remove debris from the shoreline is limited to late April to early June. Additionally, being on a small remote island poses logistical challenges for debris disposal. The municipal landfill does not accept marine debris; therefore all debris collected must be shipped off-island for disposal or recycling. The logistics and challenges of marine debris removal and disposal on a small remote island in the Bering Sea will be explored further in this presentation.

METHODOLOGY
We use a variety of methods to remove marine debris from the different shorelines on St. Paul Island. Sandy beaches provide the easiest access for debris removal. Our crews use ATVs with trailers to load up the debris while on the sandy beach and then haul it to a staging location where the debris is segregated and then placed in three cubic foot super sacks. From there the

sacks of debris are placed on pickup trucks and hauled to another staging location for shipping off island for recycling and disposal. Gravel and rocky beaches (Figure 3) can pose more difficult challenges for removing debris. Some of these beaches are easily accessible with roads a short distance from the beach or by trails that ATVs can maneuver on, however other beaches of this type are only accessible by foot with distances from a trail or road ranging from a quarter mile to over a mile. In these cases debris is hauled by hand to the nearest trail or road access. Shorelines with high bedrock cliffs, low bluffs and rock platforms pose the most difficult logistical challenge for debris removal. Access to these shorelines is gained either by boat or by climbing down small cliffs. Debris is then either placed in inflatable boats and hauled back to the harbor where it is offloaded or placed in nets found on the beach or super sacks and hauled with rope up the smaller cliffs by hand or assisted by winches or other mechanical devices.

Once the marine debris is removed from the shorelines, we face yet another logistical challenge in disposing of or recycling of the debris. Local municipal landfill cannot handle the debris so the only other options are to ship the debris by airfreight to Anchorage or via a marine shipper to Seattle, Washington. Anchorage landfills will not take the debris nor will any recyclers in Anchorage. So the only choice is to ship the debris south to Seattle. With this being the only option, we are unfortunately left with only two shipping companies that service St. Paul Island, Coastal Transportation and Northland Services. Coastal Transportation services St. Paul Island usually every 6 to 8 weeks. Whereas, Northland Services only services St. Paul Island only during the winter months for the short Opilio (snow) crab season or when major construction projects are occurring on island. Advanced planning and timing are critical in the shipping of marine debris. One of the major drawbacks to shipping debris off island is the cost. For example, under a contract with MCAF we paid over $60,000 to ship approximately 104,000 pounds of debris from St. Paul Island to Seattle.

Much of the debris collected from the shores of St. Paul Island is recyclable. In recent years, working in collaboration with MCAF and NOAA's Marine Debris Program, we have been sending marine debris to Skagit River Steel and Recycling in Burlington, Washington. Even the recycling process presents challenges, such as making sure the debris is clean, free of sand, dirt and dissimilar materials.

In summary removal of marine debris on St. Paul Island will remain challenging back braking work that will require innovative planning and on-site flexibility.

OUTCOMES

In spite of the many challenges we face with our marine debris removal program, we have still been able to remove significant amounts of debris each year from our shorelines. The challenge now is to develop innovative and efficient methods that will reduce the huge cost involved in the removal, shipping, recycling and disposal of marine debris from our shores. The best approach, using the data that has been collected debris composition, is to target the source in order to prevent debris from entering our oceans in the first place. For future cleanup efforts we can also try to increase the marketable value of the debris collected by providing a clean high quality product to the recycling community. To accomplish this we will need to clean the debris of any sand or soil, segregate out recyclable items and garbage, and teach the workers removing the debris how to segregate the different types of debris. To reduce the volume of debris being shipped to the lower 48 we can use baling machines that are located on the island. This has the potential to reduce the volume of debris being shipped by nearly 40% or more.

PRIORITY ACTIONS

- Providing sufficient funding for innovative and efficient approaches to removal, shipping, recycling and disposal of marine debris in remote locations.
- Providing economic incentives for the "fishing industry" to reduce the impact of marine debris.
- Create a program for those participating in the "fishing industry" to participate in annual marine debris cleanup programs.

FIGURES AND TABLES

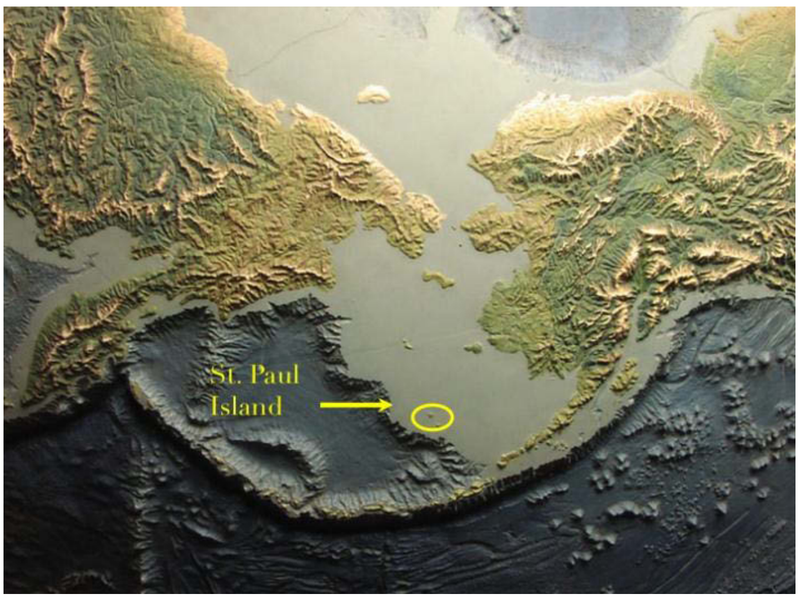

Figure 1 – Location of St. Paul Island in reference to the rest of Alaska.

Figure 2 – Satellite view of St. Paul Island Alaska.

Figure 3 – Photograph of a rocky shoreline on the north shore of St. Paul Island, Alaska.

Figure 4 – Photograph of a crab pot that washed a shore 30 or more feet inland from the mean high tide on St. Paul Island, Alaska

10.d.3. Reducing waste generated at cleanups: ideas from California Coastal Cleanup Day

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KEYWORDS
Plastic reduction, cleanups, debris removal, Coastal Cleanup Day, waste, single-use plastic

BACKGROUND
California Coastal Cleanup Day removes a million pounds of trash from inland and coastal waterways with the help of County Coordinators like San Diego Coastkeeper. But environmental service of this magnitude has a notable environmental impact. Coordinators and captains distribute single-use plastic trash bags and disposable gloves to 80,000 volunteers across the state. In an effort to reduce plastic waste and promote more sustainable daily habits, the California Coastal Commission initiated a "BYO for CCD" campaign as part of Coastal Cleanup Day 2010. Working with local captains and coordinators resulted in tremendous ingenuity and waste reduction across the state. This presentation reviews some of the challenges presented by making a cleanup "zero waste" and highlights some of the creative ideas implemented to successfully run community cleanups without using single-use plastics. While results are never perfect, any reduction in plastic waste is positive. When combined with data collection, reusable and sustainable cleanups will increase education to the public and volunteers about reducing our plastic pollution footprint.

METHODOLOGY
San Diego Coastkeeper worked in conjunction with the California Coastal Commission to record anecdotal information about challenges and outcomes from a) the County Coordinators Conference, when the BYO for CCD program was launched, and b) an online post-event coordinator survey. As a County Co-Coordinator, San Diego Coastkeeper also recorded the response of site captains and volunteers to the "Bring your Own" Campaign in the San Diego region. Methodologies for tracking the level of success of the "BYO for CCD" campaign were incomplete in 2010.

The "BYO for CCD" campaign was primarily implemented through advance communication to volunteers. California County Coordinators and the California Coastal Commission participated in heavy promotion leading up to the September 2010 event. The most common methods of promotion were on event websites, print materials, interviews with the media and press releases, and through registration correspondence and social media.

OUTCOMES

By regularly communicating with other community cleanup organizers and sharing creative ideas, the California Coastal Commission and county coordinators like San Diego Coastkeeper implemented the inaugural BYO for CCD campaign with indubitable success.

Coordinators reported some local challenges to the Bring Your Own idea. In order to be successful, the BYO program must be promoted heavily in many communications with volunteers before the event, rather than on site on the day of the cleanup. In urban areas with large volunteer numbers, reusable supplies – especially those requiring storage - cannot be provided for all participants who forget or were unaware of the BYO idea. There are also added difficulties in keeping accurate track of the weight of debris when buckets are introduced to the picture, causing delays at the weigh in station. Finally, some sites can't accommodate dumpsters and the trash must be transported from the staging area.

Creative solutions and adequate planning with sustainability in mind can significantly reduce the single-use containers used in cleaning up. Major promotion as mentioned earlier was the key to reminding volunteers to go reusable. Trash stations can be set up along trails to dump buckets into. Some captains partner closely with local waste haulers, who donate dumpsters for trash, recycling, and green waste to all sites. Innovative captains found ways to take waste all the way to zero, by incorporating trucks, trailers, large trash cans for buckets and sacks, and reusable work gloves. Supplies can be acquired from donations (i.e. rice, coffee, or peanut bags) and stored for future cleanups.

PRIORITY ACTIONS

- All cleanup organizers should plan appropriately to incorporate "Bring Your Own" techniques in all community cleanups to reduce our plastic footprint and "walk the walk" of sustainability.
- To fully realize the potential of the "Bring Your Own" concept, coordinators must promote the idea to volunteers multiple times and through various communication methods well in advance of every cleanup.
- Tracking success of the Bring Your Own idea is an important metric to supplement general cleanup data, as it educates the public about trash and plastic reduction in our environment.

10.e.1. Characterization of pre-production resin pellets from the Subtropical Convergence Zone of the North Pacific Gyre

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ABSTRACT
Marine debris is a multi-faceted problem that includes interactions with everything from environmental toxins, the world's carbon cycling systems, ocean surface chemistry, fine minerals deposition, and nano-particles. However, research on this significant environmental pollution problem has not been able to keep up with the scope of the issue. On the *S/V Kaisei* cruise in 2009 we covered over 3,000 nautical miles and sampled over 102,000 m^3 of the first 15cm of the water column to investigate marine debris accumulation, distribution, physical characteristics, and ecological consequences of marine debris concentrated in the Subtropical Convergence Zone of the North Pacific Gyre. Using established and novel techniques of Fourier transform infrared spectroscopy (FT-IR), scanning transmission electron microscopy (STEM), environmental scanning electron microscopy (ESEM), and gas chromatography-mass spectrometry (GC-MS), we were able to image and locate material degradation of pre-production, association of microbial biofilms, and accumulation of persistent organic pollutants (POP's) on environmental resin pellets. We then used Spectroscopic Organic Analysis and ArcGIS mapping systems to observe the material degradation and the associated biofilm lattice on the environmental pre-production resin pellets. This data sheds light on possible mechanisms of material weathering of synthetic polymers in deep ocean environments and new methods for identifying POP's association with them. These new techniques are highly transferable to many studies on material biofilm interactions in the environment.

10.e.2. The OceanGybe Expedition – a global perspective on plastic beach debris

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ABSTRACT
The OceanGybe Expedition is a global sustainable sailing expedition to explore the remote coastlines of the world in search of plastic pollution. For the past 4 years we have been documenting beach and oceanic plastic pollution, the effects on the local population and how each country deals differently with plastic marine debris. Our goal is to bring awareness to the vast tracts of plastic beach debris that afflicts every coastline and affects the peoples who depend on their beaches and coasts for survival. We have sailed some 70 000 ocean km, visited almost 40 different countries, crossed the three major oceans of the world and presented our findings and ocean conservation message to thousands of school children globally.

The results from The OceanGybe Expedition beach studies can be presented in either a poster format, detailing the quantities and distribution of plastic and other debris found on beaches all over the world, or as an oral presentation in the Ocean Voyages Session. Using the backdrop of a world-map, with the route and timing of each location, this presentation will provide an interesting and different global angle on the marine debris issue. Possible sources of input into the ocean will be covered and this presentation will visually and geographically describe the movement of plastic debris from continent to continent via the natural processes of wind and currents.

The oral presentation would work well within the framework of the Ocean Voyages session of the conference, as the OceanGybe Expedition sailed through the Southern, Western and Northern portions of the North Pacific High in 2010 and collected manta trawl samples in conjunction with the Algulita Foundation. The Expedition also crossed the Atlantic and Indian Oceans and could provide insight into those ocean voyages.

10.e.3. Lessons learned from ten North Pacific Subtropical Gyre voyages aboard Oceanographic Research Vessel Alguita to detect, quantify and remove plastic debris and ghost nets

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KEYWORDS
North Pacific Gyre, plastic debris, marine debris, plastic pollution, ghost nets, debris detection, debris removal, epipelagic fish, mesopelagic fish, salps, plastic ingestion, vessel impacts

BACKGROUND

The impacts of ghost nets and large masses of lines and debris (52 tons/yr) on the reef habitat of the Northwestern Hawaiian Islands (NWHI), are well known. However, few voyages focused on at-sea detection and removal have been made to the areas of the North Pacific Subtropical Gyre (NPSG) believed to concentrate the debris that contributes to these impacts. Since discovering widely dispersed surface plastic debris within the (NPSG) in 1997, *Oceanographic Research Vessel (ORV) Alguita*, chartered by the Algalita Marine Research Foundation (AMRF), has made at-sea detection, quantification and removal of debris, as well as the study of its impacts on the biota of the region, the major foci of their research, (Moore et al., 2001)(Moore, 2009). Voyages to detect, quantify and remove marine debris were made in 1999, 2000, 2002 (2 voyages), 2005, 2007, 2008, and 2009 (3 voyages). On each voyage, miscellaneous plastics and associated plankton were collected with neuston tows, and logs were kept of the type, dimension and weight of macro plastic debris collected. On some cruises, paired bongo nets were deployed at 10, 30, 50 and 100 meters depth.

METHODOLOGY

Two types of trawling strategies are used for neuston plastics. One strategy uses random trawl lengths, random distance between trawls, and random times of deployment. A second strategy involves repeated tows, one immediately following another while entering and exiting a suspected debris accumulation area. A standard Manta trawl with aperture of 20cm x 100 cm is used for neuston tows. The paired Bongo nets are 1m diameter with choke lines to close the throat in front of the collection bag when retrieving samples at a particular depth. All Manta trawl and Bongo trawls use a 333 micron mesh collection bag, and have a GO flow meter mounted at the opening. Tow speed varies from 1.5 to 3.5 knots, depending on sea state. The collected samples are preserved in formalin, then transferred to Isopropyl alcohol. The samples are then sent to be quantified and archived at the AMRF laboratory in Redondo Beach. Plastic is sorted by rinsing through Tyler sieves of 4.76, 2.80, 1.00, 0.71, 0.50, and 0.35 mm. In 1999, plankton was counted for each neuston trawl and identified to the class level. (see table 2, for station 9)

Necropsies of 619 mesopelagic, and 51 epipelagic fish taken during neuston trawls in the NPSG during February, 2008, were conducted at the Southern California Coastal Water Research Project in Costa Mesa. Macro debris is collected from the deck of the research vessel, which is approximately 4 feet above sea level, using nets and boat hooks. For some macro debris retrieval, an inflatable dingy is used. Heavy ghost nets, barrels, tires and drums are hauled aboard using trawl winches. Macro plastic is weighed, then fouling organisms removed and reweighed to determine net wgt. of the object. (see table 1) To recover ghost nets it is necessary to throw a drogue when they are sighted from deck, so that the boat can be maneuvered back to the area where the net was sighted. It has been observed that larger net aggregations tend to be below the ocean surface when spotted, and are difficult to spot when over 10 meters from the vessel. When possible, it has been found most effective to deploy a diver with snorkel gear to keep the net in sight while the vessel maneuvers back to the area

OUTCOMES

The mass of debris in our neuston trawls from the NPG has increased over the 10 year period of our surveys. Encounters with large debris objects are more frequent. Collisions with debris and entanglement of the research vessel's propellers are more frequent. Quantities of trawled debris decrease by orders of magnitude with depth. Particle size of neuston plastics has increased, with more large plastic objects and fragments >4.76 mm in our trawls. Count of plastic items in neuston trawls is highly variable (Figure 2) and appears to be dependent on sea state.

Ingestion of plastic particles by salps was first documented in 1999 (Moore et al., 2001). Necropsies of 670 neuston trawl caught fish from 2008 found 1375 pieces of plastic debris in the stomachs of 35% of the fish (Boerger et al., 2010).

Windrows, containing high concentrations of debris, caused by mesoscale currents and eddies have been observed to form in areas that were largely free of debris prior to the appearance of the windrow. These 1-5 meter wide lines or windrows of debris have been observed to form over 15 degrees of Latitude from just north of the major Hawaiian Islands to the transition zone around 40 degrees North Latitude. Though extremely patchy, ten years of trawling has produced enough data to tentatively model the abundance using a geo-spatial reference system. (Figure 1)

PRIORITY ACTIONS

Increased interest in at sea removal of large aggregations of marine debris has developed, due in part to the great effort that must be expended in the removal of large nets, lines and other trash from the NWHI. Additionally, groups and individuals are brainstorming ways to remove fragmented plastics from the NPG. No Manta or Bongo trawls from the NPG by AMRF have been plastic free. Near the center of the so called Eastern Garbage Patch,(EGP) AMRF found 5 kilos of plastic floating on the surface in each square kilometer in 1999.(Moore et al., 2001) A trash to energy plant typically burns one ton of waste to produce 550 kwh -- enough energy to run a typical office building for one day. We have evidence from trawls in 2008 and 2009 that EGP neuston plastics are double the amount we found in 1999. That means 10 kilos of skimmed debris per square kilometer, one of which might take several days to trawl. Trawling 100 square kilometers over several months would produce a single ton of fragmented plastic material to power an office building for a day. This could be augmented by large ghost nets and floats, perhaps an average of one large item per square kilometer in the patches. In a week's time

onboard *Alguita*, we are able to dip net or haul out about 500 kilos of plastic. In this scenario, skimming and netting for two weeks could produce a day's worth of fuel for a typical office building. This exercise does nothing to prevent plastic debris from reaching the ocean.
Until the manufacturers of the plastic products that are making their way to the ocean take responsibility for their fate, it will be impossible to contain plastic debris on land. Extended Producer Responsibility (EPR) has been embraced in Europe with initiatives like the green dot program, and plastic industry representatives are engaged in plastic debris research and remediation. Similar initiatives may well be necessary on a global scale to eventually prevent plastic waste from reaching the ocean environment.

FIGURES AND TABLES

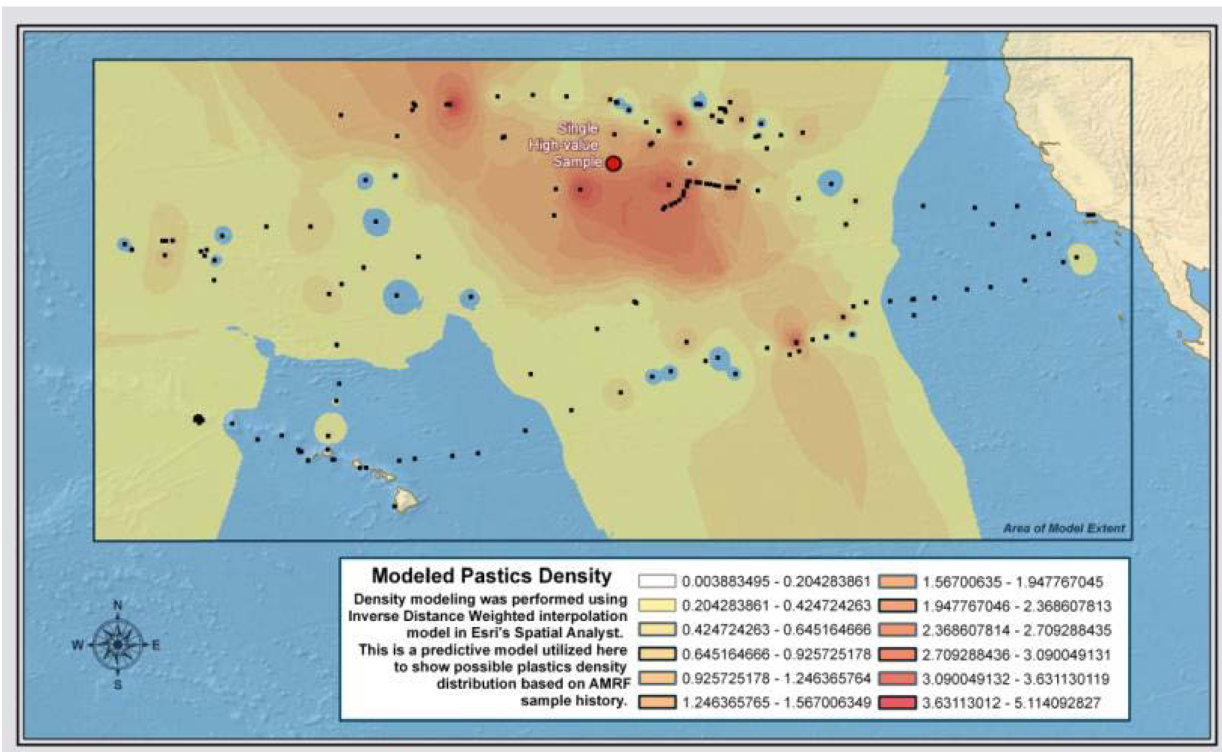

Figure 1. Plastic Abundance/Count Density Model 1999-2009 -- ESRI/AMRF

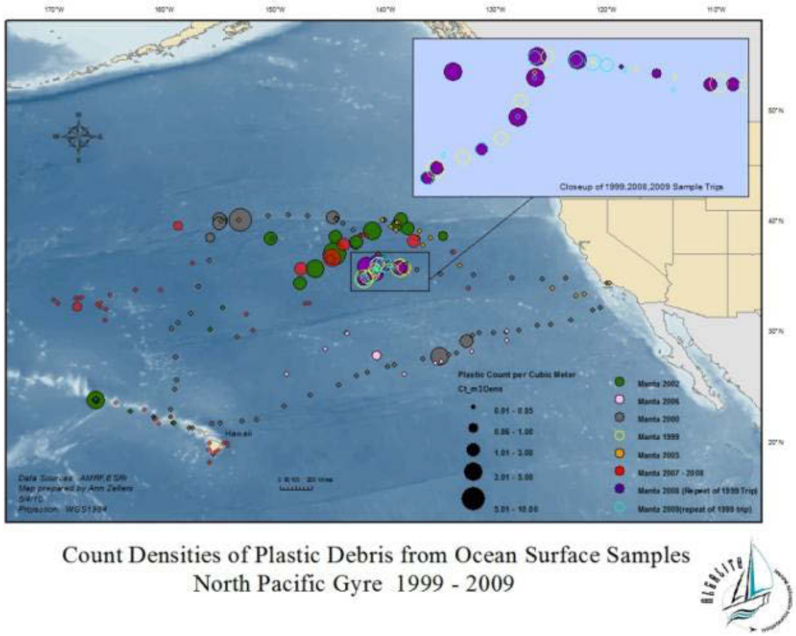

Figure 2. Alternate Plastic Abundance/Count Density Model 1999-2009 ESRI/AMRF

Table 1. Macro Debris by Type, 1999

	A	B	C	D	E	F	G	H	I
1	SORTING SHEET FOR MACRO DEBRIS			BY TYPE					
2									
3	Days of Survey -- 4		Total Distance Surveyed -- 159 km			Start Date 8-23		Finish Date 8-26-99	
4			Width Surveyed -- 2000 m (2.0 km)			Start Time 0820		Finish Time (Daylig	
5	Item Num								
6	Size/Measure	Weight of	Styrofoam/	Bottle	Polypro/Monofil	Fishing	Float	Misc	Origin
7		Fouling Org	Foamed Pl.		Line Fragment	Related	Plastic	Unid	(Country)
8									
9	F 5 700dx175	27467						Tire	
10	F 6	8853	1	Rolled up zori factory foam sheet after soles cutout as fishing float					
11	F 6				1	Rope to hold roll above			
12	F 7 90x60x20	50	1		"Litac Float Sanshin Kako Ltd."				
13	F 8 270diam	9360					1		
14	F 9 300diam	"Dairyland Sour Cream 4 liters" (In French and English)						Lid	Canada
15	F 10 270diam	19180	"Litac Float Sanshin Kako Ltd."				1		Japan
16	F 11 60x175					1	Curved Fragment		
17	F 12 110x85x25					Bait Cont			
18	F 13 180dx300			1	Entire bleach type bottle very brittle, broke easily				
19	F 14	6356						Volleyball	USA
20	F15 380dx510	22756	1 Float						
21	F 16 45x40x20		1						
22	F 17 250diam						1		Japan
23	F 17	no growth - hole in bottom			1	"55" only marking			
24	F18 460dx365h	27467	1Float						
25	F 19 370diam	7378	"Litac Float Sanshin Kako Ltd."				1		Japan
26	F 19 20dx1190L				1				
27	F 20-300diam	9080	"The Second Pu Tuo Plastic Factory"				1		Taiwan
28	F 21 320diam	24062					1		
29	F 21 12dx2900L				1				
30	F 22				1Ton Mass (estimated - not retrieved)				
31	F 23-300diam	7718					1		
32	F 23				1				
33	F 24-370diam	62198	"Hansung"				1		Taiwan
34	F 24 12dx1000L				1				
35	F 25-137diam		"KU 45"			Bait Cont			
36	F 26 267x 102							Shoe Sole	
37	F 27-300mm	1446					1		Taiwan
38	F 28 483x432	10	1						
39	F 29	370						Drum	Germany
40	400dx600 mm	Chemical Drum with liquid inside later found to be seawater by CRG Labs (drum discarded by lab)							
41	F 30 70dx260	227		Glass					
42	F 31 300x190	56		Plastic	"CAN"				Canada
43	F 31 4dx180L				1				
44	F 32				1Tangled Mass				
45	F 33 400diam	11464	"MAX - 13"	Doran(translated from Japanese)			1		Japan
46									
47									
48									
49	Totals	245498	8290.85	701	911121.8	93.1	22339	25530	

Table 2. Sorting Sheet for Plankton 1999

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	SORTING SHEET FOR NEUSTON PLANKTON BY ***ORGANISM TYPE***													
2									Date sheet finalized: 1-14-00					
3	Station Number	9	(one station per sheet)			Total Organisms 55020			Total Wet Wt. 151.65		Total Dry Wt. 21.7794			
4	If part of sample split in half indicate what part and how many splits -- 5 after large organisms removed -- Total = 32x + # removed													
5														
6	Gastropods	Fish	Siphon-	*Halobaites*	Crabs	Cavolinia	Crusta-	Fish	Chaetog-	Poly-	Squids	Lg. Orgs.	Unid./	Barnacles
7			ophores				ceans	eggs	natha	chaetes		Misc.	Misc.	
8														
9	After Split													
10	173						1536			1			1 jar	
11	32 x split													
12	5536			64			49152			32				
13														
14														
15														
16														
17														
18														
19														
20	Before Split			102	49	6	13			27	1			38
21														
22														
23														
24														
25	Note: Some samples saved for further analysis. These were given dry wts of .1044 x wet wt													
26														
27														
28														
29														
30	TOTALS													
31	5536			166	49	6	49165			59	1			38
32													Tl Orgs	55020
33													Tl wet	151.65
34													Tl dry	21.7794
35	Blotted Wt	5.76		0.56	35.02	1.23	0.36			1.58		0.01	85.77	21.36

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10.e.4. Ocean Voyages Institute/Project Kaisei – studying and monitoring of ocean trash in the North Pacific Gyre – A three year overview

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KEYWORDS
Project Kaisei, Ocean Voyages Institute, SV Kaisei, North Pacific Subtropical Convergence Zone, North Pacific Gyre, Plastic Proliferation, marine debris study, marine debris clean-up, sightings of plastic, log of marine debris sightings, log of SV Kaisei 2009, Log of SV Kaisei 2010, Log of the New Horizon 2009, Seaplex.

BACKGROUND
In 2008 Ocean Voyages Institute/Project Kaisei decided to actively find solutions to the escalating global issue of marine debris. We developed a three-fold strategy: 1) To conduct research expeditions to assess the problem from a scientific, quantitative and practical perspective. 2) To use these expeditions as a way to publicize the growing problem to youth, the general public, corporations and governments and through this aid in stopping the flow of debris intro our global ocean. 3) To develop a multi-disciplinary team to design and create marine debris collection equipment.

It is widely agreed that plastic proliferation in the global ocean is a menace to the health of the ocean ecosystem, fish, marine mammals, most ocean creatures and ourselves. Innovative solutions to this global issue are urgently needed.

METHODOLOGY
Summer 2009, Ocean Voyages Institute/Project Kaisei collaborated with Scripps Institute of Oceanography and Dr Margy Gassel of the California EPA Department of Toxic Substances, by funding the 7 days of their Seaplex mission on the RV New Horizon (with scientist Miriam Goldstein) and on the SV Kaisei (with Co-principal Investigators Dr Andrea Neal and Dr Michael Gonsior).

The studies conducted and subsequent papers published by Scripps and their Seaplex Mission and the Project Kaisei science team, document a variety of scientific studies in 2009. Logs of observations, sightings and film coverage also recorded the dramatic reality of the proliferation of debris mid-ocean.

In 2010 Ocean Voyages Institute/Project Kaisei did a second voyage to the North Pacific Subtropical Convergence Zone where we partnered with Ocean Conservancy by having marine scientist Nick Mallos on board. Nick and the Project Kaisei team began Ocean Conservancy's 25th International Coastal Cleanup mid-ocean with Project Kaisei. Clearly we need to clean up beaches and shorelines, clean up the ocean gyres of accumulated debris and stop the flow of materials into the global ocean. During the 2010 expedition, we catalogued debris sightings and kept photographic records.

By having more days on station and going at slower speeds, i.e. 2-3 knots, much more accurate sightings of plastic debris can be observed. A speed of five knots or higher drastically reduces accuracy of sightings. 10 knots or higher, it is impossible to site debris except for large ghost nets.

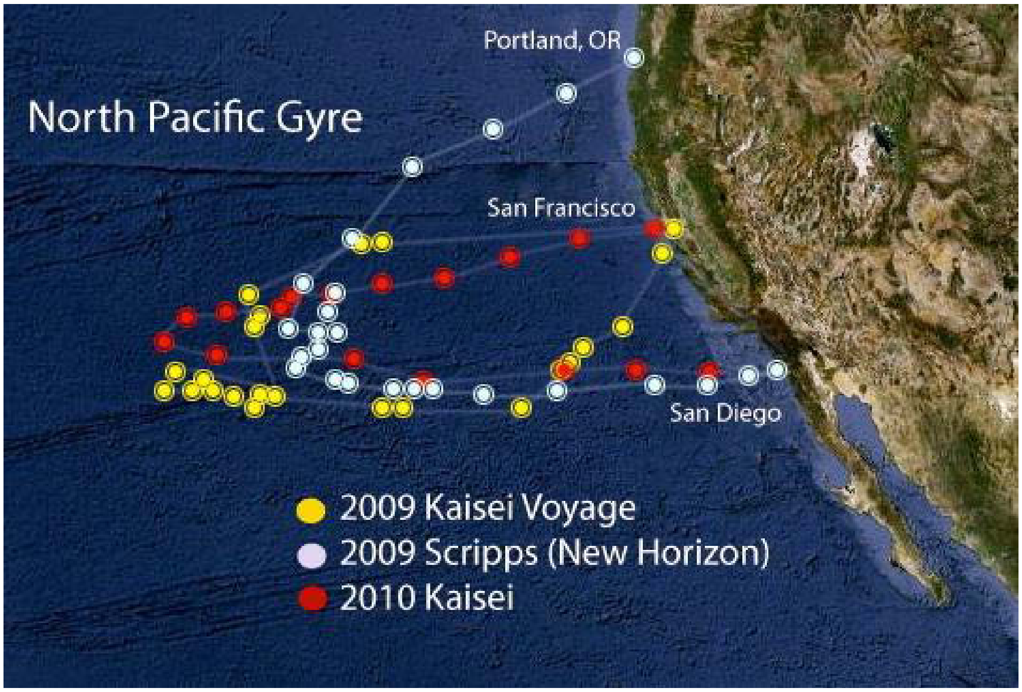
OUTCOMES
From our 2009 voyages Dr Andrea Neal and various members of the Project Kaisei science team have done numerous presentations to universities, high schools and elementary schools. Miriam Goldstein and the Scripps team have done a wide range of presentations as well. Mary Crowley, the expedition leader for 2009 and 2010 has done radio and TV interviews in 12 countries and been a featured speaker for health and ocean conservation groups as well as colleges and universities. An hour long documentary film has been produced and will premiere shortly. The scientific samples are still being analyzed by the California EPA, Scripps and Dr Neal.

Our 2010 expedition began the Ocean Conservancy's 25th International Coastal Cleanup and will have a report on "*Dan Rather Reports*" shortly. The careful log of debris sightings is particularly interesting when compared to 2009 sightings. The information provided by Jan Hafner and Nikolai Maximenko by their SCUD model helped us find debris accumulation.

PRIORITY ACTIONS
Coordinate global survey of marine debris from oceanographic research ships, NOAA, charter yachts, round the world voyagers, maritime industry. In 2011, have SV Kaisei be used to find area of greatest accumulation so that tug and barge (equipped with marine debris collection devices) and fishing vessels with adapted gear can do clean-up operations.

International PR campaign through Cohn & Wolfe to further educate and publicize issue.

FIGURES AND TABLES



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11.a.1. The power of partnerships

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ABSTRACT
What we've learned so far is that litter and marine debris have no simple solutions. So, when it comes to combating litter, we all have a role to play.

At Coca-Cola we believe our role begins with the packages we produce. All of our packages are designed for recycling. We choose packaging materials, including caps and labels that can be recycled. We even select the colors of our packages to enable recycling. Our responsibility extends beyond the packages we produce. We also actively support community recycling initiatives around the globe.

Our packaging vision is zero waste. We use the least amount of natural resources required in the design of our packages to protect and transport our beverages safely to consumers. The majority of our packages are 100 percent recyclable, and we are advancing consumer recycling programs that support the collection and recovery of beverage packaging materials. Coca-Cola was the first company to introduce a beverage bottle made with recycled plastic (1991). Since then, we have led the industry in our global use of recycled content PET and direct investments in PET plastic bottle-to-bottle recycling facilities. Coca-Cola is the first company to introduce a recyclable PET plastic bottle that is made partially from plants. Our PlantBottle packaging is being piloted today in a number of global markets and is an important first step toward our longer term goal to produce a recyclable plastic bottle made entirely from renewable resources.

We believe that eliminating litter requires action from business, government and society. We're working today with government organizations and leading NGO partners on research, education and policy. And we're working to be a leading voice in the consumer products industry through messaging to our consumers and active participation in industry and scientific coalitions.

11.a.2. Private sector efforts to create effective, collaborative partnerships to reduce litter

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KEYWORDS
Ashley Carlson, American Chemistry Council, ACC, recycling, plastics

BACKGROUND
Over the years numerous programs and approaches have been developed by government agencies, industry groups and NGOs to increase public awareness regarding marine debris, and to establish litter abatement and other programs to change behaviors that ultimately lead to marine debris impacting coastal areas and the ocean.

As producers of materials that have found their way into the marine environment, plastic makers are actively involved in marine debris and litter prevention programs and are working with governments, scientists, retailers, anti-litter groups and consumers to devise solutions to help prevent marine debris.

This presentation will highlight examples of several successful programs, including a partnership which has installed nearly 700 recycling bins and educational signage in 19 communities along the California coast; an industry stewardship program to help prevent the release of resin pellets into the environment; and efforts by plastic makers from around the world to address marine debris. The presentation will also explore recent collaborative research projects to enhance scientific understanding of microscopic debris in samples collected in the Pacific Ocean. Together, plastics makers and recyclers have spent more than $2 billion over the years to help develop technologies, build infrastructure and educate consumers in communities across the nation to recycle more plastics. Plastic makers encourage the public to Reduce, Reuse and Recycle all materials.

OUTCOMES
The American Chemistry Council's experience with pilot projects and partnerships demonstrates that by working together, positive, impactful advancements can be made in litter prevention by increasing recycling opportunities and expanding public outreach.

PRIORITY ACTIONS
Cooperation among government, non-government organizations, and industry stakeholders on programs aimed at reducing litter and increasing plastic recycling and recovery.
Recognizing that littering of any materials are detrimental to the environment, enhance programs to prevent litter.

11.a.3. Marine debris solutions through public private partnerships: industry, government & NGO partners collaboratively provide recycling opportunities in public spaces

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KEYWORDS
Keep California Beautiful, California State Parks, Caltrans, American Chemistry Council, Public Private Partnership, Litter Abatement, Marine Debris, Recycling, Transit Corridors, Schools

BACKGROUND

Numerous policies and programs have been developed over the years by government agencies, industry partners and NGOs to increase public awareness, establish marine debris and litter abatement programs and develop strategies that can help to change behaviors that ultimately lead to marine debris impacting coastal areas and the ocean. By creating public-private partnerships we can reduce, prevent and manage marine debris.

METHODOLOGY

In order to provide more away-from-home-recycling, Keep California Beautiful (KCB) is actively involved in marine debris and litter prevention programs through public private partnerships. A noteworthy public private partnership KCB is a part of is the "Plastics. Too Valuable to Waste. Recycle.™" campaign. This partnership effort involving KCB, California State Parks (CSP), the American Chemistry Council (ACC) and Caltrans has placed nearly 700 away-from-home recycle bins at more than 30 locations in the San Diego, Los Angeles, San Luis Obispo, Monterey, San Francisco and Santa Cruz areas. Additionally, this program launched three youth-based education and recycling programs: "Recycle.Goal," "Go H20!" and a youth outreach program with CSP focusing on the importance of recycling and how that diverts recyclables out of the waste stream and our oceans.

KCB has also developed new partnerships in 2010, including working with Creative Outdoor Advertising (COA) to promote and provide public space recycling along transit corridors and in public spaces for local governments that provides a revenue stream and no cost for the program. Additionally, working with various government, NGO and industry partners; KCB has also piloted the California K-12 Schools Recycling Challenge. The friendly competition is a benchmarking tool for school recycling programs to promote waste reduction activities to students, families, faculty and staff. KCB acts as the State Leader for the Keep America Beautiful Local Affiliate Program and works with its partners to mobilize thousands of volunteers who participate in recycling, cleanup and beautification events state-wide. Year round, KCB provides trash and recycling bags, seeds, hand sanitizer, gloves and donated incentives to volunteers. KCB effectively works for both industry and government agencies to implement some of the most successful public programs addressing litter prevention.

OUTCOMES
In 2010 the “Recycle. Goal.” competition was a huge success. More than 400 players spanning four clubs and 21 teams across Southern California collected and recycled 3156.91 pounds of recyclable items. We had another successful partnership with LA’s BEST called “Go H2O”. Throughout the school year, this program was integrated into 180 LA’s BEST school sites, reaching thousands of children throughout the city of Los Angeles with messages and information about the importance of recycling and developing healthy habits. The program included a turnkey recycling education program for LA’s BEST staff to use. The CSP youth education program reached 25 communities, educated 12,342 children, conducted 58 beach cleanups and collected 5,964 pounds of trash.

In 2009, the public-private partnership between KCB, Caltrans and ACC led to the placement of nine recycle bins and educational signage at the H. Dana Bowers Rest Area, north of the Golden Gate Bridge. In 2010, the partnership expanded to include the Gaviota and Camp Roberts rest stops along the central coast. On top of these successes the partnership, along with the help of Adopt-A-Beach, collected 300,680.16 lbs (or 150 tons) of recyclables in 2010.

In 2010 COA began the contracting process with several communities to include recycling bins as part of their streetscaping infrastructure. During the first California K-12 Recycling Challenge thirty-four individual schools completed the competition, as well as 3 districts representing another 13 schools. Collectively these schools included over 45,500 students and 2,100 teachers. The participating individual schools ranged in size from 56 to over 3,500 students while the district level competitors each brought over 3,000 students to the competition on a weekly basis. In total, over 74 tons of materials including 4,317 lbs of CRV beverage containers and 68,628.9 lbs mixed recyclables were recycled during the competition.

PRIORITY ACTIONS
Actions that we need to take to reduce marine debris include: expand the public private partnerships that are part of the “Too. Valuable to Waste. Recycle.” Program; continue outreach for the “Got Your Bags” program; expand participation in California K-12 Recycling Challenge, increase inclusion of recycling and trash receptacles in transit streetscaping contracts by local governments; and develop waste management partnerships to provide more away-from-home recycling.

FIGURES AND TABLES

In 2010, the public private partnership collected 150 tons of recyclables.

KCB, Caltrans and ACC are participants in a recycling partnership at Caltrans highway rest stops, giving drivers on California's roads and highways more access to "away-from-home" recycling opportunities, to help keep plastics and other products out of the waste stream and in recycling bins.

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11.a.4. Marine litter: *PlasticsEurope's* proposed way forward

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KEYWORDS
Jan-Erik-Johansson, Roberto Gomez, PlasticsEurope, Europe, recycling, plastics, industry

BACKGROUND
PlasticsEurope is the official voice of the European plastics manufacturers with representation in all 27 European Union member states. Working in close collaboration with over 50,000 converters and over 1,000 machinery manufacturers, *PlasticsEurope* takes on cross-cutting, international issues impacting plastic manufacturing. Improper waste management of plastics and its impact on the marine environment is a top priority for the industry. Huge investments are being made to help improve end-of-life waste management throughout Europe and in this presentation *PlasticsEurope* will address the needed collaboration between countries and companies in order to drive innovative solutions.

This presentation will speak to *PlasticsEurope's* collaborative relationships with other trade associations globally, and their effort to bring together the European plastics industry, which is comprised of representatives from *PlasticsEurope*, the European Association of Plastics Manufacturers, and the European Plastics Converters.

PlasticsEurope will explain how it is expanding its activities to collaborate non-industry stakeholders that can be part of the solution of marine debris (sponsoring research, educational litter prevention programs, Operational Clean Sweep in Europe, etc).

OUTCOMES
Industry can play an important role and contribute significant technical expertise to tackling the problem and shaping a solution. The industry is unanimous in its view that marine littering is completely unacceptable and that it must work with other groups in society to find solutions to prevent litter from entering the marine environment, not only in Europe but worldwide.

PRIORITY ACTIONS
Look for a worldwide plastics industry approach and commitment. Search alliances with other key players (researchers, authorities, educational institutions, value chain) to prevent marine debris.

11.b.1. In-water surveys and removal of marine debris following a tsunami in American Samoa

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KEYWORDS
Marine Debris, American Samoa, Tsunami, Removal

BACKGROUND
On September 29, 2009 at 7:04 am Samoa standard time, the National Oceanic and Atmospheric Administration (NOAA) Pacific Tsunami Warning Center issued a tsunami watch and warning for all of American Samoa as a result of an 8.1 magnitude earthquake centered 197 miles southwest of Pago Pago. Moments later, a tsunami struck Tutuila, the largest and most populated island of American Samoa, resulting in extensive flooding, infrastructure damage and 32 fatalities.

In response to this major disaster, the Federal Emergency Management Agency (FEMA) quickly provided emergency assistance with food, power, medical assistance, infrastructure damage, hazardous material removal and debris removal on land. However, they were unable to take action on non-hazardous tsunami-generated marine debris. With concern over tsunami-related damage to coral reefs, Governor Togiola Tulafono requested assistance with marine debris removal and long term recovery efforts. Given NOAA's expertise in this specific field, a team of National Marine Fisheries Service (NMFS) and National Ocean Service (NOS) personnel traveled to American Samoa on November 29, 2009 to achieve three main objectives:

1) Conduct a strategic assessment of tsunami-generated marine debris in nearshore, high-priority areas.
2) When appropriate, perform emergency restoration (righting) of corals toppled by the tsunami that are still alive and viable, at marine debris survey sites.
3) Conduct marine debris removal as time, conditions, and debris size permit.

METHODOLOGY
Through meetings with Governor Tulafono and territorial agencies, nine primary marine debris survey sites around the main island of Tutuila were determined. Following planning and logistic meetings, operations started on December 6, 2009 in which seven of nine primary sites were surveyed using both SCUBA and free-diving tow boarding techniques. By December 12, 2009 visual surveys were complete in areas that were accessible and feasible for diving. Following surveys, divers determined that overturned corals were unlikely to benefit from righting because in the ten weeks since the tsunami, the polyps on the overturned surfaces had died. From this point on, removal of debris was determined to be the most important action for promoting coral

recovery and preventing future damage, which remained the focus of operations through December 16, 2009. All operations were suspended on December 17, 2009.

The SCUBA tow boarding methodology required two divers to be towed from a 60 meter line behind the operating vessel at approximately 1-2 knots. For the purpose of this operation, divers were asked to look for debris within the 10-20 meter depth range. SCUBA tow boarders use a standard telegraph system that allows divers to communicate with the personnel aboard the operating vessel using various tone sequences, similar to Morse code. When debris is located divers send a signal to the personnel aboard, who then take a GPS location for future removal efforts. No debris was removed during each 50-minute SCUBA tow dive. SCUBA surveys were done primarily for locating debris within the specific depth range and assessing coral damage within primary sites.

The other method used is referred to as free-diving tow boarding, which is similar to SCUBA tow boarding, but divers are required to use breath-holding techniques. Divers are towed from a 25 meter line at 1-2 knots at depths ranging from the surface to approximately 10 meters. Divers use hand signals to notify personnel onboard of debris or other important communications. GPS points were taken where debris was present and when possible, debris was then removed. Free-diving operations were utilized primarily for debris removal and less for damage assessment. All debris that was removed was brought to the surface manually by hand or by a tethered line, which was tied to debris by a free-diver. During both SCUBA and free-diving surveys, various data was collected such as depth, debris type and size and whether any removal action is required.

OUTCOMES

After 19 days of operations, NOAA's efforts resulted in 56 km or 32% of Tutuila's coastline surveyed and approximately 4,014 kg of debris removed. Majority of debris was concentrated in areas with high inundation or spur and groove benthic habitats on the reef slope. Numerous types of debris were removed including an astonishing 1,973 kg of tires and 907 kg of roofing material and housing goods. Although low in weight, the 158 kg of fabrics poses a threat to corals due to its large surface area and tendency to entangle reef structures.

The success of this operation could not have been accomplished without support from NOAA Marine Debris Program, Coral Reef Conservation Program, Pacific Islands Fisheries Science Center Coral Reef Ecosystem Division, and the Office of National Marine Sanctuaries. With imperative collaboration of American Samoa territorial agencies and Governor Tulafono, the NOAA team has identified potential actions to build on the assessment and removal work and to assist the territory with long-term recovery.

PRIORITY ACTIONS

Although the NOAA team removed large amounts of debris, more remains in several of the surveyed areas around Tutuila including all reef flats, which were not surveyed by the NOAA team. It is imperative to remove this debris as it will continue to pose a threat to corals especially during storms or other extreme wave events that may remobilize debris and cause further damage to coral reefs.

It is also imperative to help facilitate and increase community resilience within American Samoa. This could be accomplished through the cooperation between federal and territorial agencies and villages by increasing the preparedness and resilience planning of each group. This support for preparedness at all levels will help mitigate and reduce the recovery time of future events, as well as improve coral reef conditions.

Lastly, it is important to produce and promote education and outreach materials to the people of American Samoa. This is a great opportunity to develop outreach materials for earthquake and tsunami awareness, evacuation planning, coastal land use planning, marine debris threats and recovery and coral reef monitoring and restoration. Education and outreach can be utilized as an essential tool to increase community resilience and help protect life, property and natural resources in the face of future events.

11.b.2. Volunteer scuba divers and underwater marine debris removal, assessment, and data collection: challenges and opportunities

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ABSTRACT
Identifying and overcoming the challenges of volunteer driven, human-powered marine debris removal, while continuously seizing unique opportunities for direct engagement, behavior change, and story-telling are key to success of underwater marine debris removal, assessment, and data collection efforts. Project AWARE Foundation has been engaging scuba divers in underwater marine debris removal and data collection efforts for over a decade. These activities are at the core of Project AWARE's programmatic focus and are a basis of a long term partnership with the Ocean Conservancy in combating marine debris. In this presentation, we'll analyze how involving thousands of scuba divers both, professional and recreational, who volunteer their skills and time to organize and participate in these activities poses some unique challenges but also offers unprecedented opportunities. Among the challenges, meaningful and timely financial, logistical, and material support to citizen scientists in over 100 countries around the world remains the top priority. Among opportunities, hundreds of unique, underwater perspectives to counter the out-of-sight-out-of-mind nature of marine debris can add to a full blown image of underwater marine debris leading directly to changes in waste management practices. The rising tide of marine debris can be diverted, in part, by the thousands of informed volunteers who participate as citizen scientists in human-powered, underwater debris removal efforts, collect and report data, change how they deal with waste and encourage others to do the same at all levels of social engagement.

11.b.3. Dive methodologies used in California to recover lost fishing gear

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KEYWORDS
Fishing gear, entanglement, impact, diver, fishermen, recovery, methods, California.

BACKGROUND
Lost fishing gear is defined as discarded or abandoned fishing nets, lines, pots, and other commercial and recreational fishing gear that sits on the seafloor, gets caught on rocky reefs or underwater structures, or floats in the water column. While deliberate disposal of fishing gear in marine waters in California is unlawful, unfortunately in the normal course of both commercial and recreational fishing operations, it is not uncommon for gear to become accidentally lost. The majority of this gear does not decompose in seawater and can remain in the marine environment for years.

Lost gear impacts our marine environment in several ways: it can continue to "catch" marine animals, including commercially valuable species, which become enmeshed or trapped; it can damage the habitat upon which it becomes entangled or upon which it rests; it can pose an underwater hazard for boaters, fouling boat propellers and anchors; and it can similarly endanger humans, especially divers. Lost fishing gear can not only contain the carcasses of marine animals, but can also affect the quality of underwater habitat via scouring action and by modification of surface contours. Lost gear is also a visual blight, diminishing the natural aesthetic quality of the seafloor and rocky reef habitat for underwater enthusiasts.

To alleviate the problem of derelict fishing gear in California, the California Lost Fishing Gear Recovery Project (www.lostfishinggear.org) of the UC Davis Wildlife Health Center's SeaDoc Society has been conducting derelict fishing gear location and removal since June 2005. Gear recovery has been conducted by commercial fishermen (sea urchin harvesters and crab fishermen) and by volunteer scientific divers. The project has removed more than 45 tons of derelict fishing gear and other marine debris from Southern California coastal waters, including hundreds of nets and traps, over 1 million feet of monofilament fishing line, and even hundreds of automobile tires and toilets from a proposed marine protected area. The aim of this program is to remove fishing gear that presents a hazard to people and to wildlife and/or that damages underwater habitat, and to do so in a safe and environmentally sensitive manner.

METHODOLOGY
Challenges unique to conducting lost fishing gear recovery in California, including high relief benthic topography covered with fragile biota, dense kelp forests, and high boat traffic, have led

the California Lost Fishing Gear Recovery Project (www.lostfishinggear.org) to develop and implement several novel search and removal strategies. Contract divers are uniformly commercial urchin harvesters who have thousands of hours of underwater work experience and local knowledge. These divers are contracted to conduct both searches for, and removal of, derelict fishing gear. Because they are engaged in diverse fisheries year-round, they are very efficient and successful in locating and recovering target gear. All dive operations occur in less than 100ft of water. Divers use underwater battery-propelled scooters to navigate kelp forests and rocky high relief habitat to search for traps and fishing nets quickly and efficiently. Standard SCUBA technologies (including NITROX) are used while surveying these areas. Derelict trap removal is conducted while surveying for lost gear using SCUBA; derelict net removal is conducted on hookah equipment (plus a back-up secondary air source) in order to minimize the risk of entanglement, provide a continuous air source for the diver, and for inflating floats to help lift the nets to the surface. While removing nets in high-visibility situations, divers use the buddy system (constant visual contact), and for both trap and net recovery, safety divers are always on standby to ensure safe dive operations and effective communication. Divers are trained in first aid, CPR, and oxygen administration, and this safety equipment is available on each vessel platform. These methodologies have proven to be safe, effective, and efficient and could be used as a model in areas outside of California that are posed with similar challenges.

OUTCOMES

These "novel" search and recovery methods have proven beneficial for several reasons. First, working intimately with fishermen has resulted in building trust within the fishing community, which in turn has led to several reports of lost fishing gear that we have been able to respond to with field recovery efforts. In addition, by involving fishermen directly in lost fishing gear reporting and recovery, the fishermen become part of the solution to the problem and they help generate ideas for future collaboration and more "sustainable" methods of addressing lost fishing gear in California. Secondly, the low-profile methods used by urchin divers in California have minimized risk of entanglement in the target gear, in kelp forests, and in boat propellers resulting in safer working conditions. Thirdly, these methods allow the divers to maneuver easily in high relief rocky habitat and cause minimal to no benthic disturbance to fragile biota that inhabit these prolific ecosystems.

PRIORITY ACTIONS

- Promote safe and effective methodologies for diver-based derelict fishing gear removal.
- Strive for diver-based methodologies that are adaptable to the variability in ocean and habitat conditions encountered.

11.b.4. Derelict fishing gear removal in the Papahānaumokuākea Marine National Monument

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ABSTRACT
Derelict fishing gear (DFG) has proven to be a threat to the endangered Hawaiian monk seal, green sea turtles, various bird species, and coral reefs in the Northwestern Hawaiian Islands (NWHI). DFG causes deleterious ecological effects and is a potential conduit for the introduction of invasive species. Since 1996, NOAA's Pacific Islands Fisheries Science Center and its multiagency partners have conducted annual DFG survey and removal operations within NWHI shorelines and shallow-water coral reef environments (0-10 meters), removing approximately 682 metric tons of debris. This presentation will cover the methods, tools and approaches that were utilized for 14 years in a large-scale DFG removal effort in the remote atolls and islands of the NWHI, now protected as the Papahānaumokuākea Marine National Monument. We will discuss extensive measures to train field staff, free-dive towed-diver and swim-survey methodology, DFG removal techniques and protocols, and DFG disposal. We will also discuss logistical and operational challenges faced in remote operational areas, along with various approaches used to maximize safety procedures and efficiency protocols to improve future DFG removal efforts.

11.c.1. Cigarettes, fishing nets, and Facebook: the utility of social media in ocean conservation

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ABSTRACT
Environmental volunteerism brought together social networks long before the terms “blog,” “tweet,” or “poke” were part of the everyday vernacular. Yet today, social media outlets like Facebook and Twitter have taken these networks to another level, enabling ocean enthusiasts to participate in conservation efforts without ever leaving their couch. People in even the most remote locations on the globe can now actively participate in a dialogue that seeks to solve the problem of marine debris. One recent example, Ocean Conservancy’s coverage of Project Kaisei’s voyage to the North Pacific Gyre exemplified the potential of social media. Anyone with a Blackberry, iPhone, or laptop computer was able to follow the story of the voyage and comment on reports in real-time. Following online postings of marine debris materials collected from the Gyre, photos appeared on the News Feeds of almost 20,000 Facebook fans and the Twitter feeds of 2,600 Ocean Conservancy followers. With the click of a button, Facebook fans could then share the story with their entire networks, expanding the network of information. These actions, along with “comments”, “likes”, and “retweets,” offer a minute-by-minute analysis of a messaging’s effectiveness and allow managers to modify their strategies to best engage their audience. This kind of viral messaging is critical in solidifying public concern about marine debris. In an effort to evolve social media’s benefits in combating marine debris, over the next three years, a joint NOAA/Ocean Conservancy initiative will launch a targeted public awareness and education campaign to tell the story of marine debris’ impacts. This will incorporate innovative social networking tools, interactive media, specific advertising, and interactive websites that will seek to engage, inform, and inspire the rapidly growing list of global “e-Ocean” activists.

11.c.2. Litter and recycling in America: a look at recent studies and trends, with recommendations for action

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BACKGROUND
Much of marine debris results from daily human choices about waste disposal – what we purchase, and how we dispose of it and its packaging when it reaches the end of its functional life. National non-profit Keep America Beautiful, Inc. (KAB) has been on the forefront of consumer education concerning litter and waste for over 50 years.

In 2009, KAB released the results of the largest survey of littering and littering behaviour ever conducted in the U.S. Through field study and observation the study made several conclusions:

Litter is decreasing, but changing. While overall litter rates (item per mile) are down considerably over the past 40 years, the composition of litter has changed towards lighter-weight materials, predictably showing a significant increase in plastics.
15% of littering is influenced by context (such as distance to a trash receptacle), but the majority is individual choice. Littering behaviour is largely influenced by social/societal norms which can be altered over time through social marketing programs.
Age of the individual and distance to a trash receptacle are the strongest predictors of littering behaviour

Additionally, recent research funded in part by KAB on the National Mall in D.C. shows that public recycling receptacles can be extremely successful in capturing waste and, particularly, plastic packaging (preliminary reports show composition of recyclables collected is as much as 95% plastic in "on the go" scenarios)

CONCLUSIONS
Human behaviour can be changed through effective social marketing combined with infrastructure that establishes/reinforces societal norms. This is most effective when reinforced by grass roots, local community programs.

11.c.3. Social marketing and the California Thank You Ocean Campaign

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KEYWORDS
Ocean Health, Public Awareness, Marine Debris, Climate Change, Marine Life

BACKGROUND
The February 2006 analysis conducted by the Public Policy Institute of California[1] (PPIC) found that the California public is substantially interested in ocean and coastal protection, but lacks knowledge about ongoing efforts to address these issues and how they can participate in ocean conservation.

The California Thank You Ocean campaign is a partnership between the State of California and the National Oceanic and Atmospheric Administration (NOAA) Office of National Marine Sanctuaries. The mission of the campaign is to educate the public about the importance of sustaining ocean life and inspire Californians to practice ocean stewardship to combat unprecedented threats facing the planet.

In the ever-changing world of communication, reaching the public and affecting change is a challenge. The Thank You Ocean campaign strives to communicate messages of ocean literacy and to encourage stewardship through traditional and emerging methods and technologies.

METHODOLOGY
The design of the Thank You Ocean campaign is based on social marketing analysis and implementation. Steps included the tracking of social issues, popular environmental concerns, stages of behavioral change, communications challenges, behavior modeling, barriers to action, message development and targeting the market.

The campaign is supported by a network of representatives from ocean-related interests, the California Ocean Communicators Alliance (OCA), a group of more than 300+ professionals in ocean-related organizations, agencies and businesses who, in the course of their work, reach millions of Californians with ocean messages. Representatives from these organizations were brought together to agree on common ocean messages. Key messages were "sustain the ocean, sustain life" and "humans and the ocean are inextricably connected." This yielded the campaign position statement of "the ocean touches everyone and everything" with the final theme of "Thank You Ocean." The campaign tag line, with a positive personal message and call to action, is "The ocean takes care of us. Let's return the favor."

OUTCOMES

The campaign has produced a public service announcement (PSA) developed by renowned cinematographer Bob Talbot, a bilingual Web site (www.thankyouocean.org and www.thankyouocean.org/espanol), a bi-weekly podcast series, and several print and outdoor advertisements. In February 2008, Thank You Ocean earned the Coastal America Partnership Award from the White House. In 2009, actor Edward James Olmos agreed to be the spokesperson for the campaign and is featured in English and Spanish TV and radio PSAs.

Changes in the media and increased urgency of ocean issues dictate innovative strategies and methods of communicating campaign messages. In response to partner and constituent input, the campaign Web site has evolved to address specific threats to the ocean: climate change, marine debris, water pollution and marine life decline. The four major threats are discussed and have links to OCA member websites, recent news articles, and suggestions on actions individuals can take in their daily lives to address each threat. Thank You Ocean Report podcasts are a popular element of the campaign, addressing timely topics using a variety of source interviews including OCA members. Social networking has been incorporated into the campaign, including Twitter, Facebook, and MySpace.

A localized San Diego summer 2010 Thank You Ocean campaign featured Edward James Olmos in radio and television PSAs urging "Don't Trash the Beach." Messages were targeted to beachgoers to encourage actions that would reduce marine debris.

In the ever-changing world of communication, reaching the public and affecting change is a challenge. As a state-federal initiative, funding for a large public awareness campaign is limited, especially under current fiscal conditions. The Thank You Ocean campaign strives to find creative ways of funding outreach efforts by utilizing new tools and creating innovative partnerships.

PRIORITY ACTIONS

Based on the experience of the California Thank You Ocean campaign, priority actions recommended for the issue of marine debris include:

Develop key messages that engage the public
Identify target market "best responders"
Secure partnerships, support and fund a campaign to increase awareness, encourage stewardship and facilitate behavioral change

REFERENCES

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11.c.4. Using social activation strategies in the movement to end plastic pollution

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KEYWORDS
plastic pollution, social marketing, coalition, ocean plastic

BACKGROUND
Plastic pollution is a major threat to the ocean ecosystems today. It is global, massive and urgent, and it originates on land, deeply rooted in our societal dependence on disposable plastic. Addressing the problem of plastic in the ocean begins with promoting and inspiring a behavior change for individuals - away from the model of convenience so heavily promoted in the past 30-40 years.
To begin to sway a society away from the disposable lifestyle of the 50-ies, we envision a synergistic action between social movement, political and legislative process, and businesses engaged in delivering alternatives.

METHODOLOGY
Plastic Pollution Coalition has developed a theory of change based on social science, integrated with solid audience research and media expertise. The theory or change integrates:

- the concept of tipping point;
- the importance of knowledge and a sense of global community;
- the value of on-ramps for action;
- and the role of traditional and social media in delivering knowledge and empowering action.

We believe in the synergistic role of that social media can play a pivotal role in empowering people to take action; in accelerating tipping points by moving large numbers of people to undertake behavioral change and demand actions**.** While broadcast media is used mainly to *inform*, the evolving new media and especially the social media landscape offers opportunities to create on-ramps for *get involved* and *be engaged***.** We plan for a synergistic and innovative use of traditional and social media.

OUTCOMES
A key goal for the social activation strategy is to create a movement from awareness to action. In this case, action is defined as personal behavior modification. We subscribe to the basic Hungerford - Volk model of responsible environmental behavior[9] in citizens - individually and in groups, and we add *empowerment*, since awareness is not enough. The following attributes are required also:

- Knowledge of an issue is a prerequisite to action.
- Awareness of actions that are available and which would be most effective.
- Motivation - the tipping point to action
- Guidance as to appropriately applying knowledge of action strategies to the given issue.

PRIORITY ACTIONS

- Deliver aggregated, curated and easily accessed content that attracts those who do not know about the issue
- Organize information in a way that promotes learning
- Present on-ramps for action
- Create a sense of collaborative, global effort

11.d.1. GhostNet gear: turning trash into treasure

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KEYWORDS
Collaboration, sustainability, ghost nets, partnerships, art, ingenuity, recycling, remoteness, alternatives, cooperation, tradition, indigenous

BACKGROUND
People living along the remote northern coastline of Australia are faced with an issue that wasn't recognised until recent decades (Gunn *et al* 2010), that of vast amounts of marine debris brought to shore by the winds and currents of the Arafura Sea. The majority of this debris (70-90% by weight) is from fishing industries and reflects the increasing use of plastics in an industry that traditionally used more eco friendly, biodegradable materials. (Kiessling 2003)

GhostNets Australia (GNA) operates in an area that is expansive, remote and sparsely populated, stretching more than 4600km (approx.2858 miles) across Northern Australia. This whole region supports less than one percent of Australia's population living in isolated pockets. The main infrastructure is focused around a few large mining centres, with most of the community townships lacking even the amenity of a sealed road. Over 70% of this coastline is held under Aboriginal ownership and many Aboriginal communities continue to use coastal resources for subsistence and other customary purposes (Munungurritj 1998; Yunupingu 1998).

As a grass-roots alliance of Indigenous communities, GNA is aimed at finding a solution to the vast amount of ghost nets accumulating on this coastline. Established in 2004, the focus to date has been on ghost net removal although data collected by the Indigenous rangers has enabled GNA to research the source of the recovered nets as well as to understand the size of the problem and its effect on marine fauna. Constraints of funding and distance combined with accepted local practices have unfortunately meant that the ubiquitous method of net disposal to date has been by burning nets in situ.

METHODOLOGY
The search for a non-pyrotechnical solution to ghost-net disposal began with a fellowship for one of our team to visit different recycling plants in the USA to determine if these options were suitable for the Australian situation. The high cost of establishment and tyranny of distance coupled with the small and scattered population centres makes building power stations such as that found in Hawaii unaffordable. GNA also sent a large amount of net pieces to various factories in the south of Australia that recycle PET plastic. The negative response from these existing plants was based yet again on the cost of transport, and the requirement for the nets to be pre cleaned, shredded and bulk packed adding another cost before they would even consider it.

In 2006 GNA, turning to the wider community for ideas, decided to host an engineering competition challenging participants to design a product using ghost net material that could be manufactured in indigenous communities as a cottage industry. Furniture, mud bricks, garden fencing, baskets, bags and art pieces were submitted. The winning entry combined utility through art with a guitar strap, the designer of which went on to hold workshops with community artists to create bags which they sold locally for about $20-$30 each.
Currently, ideas being developed include using nets as directional fencing in large scale events, incorporating nets as a strengthening component of building material, and the possibility of using nets for wildlife conservation through highway overpasses for arboreal mammals.

OUTCOMES

From this small beginning, GNA realized that while there was merit in this type of cottage industry a shift in focus was needed if the items made, by then being called GhostNet Gear, would fetch prices that reflected the work gone into them. The focus then shifted from the utilitarian nature of the product to the artistic application.
The resounding success of GhostNet Gear has taken the project by surprise. In a short period of time art works have fetched prices from $AUD600 to $AUD2,500, have been acquired for important collections such as those of the National Gallery of Australia, Queensland Art Gallery and University of Queensland, and have attracted huge interest from various reputable galleries both nationally and internationally. This program has been of such artistic success it is now being used as a case study by the major funding body Arts Queensland.

Although these artworks use a fraction of the net, thus not really being a recycling option, they provide the program with two major outcomes: firstly the community artists now spend time beachcombing for their raw materials, providing ongoing management of the issue. Second, exhibitions being held both nationally and internationally are generating significant awareness of the issue in a very proactive manner and creating a message that resonates. Thirdly Ghostnet Gear provides a solid social platform which can be used to reach other countries, and educate about positive alternatives for worn fishing net, and the environmental impacts of dumping debris at sea.

While the GhostNet Gear program has been successful and creative recycling ideas continue to be generated, seeking long-term bulk-use solutions remains an ongoing process with high transport expenses and logistical difficulties constant issues. GhostNets Australia will continue to explore alternative recycling measures and seek partnerships to assist with this in a continual bid to develop long term, permanent solutions to the ghost net problem.

PRIORITY ACTIONS

Undertake an International touring art exhibition featuring high end works created by indigenous artists using ghost net to raise awareness of the ghost net issue.
Through the production of both GhostNet Gear artwork and more utilitarian products (such as the creation of fencing or the production of building materials), positively impact on the broader community and thereby increase awareness of the ghost net issue locally and abroad.
Continue working towards sourcing a bulk use solution that addresses the logistics involved in removing ghost net and marine debris from remote localities.

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11.d.2. Assessing the viability of using marine debris as a feedstock in advanced gasification solutions for disposal and energy production

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KEYWORDS
Gasification, Marine Debris, Plastics, Ze-gen, Derelict Fishing Gear, Waste-to-Energy, Remote Disposal, Waste, Beneficial Reuse

BACKGROUND
The accumulation of marine debris is a worldwide challenge due to the long-lived nature of these materials, limited options for reuse, recycling and/or disposal, and propensity for inappropriate disposal at sea. With the increased use of synthetic materials in product packaging, fishing equipment and gear, and industrial, commercial and consumer products of all kinds, waste accumulation on land and at sea is an escalating challenge. The issue of rigid waste materials that are discarded into the ocean environment, such as plastics, rubber, and derelict fishing gear (DFG) and netting, for example, is particularly problematic because of its accumulation on beaches, aggregation into flotsam in ocean currents, and health impact on marine life, onshore animals, and humans.

The sources of marine debris have been and continue to be much studied, with special emphasis placed on the impact such debris can have on wildlife health, marine abrasion of natural structures, and navigation hazards. These issues are the focus of the National Oceanic and Atmospheric Administration's (NOAA) Marine Debris Program. The material composition of marine debris, particularly derelict fishing gear (DFG), and current materials management methods around the world, has been well documented in the literature (Jambeck, 2008). While marine debris accumulation is a worldwide issue being tackled differently in different locales and by a variety of international entities, I have used the work done in the State of Hawaii as a representative case study in this research to shed light on the wider problem. The State of Hawaii has done considerable study on the subject of waste accumulation of derelict fishing gear and floating plastic, given Hawaii's geographic location at the center of the North Pacific Gyre, which has the unfortunate distinction of being a confluence point for marine debris. In its 2010 Hawaii Marine Debris Action Plan, the State of Hawaii "establish[ed] a comprehensive framework for strategic action to reduce the ecological, health and safety, and economic impacts of marine debris in Hawai'i by 2020." The report assessed the issue of marine debris in the Hawaiian Archipelago and identified DFG as a major source of waste in need of immediate attention and effective solutions. In the Northwestern Hawaiian Islands alone, approximately 700 tons of DFG have been removed and disposed of since 1996, which exemplifies the worldwide challenge to marine wildlife, habitat and navigation presented by accumulating marine debris (Hawaii Marine Debris Action Plan, 2010). DFG continues to jeopardize marine life (Zabin et al.,2004) and to be a particularly important subset of marine debris in dire need of better collection and disposal methods.

Current options for disposing of marine debris include 1) selective recycling of plastic fractions, 2) reuse for energy generation using thermal treatment technology, 3) thermal reduction without energy recovery, or 4) landfill disposal where no reuse options exist. Two examples often cited by the NOAA Marine Debris Program for effective disposal with energy recovery are 1) Nets to Energy and Partnership in Hawaii and 2) Fishing for Energy Program, both of which involve a partnership with Schnitzer Steel Industries and Covanta Energy, whereby DFG and netting are transported for material handling and shredding at a nearby processing location at which the materials are appropriately sized and rendered into a suitable fuel for energy use in a solid waste combustion facility. The Nets to Energy Program and Partnership in Hawaii routes waste material to the City and County of Honolulu's H-Power Energy-from-Waste facility, operated by Covanta Energy. Similarly, the Fishing for Energy is a partnership between the National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program, Covanta Energy Corporation, National Fish and Wildlife Foundation (NFWF), and Schnitzer Steel, in which locations were identified and provided in regional ports for fisherman to dispose of old nets and derelict finishing gear for recovery at no cost to the fishing community. These materials are then removed from the environment, transported to the nearest Covanta Energy-from-Waste facility where they are shredded and sized appropriately for use as fuel. Please refer to the comprehensive review of thermal treatment technologies as applied to marine debris, particularly to derelict fishing gear, for further study (Jambeck, 2008).

This paper focuses on the challenges and opportunities for using new gasification technology for effectively processing and disposing of marine debris, with particular emphasis on waste plastics and DFG, and analyzes the effectiveness of using these materials as fuel for advanced gasification technologies as an environmentally preferred alternative to incineration. Gasification technology offers an alternative disposal method to incineration that may provide environmental benefit in the form of improved energy recovery and reduced environmental impact. While there are a variety of types of gasification systems, all gasification processes involve the conversion of carbon-based materials, such as coal, biomass, petroleum, or waste material, into carbon monoxide and hydrogen by reacting the raw material in an oxygen-constrained environment at high temperature. The resulting gas mixture is called synthesis gas or “syngas” which can be used as a fuel to produce thermal energy, electrical energy, or as a chemical precursor to refined chemical products. Ze-gen’s proprietary gasification technology has been in development since 2007 and the company operates a pilot-scale gasification facility in New Bedford, Massachusetts where feedstock and process configurations are evaluated on an ongoing basis. The purpose of the facility is to assess the viability of a variety of waste materials as feedstock for gasification, measure the quality of resulting syngas for use as alternative fuel, measure associated emissions from the combustion of the produced fuel, and inform the design of future Ze-gen commercial gasification facilities.

The cumbersome and wide distribution of marine debris makes collection and cost-effective disposal difficult, implying that effective thermal treatment and disposal options located near collection points would be preferable. Following on an interest in studying how gasification facilities could be employed to process marine debris, this study evaluated the viability of using marine debris as a feedstock in advanced gasification solutions like Ze-gen Incorporated's Liquid Metal Gasification system for disposal and energy recovery.

METHODOLOGY

This study evaluated samples of marine debris from the New Bedford, Massachusetts area – one of the largest fishing ports in the Eastern United States – to assess the viability and attractiveness of using marine debris as fuel in the Ze-gen advanced gasification process. A material sample, comprised primarily of derelict fishing nets and buoys, was collected from the port of New Bedford, Massachusetts to serve as a proxy for marine debris in general.

In order to assess the chemical composition of the marine debris sample, Ze-gen performed Proximate analysis, Ultimate analysis, and BTU value analysis on the material to assess its potential fuel value and level of contaminants which might affect air and water emissions and impact its suitability as a potential feedstock. Proximate analysis indicates potential ash content stemming from inorganic constituents, Ultimate analysis measures key elemental components for gasification potential and emissions including carbon, oxygen, hydrogen, nitrogen, sulfur, and moisture content, and BTU content measures the heating value of the material by weight – a key measure of the inherent energy available for recovery during treatment. Once this data is collected, HSC thermodynamic modeling was used to assess equilibrium reaction chemistry and potential syngas quality that would result from the gasification of marine debris materials under equilibrium conditions. Marine debris material was evaluated as a prospective fuel and results were compared against other gasifier fuels currently being used in the Ze-gen advanced gasification process. The purpose was to evaluate marine debris as a viable feedstock for onshore or offshore gasification systems as a means of marine debris disposal and onsite energy generation in areas with accumulated marine debris and limited disposal options.

OUTCOMES

In January 2011, Ze-gen engaged Alpha Analytical to perform Proximate, Ultimate and BTU analysis on a marine debris sample collected from the port of New Bedford, Massachusetts. The results are summarized in Figure 1. Feedstock analysis showed marine debris content of carbon, oxygen, hydrogen, metals, fuel-bound nitrogen, and BTU/lb were in line with suitable levels for fuel use in Ze-gen's Liquid Metal Gasification system. In fact the marine debris sample, which was made up almost entirely of DFG netting, indicated a low ash content of less than 1%, a BTU/lb (HHV) content of over 13,338 BTU/lb (dry basis), relatively low levels of sulfur, and no chlorine. This composition implies that its fuel value would be high when compared to other fuels being evaluated and that the incremental environmental impact on air and water emissions would be low. See Figure 2 for a comparison of this sample of marine debris against other priority feedstock being tested by Ze-gen, notably creosote-treated wood railroad ties and source-separated waste plastics.

Furthermore, HSC thermodynamic modeling was conducted to estimate equilibrium chemical reactions from the gasification of this feedstock. The analysis conducted plots the composition of effluent syngas fuel from gasification across feedstock by analyzing theoretical chemical reactions across the range of equivalence ratios. The equivalence ratio of a system, , denoted by Φ, is defined as the ratio of the fuel-to-oxidizer ratio to the stoichiometric fuel-to-oxidizer ratio. Mathematically,

$$\phi = \frac{\text{fuel-to-oxidizer ratio}}{(\text{fuel-to-oxidizer ratio})_{st}} = \frac{m_{fuel}/m_{ox}}{(m_{fuel}/m_{ox})_{st}} = \frac{n_{fuel}/n_{ox}}{(n_{fuel}/n_{ox})_{st}}$$

where, *m* represents the mass, *n* represents number of moles, suffix *st* stands for stoichiometric conditions.

Φ is the measure of oxidation, where Φ=1 is stoichiometirc, Φ>1 represents incineration and Φ<1 represents gasification. Results indicated a theoretical fuel value range of 7.5 – 22 mmBTU/ton of feed for effluent syngas fuel, which is favorable when compared to other fuels being evaluated. In practice, it is likely that the value would be less than 18 mmBTU/ton of feed due to resonance time, heat losses and char-formation considerations. See Figures 3, 4 and 5 for a comparison of projected gasification results and projected effluent syngas composition of Marine Debris (Figure 3) against those of other gasifier fuels currently being used in the Ze-gen advanced gasification process, such as Wood (Figure 4) and Railroad Ties (Figure 5).

Based on preliminary chemical analysis and HSC chemistry modeling of theoretical output from high-temperature gasification, Marine Debris DFG and marine netting debris is quite suitable for thermal treatment and energy recovery using Ze-gen's advanced gasification system. Comprised mostly of synthetic plastics, the material has a composition that lends itself toward near-complete destruction and has a high energy content making it suitable for fuel use. Furthermore, it has relatively low levels of problematic contaminants, specifically sulfur and chlorine that can form acid gasses when high levels are entrained in feedstock. While this evaluation is preliminary, the results were positive and warrant further study. Further evaluation might include a prolonged test of marine debris as feedstock in actual test conditions at the Ze-gen pilot plant facility in the future to examine effluent gas composition, syngas fuel quality, and associated air and water emissions associated with the gasification of this material.

It is important to note that the greatest challenge of using Marine Debris DFG as a fuel for gasification may lie in the difficulty associated with handling the material and preparing it for fuel use. Outside of material collection, which is not the focus of this study, the biggest obstacle to effectively dealing with floating plastic and DFG is the need to properly size and shred these materials into small pieces suitable for fuel use by incineration facilities or advanced gasification facilities. As shown by documented processing of DFG by Schnitzer Steel Industries as part of the Nets to Energy and Partnership in Hawaii and the Fishing for Energy Program, multi-stage shredding equipment may be required to process this material, especially given that nets can get caught on blades and conveyors during processing. This practical consideration for how best to collect, transport, convey, and shred material to a size of approximately 1 – 2" pieces is non-trivial and must be considered when designing a commercial-scale gasification system to handle marine debris and particularly DFG. Any future evaluation of marine debris as feedstock for Ze-gen's gasification system will include an evaluation of the feedstock handling equipment required to effectively prepare the feedstock for fuel use.

PRIORITY ACTIONS

As this study illustrates, advanced gasification technology could offer a new option for treating, disposing of and recovering energy from marine debris materials, particularly derelict fishing gear and netting. In the effort to reduce the impact of marine debris on the environment, significant attention must be paid to studying the application of new technologies for disposal that can be deployed near relevant waste collection points, thereby offering economic transportation to final disposal. Stakeholders must study the efficacy of the array of disposal technologies available and evaluate their relative ability to 1) physically process marine debris materials, 2) treat marine debris waste effectively while minimizing environmental impact, and 3) treat marine debris waste while maximizing its beneficial use locally.

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11.d.3. Developing a 21st Century waste-to-energy facility in American Samoa

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KEYWORDS
solid waste, municipal solid waste, study, waste composition, waste to energy, electricity production, debris management, solid waste management, landfill alternative

BACKGROUND
In addition to providing electricity, the American Samoa Power Authority (ASPA) manages solid waste collection and disposal for the territory, including marine debris collected from the shoreline. Landfilling is currently the primary mode of disposal, but limited available land on the main island limits its long-term viability as the territory's sole waste management tool. The territory's relative isolation and instability of world oil markets prompted ASPA to look at more environmentally and economically sustainable means of waste management that could also address unstable global fuel prices.

In 2008, ASPA was awarded a technical assistance grant to conduct an extensive waste composition study to quantify and characterize the composition of waste disposed of at the Futiga landfill. The overall objectives of the project were to develop reliable estimates of the quantity and composition of wastes disposed by key generator groups. The data was then used to identify potential waste-to-energy options for American Samoa, including the types of processing facilities potentially suitable for island conditions, facility costs and energy generation.

METHODOLOGY
SCS Engineers conducted a waste volume and composition assessment study at the Futiga landfill over a period of several weeks, which consisted of hand-sorting samples into 53 material categories and weighing each component of the sample. In addition, visual sorting of entire truck loads of solid waste were conducted for loads that contained bulky items or few types of waste. The raw data was corrected for observed anomalies then extrapolated to forecast the amount of municipal solid waste stream that would be typically disposed of at the landfill, and thus available for feedstock to a future waste to energy plant.

A Pro Forma Model was developed to analyze the capital and operating costs for the proposed waste to energy facility. This model assumed that ASPA would contract with a private vendor to own and operate the facility to enable the project to take advantage of grants available under the American Recovery and Reinvestment Act. Alternate funding strategies were also discussed to make the project viable.

OUTCOMES

The largest component of the overall waste stream is paper and related material. Organics and mixed residue comprised the next largest components, at 19.6% and 16%, respectively. The remaining waste types together accounted for about 46% of the landfill's waste stream.

Waste-to-energy appears to be a viable solid waste management alternative for American Samoa, with approximately 62 tons per day available as feedstock/fuel for the plant. Such facilities produce clean, renewable heat and/or electrical energy through the combustion of municipal solid waste in specially designed power plants equipped with state-of-the-art air pollution control equipment. Trash volume can be reduced by approximately 90% and the remaining residue is subjected to frequent analyses to ensure conformance to strict environmental standards allowing its use as an industrial material or co-disposal with other solid waste in sanitary landfills. The implementation of such a system would require a significant investment in planning and development and capital resources for ASPA and would probably constitute one of the largest public works/utility projects in the territory. Nevertheless, this WTE project would result in an improved, long-term solid waste management solution for American Samoa, as well as providing much needed base load power resources for electric generation.

ASPA is now planning to develop a 2.0 MW, modular waste to energy facility as part of a public-private partnership, although the project has been delayed due to recent tsunami and cyclone damage to the island. The study attained many major milestones; including the two-season waste composition study being perhaps the most extensive such study undertaken in the entire Pacific.

PRIORITY ACTIONS

ASPA should appoint a Project Team to help guide the process, which will include engineering and environmental, management, public involvement, legal, permitting, financing, and procurement. Of critical importance is a proactive public involvement and outreach program to inform territory citizens of the project, how citizens will influence the viability of the project, and how the project will help solve solid waste and marine debris management issues, while also providing an alternative, renewable energy supply for the territory.

FIGURES AND TABLES

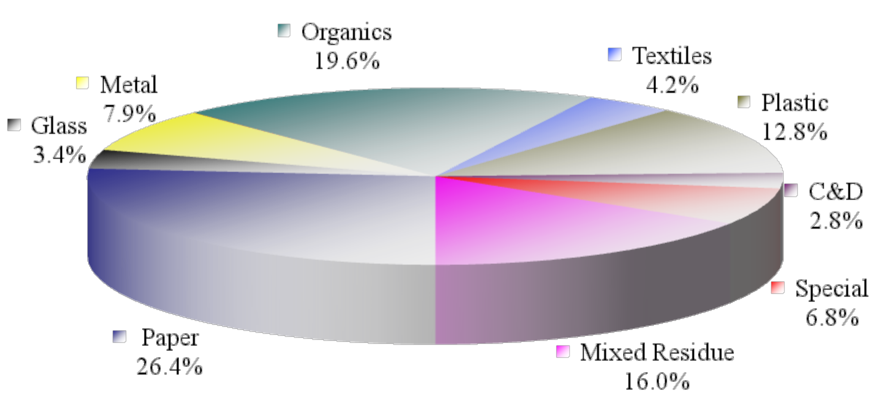

Figure 1. Components of Waste Stream

Table 1. Btu Analysis

Material Type	Portion of Overall Wastestream	Inherent Energy (Btu/lb)	Moisture Content	Revised Energy (Btu/lb)	Total Energy Contribution (Btu/lb)
Food	3.5%	2,000	92.5%	151	5
Paper (without cardboard)	6.7%	7,200	23.5%	5,508	371
Cardboard	17.6%	7,000	52.5%	3,325	586
Plastics	11.8%	14,000	23.0%	10,780	1,272
Textiles	3.9%	7,500	23.5%	5,738	221
Rubber	0.0%	10,000		10,000	5
Leather	0.0%	7,500		7,500	0
Garden trimmings	10.6%	2,800	66.5%	938	99
Wood	1.2%	8,000		8,000	93
Glass	3.2%	60		60	2
Tin cans	4.7%	300		300	14
Nonferrous metals	1.3%	0		0	0
Ferrous metals	0.5%	300		300	1
Dirt, ashes, brick, etc.	0.0%	3,000		3,000	1
Municipal solid wastes	15.0%	4,500	70.0%	1,350	202
Waste Oil	2.2%	21,000	92.5%	21,000	472
Tires	5.3%	13,500	23.5%	13,500	713
Total	87.4%				4,058

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11.d.4. Marine debris to energy: integrated marine debris and derelict fishing gear assessment, collection and management

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KEYWORDS
Derelict fishing gear, Gulf of Maine, Commercial Fishermen, Cleanups, Sonar, GIS

BACKGROUND

Despite a relatively small (18 miles) coastline, New Hampshire has an active commercial and recreational fishing industry. Consequently, there is a large amount of ocean-based marine debris on the shoreline and underwater. Beach cleanups have been conducted in New Hampshire for over 20 years, but a key component to mitigating marine debris in these areas with high amounts of ocean-based debris has been working with fishermen and fisheries extension specialists to address the significant challenges of mitigating derelict gear. These challenges include assessing the extent of derelict fishing gear (through beach cleanups, sonar and offshore data collection), cleaning up gear and working within the legal framework involved in disposal.

The project centers around work conducted by a partnership between Blue Ocean Society for Marine Conservation, NH Sea Grant, UNH Cooperative Extension and the University of Georgia and funded by the NOAA Marine Debris Program with supplementary funding from the New Hampshire Coastal Program. The project's goal is to assess and clean up marine debris in the waters and on the coastline from York, ME to Newburyport, MA. Major components of this project, which is ongoing, involve engaging commercial and recreational fishermen in identifying locations of, and collecting and disposing of marine debris properly, including collecting offshore debris, providing for disposal in strategically-placed bins, and tracking the quantity of debris collected; locating and identifying identify underwater debris and pelagic litter using multi-beam sonar and recording sightings from whale watch vessels; recruiting and training community volunteers to conduct shoreline cleanups and record data, and concentrating project information, data and reports into a web site, www.nhmarinedebris.org, that has already been created and is hosted at the UNH Cooperative Extension, including incorporating and mapping historical data and disseminating project information to the public. The result is a multi-faceted approach to identifying, monitoring, and mitigating marine debris in New Hampshire using targeted on-the-ground removal and educational efforts.

METHODOLOGY

During this project, we have formed a partnership with local commercial fishermen's associations, including the NH Commercial Fishermen's Association, Atlantic Offshore Lobstermen's Association, and Yankee Fishermen's Co-op and worked with those groups and NH Port Authority to identify locations for derelict fishing gear collection bins. We worked with

Waste Management to place the bins, with the first bin, a roll-off container, installed in 2008 and subsequent bins installed (with additional funding) in 2010. Dumpsters (that lock) have been installed in Seabrook, Rye, Portsmouth and Newington, NH. Gear collected in roll-off containers is direct-hauled to Wheelabrator Technologies, which is located in MA. Because of waste hauling logistics, the smaller dumpsters must be dumped into trucks which can only travel locally (in NH) to Turnkey Recycling and Environmental Enterprises (TREE) where recyclables are picked out and the remainder is landfilled. We also worked with the NH Commercial Fishermen's Association and NH Fish and Game in their spring lobster trap cleanup. Gear was transported to a construction and demolition debris materials recovery facility, ERRCO in Epping, NH for separation and recycling. Community volunteers conducted regular shoreline cleanups through BOS's Adopt-a-Beach Program, and transported gear to bins when possible and recycled other materials in state-provided recycling bins or their own residential bins.

Fishermen were also recruited to collect data on derelict gear offshore, and retrieve that gear when possible. We developed a best management practice guide to encourage debris reporting and participation by local industry members. Future work will involve working with Rozalia Project for a Clean Ocean on a survey for underwater debris along the NH coastline to identify concentrations of gear, working again with the NH Commercial Fishermen's Association and NH Fish and Game on the lobster trap cleanup in Spring 2011 and work with local agencies and organizations to develop a plan for legal, practical retrieval of other gear where possible.

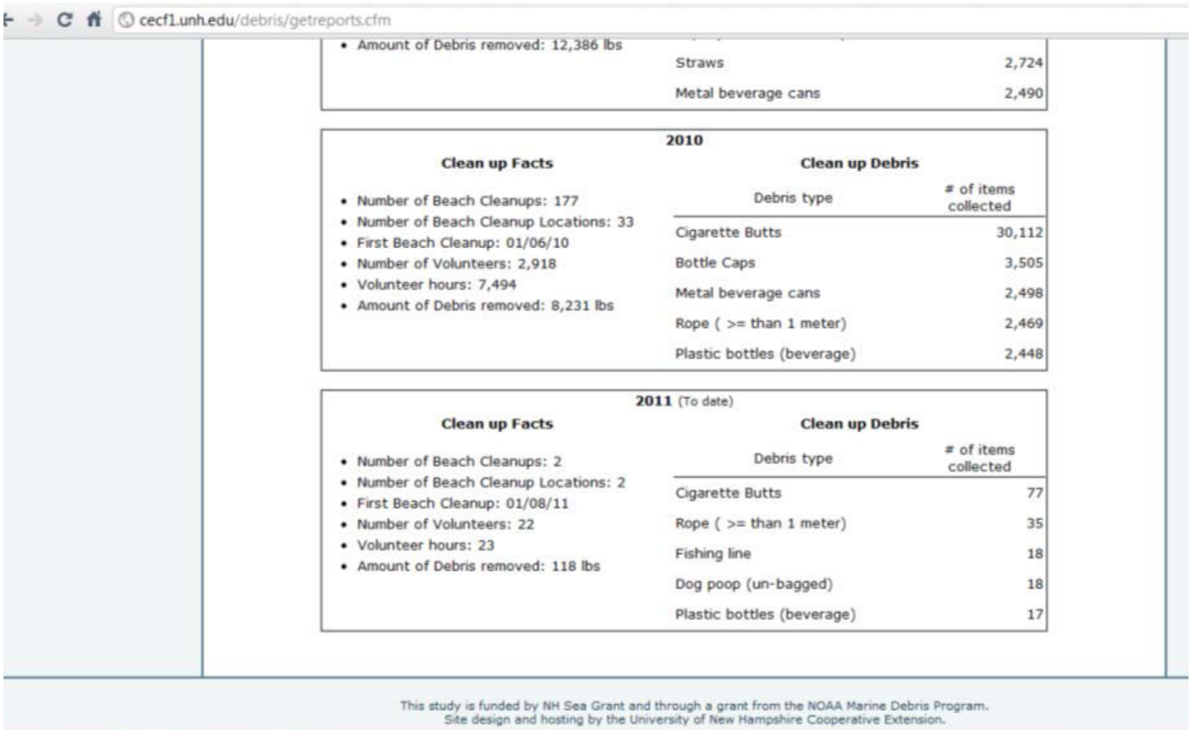
OUTCOMES
Once debris was collected, the project consisted of an integrated waste management approach. Working with a large waste-handling corporation, as well as a local construction and demolition debris recycler, the project was able to access a local materials recycling facility for recyclable materials that cannot be combusted for energy (e.g., metal), while the combustible material creates energy at their waste-to-energy facility.

Over 36 tons of gear has been collected in the derelict fishing gear bins to date. From September 2009-December 2010, 287 beach cleanups were conducted, resulting in the removal of over 12 tons of debris.

Challenges to this project have included maintaining regular communication with the many parties involved. A practical challenge is the requirements for space and security associated with large derelict gear bins at the publicly-accessible state piers. The largest challenge is a political one – involving the legal hurdles in retrieving gear on the shore and at sea. At shore we have worked toward mitigating the gear with our involvement in the annual trap cleanup, and hope this will expand into more ways to work within the legal framework to remove additional gear.

PRIORITY ACTIONS
Develop ways to work more closely with state agencies and commercial fishermen to increase the amount of derelict gear removed, especially gear identified underwater.

FIGURES AND TABLES



cecf1.unh.edu/debris/getreports.cfm

- Amount of Debris removed: 12,386 lbs

Straws	2,724
Metal beverage cans	2,490

2010

Clean up Facts

- Number of Beach Cleanups: 177
- Number of Beach Cleanup Locations: 33
- First Beach Cleanup: 01/06/10
- Number of Volunteers: 2,918
- Volunteer hours: 7,494
- Amount of Debris removed: 8,231 lbs

Clean up Debris

Debris type	# of items collected
Cigarette Butts	30,112
Bottle Caps	3,505
Metal beverage cans	2,498
Rope (>= than 1 meter)	2,469
Plastic bottles (beverage)	2,448

2011 (To date)

Clean up Facts

- Number of Beach Cleanups: 2
- Number of Beach Cleanup Locations: 2
- First Beach Cleanup: 01/08/11
- Number of Volunteers: 22
- Volunteer hours: 23
- Amount of Debris removed: 118 lbs

Clean up Debris

Debris type	# of items collected
Cigarette Butts	77
Rope (>= than 1 meter)	35
Fishing line	18
Dog poop (un-bagged)	18
Plastic bottles (beverage)	17

This study is funded by NH Sea Grant and through a grant from the NOAA Marine Debris Program.
Site design and hosting by the University of New Hampshire Cooperative Extension.

Figure 1. Screen shot from nhmarinedebris.org, showing beach cleanup report for 2010-2011.

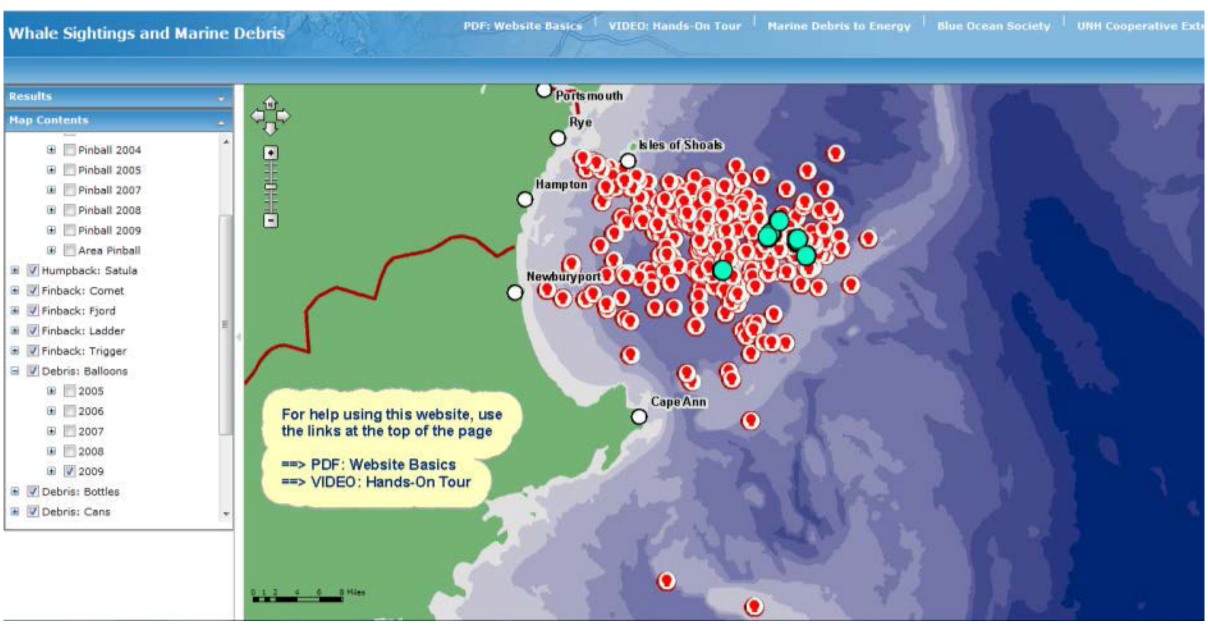


Figure 2. Screen shot from nhmarinedebris.org, showing balloons recorded offshore in 2009, along with sightings of a humpback whale known as "Pinball."

12.a.1. CPIA – Working with Canada's plastic industry to support successful education programs and industry innovations related to plastics recovery

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KEYWORDS
Cathy Cirko, CPIA, Canada, Recycling, Recovery, Plastics

BACKGROUND
The Canadian Plastics Industry Association (CPIA) is the voice of the Canadian Plastics Industry that is committed to: (1) communicating the facts about plastics manufacturing and use, including the material's economic, social and environmental contributions to Canadian society; (2) increasing the amount of plastics resources being diverted from landfill through the use of various management options, such as reduction, reuse, recycle and energy recovery; and, (3) building upon the industry's long history of innovation and achievement by playing a catalytic role to advance developments in technologies to increase plastics recovery.

CPIA research shows that there is a strong correlation between positive public perception of plastics and high plastic recovery rates (at-end-of-life). Conversely there is a strong correlation between negative public perception of plastics and low recovery rates resulting in restrictions on plastics use. CPIA works with retailers, brandowners, plastic converters, equipment & material suppliers as well as stewardship organizations and governments on ground breaking recovery initiatives and sponsors forums and networking events that bring together leaders in the plastics industry to share ideas, discuss business opportunities and promote innovation. CPIA also works on bringing world-class technologies to Canada through its Technology Transfer Trade Mission with Germany introducing Canadian recyclers, processors and policy makers to German recycling and energy recovery systems, as well as equipment supply firms.

CPIA believes that there is substantial opportunity for Canada to increase plastic waste diversion through both mechanical recycling and energy recovery from waste. CPIA is committed to working with government and other stakeholders to help create more positive end-of-life opportunities for plastics.

OUTCOMES
This presentation will provide an overview of the CPIA programs in the areas of post-use plastic resource recovery, education outreach and innovation stimulation. It will review the programs developed by CPIA to create industry ambassadors and to provide resources for educators such as curricula written for elementary and secondary instructors, on-line educational games, science experiments and comprehensive information on anti-littering and plastics recovery. The presentation will also highlight CPIA's work with governments and stakeholders aimed at jointly

designing systems and products that move the plastics recovery rate forward and in bringing world-class technologies to Canada. It will additionally inform on CPIA's ground breaking innovation forums where potential plastic recovery technologies are unleashed on industry and leaders in the plastics industry and academia are brought together to explore partnership opportunities for technology transfer.

PRIORITY ACTIONS

Diversion from landfill through recovery of plastics is good for the environment and it is good business. The Canadian plastics industry is committed to working with all stakeholders to seize recovery opportunities. Global observations teach us that an integrated approach to waste diversion works.

It is recommended that:

Governments can support industry's efforts by promoting an integrated approach to waste diversion that includes greater recycling and energy recovery (recycling is important but realistically will not be able to solve waste and energy issues alone); and,

Work with industry to educate others by showcasing case studies/best practices/models available globally for increasing diversion of waste from landfill.

12.a.2. Supply and contamination issues affecting plastics recycling in North America

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KEYWORDS
Gerry Fishbeck, Association of Postconsumer Plastics Recyclers, APR, recycling, plastics

BACKGROUND
The Association of Postconsumer Plastic Recyclers (APR) represents companies who acquire, reprocess and sell the byproduct of more than 90% of the post-consumer plastic processing capacity in the United States, Canada and Mexico. APR's membership includes numerous recycling companies, consumer product companies, equipment manufacturers and organizations committed to plastics recycling. APR strongly advocates the recycling of all post-consumer plastic bottles and works to increase the amount of plastic material that is recycled in North America. And the more plastic material recycled is less material littered in our natural environments. APR will provide a general overview of some of the key issues facing plastics recyclers in North America. Specifically, it will address:

- The inclusion of caps and closures for items like plastic bottles, which has long been an issue for recyclers. APR will discuss our recent position statement that indicates plastic reclaimers are prepared to accept and reprocess closures included with containers, creating a positive reduction in marine debris.
- The growing demand for post-consumer resins and the lack of adequate supply. Plastic Recyclers continue to face shortages of supply of material to reprocess. The export of materials to the Far East continues to absorb more than 50% of the PET bottles and 30% of the HDPE bottles collected in the US.
- Contamination of existing supply. Bales that are available for processing have been decreasing in quality, causing significant yield losses for reclaimers.
- Misuse of labeling of material is wreaking havoc with plastics recycling. We will address these concerns and possible solutions.
- Degradable additives are causing a significant problem for reclaimers. We will present our position on this topic and discuss our recommendations.

OUTCOMES
A reduction in the amount of potential marine debris can be produced with the inclusion of caps and closures for items like plastic bottles in the recycling process.

A better understanding by the public needs to be achieved regarding degradable materials and the problem for recyclers of mixing these materials in the general waste stream.

PRIORITY ACTIONS

- Increase in the recycling of caps and closures for plastic bottles, which will help with the reduction of marine debris.
- Retention of PET and HDPE bottles for recycling in North America, instead of shipping these products to foreign markets.

12.a.3. The *Fishing for Energy* partnership: removing the barrier of derelict gear disposal

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KEYWORDS
Public-Private Partnership, Derelict Fishing Gear, Commercial Fishermen

BACKGROUND
Fishing for Energy is a partnership between Covanta Energy Corporation, the National Fish and Wildlife Foundation, the National Oceanic and Atmospheric Administration and Schnitzer Steel Industries. The partnership brings together federal, non-governmental and private corporations to provide opportunities for commercial fishermen to dispose of old, unused and derelict fishing gear. Fishermen identified numerous barriers to voluntary removal and proper disposal of derelict and unusable fishing gear, including the high cost of transporting the gear to landfills and landfills refusing to accept some types of gear. To address this problem, *Fishing for Energy* works through four strategic areas that seek to establish voluntary removal of derelict gear by fishermen: (1) prevention: no-cost collection bins at strategic ports for commercial fishermen to unload gear; (2) direct removal: funding opportunities for the direct removal of derelict fishing gear from the marine environment; (3) education: through public and targeted media and (4) regulation: work with state regulators address legal impediments of derelict fishing gear removal.

The *Fishing for Energy* program has been blessed with wonderful partners that are dedicated to the mission of the program and draw from their areas of expertise to make the partnership successful. Starting with its first port in 2008, this national partnership has grown to serve over twenty ports in eight coastal states and has recycled over 1 million pounds of gear. Bringing together diverse partners to achieve a unified goal of assisting fishermen in the collection and disposal of derelict fishing gear requires flexibility in both methodology and execution of partnerships. The National Fish and Wildlife Foundation draws on it's over 25 years of experience in facilitating public private partnerships to achieve conservation goals.

METHODOLOGY
A number of factors contribute to the *Fishing for Energy* partnership's success, most importantly capitalizing on the unique expertise made available to the group by each partner in order to streamline the program goals. It also has the ability to leverage funding and resources through various partners which helps to minimize the need for high government spending by relying on significant industry involvement.

For bin placement, NOAA's Marine Debris program works with the National Fish and Wildlife Foundation to identify ports that may be interested in the program through their relationship with Fishery Management Councils, NGOs interested in marine debris and state managers. The National Fish and Wildlife Foundation plays the coordination role for all partners and ports to map out the needs of participating ports and organize the appropriate logistics for program implementation. Once a location has been identified, the *Fishing for Energy* partnership places bins for commercial fishermen to unload gear at no cost. The partnership then covers the transportation and tipping fees associated with disposal. Schnitzer Steel recycles the metals and shears the remaining gear, which is transported to Covanta Energy, an energy from waste facility, where it is converted in to renewable energy.

Due to the variability of regulations that impact all aspects of the derelict gear removal process, *Fishing for Energy* has adapted a flexible system of engaging new ports. For collection and disposal work, some nominated locations may not have all partners represented close enough to process materials or certain states may have regulations regarding hauler jurisdictional operation. Even the type of gear can require adaption of the standard process to meet program goals. Adding more partners into the program to accommodate these needs for each location can dilute the benefits making the program less attractive to corporate members. Instead of adding partners, *Fishing for Energy* contracts out these services when necessary to fill in gaps.

NFWF also manages the grant solicitation portion of the program which is made possible through funding by the NOAA Marine Debris program and Covanta Energy. A request for proposals is released in the fall for projects which are reviewed in winter for implementation in summer or early fall of the following year. The first two years of the grants program have focused on direct removal of derelict fishing gear from the marine environment; however capacity building for ports to enable participation in the bin program is also a priority. All gear removal grants have three requirements; proposed projects should be within one-two hour driving radius of Covanta facility locations, must engage the commercial fishing industry and must account for transportation costs of disposal. These requirements are a direct reflection of lessons learned in the first grants slate and are in place to meet our goals while keeping the partnership sustainable.

OUTCOMES

Since 2008, the partnership has successfully expanded the program from Massachusetts to eight coastal states and twenty-four participating ports. More than 500 tons of gear has been collected by giving commercial fishermen accessible locations where they can bring all of their gear. Certain constraints retard the expansion of the partnership: rules about hauling waste across county lines, distance from ports to the destination facilities, and apprehension from ports in new states. Moving to new states has proved challenging, but once a successful program has been established at one port, the partnership has found that reaching out to more ports in the area is easier. In fact, even in established ports, as word of the program grows, there has been steady increase in the gear collected over time.

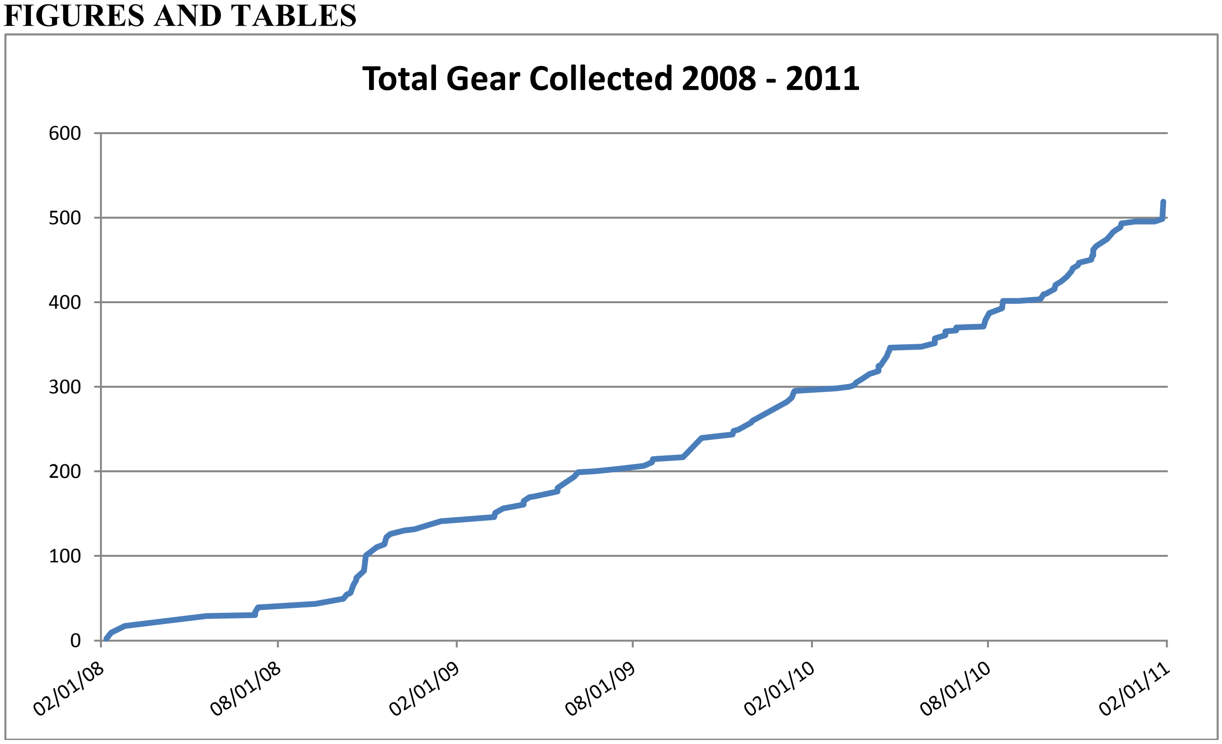
The grants program allows for a more directed engagement of fishermen to identify locations of derelict fishing gear and actively remove it from the sea bed. Three projects received funding in the first solicitation for a total of $162,000. The projects intend to engaging nearly 100 fishermen and will collect more than 90 tons of gear. The partners will then recycle the metals and convert the remaining gear into renewable energy. A second proposal slate is under review at the time of this writing.

When adding grant-making to the partnership, further challenges are added in varying states regulations restricting who, when and how gear can be removed from coastal waters. The *Fishing for Energy* partnership has been navigating these regulations and working to increase interest from state managers through the grants process at the same time. Acknowledging the long-term implications of successful gear collection as a result of these regulations, the *Fishing for Energy* partnership is collecting information on fishery regulations within states and working with state managers responsible for regulatory oversight to address these issues. In 2011 the partnership will host its first regional workshop in New England for state managers to discuss current legislation impeding direct removal of derelict fishing gear from coastal waters and share methodologies for facilitating these efforts.

PRIORITY ACTIONS

- Focus on a set of key strategies to achieve the goal, then work to remove barriers to the successful implementation of these strategies.
- More partners are not always better, look for ways that each partner can fill niche areas within the program.
- Define roles of each partners based on the most effective contribution each can make for cost minimization and impact maximization to deal directly with derelict fishing gear issues.

FIGURES AND TABLES



Total gear collected through Fishing for Energy program from 2008 to February 2011.


West Coast
East Coast
FISHING
FOR ENERGY
Hammond
Astoria
Garibaldi
Newport
Moss Landing
Portland
Rockport
Gloucester
Boston
Scituate
Wellfleet
Sandwich
Hyannis
New Bedford
Chatham
Newport
Point Judith
Southampton
Northport
Brookhaven
Barnegat Light
Cape May
Newport News

12.a.4. Mainstreaming marine litter management in Caribbean SIDS through government and civil society partnerships

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KEYWORDS
Marine, Litter, Waste, Debris, Pollution, Caribbean, SIDS, UNEP, Community, LBS Protocol

BACKGROUND

Marine litter is a significant pollution issue for the Caribbean region. Litter damages valuable natural resources including wildlife and sensitive aquatic and coastal habitats. Apart from these environmental impacts, the quality of life of local inhabitants and visitors, and the region's long-term economic sustainability, are also negatively impacted. Marine litter reaches the Caribbean Sea after being dumped along roadsides or into creeks, rivers, storm drains and sewers. Another major land-based source is from beach visitors when they leave "picnic" trash and litter on beaches or from run-off from poorly managed landfills and waste dumps during storms and coastal flooding. Litter also originates from marine-based activities including shipping operations, offshore drilling rigs and platforms, fishing piers and marinas.

Caribbean SIDS face unique challenges to prevent and minimize pollution and to safeguard their highly vulnerable coastal and marine resources. Marine litter management in SIDS can be particularly difficult given the need to engage a broad range of stakeholders and sectors ranging from fishing, maritime, tourism, coastal zone, environment and land-use planning to domestic solid waste management. While many Caribbean economies evolved from agricultural-based economies, the increased dependency on the tourism industry now contributes to a complex perception by society on how marine litter should be addressed, and who is ultimately responsible for marine litter management.

Traditional approaches to deal with marine litter have focused on periodic coastal and river clean ups but less on prevention and reduction. Little attention has been paid to foster changes in societal attitudes and behaviors about marine litter, solid waste and environmental management. Within the framework of the UNEP through its Caribbean Environment Programme (Figure 3) developed the Caribbean Regional Action Plan for Marine Litter Management (RAPMaLi) (UNEP CAR/RCU 2008), Caribbean SIDS are now adopting and implementing more innovative measures to ensure that marine litter management is more integrated and holistic.

METHODOLOGY

The paper highlights the experiences of three Caribbean countries - Barbados, Saint Lucia and Guyana resulting from their efforts to engage governments, civil society and the private sector to work more closely together in finding practical solutions to minimize negative impacts of marine litter. The importance that public education and awareness, regulatory and enforcement mechanisms, and regional and international agreements can play to develop and strengthen partnerships between public, private sectors and NGOs is presented.

OUTCOMES

From activities implemented in support of marine litter management in Barbados, Saint Lucia and Guyana, several key themes emerged that are necessary to successfully address marine litter issues in the future.

Understanding marine litter sources

Sources of marine litter are often not well understood and future efforts must overcome deep-rooted perceptions. In Saint Lucia, while focusing on what appeared to be the major marine litter source – local fishermen, it became apparent that land-based sources were more prevalent (Figure 1). Finding appropriate solutions required the engagement of additional stakeholders such as the local Port Authority and the solid waste management authority. The development of Marine Litter Monitoring Guides (Figure 2) as occurred in Barbados can assist in improving understanding of marine litter issues within a local context.

Identifying marine litter impacts

The negative impacts of Marine Litter are often perceived to be primarily aesthetic in nature and/or affecting only coastal and marine ecosystems. Social and economic implications of poor solid waste management are less studied or understood. In Barbados, local communities did not always fully appreciate the root causes of marine litter and marine pollution and the pathways by which litter and pollutants from land reach the coast. The early engagement of local community councils in clean-up activities has now resulted in greater support to these events. In Saint Lucia, demonstrating the economic and health implications of poor waste management has engendered greater support by private sector and the general public who can now relate to how poor marine litter and solid waste management directly affects their livelihoods and health.

Conducting successful marine litter projects through effective stakeholder engagement

The success of marine litter interventions in all three countries was highly dependent on adopting a multi-stakeholder approach. Key stakeholders in each country must be identified and involved very early in any marine litter intervention. In the case of Saint Lucia, this involved fishermen, the port authority, Government Departments of Fisheries, Environmental Health, Solid Waste Management and Environment. In Barbados, engagement of local communities through existing organizations was essential to ensure the existence of a mechanism that could provide continued support to the public. Activities in Guyana also demonstrated the importance of ensuring that any intervention took into account cultural and behavioral patterns concerning solid waste management.

The importance of data acquisition
Data acquisition, where possible, is extremely important. During meetings held with stakeholders in each country, it was critical to provide persons with data on extent of marine debris and solid waste and the results of any cleanup assessments. Such an approach assisted in providing validity and support for continued stakeholder engagement. In Guyana, where marine litter is predominantly a land-based waste management problem, such data also assisted in highlighting the weaknesses in existing waste management legislation and the need for improved regulations for solid waste management.

Recycling and Fund Raising
Marine Litter clean up activities must become more than simply a clean-up exercise. In Barbados, efforts were made to separate recyclable litter from non-recyclable litter. It has been suggested that future cleanups could be used as a source of funds for community activities and also help reduce the amount of litter transported to the landfill after cleanups.

Role of Regional MEAs such as the MARPOL Convention and Protocol on Controlling Pollution from Land-Based sources of Pollution (LBS Protocol).
Global and Regional Multilateral Agreements can provide direct technical support and serve as a catalyst to promote local action in support of marine litter management. Opportunities to share experiences, best practices and lessons learned through such fora must be expanded.

PRIORITY ACTIONS
The promotion of communication and education about the problems and impacts of marine litter must become more dynamic to capture the interest of private sector and the general public.
A more pro-active approach towards collaboration between Government, civil society and the private sector is required. Partnership-building should involve surrounding communities including schools and youth groups in developing local marine litter management plans.
There is a need for more local research on the social, economic and ecological impacts of poor waste management and the effectiveness of any existing measures for its control.

FIGURES

Figure 1: Meetings with Fishers in Saint Lucia to conduct surveys of marine litter impacts.

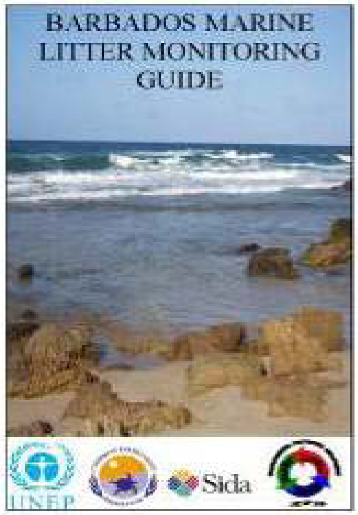

Figure 2: Marine Litter Monitoring Guide Developed for Barbados.

Figure 3: Map of the Wider Caribbean showing countries of UNEP's Caribbean Environment Programme

REFERENCES

UNEP CAR/RCU, 2008. *Marine Litter in the Wider Caribbean: A Regional Overview*. United Nations Environment Programme. 81 pp.

12.b.1. Research effort to document military munitions disposal sites worldwide.

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BACKGROUND
When a nation goes to war, it is not just the Army and Navy of that nation involved. It is the whole nation. One of the major players in any war is the industrial complex of that country – who else is capable of supplying the machinery needed to support the massive numbers of troops who will be doing the fighting? Among the need for clothing, food, trucks, and weapons is the need for tremendous amounts of ammunition.

But what happens to the excess production of supplies and ammunition when the war is over or the ammunition stocks that are captured as a result of that war? It all becomes a part of the demobilization process, a process that has been planned for even as the war was in progress. We are not here to discuss the process of demobilization, countless pages have been written on those. We are here to talk about one small phase of the program that brings a country back to the normal peacetime status. We are going to present some of the facts and issues that the United States and its Allies have faced during the 20th Century with respect to excess ammunition and unsafe ammunition. We have focused primarily on chemical warfare ammunition and the practice of its disposal in the oceans.

One of the first problems we encountered in our study was the ability to discover actual records or if there were records that discussed the rules and regulations governing disposal of ammunition. The second major hurdle was finding actual records showing that a disposal took place and under what conditions. To locate this material, we spent countless hours going through the records in the National Archives at both College Park, Maryland and in Washington, DC. We searched files from the Army, the Air Force, the Navy, and the Coast Guard. These included unit files, theater level headquarters correspondence and radio message traffic, port files, ammunition depot records and log books of water craft. We read hundreds of thousands of pages of historical documents. We searched military libraries and historical holdings and we contacted veteran groups with the hope that some of them would be able to give us an oral account of a disposal. We even searched the internet for information to include newspaper articles that recounted a disposal of ammunition in the ocean.

Were we successful in this search…..only partially. Documentation for the WWI era was scarce. The documents for WWII were more numerous. However, for the most part they were confusing, and in some cases they were contradictory and incomplete. Very seldom were we able to find a complete series of documents showing the entire "life cycle" of chemical munitions including shipping, inventory, and storage that contained any details of their final disposition. The most accurate information we found involving this level of detail came from individual unit histories that involved weekly or monthly reports. Even these reports were incomplete and contained information of limited periods of time. Example of the level of information is Weekly Activities Report of the 816th Chemical Company (Air) stationed in India in 1945.

Our quest, as previously stated was to gather information related to the sea disposal of chemical agents and munitions. Taking into consideration we were looking for sea disposals that occurred over a 54 year timespan, that task alone was Herculean. However, one Herculean task led to another. To locate the sea disposals we had to know where these stores had been located and track the shipping of the munitions first. In many cases we found incomplete records indicating the location of various amounts of toxic chemical agents/munitions. Even in the majority of the cases where we were able to establish the particular location of the chemical munitions, there were no records as to what happened to them.

As in all projects of this nature, success created other problems and puzzles to decipher. Information regarding the disposal activities that occurred between 1918 and 1943 was less than plentiful and more difficult in obtaining. In fact, it was extremely disappointing, as records were not forthcoming for this time period. We did however manage to locate some firsthand documents and some secondary information that originated from books and newspaper articles.

The World War II years, particularly 1943 to 1947, showed that the information was more abundant. Records from the early phases of World War II were very erratic and incomplete. Much of the information we found was written in the various codes, for lack of a better word, that were used during those years. Many of the documents we found referred to locations such as DAUB, BEVI, or IRON. Where were these places? They certainly weren't referring to any geographic location we were going find on a map. The answer, find a key to decoding these words. Were we successful in this task? Yes we were for at least the particular year of 1945. Other information we located referred to documents such as REURAD 10569, requesting disposition of munitions which was simply a confirmation document granting authority to dispose of the ammunition listed in the first radio message IAW pertinent regulations. A third class of documents simply were identified as originating at APO (Army Post Office) xxx being sent to APO xxx. These documents meant we had to locate a publication listing the APO with its geographical location. Here again, we met with partial success. We can identify some of the APO numbers to either general locations across the WWII theaters of war and some to a specific area. Many Navy documents also identified its installations by SPO (Shore Post Office) or by a simple number such as "66". We were fortunate enough to also find key documents that permitted us to identify these locations. As a result of our research efforts we were successful in collecting a series of documents that provided information that enabled us to decipher some of the codes and mailing addresses that were used in various stages of the war. We were also able to assemble a series of maps and other associated documents that provided insight as to how our military conducted business during the 1940's. One of those sources of information involved military regulations and guidance documents.

In the military, there are regulations to govern everything including the transportation and disposal of ammunitions. These regulations change over time due to the advancement of technology and the related information gained thereby. Safety was a consideration, both of the troops and the civilians in areas where these munitions were stored or shipped. The discovery of the various service related regulations and guidance documents was significant and provided individual reference points as the research effort proceeded.

The end result of the entire research effort was a detailed list of where sea disposals had occurred. To accomplish this we had to locate documents containing the latitude and longitude of where each disposal site was located. In some cases there were several locations that were used depending on the time period and who commanded the area in question. A very good example of this is shown in the records concerning the sea disposal sites around the Hawaiian Islands.

12.b.2. Coral impact assessment and mitigation for a Remotely Operated Underwater Munitions Recovery System demonstration

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KEYWORDS
Ordnance, Reef, Hawaii, ROV, Munitions, Technology Assessment, Coral, NOAA, Impact, Mitigation

BACKGROUND
The objective of the Remotely Operated Underwater Munitions Recovery System (ROUMRS) demonstration is to provide the Department of Defense with an alternative to using divers to recover underwater military munitions and to allow recovery of some items that might otherwise be detonated in place (blow-in-place). The integrated ROUMRS system consists of a remotely operated vehicle with adaptable attachments, specialized tools and lifting packages.

The purpose of NOAA's involvement was to provide the Army assistance in developing plans and protocols to avoid injuries to coral of significant ecological value and minimizing impacts to benthic habitat as a whole. NOAA provided a basic coral injury risk assessment for munitions removal and related demilitarization activities off the Waianae coast of Oahu and will give guidance on assessing and mitigating resulting injuries to coral and coral reefs.

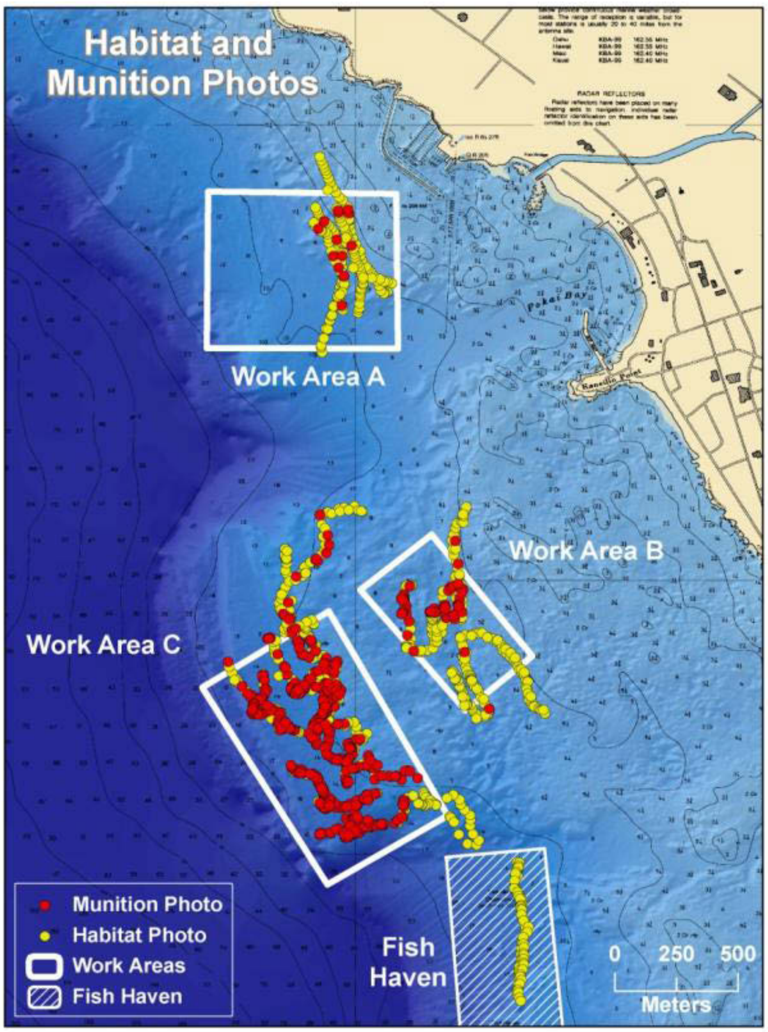
METHODOLOGY
Identification of munitions and areas of lower coral impact risks was accomplished visually by NOAA scientific divers using SCUBA. NOAA staff reviewed all photo documentation obtained during the survey dives and estimated the number and categorized the types of munitions as well as habitat types. Munitions were visually identified in the photographs and were categorized into three general types: small arms ammunition (SAA) (i.e., ammunition without projectiles that contain explosives that is .50 caliber or smaller), small to medium caliber munitions (munitions above .50 caliber to and including 105 mm), and large caliber and other munitions (munitions larger than 105 mm and bombs, rockets, etc.).

OUTCOMES
A total of 78 survey dives were conducted in the prospective work areas resulting in 1,862 photographs of munitions and habitat types. Assuming that an average visibility of roughly 60 feet horizontal distance (30 foot radius) existed throughout most of the demonstration site a total area of 72 acres was surveyed through all the dives. Within the ROV designated work areas approximately 52 acres were directly surveyed (~18%). Approximately 21,000 munitions (the majority being SAA) were documented from the survey dives. The locations of each of the

munitions groups were characterized as being a low, moderate or high risk area for impacts to coral. This information will be used in selecting mooring locations, determining the cost and benefit to the environment of removing the munitions vs. leaving them in place, and in the level of care required during operations. The cooperative working relationship developed helps both the natural resource trustees and the Army meet their responsibilities in the most efficient fashion possible.

PRIORITY ACTIONS
The location of individual munitions were evaluated based on risk of coral injuries from ROV activities. NOAA provided recommendations on avoiding coral injury while maximizing efficiency of the remote recovery of munitions.

FIGURES AND TABLES



12.b.3. Assessing the dangers of removal of sea-dumped munitions and other hazardous debris

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BACKGROUND
Our title defines the four areas addressed in this short presentation. The *dangers* posed to human health and the marine habitat are severe in the case of *munitions*, especially those chemical weapons dumped at sea. The *removal* of all such hazardous debris, with attendant risks and limitations of technology is a major topic in itself, covered in more detail in other presentations. As we have been asked to include *other hazardous debris*, we will also look briefly at sunken ships, particularly in terms of oil leaks. But with about three quarters of the world's declared stockpiles of Chemical Weapons (CWs) destroyed to-date, attention is now on those not declared, especially sea-dumped CWs, the focus of our presentation.

The most obvious dangers from the dumping of underwater chemical munitions and scuttling of whole ships containing CWs are the threats to human health and the marine environment which have generated growing concern. Thousands of tons of mustard, lewisite, phosgene, and other arsenic compounds are among the top chemical agents disposed of in the oceans. As time passes, the casings and containers of these munitions disintegrate, or are disturbed by human activity such as deeper fishing and pipeline laying, causing leakage of the toxic chemicals contained inside. Databases are incomplete and not coordinated on a global basis, though some research has been conducted into the human health aspects as well as the broader environmental consequences on the marine habitat, for example on coral and fish stocks. In other words, sea-dumped CWs, which have received limited attention to date, could be a serious sleeper ready to cause severe damage in the future.

At Global Green USA we are building a foundation for the ultimate cleanup of all sea-dumped munitions, including chemical, conventional and radiological weapons. We plan to develop a series of projects to assess the hazards posed by toxic underwater munitions worldwide, prioritize risks and dangers among sites by developing a comprehensive database, bring these threats to light in a series of international dialogues, and examine possible mitigation strategies. Many countries participated in sea-dumping CW and have a certain responsibility to assist in research and remediation efforts, but a framework for this as well as the weapons' ultimate removal and safe destruction is not yet in place. This is the situation we hope to rectify by initiating a series of roundtable discussions and conferences with a view to firming up projects, publishing the results, and ultimately recommending action.

Stakeholders and interested parties potentially affected by sea-dumped munitions conceivably include almost everyone on earth, as coral reefs serve as the basis for marine and fish stock habitats and the larger ecosystem. State parties, for one, have an interest in learning what potential dangers might lurk in their waters and what constitutes their own legal and ethical responsibilities, as precise coordinates are not available for all dump sites and thus locations of these munitions are often not well recorded. Chemical munitions lying in the Baltic Sea have long been hazards for Danish fishermen and, just miles off of the coast of Lithuania, they have become a concern of Lithuania's citizens. Areas where we have already done considerable background research over the past two years include the Pacific, especially the Hawaiian Islands and the areas east and southeast of Japan, and the Baltic Sea. But at the 5IMDC in Honolulu it is appropriate for us to focus on the dangers posed around the coasts of the Hawaiian Islands, which several slides in our presentation address.

Off Hawaii's coasts alone the U.S. Army dumped thousands of tons of chemical weapons between 1932 and 1945. Our slides show the extent and risks posed by the dumping of CWs off Hawaii's shallow waters. Until the Virginian *Daily Press* drew attention to these chemical weapons dumpsites in 2005, the general population of Hawaii lived unaware of their existence. The U.S. Army has disclosed some information on the location of sea-dumped chemical weapons and has worked with several organizations, specifically the University of Hawaii, to research the possible environmental safety and public health impacts of the weapons. However, the scientific community still faces a serious lack of information and participation from all stakeholders is required to remedy the problem and clarify the potential health and environmental risks of these weapons.

At the other extreme of the Pacific Ocean, around Japan, WWII also left a legacy of sea-dumped CWs, as well as sunken ships containing large amounts of oil, as evidenced in our slides. There have been over 820 discoveries of dumped chemical weapons around Japan. The wartime government of Japan disposed of CWs not only in China but also all around Japan, with a total number of 30 declared disposal sites shown in our slide. During recent years, the Japanese government has researched and updated the disclosed information on chemical weapons, which could contribute to mitigating some negative impacts on humans and the marine environment, especially on fishermen who are more likely to encounter chemical weapons. However, records on the dumped chemical weapons still remain highly incomplete, resulting in the possibility that Japanese continue to accidentally discover and be harmed by CWs. As our slides show over the years there have been more than 10 deaths and 400 injuries from CWs around the waters of Japan.

In addition to State parties, another group of stakeholders is made up of NGOs, which have studied issues including continued exposure to mustard gas and the problems posed by lack of complete information on sea-dumped CWs. The National Oceanic and Atmospheric Administration (NOAA), in conjunction with the University of Hawaii, also completed a study of a site known as "Ordnance Reef" near Oahu where chemical munitions were disposed of after WWII.

Although governments, NGOs, and other organizations have researched and explored sea-dumped chemical weapons, currently, there is no coordinated global effort to assess and clean up these underwater munitions. The presence of underwater chemical weapons is a global issue, since many countries participated in dumping weapons, and as dumping occurred all over the world. All countries that participated in sea-dumping have a responsibility to assist in research and remediation efforts, but a framework for their removal is not yet in place. Our goal is to assess the dangers and facilitate the development of a global effort to clean up the munitions and improve oceanic health, by measuring and monitoring the status and potential impacts of sea-dumped chemical weapons through mapping, water sampling, and other techniques. In order to maintain transparency, projects will focus on educating the public, mainly citizens in close proximity to affected areas, and on informing them of the findings and results. We plan to harness public support for and interest in sea-dumped chemical weapons issues through coalition-building efforts enhanced by Green Cross national organizations around the world, and in this way contribute to minimizing all hazardous debris in our oceans.

12.c.1. Marine debris: more than a low-grade fever for marine mammals and sea turtles

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KEYWORDS
Marine mammals, sea turtles, marine debris, entanglement, ingestion, fishing gear, plastic

BACKGROUND

Marine debris is one of the most pervasive pollution problems plaguing the world's oceans. Although, in principle, the problem of marine debris is solvable, evidence indicates that the problem is increasing, with significant implications for ocean wildlife. Numerous studies have reported on the threat that marine debris poses to ocean wildlife. Some cite interactions with individual animals; others are more comprehensive, tracking interaction trends for several species or species groups in a certain area over time. Reliable estimates of the total numbers of interactions are unavailable due to the unknown number and proportion of both unobserved and unreported interactions.

The most recent comprehensive reviews of marine debris impacts on ocean wildlife were Balazs (1985) for sea turtles and Laist (1997) for marine mammals and other wildlife species. They summarized reports primarily from peer-reviewed articles on types and numbers of interactions (entanglement or ingestion), species involved, and debris types. They also reported on which forms of marine debris or types of interactions appeared to be most hazardous to wildlife populations. They concluded that patterns of interactions differed by species, age, and life history, and that entanglement in marine debris was a more common source of mortality than is ingestion of debris for both marine mammals and sea turtles. Both types of interactions may be hindering recovery of certain species.

More recent studies have been published on sea turtle and marine mammal interactions with marine debris, but they continue to provide only a snapshot of the problem and are limited to certain species or geographic areas. The objective of this presentation was to provide a comprehensive and up-to-date global synthesis of available information on the impacts of marine debris on marine mammals and sea turtles. In particular, we sought to determine which species were reported as impacted by marine debris, the type of interaction, types of debris involved in those interactions, and data gaps.

METHODOLOGY

Data collection involved an extensive literature review and requests from researchers resulting in 78 articles or reports on marine debris interactions that have occurred since the earlier reviews. These articles describe everything from interactions with individual animals to region-wide studies. Reports of entanglements in fishing gear are sometimes difficult to ascribe to active vs. passive fishing gear, so we considered only those entanglement reports of entanglements in which authors specified that interactions involved derelict (vs. actively fished) fishing gear. Summary statistics were derived based on new information in those papers as well as data previously summarized by Balazs and Laist. For each journal article or report, we identified the species affected, type of interaction (ingestion vs. entanglement), and type of debris involved in reported interactions.

For both marine mammals and sea turtles, we summed the number of species reported with marine debris interactions. For marine mammals, species were sorted into one of six taxonomic groups (i.e., orders or suborders of marine mammals), and for each group, we summed the number of species in each of three interaction categories (i.e., entanglement, ingestion, or both) and affected by three broad categories of debris type (i.e., derelict fishing gear, plastic/other material, or both). Debris types were further subdivided into different types of derelict fishing gear (e.g. monofilament line, hook-and-line, etc.) and different types of plastic/other material (e.g., plastic bag, plastic sheeting, etc.). We then summed the number of species in each group reported as either entangled or having ingested debris and calculated the percentage of marine mammal species affected by the different types of debris for four possible interaction categories (entanglement in derelict fishing gear, ingestion of derelict fishing gear, entanglement in plastic/other material, ingestion of plastic/other material). Analysis of sea turtle data was similar, except all sea turtles were considered a single group. Reports consisted of a mix of single event accounts and systematic surveys, so interaction rates could not be determined.

OUTCOMES

Reports of interactions with marine debris were found for all 7 species of sea turtles and 54 of 120 species of marine mammals (IUCN 2010); an increase of 5 marine mammal species and 1 sea turtle species since previous reviews. While entanglement in derelict fishing gear is more commonly reported than ingestion, reports of ingestion of both derelict fishing gear and plastic/other material are increasing, especially for toothed whales and sea turtles.

For marine mammals, debris interactions were reported for 54% (7 of 13 species) of Mysticete (baleen) whales; 32% (22 of 68 species) of Odontocete (toothed) whales; 81% (13 of 16 species) of Otariids (eared seals); 47% (9 of 19 species) of Phocids (true seals); 50% (2 of 4 species) of Sirenians (manatees and dugongs); and the one species of marine Mustelid (sea otter). Overall, more marine mammal species were reported only as entangled in debris (n=25) than only having ingested it (n=18), whereas 11 species had reports of both types of interactions. Interactions with derelict fishing gear only was reported as affecting more marine mammal species (n=18) than interactions involving only plastic/other material (n=13), whereas 23 other species had reports of interactions with both types. Entanglement in derelict fishing gear was reported far more frequently as a species only type of interaction than was ingestion of derelict fishing gear (36 vs. 11 species). For plastic/other material, ingestion was reported far more frequently than it was for entanglement (27 vs. 12 species). The prevalence of different debris types that cause entanglement and ingestion based on the percent of affected marine mammal species is shown in Figures 1 and 2. The most commonly reported types of derelict fishing gear affecting marine mammals are nets, multi-strand rope, and hooks-and-line. The most commonly reported plastic/other material affecting marine mammals are plastic bags, plastic pieces, plastic sheeting, and rubber bands.

For sea turtles, all 7 species had reports of entanglement and ingestion. Interactions with both derelict fishing gear and plastic/other material were also reported for all species. Entanglements involving both derelict fishing gear and plastic/other material were reported for all species, while ingestion of both debris types was reported for 6 out of 7 species (no reports have yet to document ingestion of fishing gear by flatback turtles). The prevalence of different debris types that cause entanglement and ingestion based on the percentage of affected sea turtle species is shown in Figures 3 and 4. The most commonly reported types of derelict fishing gear affecting sea turtles are multi-strand rope, nets, hooks-and-line, and monofilament line. The most commonly reported plastic/other materials are plastic bags, plastic pieces, string/twine, and burlap bags. Sea turtles are also commonly reported with ingested tar/oil (although this is not typically considered marine debris).

PRIORITY ACTIONS

Marine mammals and sea turtles become entangled in and ingest all types of marine debris, particularly plastic/other material and derelict fishing gear. UNEP (2009a; 2009b) has recommended development of international policies and regional action plans to minimize all sources and types of debris. To maximize mitigation of impacts on marine mammals and sea turtles, those plans should emphasize efforts to minimize derelict fishing gear (including recreational gear) and commonly ingested plastic items.

Only a handful of studies have attempted to quantify numbers of animals within an area or species affected by debris, or the sex and age classes of species most vulnerable. More comprehensive risk assessments and systematic, routine monitoring of marine debris sources, types, and interaction levels in all marine mammal and sea turtle habitats are needed to address these data gaps. Population level assessments of debris impacts are also needed.

FIGURES AND TABLES

Fig. 1: Percentages of Marine Mammal Species Reported as Affected

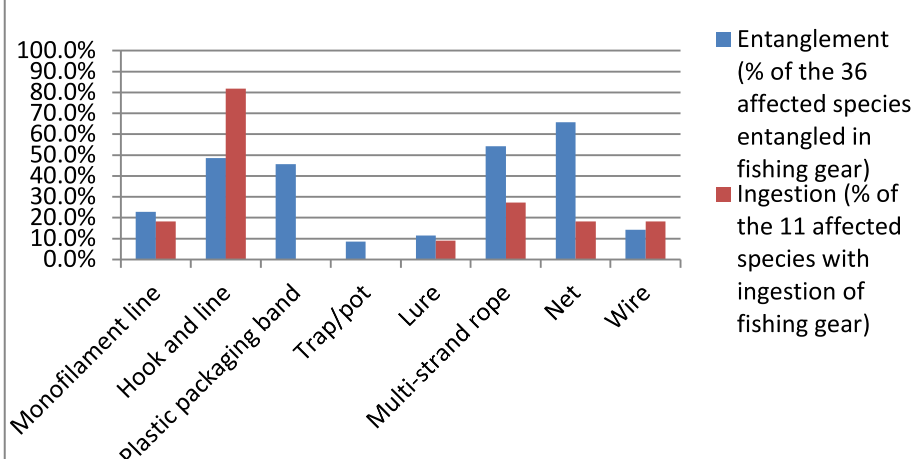


Fig. 2: Percentages of Marine Mammal Species Reported as Affected by Different Types of Plastic/Other Material

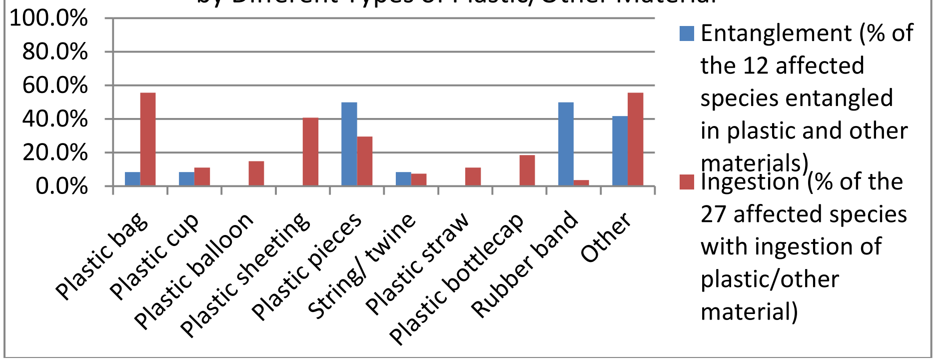


Fig. 3: Percentages of Sea Turtle Species Reported as Affected by Different Types of Derelict Fishing Gear

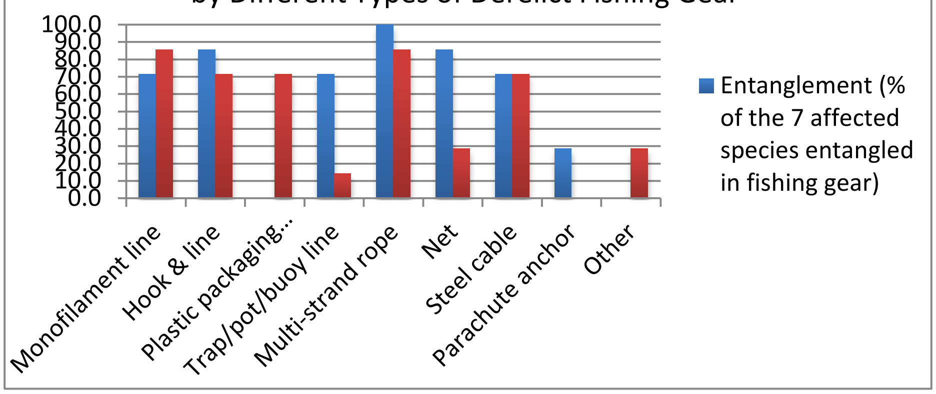
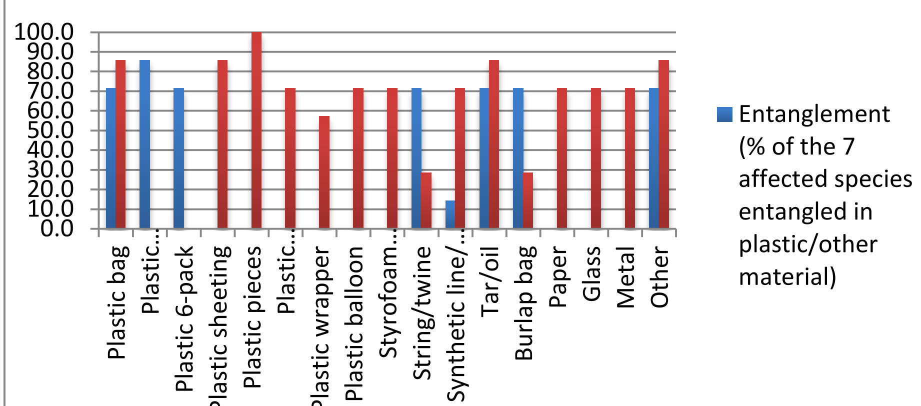


Fig. 4: Percentages of Sea Turtle Species Reported as Affected



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12.c.2. Microbial comparison of epibiont communities on *Sargassum* and plastic debris vs. surrounding water in the North Atlantic gyre

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KEYWORDS

Sargassum, Phycosphere, Plastisphere, Plastics, Marine Debris, pyrosequencing, V6-V4

BACKGROUND

The International Census of Marine Microbes (ICoMM) has characterized the microbial diversity of many marine habitats over the past 6 years (Amaral-Zettler, Artigas et al. 2010). However, the number of studies focused on substrate-associated communities has been minimal. *Sargassum* is a natural and abundant substrate in oligotrophic areas of the Atlantic Ocean. Plastic debris is another abundant substrate of anthropogenic origin in the marine environment that is receiving increased attention (Law, Moret-Ferguson et al. 2010). During a dedicated research cruise by the Sea Education Association (Woods Hole, MA) in July of 2010, we collected replicate samples of microbes from seawater, *Sargassum*, and plastic debris in the North Atlantic gyre. In this study, we present preliminary data comparing the microbial diversity and community membership from these samples based on pyrotag sequencing of the V6-V4 hypervariable region of the 16S rRNA gene. We investigated the hypothesis that *Sargassum* and plastic marine debris represent distinct diversity hotspots in a sea of relatively low-diversity oligotrophic waters.

METHODOLOGY

We collected water in a sterile 1 liter polyethylene terephthalate bottle from the Sea Education Association (SEA) vessel R/V *Corwith Cramer* as part of SEA research cruise C-230. Plastics and *Sargassum* were collected in a neuston net at the same time as the water sample from a clean seawater system drawing water from 3 m below the surface. We filtered water samples through a 0.2 µm Sterivex™ filter (Millipore) and flooded the filters with 2.0 ml of Puregene lysis buffer (Qiagen, Valencia, California). Plastic and *Sargassum* were aseptically removed from the cod-end of the tow and placed in 1 ml of Puregene lysis buffer. All samples were stored in liquid N_2 until transported to the laboratory in Woods Hole. Our polypropylene, *Sargassum* and water samples were collected simultaneously on July 7, 2010, while the polyethylene sample was collected on June 21, 2010. We extracted DNA using a modified bead-beating approach in combination with the Puregene Tissue DNA extraction kit.

We amplified bacterial V6–V4 hypervariable regions using primers targeting the 518 and 1046 regions the bacterial 16S rRNA gene. We multiplex-sequenced the resulting amplicons with a barcoded primer strategy (Huber, Mark Welch et al. 2007) on a 454 Genome Sequencer FLX (Roche, Basel, Switzerland) using the manufacturer's suggested amplicon protocol for the GS-FLX –Titanium platform. We trimmed sequences of adapter and primer sequences and removed low-quality reads as described previously (Huse, Huber et al. 2007) and assigned Operational Taxonomic Units (OTUs) or species equivalents using the 2% single linkage preclustering and pair-wise alignment with average linkage clustering method (SLP-PWAN) described by Huse et al. (2010). Three percent cluster widths were used for all data analyses. We used tools available in R (R Development Core Team, 2010) to calculate Venn diagrams and plotted the results using the Venn Diagram Plotter (http://ncrr.pnl.gov/ or http://www.sysbio.org/resources/staff/). We estimated species richness using parametric richness estimation as implemented in the CatchAll Program (Bunge 2011 (forthcoming)). CatchAll estimates the total number of observed and unobserved species using a variety of competing model fits and model assessments based on frequency count data. We corrected the 95% confidence intervals for multiple comparisons using a Bonferroni correction.

OUTCOMES

Our findings to date require us to reject our hypothesis as originally conceived since we observed more species in our seawater sample than either of the plastics samples or the *Sargassum* sample (Figure 1). The reasons for this may in part be to due to unequal sampling efforts between samples (i.e. we recovered ~16,000 reads from our seawater sample but only ~7,000 reads from our polypropylene sample). However, while we did not observe more species in the plastics or *Sargassum* samples than in our seawater sample, parametric diversity estimates (Figure 2) revealed that when one extrapolates from the sample to the population, all of our confidence intervals overlapped indicating that our samples may be equally diverse. It is important to note that while there are some shared OTUs between all of our samples (Figure 1), the majority of OTUs are unique to each sample. This demonstrates that the microbial communities associated with plastics and *Sargassum* are quite distinct from those in the surrounding surface water. We also found that while all samples contained an OTU assigned to SAR 11 (Candidatus *Pelagibacter*), considered to be one of most abundant heterotrophic bacteria in the ocean, this was not the most abundant OTU in all of our samples. Quite surprisingly, the most abundant OTU found in our polyethylene sample was an OTU assigned to the genus *Vibrio*. Although endemic to the marine environment, the genus *Vibrio* has several members that are human and animal pathogens. Our findings highlight the importance of better understanding microbial populations associated with the phycosphere and the "plastisphere" in our oceans.

PRIORITY ACTIONS

Our study emphasizes that plastics and *Sargassum* provide substrates that support microbial communities in the ocean. The fact that these communities are distinct from the surrounding water column suggests that they may serve a unique ecological role in the water column and warrant further investigation.

FIGURES AND TABLES

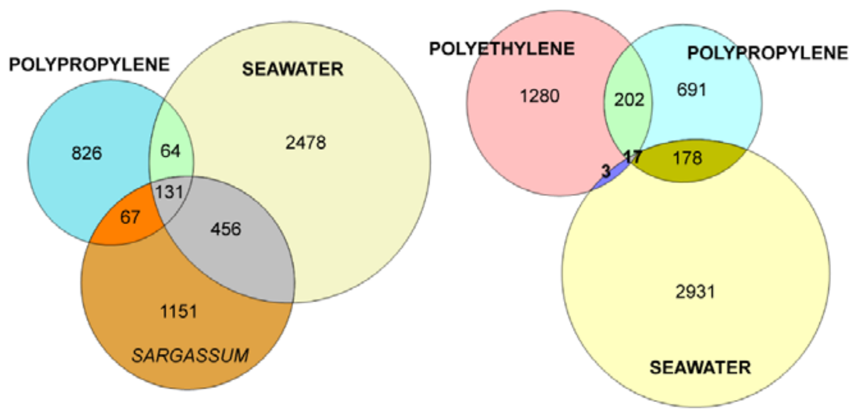

Figure 1. Venn diagrams depicting the number of shared OTUs between samples and OTUs unique to each

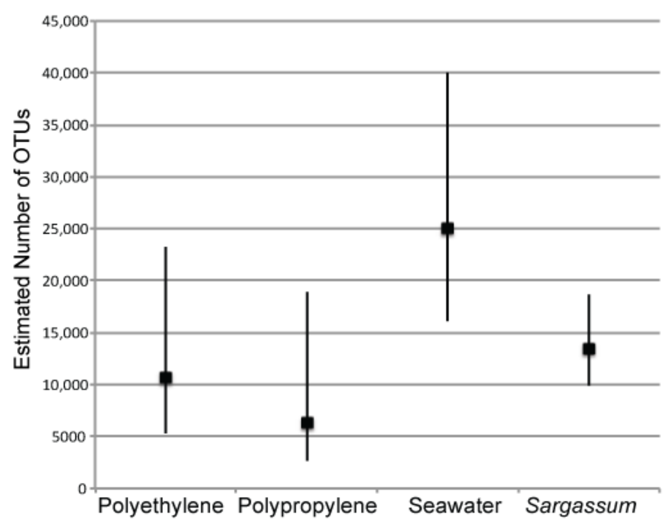

Figure 2. Alpha diversity based on parametric estimates of species richness for plastics, seawater and *Sargassum* samples. Bonferroni-corrected confidence intervals

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12.c.3. Plastic ingestion and cephalopod prey selection in Pacific northern fulmars (*Fulmarus glacialis*) collected in Monterey Bay, California in 2003 and 2007: are plastic and prey correlated?

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KEYWORDS
Northern Fulmar, cephalopod beak, plastic, ingestion, diet, California, Fulmarus glacialis

BACKGROUND

Northern Fulmars forage along the California coastline during the non-breeding winter months. They feed primarily on squid and fish, with some intake of offal and marine carcasses (Baltz & Morejohn 1977, Hariington-Tweit 1979, Hunt et al. 1981, Sanger 1983, Hills & Fiscus 1988). Fulmars are opportunistic feeders that forage at the surface, therefore, they are susceptible to ingesting floating plastic and debris (Van Franeker & Meijboom 2002, Nevins et al. 2005, Mallory et al. 2006).

Previous studies suggest direct and indirect health effects are associated with ingested plastics. Documented effects include reduced hunger (satiety), internal blockage, contaminant accumulation, and negative correlations between bird fat indices or mass in relation to ingested plastic (Pettit et al. 1981, Day et al. 1985, Zonfrillo 1985, Frey et al. 1987, Pierce et al. 2004, Mallory et al. 2006). Inability or difficulty regurgitating hard material (plastics and prey parts) can interfere directly with the bird's digestion causing gastrointestinal blockage (Day 1980, Pierce et al. 2004) or indirectly by reducing feeding stimulus and activity (Sturkie 1965 as cited in Azzarello & Van Vleet 1987). Unlike most seabird species, Northern Fulmars have a constriction between the gizzard and proventriculus making regurgitation improbable (Furness 1985, Azzarello & Van Vleet 1987). As a result, plastics and prey hard parts are retained for an unknown amount of time.

In addition to the constriction, the gizzard is relatively small and susceptible to distension in individuals carrying large plastic loads. Distension of the gizzard in fulmars may lead to decreased stomach contractions (Day 1980). Contractions signal the absence of food, therefore, hunger and foraging effort would decrease as plastic loads increase (Connors & Smith 1982, Day et al. 1985, Ryan 1988). In addition to satiation effects, accumulated plastics may reduce maximum food load (volume of food that can be ingested in one foraging bout; Van Franeker & Meijboom 2002). Presently, evidence for satiation effects are difficult to attribute solely to plastic ingestion. However, decreased sense of hunger, decreased urge to forage, and a decrease in ingested volume of food will negatively affect the condition of the bird, eventually resulting in mortality (Pierce et al. 2004).

If greater plastic loads lead to reduced hunger or foraging efficiency in Northern Fulmars, a change in prey (i.e. different size classes, species, frequency of occurrence etc.) may occur. Researchers have not examined the possible correlation between Northern Fulmar plastic loads and prey species although plastic loads may be influencing the types of prey ingested or vice versa.

METHODOLOGY

Northern Fulmars that washed ashore in the Monterey Bay area in 2003 and 2007 were collected, necropsied, and sampled. Stomachs were collected and organs were checked for obvious problems or diseases and scored from zero (poor condition) to three (good condition; Van Franker & Meijboom 2002). The stomachs were processed to collect all prey parts, plastics and other remaining non-food hard particles. The stomach contents were sorted into categories (prey, natural items, user plastics, industrial plastics, etc.), enumerated, and weighed (Van Franker & Meijboom 2002). Cephalopod beaks were identified via measurements, physical descriptions, reference collections, and literature sources (Clarke et al. 1986, Walker unpublished source 2009, MLML reference collection).

Histograms of cephalopod Lower Rostral Lengths (LRL), Estimated Mantle Lengths, (mm), and Mass (g) were created using beak measurements and regression equations from published sources and in press sources. A Percent Similarity Index (PSI) compared identified cephalopod species between the collected years. Canonical correlation analysis tested for correlations between the number and mass of the plastic categories and the number of beaks in the samples of both years.

OUTCOMES

For 2003 Fulmar samples, the mean number of total plastic pieces per stomach was 8.98 (SE = 0.633), user plastic was 6.56 (SE = 0.523) and industrial pellets was 1.37 (SE = 0.133). The mean mass of total plastic pieces per stomach was 0.149 g (SE = 0.012), user plastic was 0.106 g (SE = 0.008) and industrial pellets was 0.027 g (SE = 0.003). In the 2007 Fulmar samples, the mean number of total plastic pieces per stomach was 22.24 (SE = 1.97), user plastic was 12.44 (SE = 0.896) and industrial pellets was 1.43 (SE = 0.143). The mean mass of total plastic pieces per stomach was 0.468 g (SE = 0.084), user plastic was 0.229 g (SE = 0.039) and industrial pellets was 0.02799 g (SE = 0.003).

Fulmar diet was similar in both years (PSI = 78.73) indicating a reliance on Gonatidae cephalopod species. The five dominant species were Gonatus onyx (144), Gonatus pyros (132), Gonatidae spp. (56), Gonatus californiensis (48), and Chiroteuthis calyx (32) in 2003 (n = 542). Similarly, Gonatus pyros (150), Gonatus onyx (83), Gonatus californiensis (49), Gonatidae spp. (40), and Gonatus berryi (24) were dominant in 2007 (n = 523). In 2003, average LRL was 3.76 mm (n = 474), whereas in 2007 average LRL was 3.80 (n = 457). Based on the average LRL(s), the estimated average dorsal mantle length of cephalopods was 94.39 mm in 2003 (range 9.03 – 325.72) and 97.82 mm in 2007 (range 7.69 – 336.88). The estimated average mass of the cephalopods was 75.27 g in 2003 (range 0.08 – 1712.20) and 98.12 g in 2007 (range 0.08 – 1712.20).

The Canonical Correlation Analysis indicated a significant negative correlation based on the p-value (p = .001) and the canonical weights and loading factors. The correlation was even stronger when 5 outliers (2 cases from 2007 and 3 from 2003) and non-independent variables were removed (p = 0.0003).

In summary, these results suggest a reliance on Gonatidae cephalopods in both years and a significant negative correlation between number of cephalopod beaks versus number and mass of plastic pellets and user fragments found in Pacific Northern Fulmar stomachs. Indirect impacts of plastics are difficult to assess, but could manifest as changes to a bird's foraging strategy. This research is an initial step in detecting changes that are occurring in fulmars that are ingesting plastic with their prey. Current trends in plastic ingestion by Fulmars is better understood when prey items are examined concurrently because this research suggests intake of plastic and prey is correlated. This study is the first to examine if there is a relationship between identified prey species and amounts of plastic debris in Northern Fulmars.

PRIORITY ACTIONS

We suggest that to further understand plastic ingestion, researchers should examine prey and plastic items simultaneously because these variables may not be independent of each other. We suggest that pelagic foragers with high incidences of plastic ingestion, such as Fulmars, should serve as bio-indicators to monitor the marine debris in prey and debris convergence zones.

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12.d.1. Large scale monitoring of surface floating marine litter by high resolution imagery

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KEYWORDS
Marine Strategy Framework Directive, MFSD, marine litter, debris, surface floating, large scale monitoring, high resolution camera, image processing, recognition

BACKGROUND
The European Marine Strategy Framework Directive (2008/56/EC) provides for the protection of European marine waters and aims at achieving good environmental status in the European marine environment by 2020. Within that framework, Marine Litter is one of 11 Descriptors for the state of the marine environment:
Descriptor 10: Properties and quantities of marine litter do not cause harm to the coastal and marine environment.
As provided for in the Commission Decision adopted by EU Member States on 1.9.2010 (2010/477/EU) [1], Member States are required to monitoring Marine Litter in various compartments of the sea in order to assess the environmental status. Surface floating litter is among the indicators to be considered:
"- Amount and composition of litter in the water column - including floating and suspended litter - and accumulation on the sea floor. The attribute will measure litter dynamics and potential interactions with marine life. Accumulation areas will be located."
Surface floating litter poses a direct threat to marine wildlife and is a source for beach and seafloor contamination, while being a source of micro litter in all compartments [2]. The abundance of floating debris is typically estimated by direct observations, by net trawls or by aerial surveys [3]. There is however a clear need to develop cost-effective monitoring methods covering large areas for small sized debris in the decimeter and centimeter range. While that marine litter fraction cannot be detected through aerial surveys, it cannot be quantified on longer transects by net trawls due to the involved operational costs.

Surveys should be made frequently and cover wide areas in order to provide a large scale assessment to cover the regional dimension of marine litter pathways. Large scale surveys are also needed in order to identify areas of accumulation in open sea.

METHODOLOGY
A camera system "Sealittercam" was developed in order to monitor small marine debris from board of ship of opportunities covering repeatedly large areas. A 16 megapixel CCD camera (SVS-Vistek, Germany) was used to acquire the high resolution pictures of the surface water in

front of a cruise ship (Costa Pacifica, Costa Crociere, Italy). The camera was mounted in a protective casing on the bow and pointed vertically to the sea surface from 16 m elevation, covering an area of 7.7 x 11.5 m. The images were taken at a rate of 1/second, creating thus a continuous sequence of surface pictures. The system was tested on a cruise around the Western Mediterranean Sea. During the one week test from 30.8.-6.9.2010 variable light, wind and sea conditions were encountered. Experiments at various ships speeds and camera settings have been performed. The exact geographical coordinates have been recorded continuously for georeferencing of the images. Images have been stored on hard disk drives (2x2 Terrabytes) for later processing.

Images are processed through object-based image analysis software. The algorithms for the debris detection by software (e-cognition, Trimble, Munich, Germany) have been developed based ona set of selected images with identified debris such as plastic bags, bottles, etc.. The software sorted images into categories according to their basic properties, such as brightness and occurrence of interferences such as reflections and wave crests. The system flags then images containing possibly marine debris for visual inspection.

OUTCOMES

A total of 78000 pictures has been acquired during a 1 week cruise starting in Savona, Italy, with stops in Barcelona (Spain), Palma de Mallorca (Spain), Tunis (Tunisia), Valletta (Malta), Catania (Italy), Civitavecchia (Italy) and returning to Savona.

This survey included very different environmental conditions such as brightness, light direction, sea state and wind direction/speed. Exposure times of down to 160 µs proved to be necessary for achieving the required image quality at cruising speed of ca. 30 km/h with image gain techniques providing the necessary sensitivity.

As cruises typically visit cities during day and travel mostly overnight, the transects which can be used for image acquisition consist of stretches of variable lengths varying between only few hours at dusk or dawn and providing only occasionally whole days cruising. The intensity of available light varies therefore extremely during image acquisition and includes situations of strong sunlight reflections as well as shades created by sun in cruise direction or low sun with strong coloration. The optical properties of the seawater changes accordingly in a wide range. While waves and water movement caused by the ship could be avoided due to the positioning of the camera on the bow and the stability of the 290 m vessel, already light winds (2-3 beaufort) can cause small wave crests and resulting bubbles which remain stable for a longer time. These disturb the detection as they are difficult to differentiate from white flakes of plastic.
Surface reflections in waves, foam and bubbles formed at higher windspeed showed to be limiting factors.

The system can recognise floating or slightly submerged material of different colours and shapes. Marine litter down to centimeter size can be observed and counted with the system.

Images have been categorised into smooth sea surface images, images with non debris articfacts, such as reflections or wave crests or bubbles and images containing possibly marine debris. Quantification and mapping of the debris is under development.

An autonomous camera with integrated wind speed/directions and light meter will be installed as next step. The reliability of debris identification will be enhanced by the acquisition at 4 images per second. This allows the multiple detection of debris and therefore the distinction from bubbles and foam.

Acknowledgements: The camera has been provided for test purposes by SVS.Vistek, Germany. Many thanks for the kind invitation on board by Costa Crociere S.P.A. and to the Ship Superintendent Vincenzo Galati. A special thank to the crew of the Costa Pacifica, in particular to Chief Engineer Giuseppe Bertolino, Staff Engineer Eugenio Esposito and Electronic Engineer Eligio Arvotti for their kind support.

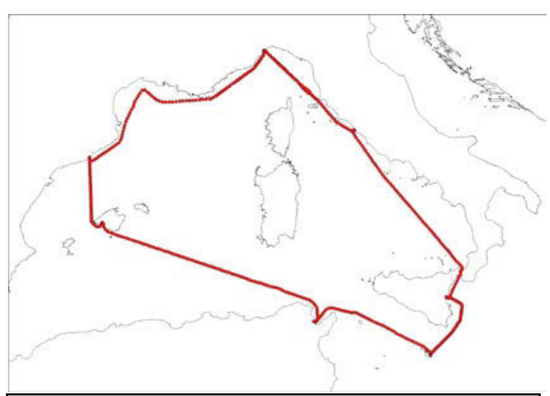
PRIORITY ACTIONS
Develop cost effective large scale assessments which provide comparable data to be used for trend assessments and source area identification.

FIGURES AND TABLES

Costa Pacifica with indication of surveyed area

Sealittercam in housing mounted on bow

Example of sea surface image with detected debris



Route of Costa Pacifica in Western Mediterranean Sea, Summer 2010

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12.d.2. SCUD – ocean surface current product in aid to pelagic marine debris studies.

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KEYWORDS
surface currents, convergence zone, debris pathways and accumulation, garbage patches

BACKGROUND

Marine debris and long-living plastic in particular are becoming increasingly important environmental issue. Debris driven by ocean currents can travel large distances across the oceans, but observation of their trajectories are extremely limited. For practical applications a large number of trackable debris markers would be necessary. Deployment of such large number of markers is very difficult, if not practically impossible. The problem of this study can be stated as follows: " Can satellite and in situ observations be utilized in assessment of marine debris trajectories?"

METHODOLOGY

The motion of marine debris is studies by numerical experimentation with surface ocean currents. The surface currents are assessed by a simple diagnostic model SCUD (Surface Currents from Diagnostic Model, Maximenko and Hafner, 2010). The model utilizes remote sensing data to determine daily maps of geostrophic and wind driven – Ekman- currents, of which the total current is comprised. The geostrophic currents are determined from satellite measured sea level anomalies (distributed by AVISO) and the wind driven currents are determined by QuikASCAT measured surface winds. Over 10 years of daily maps of surface currents were completed on ¼ degree latitude/longitude grid. Then they were utilized to construct patterns of marine debris distribution after years of advection by model currents. As the first experiment we released over 476,000 particles evenly distributed in the model domain. The initial location of the particles matched the ¼ degree latitude/longitude SCUD model grid. Then the model was integrated over 10 years starting on August 1999 through November 2009.

OUTCOMES

The trajectories of model particles constructed by integration of SCUD currents over 10 years reveal the formation of five main convergence zones in the North and South Atlantic, South Indian and North and South Pacific Ocean. Figure 1 shows the final locations of model particles concentrated in the five convergence zones. This is consistent with results of statistical modeling by Maximenko et al. 2011. Similarly the integration of the model can be applied backward in time to determine origins of the particles. A combination of forward and backward model integration can be used to determine characteristic structure of particle patches. This is an important factor in tracking debris and in clean-up operation in the open ocean.

The relatively high resolution of SCUD currents (¼ degree) allow us to resolve the fine structure of the debris distribution in space. Figure 2 demonstrates that the model particle concentration in the area northeast of Hawaii (corresponding to so-called North Pacific Garbage Patch) is far from uniform, even after 10 years of advection by SCUD currents. Persistent mesoscale oceanic eddies (resolved by SCUD model) "stir" particles during the model integration and result in patchy particle distribution. The particle field exhibits elongated lines of high concentration which alternate with almost clear areas. This patchy character is no surprise to observers collecting samples in central patch areas. Also it partly explains a high level of noise observed in surface trawl data. Not only the field of floating debris is of relatively low concentration, but also it is highly variable in space and time. There are relatively large areas void of debris even within the most concentrated patches.

PRIORITY ACTIONS

For SCUD to be an operational tool for marine debris research and management, the following points are needed to be addressed:

- operational SCUD product requires QSCAT to be replaced by ASCAT winds
- global inventory of marine debris sources and sinks in the ocean and on shore is needed
- effect of vertical mixing on floating debris should be included in the SCUD model
- coastal dynamics processes, esp. high frequency and debris deposition processes need to be considered in the model
- validation of SCUD model by in situ data

FIGURES AND TABLES

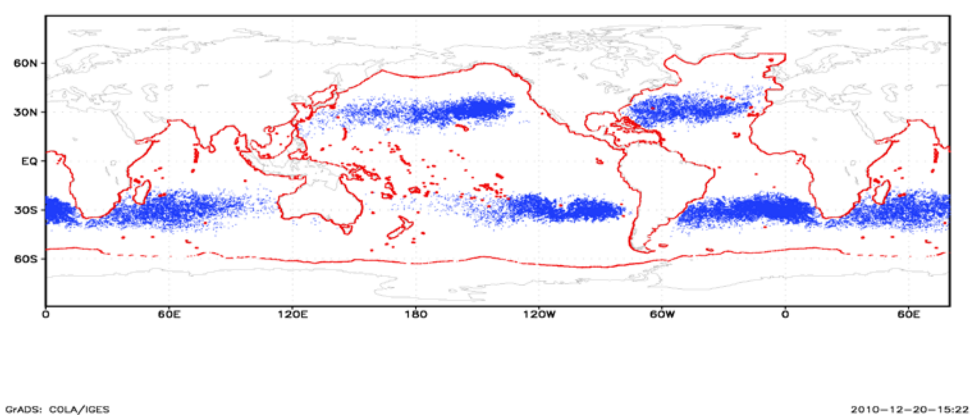

Figure 1. The November 2009 locations of 476,015 particles released on August 1999 from uniform ¼ degree distribution. The particles were advected by SCDU currents for over 10 years. Still floating particles are depicted in blue, particles that have been washed on shore are shown in red. (Note that the "liquid" boundaries in the model domain in the Southern Ocean, North Pacific, North Atlantic and Indonesian Seas are treated by SCUD as a "shore".)

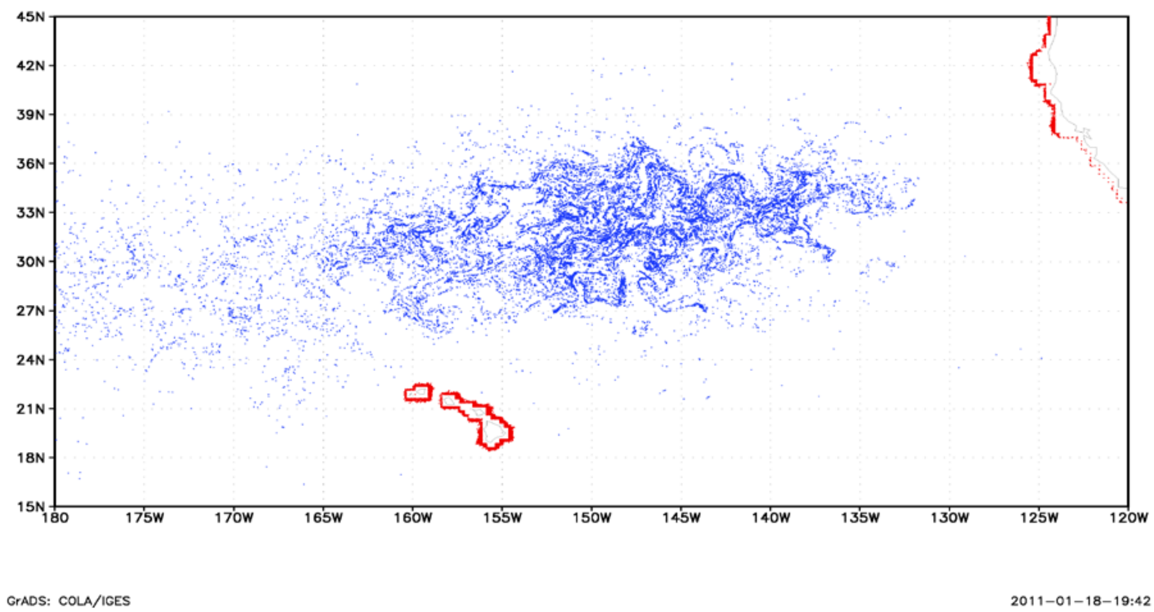

Figure 2. Samer as Fig. 1 but for the North Pacific.

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12.d.3. Aerial marine debris costal survey method and standardization

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ABSTRACT
Aerial surveys provide a valuable data set for assessing marine debris concentration and distribution along coastlines. The data gathered is often project specific and tailored for individual need requirements. These data are relatively expensive to obtain and often are not compatible with other aerial survey datasets. By establishing a suggested set of survey techniques and standards for aerial surveys, data gathered could be useful to various agencies and decision makers. Proper aerial survey methodology and techniques will provide a minimum level of safety and give assurance that the coastline is adequately being surveyed. These methods need to take into consideration numerous factors including: aircraft type, pilot proficiency, survey direction and route, weather, seasonal concerns, sun angle, airspace restrictions and terrain. By establishing a set of standards for data acquisition, the data gathered can be shared across various groups, either eliminating the need for redundant surveys or to compliment and value add to future survey data sets. Standards to be considered include: sensor type, image resolution, data recording, GPS integration, camera mounts and views, GIS integration and data storage. By using basic standard methods, aerial data sets can be shared today and useful for future decision makers looking at temporal change.

12.d.4. Remote sensing for marine debris detection – GhostNet project experience in the North Pacific Subtropical Convergence Zone

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KEYWORDS
GhostNet, derelict nets, remote sensing, North Pacific, Subtropical Convergence Zone, Transition Zone Chlorophyll Front, Debris Estimated Likelihood Index

BACKGROUND

Marine debris, especially lost or abandoned fishing gear, is recognized as a serious threat to fish, sea and shore birds, sea turtles, and marine mammals. Young curious seals, such as Hawaiian Monk Seals and Northern Fur Seals, are especially vulnerable to entanglement and drowning (Fowler, 1987). In addition, grounded nets damage reef and beach environments (Donohue et al., 2001; Dameron et al., 2006). The goal of the GhostNet project (a partnership of industry, Government, and academia) is the detection of derelict nets at sea through the use of ocean circulation models, wind analyses, drifting buoys and satellite imagery to locate convergent areas where nets are likely to collect, followed by airborne surveys with remote sensing instruments to spot individual derelict nets. After a study of historical reports of marine debris and known debris circulation patterns, it was decided that the project would concentrate on the Gulf of Alaska and the North Pacific Subtropical Convergence Zone north of Hawaii. The components of the GhostNet Project were first tested together in the field during a 14-day marine debris survey of the Gulf of Alaska in July and August 2003. Model, buoy, and satellite data were used in flight planning. A manned aircraft survey with visible and infrared cameras and a LIDAR instrument were used to survey for debris in targeted locations. It was decided to concentrate on observing frontal areas such as the shelf-break front and eddies as likely areas for the concentration of marine debris, and information on the location of these areas was provided to the flight crew prior to each leg of the observation flights. A total of 76 individual observations of debris of anthropogenic origin were logged during nine flight legs. Debris was predominately observed close to shore, in frontal regions, behind islands extending into the Alaska Coastal Current and in long-lived eddies. Very little debris was observed in the open Gulf of Alaska, except in the eddies. Techniques for detection of possible convergent areas, techniques for observing marine debris, and lessons learned from the Gulf of Alaska survey were all refined and utilized with success in a subsequent major GhostNet field program in the North Pacific Subtropical Convergence Zone in March and April 2005. The ultimate purpose of these field programs was to develop and test techniques for the efficient and cost-effective detection and tracking of marine debris at sea, leading to an operational technique of locating and removing marine debris before it impacts precious coral reefs.

METHODOLOGY

The methodology for locating marine debris in the open ocean is a many-faceted approach. Ocean circulation models and ocean drift models suggest that debris in the North Pacific will be preferentially concentrated along an east-west region north of the Hawaiian Islands (Kubota, 1994) that coincides with the North Pacific Subtropical Convergence Zone (STCZ). The STCZ is located between 23°N and 37°N, and varies in location seasonally. The Transition Zone Chlorophyll Front (TZCF), which is a frontal region with high chlorophyll gradient separating unproductive tropical waters from the highly productive waters of the North Pacific Transition Zone, generally coincides with the STCZ in winter and spring. The TZCF can be tracked from the position of the 0.2 mg/m^3 chlorophyll *a* isopleth and the 18°C isotherm (Bograd et al., 2004). Since the maximum convergence occurs in winter, it was expected that debris would concentrate near the TZCF in winter and could be observed in early spring, as soon as the winds died down and the debris floats to the surface where it could be spotted. Some buoys were deployed and tracked in order to observe circulation patterns; however, the most important information on possible search areas were 14-day composites of sea surface temperature (SST) obtained from the Geostationary Operational Environmental Satellite (GOES-10), and chlorophyll *a* (Chl*a*) measurements obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument flown on the NASA Earth Observing System Aqua platform. These composites provided the general search area coordinates. Wind information from satellites and meteorological models were used to determine areas where weather conditions were favorable for debris searches (winds less than 15 m/s). A Lockheed WP-3D (NOAA P3) aircraft made one test flight and three observation flights out of Honolulu between March 18, 2005 and April 3, 2005, north to the regions identified as areas likely to contain concentrated debris. Once in the suspected debris areas, the aircraft was flown at an altitude of 300 m at a speed of 100 m/s. Between four and six observers made and recorded visual observations. Most sightings were made by the pilots and by observers at windows behind the cockpit on each side of the cabin. Additional observers near the rear of the cabin checked the performance of the primary observers.

OUTCOMES

Table 1 presents the number and type of debris objects observed. A total of 1885 individual observations were recorded including 122 derelict fishing nets, with the largest concentration of debris observed just north of the TZCF near 30^0N. The most common category of debris, by a wide margin, was fishing floats, typically foam "corks" and plastic buoys. Among the surprisingly large number of nets observed were two net bundles larger than 10 m in diameter.

From debris observations along the flight track, the debris density for each 6 minute period during the flight was calculated. These density values are plotted in Figure 1 on top of a background of Chl*a*. A rapid increase in debris observations north of the maximum Chl*a* gradient in higher Chl*a* waters is evident. In order to attempt to develop a diagnostic tool that could be used to prioritize search areas for future marine debris surveys, the debris density was converted to amount of debris per unit effort (DPUE), and correlated with satellite SST and chlorophyll measurements. The DPUE was significantly correlated with SST, Chl*a*, and Chl*a* gradient (with the last parameter having the highest correlation). With these three environmental parameters as input, a Debris Estimated Likelihood Index (DELI) was developed which provides a relative likelihood of finding debris in the STCZ north of Hawaii in spring (Figure 2).

PRIORITY ACTIONS

In 2008, a marine debris cruise to the STCZ attempted to use the DELI to guide debris detection from a ship and ship-launched unmanned aircraft system (UAS). The weather, unfortunately, was not cooperative with persistent cloudiness, low visibility, and high winds. There were not enough cloud-free opportunities to measure ocean color well, rendering the DELI unreliable. During that cruise, the GhostNet UAS had its first open-ocean tests, but no debris was sighted. Since that cruise, the UAS development has continued and accelerated in a project which will be completed in August 2011. Priority actions at this point are:

Test and validate the DELI under more favorable conditions with manned aircraft debris surveillance – preferably a debris mapping mission

Test new debris imaging sensors and anomaly detection software

Test the concept for operational debris detection and removal, consisting of a ship capable of recovering debris and launching/recovering the GhostNet UAS. The latter would be used to detect and report the position of debris in real time. Preferably utilize manned aircraft for validation during early proof-of-concept cruises.

Map marine debris in the North Pacific, preferably at various times of year. If possible, estimate the total volume of debris present in the open ocean.

Develop and validate ocean circulation and debris trajectory models with skill at predicting debris seasonal movements.

FIGURES AND TABLES

Type of Debris	Flight 2	Flight 3	Flight 4	TOTAL
Buoys	24	31	13	68
General Debris	29	86	158	273
Floats	201	560	631	1394
Lines	1	9	13	23
Logs	4	2	1	7
Nets	20	43	59	122
TOTAL	279	731	875	1885

Table 1 – Debris observed on three flights to the STCZ. Flights 2, 3, and 4 were March 27, March 29, and April 3, 2005, respectively (Pichel et al., 2007).

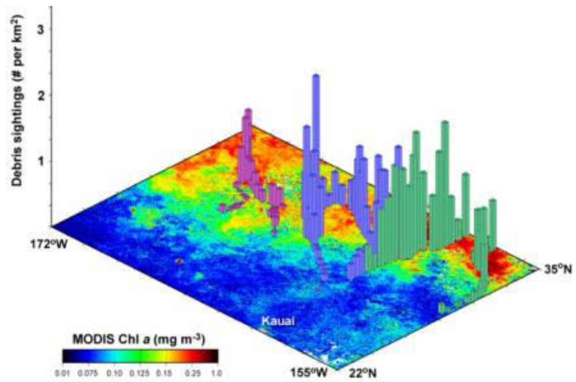

Figure 1 – Debris density for Flights 2 (red violet), 3 (green), and 4 (blue) plotted on a map of Chlorophyll *a* (Pichel et al., 2007).

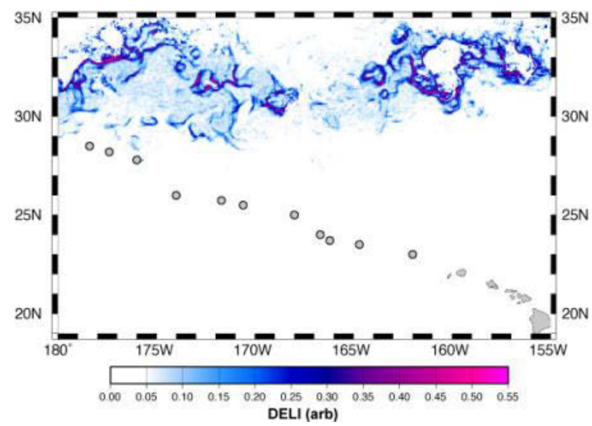

Figure 2 – Debris Estimated Likelihood Index (DELI). Grey dots are the Northwest Hawaiian Islands (Pichel et al., 2007).

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Poster Presentations

1. Improving coordination and communication for rapid response to marine debris reported on beaches and reefs around Oahu, Hawaii

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KEYWORDS
response and removal, inter-agency coordination, communication protocol, on-land and in-water marine debris, tracking mechanisms

BACKGROUND
Rapid response to reports of marine debris in the coastal environment is essential to minimize impacts to marine habitats and marine life. Complex jurisdictional mandates and lack of capacity to respond to reported accumulations of marine debris on beaches and reefs impedes rapid response to marine debris. Coordination and communication is essential for a streamlined response to marine debris removal. The Rapid Response to Marine Debris Project was conducted to improve coordination and communication among government agencies responsible for marine debris removal on the beaches and reefs around Oahu. This project relates to two priority activities under Strategies 1.2 and 1.3 in the Hawaii Marine Debris Action Plan (HI-MDAP) (NOAA, 2010).

METHODOLOGY

(1) Identified agencies and organizations (*responders)* that receive or respond to reports of found marine debris on land or in nearshore waters.
(2) Gathered information on the existing methods and resources used by responders for rapid response to marine debris.
(3) Identified challenges that affect rapid response and made recommendations to support improved coordination for rapid response to non-hazardous marine debris.
(4) Prepared a Memorandum of Understanding between primary responders to facilitate collaboration and resource sharing.
(5) Prepared a responders handbook with information on each agency, existing protocols and coordination mechanisms, maps showing jurisdictional boundaries, and assets available for removal.

OUTCOMES
The project findings identified several challenges that affect rapid response and also resulted in significant outcomes. A Memorandum of Understanding between primary responders was

drafted to facilitate collaboration and resource sharing. A reporting system and communication protocol were developed for processing and responding to reports of marine debris. In addition, a secondary support network of other government agencies, non-profit organizations, and additional unique resources (e.g., inmate work program) were identified to assist with marine debris response and removal efforts.

PRIORITY ACTIONS

- Develop inter-agency communication and coordination protocols for government agencies on Oahu to improve rapid response and removal of marine debris found on land or in nearshore waters.
- Document resources expended for rapid response to marine debris to demonstrate the potential need for additional funding.

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2. Success story of limiting land based sources of debris

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ABSTRACT
A joint cleanup program initiative has been taken with a partnership between a sponsor, service provider and local government after our cleanup program happened in our mostly crowed beach of Bangladesh. Now an average beach looks pretty cleaner than ever before. Within some time, I voluntary program will be lunched for daily/weekly basis cleanup for land based debris. Local school and college has been already addressed for the initiative and it's a proven with time. Local educational institutes have engaged with our yearly International Coastal Cleanup since 2006.

3. An innovative use of a "capture cage" to disentangle California sea lions, Zalophus californianus, in Oregon

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KEYWORDS
Entanglement, marine debris, packing band, California sea lion, *Zalophus californianus*, capture cage, Oregon

BACKGROUND
Thousands of marine animals die each year when they become entangled in marine debris and California sea lions (*Zalophus californianus*) are no exception. In Oregon, the most commonly observed materials entangling California sea lions are plastic packing bands. As the sea lion grows, these bands begin to cut deeply into the neck of the animal causing serious injury and sometimes death. Despite the fact that these sea lions haul-out less than 10 m from a public viewing dock, we have had no safe method to capture the sea lions and remove the entangling debris. These animals will not tolerate close approach without fleeing into the water. Moreover, administering anesthesia without concurrent restraint is deemed too dangerous for the animals since a sea lion injected with drugs by a pole or dart would likely jump into the water and drown before rescuers could get to it.

A new option to respond to entangled California sea lions was recently developed. In February 2010, a custom-built capture cage was deployed in Newport, Oregon adjacent to pre-existing floating docks commonly used as haul-outs for sea lions. The primary purpose of the cage is to "capture" entangled sea lions by providing a haul-out where the sea lion can be safely enclosed.

METHODOLOGY
This capture cage has been deployed specifically to address the problem of sea lion entanglement. The cage is basically a modified floating dock enclosed on four sides by a galvanized steel structure (2.8 m wide x 4 m long x 2.15 m high), with sliding guillotine doors on two sides. The door facing the water is locked in the open position so sea lions can come and go as they choose. The cage design was based on cages used by the Oregon Department of Fish and Wildlife for the capture of sea lions in the Columbia River. Once an entangled sea lion is sighted within the cage, responders approach the open door of the cage in a small boat. Once the boat is alongside the cage, the large door is unlocked and closed as quickly as possible. All sea lions confined within the cage are monitored for signs of excessive stress and/or aggression. If necessary, the doors of the cage can be opened to prevent injury to confined animals. The entangled sea lion is injected with a sedative via pole syringe through the cage wall. The individual is monitored for anesthetic response and once the animal is deemed sufficiently immobile, cage doors are opened to allow quick release of any non-target animals confined in the cage. Once all non-target animals are removed from cage, veterinarians and other responders

enter the cage to begin disentanglement and treatment of injuries. Cage doors remain closed to prevent other animals from entering the cage during the procedure. Once treatment is complete, veterinarians and other responders leave the cage and anesthesia is reversed by injection by pole syringe. The animal is monitored in the closed cage for response to reversal. Once the animal is deemed fully recovered from anesthesia, the cage doors are opened and the animal released.

OUTCOMES

To date, we have disentangled one adult male California sea lion with a plastic packing band deeply embedded in his neck. We had observed this individual for over one year but were unable to safely capture him until we had this cage. Plans are currently underway to install a webcam to monitor the cage for entangled sea lions so responders can expedite their arrival to the cage before the entangled individual jumps into the water.

PRIORITY ACTIONS

- Lose the loop – always cut and properly discard entangling loops that could potentially end up as marine debris.
- Develop biodegradable alternatives to plastic packing bands.

FIGURES AND TABLES

Figure 1. California sea lion entangled in plastic packing band on Newport, Oregon dock.

Figure 2. Capture cage with entangled California sea lion inside.

4. Marine debris and service learning

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KEYWORDS
Service learning, marine debris cleanups

BACKGROUND
Service learning is a requirement of many school systems. It is intended to inspire students to become active citizens in their communities. However, service learning often becomes work projects that have little meaning for the students and do little to inspire their ongoing involvement in their communities. Service learning is much more than picking up trash. It provides an opportunity for students to engage in marine debris related projects, and for marine debris to play a critical role in educating students about service, action, choice, and citizenship action.

METHODOLOGY
Service learning includes five stages and understanding how each stage works, especially in the context of marine debris, will make student based clean-ups more educationally relevant and environmentally effective. This poster will discuss how to frame marine debris clean-ups to meet service learning requirements, and to make student based marine debris clean up more meaningful.

OUTCOMES
The service learning process includes investigation, preparation, action, reflection, and demonstration.

In the investigate stage students inventory the resources they have that can help the marine debris problem. This includes an inventory of their skills, talents and interests. They also investigate community needs related to the marine debris problem to identify a specific need they will address. Students prepare by gaining background knowledge about the marine debris problem in general, and the specific aspect of the problem they wish to investigate. They find people and organizations that care about the marine debris problem, or the aspect of the marine debris problem they have identified, and they build a team of people that can help plan for action.

Once students have identified a marine debris related issue, and have gained background knowledge about that issue they are ready to act. Action can be direct service, indirect service, advocacy and/or research. Reflection is an important part of the service learning journey. Reflection relates the action back to the student and is important for deep learning and behavior change. Finally, students need to share their great work through demonstration. They review how they planned, what they did, how they reflected and then they tell their story to others.

Applying this service learning progression makes learning about the marine debris problem more relevant to students, affects meaningful action, and can result in positive environmental behavior change.

PRIORITY ACTIONS

Service learning is a teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility and strengthen communities. Service learning is not an episodic volunteer program or logging a set number of hours. Marine debris related investigations can meet the needs, outcomes and requirements of service learning if the full service learning sequence of investigate, prepare, act, reflect, demonstrate is followed. In addition, using the service learning sequence makes marine debris related projects more meaningful to students and are more likely to affect behavior change.

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5. Bringing marine debris education inland through community recreation centers.

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KEYWORDS
Inland, Community, Engagement

BACKGROUND
Currently, education is rarely developed for inland communities about the significance of preventing marine debris. There is an assumption that inland communities will not be able to connect their actions to potential impacts on marine environments. Data collected by The Ocean Conservancy revealed that an accumulation of marine debris can be linked to a variety of recreational activities along inland waterways. The long distance of inland communities to coastal areas can also lead to a disconnected style of education that hinders students' ability for exploratory and immersion learning which is essential in developing an emotional connection with an environment. Because these communities cannot easily experience coastal areas, programming needs to be developed to educate and engage landlocked residents about their roles and opportunities in becoming part of the solution.

METHODOLOGY
1. Develop a partnership with Parks and Recreation community to access their unique relationship with youth ages 6-18. (Partnership: Downtown Aquarium role: developed program to implement in the Recreation Center's summer and after school programs. Educators from the Aquarium taught content to students and followed up with an opportunity for them to visit the aquarium and explore exhibits that illustrate marine habitats).
2. "All Caught Up" exercise helped to encourage an emotional connection (the activity involves the students placing a rubber band around their thumb and pinky finger behind their hand. They then proceed to remove the rubber band without using anything to assist them. Their hand represents a marine animal and the rubber band represents a piece of marine debris. We discussed how anxious it makes us feel to not be able to remove the rubber band without being able to use our other hand, body, or mouth to assist. The anxiety we felt was uncomfortable but for us it isn't life threatening.
3. Colorado River Watershed Education: Introduced what it means to be a headwater state; followed water from mountains to ocean (explaining issue of how trash travels), showed the interconnectedness of all communities through the water cycle.
4. Coastal Commotion Art Contest: allowed participants to explore and express their understanding of introduced concepts.
5. Targets were community centers, summer programs, youth 6-18.

OUTCOMES

Developing programming through community centers has the ability to educate landlocked residents about the interconnectedness of watersheds and ocean environments. The first step is to make a tangible link between inland actions and our oceans. To do this, an outreach program titled "Coastal Commotion" was launched from Denver's Downtown Aquarium in the summer of 2010. This program encouraged its residents, ages 6 to 18, to utilize art to express their understanding and concerns about marine debris and their connectedness to the issue. The outreach utilized community centers and summer programs to increase awareness with both the youth that participated in the programs as well as the instructors. This style of programming was effective in engaging and stimulated both a change in attitudes and actions towards ocean conservation. Program implementers saw participants develop an emotional connection to marine environments and a clear understanding on how trash travels. This led to the second step which was a successful call to action of outreach participants by volunteering their time at the International Coastal Cleanup site in their community. They also pledged to become stewards of their local waterways. Utilizing the relationship of these centers with their communities can be a model for action oriented programming that can lead to a decrease of inland debris on marine environments globally.

PRIORITY ACTIONS

Utilize all international coastal cleanup coordinators in inland communities to develop partnerships with community centers. Implement programming that creates both exploratory learning and activities that create an emotional connection with marine environments.

REFERENCES

The Ocean Conservancy 2010 ICC Report

Colorado Watershed Map: Northern Colorado Water Conservancy District
www.NCWCD.org/project_features/location_map.asp

6. Google Earth tours: an engaging and effective tool for intermediate students to investigate and communicate marine debris issues

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ABSTRACT
TOPP (Tagging of Pacific Predators), a Census of Marine Life project, and NOAA are developing and piloting a variety of marine debris-related activities for the middle school classroom. These activities leverage and weave TOPP and NOAA resources to support middle school students' recognition of the negative impact of marine debris on pelagic predators. Students publish investigations through thoughtfully embedding a variety of relevant media (images, videos, texts, graphs, surveys, timelines, data tables, interviews) into Google Earth tours. Classroom implementation is facilitated through corresponding teacher workshops.

7. Nearshore seafloor mapping as a tool for developing curriculum-based marine debris classroom programs

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ABSTRACT

The Provincetown Center for Coastal Studies (PCCS) is conducting a 3-year, state-funded pilot project to develop nearshore seafloor resource characterization maps of Cape Cod Bay, Massachusetts. The project has mapped the seafloor in portions of Cape Cod Bay from the 10 m isobath to the shoreline in the towns of Provincetown and Truro. The Center acquired a state-of-the-art sonar system that allows these areas to be mapped in a third of the time compared with the previous generation of sonar equipment. This system provides seafloor bathymetry and coincident sidescan sonar imagery.

What these maps have shown during the first full field season is a plethora of lost fishing gear scattered along the seafloor near the port of Provincetown, MA. Using this sonar imagery, PCCS has developed a classroom program for two local area elementary schools to help identify various sources of marine debris. Using the sonar imagery, students are able to plot on nautical charts areas of underwater debris. Students also take part in beach surveys to determine types of debris found in the area, and if they are related to the ghost gear. Students determine what debris will most negatively impact local wildlife and design outreach material for the public.

8. Plastic ingestion by planktivorous fishes in the North Pacific Central Gyre

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ABSTRACT
A significant amount of marine debris has accumulated in the North Pacific Central Gyre (NPCG). The effects on larger marine organisms have been documented through cases of entanglement and ingestion; however, little is known about the effects on lower trophic level marine organisms. This study is the first to document ingestion and quantify the amount of plastic found in the gut of common planktivorous fish in the NPCG. From February 11 to 14, 2008, 11 neuston samples were collected by manta trawl in the NPCG. Plastic from each trawl and fish stomach was counted and weighed and categorized by type, size class and color. Approximately 35% of the fish studied had ingested plastic, averaging 2.1 pieces per fish. Additional studies are needed to determine the residence time of ingested plastics and their effects on fish health and the food chain implications.

9. Assessing impacts of benthic marine debris on coral communities in the inner Gulf of Thailand

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KEYWORDS
fishing gear, marine debris, coral community, Gulf of Thailand, management

BACKGROUND

Coral communities in the Gulf of Thailand support development of diving business as well as coastal fisheries. The ecological impacts caused by benthic marine debris are a serious concern to coastal managers and marine scientists in Thailand. However there were few data about assessing the effects of benthic marine debris on coral communities in the Gulf of Thailand. Abandoned fishing nets accounted for 90% of the collected marine debris (Pengsakun et al., 2010). This study evaluated the distribution and extent of marine debris, represented mostly by abandoned fishing nets, and quantified their impacts to reef associated sessile invertebrates in the inner Gulf of Thailand.

METHODOLOGY

The field surveys were conducted in 2009 – 2010 with emphasis on the coral communities in the vicinity of Pattaya, Chonburi Province. Within each study site, three randomly position transects were located. Abandoned fishing nets and other marine debris were surveyed by searching an area 1 m out from each transect side (Chiappone et al., 2005). Numbers of sessile invertebrates impacted were noted. Impacts from marine debris were various degrees of partial mortality of scleractinian corals, zoanthids and sponges.

OUTCOMES

The abandoned fishing net caused partial mortality on scleractinian coral colonies in a range of 16.7-50.0%. However certain coral species, such as *Platygyra pini*, *Goniopora columna* and *G. fruiticosa*, showed no impacts caused by the abandoned fishing nets. A zoanthid, *Protopalythoa* sp., was the most severely affected (75.0% of colony mortality) but *Palythoa caesia* colonies were partially damaged (15.9%). We found that several marine sponges, such as *Neopetrosia* sp., *Haliclona* sp. and *Clathria* (Thalysias) *reinwardti*, can adapt very well to the impacts of abandoned fishing nets (Figure 1).

This study documented widespread distribution of abandoned fishing nets in the inner Gulf of Thailand. The impacts of marine debris on coral communities are partly determined by life histories of benthic organisms. Most of them are slow growing and long lived, so the impacts of marine debris on their recruitment and growth are also significant disturbances.

PRIORITY ACTIONS

The present study clearly demonstrates that abandoned fishing net causes severe impacts on coral communities in the Gulf of Thailand. Long-term monitoring of impact and accumulation patterns of benthic marine debris and the degree of recovery of impacted coral reef organisms from debris effects are not adequately examined. Cleanup efforts and a suitable management plan are urgently required to prevent or mitigate the extent of abandoned fishing nets in order to ensure sustainable coastal tourism in Thailand.

FIGURES AND TABLES

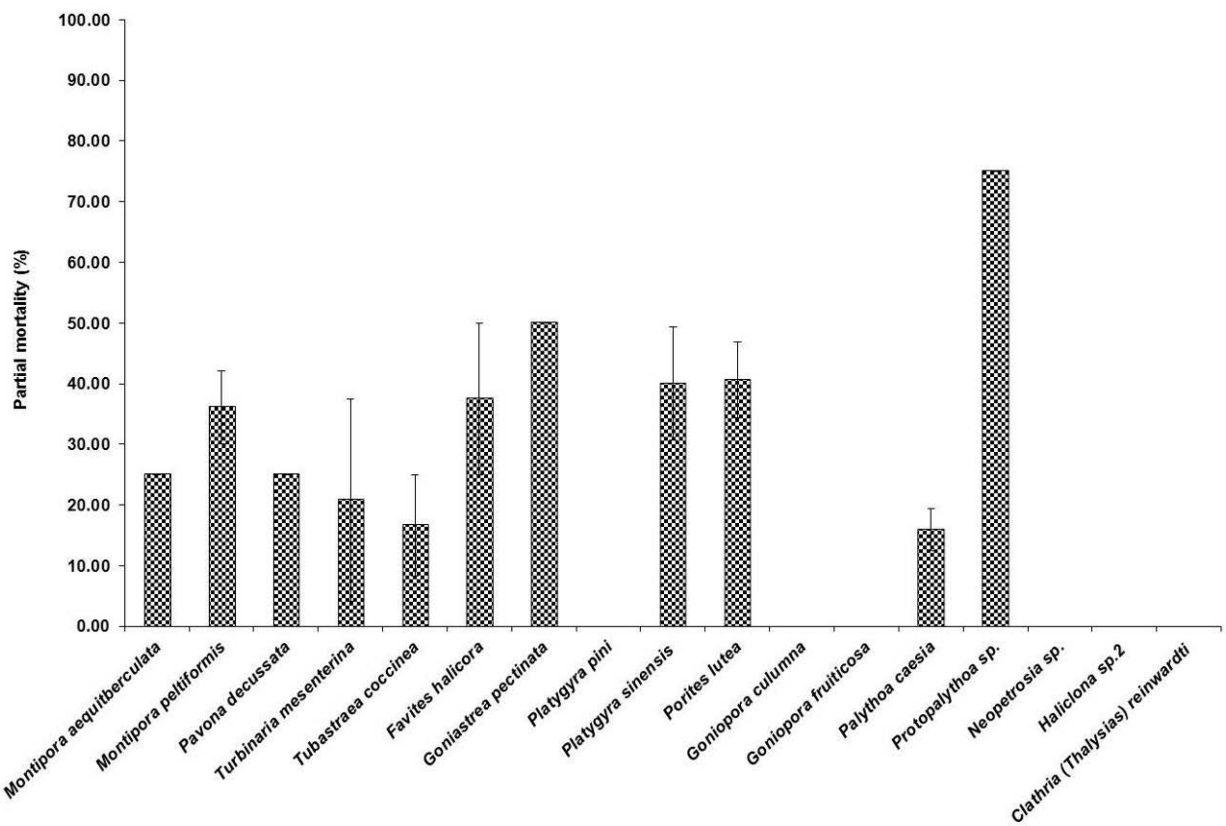

Figure 1 Impacts of abandoned fishing nets on reef organisms in the inner Gulf of Thailand

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10. Incidence, mass and variety of plastics ingested by Laysan and black-footed albatrosses recovered as by-catch in the North Pacific Ocean

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ABSTRACT
Laysan (Phoebastria immutabilis) and Black-footed Albatrosses (P. nigripes) ingest plastic debris, as evidenced by plastic in the digestive contents of their chicks, however there is little documentation of ingested plastics carried in foraging adults. We quantified plastics among the digestive contents of 18 Laysan Albatrosses and 29 Black-footed Albatrosses collected as by-catch in the North Pacific Ocean. Ingested plastic was present in 30 of the 47 birds examined, with Laysan Albatrosses exhibiting a greater incidence of plastic ingestion (83.3% n=18) than Black-footed Albatrosses (51.7% n=29)(X^2=4.8, df=1, P=0.03). Of the varieties of ingested plastic recovered, plastic fragments contributed the greatest mean mass in both species. Between species, Laysan Albatross specimens contained a higher mean mass of plastic fragments, and Black-footed Albatross specimens contained a higher mean mass of plastic line. Though the overall mean mass of ingested plastic in both species (0.46g ± 1.45) was lower than previously noted among albatross chicks, the high incidence of ingested plastic reported here suggests that long-term effects, e.g. absorption of contaminants from plastics, may be of concern throughout the population. Furthermore, signs of regurgitation, coupled with limited digestive contents, indicate further research is required to determine if specimens obtained through fisheries by-catch result in underestimates of plastic burdens.

11. Inter-annual, inter-colony and species specific differences in plastic ingestion by Black-footed and Laysan Albatross chicks in Hawaii

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KEYWORDS
Black-footed Albatross, Phoebastria nigripes, Laysan Albatross, Phoebastria immutabilis, bolus, plastic ingestion, marine debris, Hawaii, North Pacific Ocean

BACKGROUND

Albatross and other surface-foraging petrels seem particularly susceptible to ingesting plastic (e.g., Nevins et al., 2005). Birds collect plastic at sea, perhaps mistaking it for food or ingesting it along with prey such as flying fish eggs or pelagic barnacles (Harrison et al., 2003). Adults feed this material to their chicks along with prey and other natural non-food items (Kenyon and Kridler, 1969). Both albatross species breeding in Hawaii (Laysan Albatross, Black-footed Albatross) have a long history of documented plastic ingestion. An additional method to study plastic ingestion in albatrosses is to investigate the castings or boluses which chicks regurgitate in the weeks prior to fledging, peaking in the latter half of May and June. These boluses contain the hard indigestible parts of the birds' diet including squid beaks and plastic items, and thus reflect the feeding history of the chick (Pettit et al., 1981; Young et al., 2009).

Although plastic ingestion in Laysan and Black-footed albatross is a widespread and conspicuous phenomenon, standardized data on the amount and type of the material ingested by these two sympatric species is generally lacking. In this study we characterize the amount and types of ingested material regurgitated by LAAL and BFAL chicks from two colonies in Hawaii. Determining ingested plastic levels and types, and identifying colony and species specific trends may have implications for future management strategies and can provide a baseline for future monitoring of plastic ingestion using boluses. Determining the amount and type of ingested plastic, and identifying colony and species-specific trends has important implications for future monitoring of plastic pollution impacts on albatrosses and marine debris trends at sea. Our objectives were to: 1) develop standardized bolus processing and quantification methods to facilitate comparable studies across colonies and species, 2) validate these standardized metrics using data from colonies with high and low plastic ingestion rates, and 3) use these metrics to illustrate differences in plastic amount and type between species and colonies.

METHODOLOGY

We analyzed Kure Atoll samples from 2008 and 2009 and Tern Island samples from 2009. Boluses were collected in May and June, as soon as possible after regurgitation to prevent the break-up of the boluses and the loss of material through scavenging. Samples were collected opportunistically on Kure (C.V. and M.H.) and Tern from monotypic areas, rinsed in water and dipped in 10% bleach solution to remove organic detritus and prevent mold growth. Only fresh boluses that were directly observed being regurgitated or were found next to a chick were collected. Twenty-five boluses were randomly chosen for each species per year per site. Boluses were soaked in water and dissected, taking great care to separate all of the material without breaking any of the plastic pieces or squid beak mandibles. The sorted material was classified into 11 categories, belonging to four constituents: plastic, natural food, natural non-food and other. We considered four plastics categories: pellets, sheets, line, foam and fragments (van Franeker, 2008). Natural food included two categories: squid beaks and other food. Natural non-food consisted of a single category encompassing nuts and twigs. Finally, the remainder of the bolus was classified as other, which included unclassified and excluded material. Dry mass (g) and displacement volume (ml) of each bolus category was quantified and recorded. All measurements were made by a single person (A.J.T.) to keep results standardized. Finally, one of us (C.W.C.) determined the number of plastic pellets and fragments within each bolus and measured their size (longest dimension) and color. To understand both the scale of ingested plastic and its composition we compared the entire mass and volume and the proportion of mass and volume of all combined plastics, all natural food and each of the 11 individual categories of the material within the boluses, as well as the number and size of plastic pieces (fragments and pellets).

OUTCOMES

To validate the volume measurements, the mass and volume measurements were compared for all bolus categories using expected linear relationships. Initially, processing of the Kure 2008 data yielded over-estimates in the post-processing volume measurements, especially for the food and line categories, which were likely the result of trapped air bubbles. Subsequent modifications of the measuring protocols managed to remove this bias, yielding tight relationships between pre and post-processing volume measurements.

Comparisons of the mass / volume measurements revealed significant positive linear relationships for all bolus categories ($r^2 > 0.796$, $p < 0.001$) (Fig. 2, Table 2). Relationships were strongest for fragment ($r^2 = 0.990$, $p < 0.001$) and line ($r^2 = 0.976$, $p < 0.001$) and weakest for sheets ($r^2 = 0.796$, $p < 0.001$). Slopes of the relationships ranged from 1.183 for sheets to 2.183 for foam. There was no difference in total bolus mass between 2008 and 2009 for either the BFAL or for the LAAL at Kure Atoll. Furthermore, there were no significant inter-annual differences in the proportional mass of the bolus categories, except for sheets being proportionally higher in 2008 than 2009. The total mass of boluses in 2009 was higher on Kure Atoll than on Tern Island. For Kure Atoll BFAL, mass was significantly greater for all plastic, sheet, line, and foam; while total mass of fragment did not differ between colonies. In comparison, Tern island BFAL boluses had significantly greater mass for all food, beaks and other food. The mass of the non-food category was not statistically different between colonies (Fig. 1).

The number of pellets found in the boluses was low throughout all bolus groups (Mean #, 0.6 ± 1.5) and so were included with the fragments for the purposes of this analysis. The average number of plastic pieces including fragments and pellets was significantly different among bolus groups based on year, colony, and species (ANOVA, $F = 12.427$, $df = 5$, $p < 0.001$) with LAAL boluses from Kure Atoll having the greatest average number (2008 = 73 ± 70 SD, 2009 = 78 ± 39 SD) and Tern Island having the lowest average number (BFAL = 24 ± 20 SD, LAAL = 11 ± 7 SD) (Fig. 6A). Average length of pieces ranged from 13 ± 3 mm (Tern BFAL 2009) to 16 ± 2 mm (Kure LAAL 2008), with no significant difference in the lengths between bolus groups (ANOVA, $F = 1.672$, $df = 5$, $p = 0.145$). White was the dominant color of plastic pieces found within the albatross boluses, with an average of 25 ± 27 SD pieces per bolus. There were no differences in the color distribution amongst the six bolus groups (G-test, $G = 30$, $df = 45$, $p > 0.95$).

While Kure Atoll boluses showed overall higher levels of plastic, their proportional composition revealed colony-based species-specific differences. In particular, Tern Island boluses differed from Kure Atoll bolus in that LAAL had a higher proportion of line while BFAL had a higher proportion of fragments relative to the other species. This significant interaction highlights that in addition to the differences in plastic ingestion across colonies and species, each species is not typified by an ingested plastic signature. Rather, the species composition of ingested plastic varies by colony and foraging location.

PRIORITY ACTIONS

Our study shows that a multi-species and multi-colony approach is needed to fully characterize the variation present in the patterns of plastic ingestion within these sympatric albatross species. In particular, the segregation of foraging locations by and colony, highlight the importance of considering multiple colonies when assessing plastic ingestion in these two sympatrically-breeding albatrosses. Furthermore, this information is critical when attempting to use albatross as biological sensors of marine debris, by sampling vast, yet different areas of the North Pacific Ocean relying on the full complement of species and colony sites available to researchers. The availability of data from multiple colonies and species make albatross boluses valuable tools to study marine debris across the North Pacific Ocean.

FIGURES AND TABLES

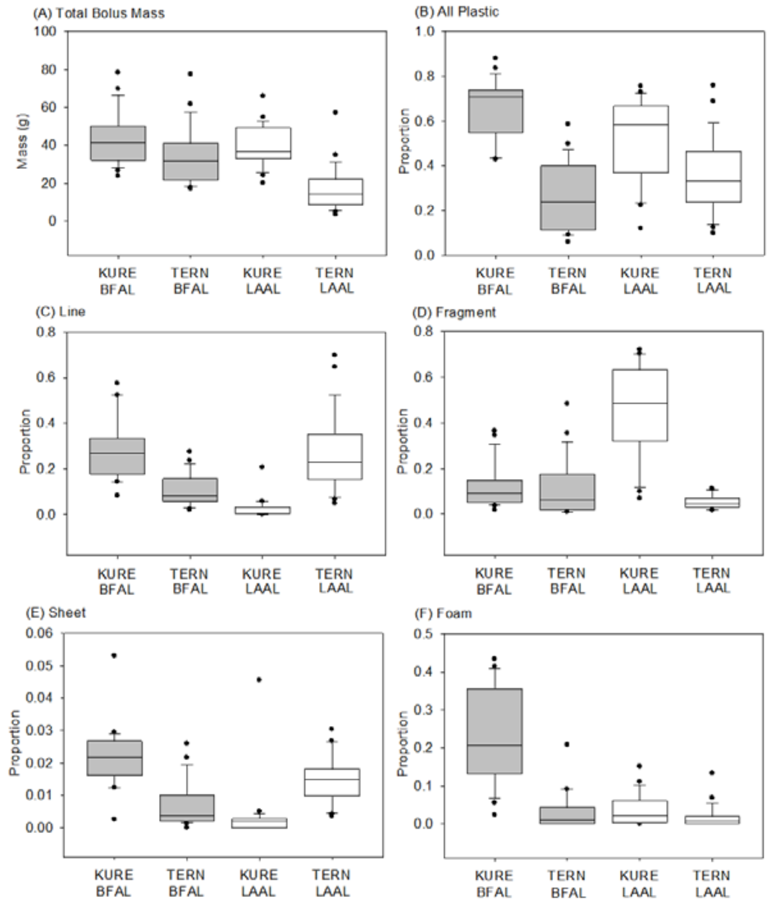

Figure 1. Box plots (mean, 25%, 75%), whisker bars (10%, 90%) and outliers of the distributions of absolute proportional mass of the entire bolus and different plastic categories for Black-footed (BFAL) and Laysan (LAAL) albatross in 2009 for Kure Atoll and Tern Island.

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12. Biodegradable cull panels decrease lethality of lost and abandoned blue crab traps

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KEYWORDS
Degradable, Plastic, Panel, Cull, Crab, Trap, Pots, Derelict, Lethality, Marine Debris

BACKGROUND
Lost or abandoned (derelict) traps can present safety, nuisance, and environmental impacts in estuarine waters. Blue crabs and various fish species that are entrapped and die in derelict traps can act as an attractant to crabs resulting in a self-baiting effect. Derelict fishing gear damages sensitive habitat and continues to capture both target and by-catch species. In Florida, Alabama, Mississippi, and Louisiana, estimates derived from trap loss calculations suggest derelict traps numbered 605,000 in 1993. A trap removal program in the Virginia portion of Chesapeake Bay removed over 18,000 derelict traps from December 2008 to March 2010. Derelict pots have been shown to capture between 50 and 100 blue crabs per trap per season (Havens et al. 2008). In the Chesapeake Bay, over 600,000 traps are deployed annually and the annual loss rate of traps is estimated to be between 10 and 30% of those deployed (Havens et al. 2008; Kennedy et al. 2007). Since derelict traps are continually added to the system and traps can continue to capture animals for several years, a method to disarm pots that become lost is desired. The use of various degradable components on commercially available traps was investigated.

METHODOLOGY
The project's four working assumptions were 1) the modification should render the trap ineffective of capturing marine life within one season of loss, 2) the material, once degraded, must be environmentally neutral, 3) the modification must be relatively inexpensive in order to be of practical use, and 4) the modification must be relatively easy to install and enforce.

Several degradable materials were assessed for viable use as a trap modification (i.e. degradable latch fastener or degradable panel placed on the trap wall). Twenty-gauge galvanized steel, sisal twine, jute twine, and cotton twine were tested under 4 lbs tension to mimic latch cords on crab pots. Wood (3/8 untreated pine, ¼ poplar, 1/8 laun), pressed cardboard (wax coated and uncoated) and biodegradable plastics were tested as potential material for a degradable panel. All materials were deployed in four different locations of different salinities and the time to breakage was recorded. To assess the effectiveness of different modification types, lab experiments were conducted to assess escape rates of blue crabs from traps with 1) slightly open and fully gapped lids to simulate the use of degradable latch fasteners, and 2) funnel size openings in the trap wall to simulate the use of degradable panels.

Commercial watermen were employed to fish crab traps with biodegradable cull ring panels alongside standard crab traps in Chesapeake Bay to assess potential effects on blue crab catch and the degradability of the plastic panels. Oval biodegradable cull ring panels (150 mm long x 100 mm at the widest point and 1.5 mm thick) were constructed of polycaprolactone (PCL) and polyhydroxyalkanoate (PHA). Each panel included a cull ring of 60 mm (2 3/8 in) inside diameter (to correspond to the Virginia regulation cull ring size used in standard pots). An oval section of crab pot wire of the same size was removed from opposite sides of the upper chamber of the crab pot and the panels attached using polyamide (nylon) cable ties (Figure 1).

OUTCOMES

The best candidate degradable materials were the environmentally safe biodegradable plastics polyhydroxyalkanoate (PHA) or polycaprolactone (PCL). The biodegradable plastic timeframe, which degrades in one season, coincides with annual removal and repair of pots and will allow for seasonal replacement of panels. Time to breakage of the various materials varied with material and salinity. Cotton twine performed the best across different salinities but none of the materials lasted the necessary minimum 8 month time frame (Chart 1). Compressed cardboard (both waxed and non-waxed) began decomposing after two months. All wood panels were no longer functioning after about 7 to 8 months in the higher salinity areas. The biodegradable plastic cull ring panels all lasted beyond the necessary 8 month time frame.

Biodegradable cull ring panels were more effective at allowing blue crab escape than degradable latches which allow the lid to gape open. Seventy eight percent of the crabs entering pots modified with degradable plastic cull ring panels escaped within 1 hour as compared with pots modified with rot cord latches (14%) and gapped openings (pot lid held open) (11%) (Chart 2).The cull ring ‘panels’ expand the size of the units so that, once degraded, the hole matches the entrance funnel size. In practical terms, anything that can enter the trap would then be able to escape. Recent studies used commercial watermen to test catch rates between traps modified with biodegradable cull panels and standard traps. There was no evidence that biodegradable cull panels adversely affected crab catch. In all locations and time periods, legal catches were similar (or greater) in abundance, biomass, and size between modified and standard pots (Bilkovic et al. *In Review*).

We have found that lost pots can become effective habitat for marine organisms if modified to become ineffective at trapping. The three dimensional structure provided by the lost traps provides shelter to oysters and other encrusting organisms. Other marine organisms including juvenile blue crabs have been shown to use the encrusted pots as shelter. Our results indicate that properly designed biodegradable cull ring panels are an effective and efficient pot modification to reduce catch of lost and abandoned crab pots and transform a type of marine pollution into potential productive habitat.

PRIORITY ACTIONS

All states with fisheries that use traps/ pots should have regulations that require a biodegradable cull panel into the traps to disarm the trap once it’s lost or abandoned.

FIGURES AND TABLES

Figure 1. Biodegradable plastic cull ring panel

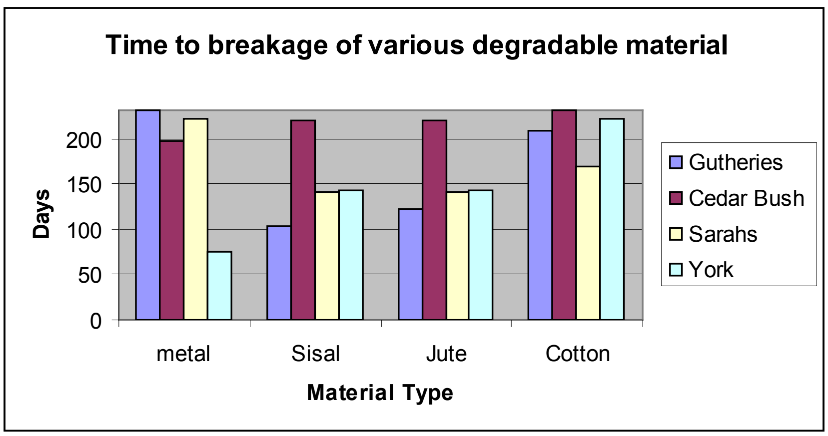

Chart 1. Time to breakage of 20 gauge galvanized steel, sisal, jute, and cotton twine under different salinity regimes (Gutheries Creek 5 $^{o}/_{oo}$, Cedar Bush Creek 15 $^{o}/_{oo}$, Sarahs Creek 20 $^{o}/_{oo}$, York River 20 $^{o}/_{oo}$).

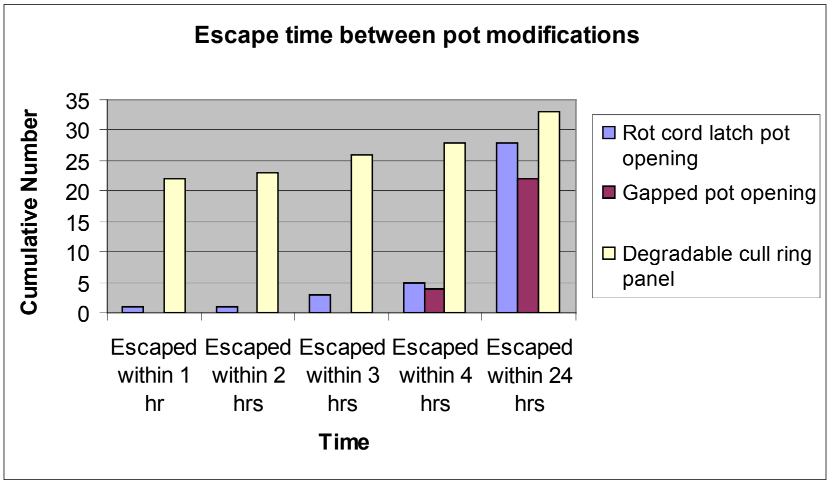

Chart 2. Time to escape for crabs captured in various pot modifications (rot cord latch opening, gapped opening, and degradable plastic cull ring panel).

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13. EPA addresses and prevents marine debris through education, monitoring, and research tools

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KEYWORDS
Tools, land-based, programs, solid waste, stormwater, toolkit, prevention, facilities, municipalities, education

BACKGROUND
EPA works to prevent, control, and reduce sources and movement of pollution that may become marine debris by addressing the actions from which it is generated or transported. The focus of this poster will be the tools and resources available from EPA which can assist in addressing land-based sources of marine debris.

OUTCOMES
Among the EPA resources available are marine debris education, monitoring, and research tools, which can help to increase awareness of the marine debris issue, identify the links between human behaviors and marine debris, and identify the types, sources, and movement of marine debris. These types of tools include the Marine Debris – Trash on the Move brochure and the National Marine Debris Monitoring Program. Additionally, EPA developed a Marine Debris Prevention Toolkit which allows users to search an online database of marine debris prevention tools (both EPA and non-EPA) by type of tool, audience, marine debris type, and location. The Toolkit includes items such as videotape, audiotape, PSAs, bumper stickers, posters, factsheets, brochures, bookmarks and also has a feature where an organization can submit their marine debris prevention materials electronically to be added to the Toolkit.

EPA works to prevent, control, and reduce the sources and movement of pollution that become marine debris using a watershed approach, which includes solid waste and stormwater management tools and best management practices for individuals, industrial and manufacturing facilities, and municipalities. The tools include fact sheets, brochures, manuals, posters, and other documents providing information on recycling programs, outreach targeting poor waste management practices, and education to prevent trash entering waterways through stormwater drains and combined sewer systems.

PRIORITY ACTIONS
1) Develop outreach tools to target specific sources or items of marine debris (e.g., cigarette butts, plastic bags).

2) Perform regional evaluation of existing marine debris prevention tools to assess their effectiveness.

3) Identify gaps in EPA Marine Debris Prevention Toolkit and obtain materials from other organizations/agencies to fill gaps.

14. Balloon releases: biohazard and preventable problem

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KEYWORDS
Balloon, helium-filled, latex, litter, harm to wildlife, plastic ribbon, entanglement, ingestion

BACKGROUND
People, schools, businesses and sports venues worldwide purchase mass quantities of helium-filled latex balloons, transport them to a selected site, and release them into the air. These mass releases of balloons are done usually to celebrate an event (i.e., weddings, political rallies, funerals, memorial services, sporting events) or to promote something (i.e., store openings, car dealerships having a sale). As they rise, the balloons may or may not burst, but eventually all balloons and their attachments return to earth, landing in the ocean, inland waterbodies, or on land. Evidence shows that a portion of these balloons and their attachments cause harm to wildlife through entanglement and ingestion.

Balloons + Ribbons: Unique Litter
Unlike other forms of litter, balloons are unique in two ways:

6. It is planned litter. People purchase helium-filled balloons with the intent to release them "on purpose." Planners of sporting events, celebrations, funerals, weddings, and other activities go out of their way to purchase, transport and then release balloons.
7. An entire industry defends and promotes the mass release of balloons.

Some people who would never think of littering a newspaper, food wrapper or beverage can will participate in a mass release of balloons without realizing that the balloons will return to earth as potentially harmful litter. Perhaps this is because released balloons have been viewed as an inspirational, uplifting sight. Images of balloons floating up into the sky can be found on birthday cards and in advertisements for many products. People who release balloons appear to be unaware that balloons are potentially harmful to wildlife, and that balloons and their attachments fit the definition of marine litter: *"Marine litter is any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment. Marine litter consists of items that have been made or used by people and deliberately discarded into the sea or rivers or on beaches; brought indirectly to the sea with rivers, sewage, storm water or winds; or accidentally lost…"*

Evidence of Problem – Web sites by the balloon industry, and people who plan to release large quantities of balloons into the air, express the opinion that there is little evidence that balloons and their attachments cause harm, yet there is convincing evidence to the contrary. Evidence of ingestion of balloons is well documented, especially by marine biologists who work to protect and conserve sea turtles. From these documented cases of ingestion, it is clear that many wildlife species mistake balloons as food. Documentation also shows that ribbons attached to balloons have entangled animals, especially birds. Marine mammals and farm animals have also suffered balloon ribbon entanglement.

During the International Coastal Cleanup (ICC), organized annually by the Ocean Conservancy, balloons and their attached ribbons are found by the tens of thousands. In the 2009 ICC, volunteers reported finding 82,902 balloons. In the *Proceedings of the International Marine Debris Conference on Derelict Fishing Gear and the Ocean Environment*, held in Hawai'I in August 2000, Anthony L. Andrady, Program Manager and Senior Research Scientist, Chemistry and Life Sciences Division, Research Triangle Institute, North Carolina wrote:

> *"Latex rubber balloons are an important category of product in the marine environment. Promotional releases of balloons that descend into the sea pose a serious ingestion and/or entanglement hazard to marine animals. Based on the fairly rapid disintegration of balloons on exposure to sunlight in air, the expectation is that balloons do not pose a particularly significant problem. In an experiment we carried out in North Carolina we observed that balloons exposed floating in seawater deteriorated much slower than those exposed in air, and even after 12 months of exposure still retained their elasticity."*

Balloons Travel – Balloons can travel great distances, so balloons released inland have the ability to reach the ocean. In 2009, students from Ripley Elementary School in Ripley, Tennessee, released balloons containing a message attached to the string asking people who find the balloons to contact the school. They received answers from West Virginia and a town in Maryland, 900 miles east of Ripley. One of the 1,998 balloons that were released during the opening ceremony of the Olympic Games in Nagano, Japan in 1998 was found in Los Angeles, California, just 49 hours later—a distance of approximately 5300 miles or 8600 km.

Industry Position on Balloon Releases – Trade associations for distributors and manufacturers of balloons and balloon accessories, as well as balloon decorators, retailers, and entertainers, defend the release of latex balloons based on the following points:

A. Latex balloons are made from organic material, and are 100 percent biodegradable

B. References to a study conducted by the National Association of Balloon Artists that claims, "…*under similar conditions latex decomposes as quickly as an oak leaf.*"

C. Rubber trees (which produce the sap that is then made into latex balloons) *"...play (a) valuable ecological role in the earth's fragile ecological balance by removing carbon dioxide from the atmosphere which helps prevent global warming*."

D. Latex balloons burst into "*spaghetti-like pieces that scatter to the four winds"* and they *"rarely return to the earth's surface intact."*

E. The balloon industry has guidelines for mass releases that state that helium-filled balloons must be made of latex (not Mylar or plastic), must be hand-tied, and have no attachments including ribbons, plastic valves or plastic disks.

It appears that the balloon industry has been successful in leading the public into thinking that biodegradable is the same as safe, and that safe is the same as "environmentally friendly". A university in the U.S. defended its release of 5000 balloons as being "environmentally friendly" because the balloons and cotton strings were 100% biodegradable. Likewise, at a release of balloons at a fundraiser in the U.K., the planners prepared flyers saying that the balloons were natural and biodegradable. The flyers were shown to people who objected to the release.

METHODOLOGY

Over a period of a year, we researched A) who releases balloons in large quantities, B) evidence of impacts, C) the balloon industry's position on mass releases, D) litter-prevention and ocean conservation groups engaged in the issue, and E) solutions. We also did research on the plastic items (ribbons, valves, tie-off disks) that are often attached to helium-filled balloons.

OUTCOMES

The majority of balloon releases as reported in the media in this period were from 300 to 5000 balloons. While the balloon industry guidelines urge that balloons be hand tied without attachments, most balloons had plastic ribbons attached. We were unable to discern what percentage of the balloons had plastic valves or disks that are used to quickly fill and tie-off balloons.

PRIORITY ACTIONS

Our study leads us to the conclusion that many people believe that biodegradable items are equivalent to harmless. Although latex is capable of being decomposed by biological agents (especially bacteria), it is to be considered "litter" the same as other biodegradable litter (paper bags, newspapers, cardboard items). The Balloon Council and other balloon industry websites infer that biodegradable balloons are OK to litter when they equate balloons to oak leaves. Correcting this public perception underlies all of our recommendations and priority actions.

Outreach to the balloon wholesale and retail outlets, the public, event planners, and others all must focus on the following points, and messaging should be consistent:

- Biodegradable does not mean the same as harmless.
- Biodegradable does not mean the same as digestible.
- There is no evidence that an oak leaf has ever been found to choke a bird or kill a sea turtle, but there is ample evidence that balloons and their attachments (ribbons, plastic valves, plastic tie-off disks) have harmed and killed wildlife and farm animals through ingestion and entanglement.
- Latex balloons and their attachments cannot be equated with a leaf.
- Balloons and their attachments should never be released, as this is an act of littering, and they are harmful as litter.
- There is no such thing as an "environmentally friendly" balloon release.

Educate, Legislate, Innovate

Like many marine debris issues, solutions can be found in education, legislation and innovation. A new international group *Alliance for Balloon Education (ABE)* is dedicated to work on these.

Educate:

1. Educate the balloon industry on the wholesale and retail levels. Work with them to find innovative alternatives to balloon releases. As a model, we can look to other industries that produce items that are often littered. Some business leaders have embraced corporate responsibility, and are investing resources in educating their consumers on proper disposal of waste items.

2. Educate the public. Provide alternatives to releasing balloons, and provide language they can use if they are asked to participate in a balloon release.
3. Educate those who plan balloon releases. Schools, sports teams, businesses, and event planners could be encouraged to sign a pledge to not release balloons.
4. Work with ad agencies and the greeting card industry to stop making balloon releases look like acceptable behavior. Request they do not include images of balloon releases in their ads and products.
5. Educate businesses that hand out balloons to their customers or use balloons as promotional items (car dealerships, stores, real estate companies).

Legislate: A few states in the U.S. have banned the mass release of balloons. Efforts should be made to pass and enforce similar laws worldwide.

Innovate: Balloons are associated with celebrations and joyful gatherings and are used in retail as promotional items. There are many innovative alternatives to the mass release of balloons. These include: planting a tree or wildlife garden, dropping balloons (works indoors as well as in outdoor courtyards on windless days), blowing bubbles, or popping balloons in unison. There are hundreds of low-cost items that could be used rather than helium-filled balloons.

Helium as a nonrenewable resource: According to Lee Sobotka, Ph.D., professor of chemistry and physics at Washington University in St. Louis, helium is being sold off far too cheaply and there is no incentive to recycle it. Helium is a vital component of medical instruments, mass spectroscopy, welding, fiber optics and computer microchip production, among other technological applications. As the price of helium increases, the balloon industry may be more willing to explore alternatives to helium-filled balloons.

FIGURES AND TABLES

Figure 1. From left: An endangered Kemp's ridley sea turtle (*Lepidochelys kempii*) was found with a balloon and ribbon blocking its throat. The razorbill, newborn lamb and Guadalupe Fur Seal were all entangled in balloons and ribbons. (Photo credits: Mote Marine; Christine McGuinness; Daily Mail, UK; Jeff Hall, CA Wildlife Center, Malibu, CA)

Figure 2. Various types of valves and disks used to inflate and seal latex balloons. All are made of plastic. Some have plastic ribbons pre-attached. During a year of monitoring balloon releases reported in the media, it was found that the majority of releases included plastic ribbons. Balloons and ribbons collected by volunteers during cleanups also revealed that many included plastic attachments.

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15. Engaging Virgin Islanders in addressing the problem of marine debris

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ABSTRACT
The USVI has been participating in the local event called *Coastweeks* for twenty years. This event is a part of the Ocean Conservancy's International Coastal Cleanup. Over this time this event has become well known with increasing numbers of volunteers working to clean local beaches. From the beginning the Virgin Islands Marine Advisory Service (VIMAS), part of the UPS Sea Grant program, has been coordinating this effort with the assistance of various nonprofits and government agencies. This poster details these efforts and strategies used to make this event successful.

16. Scuba Dogs Society battles the trash fish in Puerto Rico

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ABSTRACT
The "International Coastal Cleanup" is the bigger effort of environmental volunteers of the world, coordinated internationally by Ocean Conservancy and locally by Scuba Dogs Society. This event of conservation is a global initiative where 108 countries take part, and Puerto Rico is one of them. In 2002 it was begun by 10 beaches, 590 volunteers: they removed 8,000 pounds of garbage in 8.25 miles of coastline. Only in 2009 there were cleaned about 250 coasts (rivers, beaches, reservoir, etc.) 14,756 volunteers (80% students from schools and universities) informed 63 municipalities of the island and 230,000 pounds of garbage were gathered and 400 miles of coast were covered. With very much pride, Puerto Rico placed in the 5th in volunteers' participation between the nation's participants of the Cleanup and only overcome by USA, Philippines, Canada and India. This has brought an effect in the number of coastal cleanup for the communities and others organized groups. Today we see a few communities more prepared and been interested in the conservation of their coasts. Since 2002 this activity has been a success and not only can be measured in terms of numbers of participants, but in the decrease of the marine debris. For third year in consecutive, the results show a positive trends. But more than cleaning, our volunteers and sponsors have contributed to the creation of a scientific database of marine debris. This achievement performs supreme importance for the decisions makings, well informed in the marine managing of the coastal areas. This information has served to stimulate and to achieve national laws as it is the case of the Law # 329 of December 29, 2003. This year (2010), according to the information of the coasts reported at the moment, we have 12,320 volunteers and 175,000 pounds of wastes. In addition, many coasts are still absent for bringing information. We are proud to say that we have been creating awareness and engaging thousands into taking positive action to help cleanup, protect and preserve our natural resources.

17. Southeast Atlantic Marine Debris Initiative (SEA-MDI)

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KEYWORDS
Consortium, Partnership, Regional Approach, Mobile Application, Marine Debris Tracker

BACKGROUND

The Southeast Atlantic Marine Debris Initiative (SEA-MDI) is a partnership started in 2010 with NOAA's Marine Debris Program. SEA-MDI, through partnerships comprised of unique expertise, is developing culturally relevant and innovative outreach tools for the NOAA Marine Debris Program, providing information on alternative disposal methods for marine debris, and developing and disseminating tools and innovative products to address marine debris. The area off the coast of the Southeastern U.S. is also known as the South Atlantic Bight (SAB). While this project extends from North Carolina through the Georgia coastline, it covers a significant portion of the SAB. Excluding estuarine environments, the NC-SC-GA coastline consists of approximately 600 miles of ocean coastline including unique environments and resources such as living bottoms which are rock reefs covered with attached algae and animals, which comprise up to 20% of the shelf bottom and support more than 70% of the offshore fisheries (Ocean Explorer, 2001). With the southeast coast being one of the fastest growing areas of the U.S. (US Commission on Ocean Policy, 2004), the marine debris situation in the SAB, which is currently assessed at the state, but not the regional level, is likely to deteriorate. In addition to rapid growth, the SAB region is also subject to frequent major storms (e.g., hurricanes) which further stress the coastline while having the potential to cause acute marine debris issues. The North Atlantic Gyre is also off the SAB coast and Bermuda is the resting stop for much of the marine debris swirling in this lesser-publicized gyre; however, marine debris from the gyre could also end up on the US coastline while US-based debris could be transported into the gyre and on to Europe as well.

SEA-MDI, through its direct partnership with NOAA MD Program and SEA-MDI sub-award projects will directly benefit living marine resources in the Southeast U.S. Coastline, SAB area. Specifically, resources in Grey's Reef National Marine Sanctuary including algae and invertebrates on exposed rock surfaces (invertebrates include sponges, barnacles, sea fans, hard coral, sea stars, crabs, lobsters, and shrimp), numerous species of benthic and pelagic fish (including black sea bass, snapper, grouper, and mackerel), and threatened loggerhead sea turtles that use Gray's Reef year-round for foraging and resting. The reef is also part of the only known winter calving grounds for the highly endangered Northern Right Whale (NOAA, 2010). Other important and critical resources exist in the four National Estuarine Research Reserves (NERRs) in the area (North Carolina; North Inlet-Winyah, SC; ACE Basin, SC; and Sapelo Island, GA). This project will also benefit navigational safety in the SAB focus region for this partnership where derelict vessels pose a specific marine debris concern.

METHODOLOGY

An initial task of SEA-MDI is the formation of a three-state Marine Debris Consortium (North Carolina, South Carolina and Georgia) made up of marine debris experts from federal and state agencies, academia and non-profit organizations. The Consortium's aim is to create effective regional strategies addressing Marine Debris prevention, reduction and mitigation while facilitating Federal efforts by placing the region's work into a national context. Consortium Members will raise the profile of marine debris issues at the regional and national levels, compile and maintain a regional database listing current marine debris research and projects, share knowledge and innovations regarding marine debris prevention, reduction, and mitigation, and participate in the development of a framework to identify, evaluate, fund, and administer projects that address marine debris and help to restore NOAA trust resource species and habitats in the region.

Secondly, SEA-MDI in partnership with NOAA Marine Debris Program is using innovative technologies and unique expertise to add culturally relevant outreach tools and information to the current outreach partnerships of the NOAA Marine Debris Program. This includes the development of a Smartphone Application called ***Marine Debris Tracker***, allowing the public to log and track marine debris when they find it using both Android and iPhone platforms. An accompanying website to show data collected from the App was also developed for additional education and outreach purposes. SEA-MDI will also collaborate in hosting a TEDx Talk in one of the SEA-MDI states and posting the TEDx and similar talks on the SEA-MDI website (with the potential of being highlighted on the parent organization TED Talks website). SEA-MDI will document current waste management programs of various marine debris projects and partnerships (e.g., Fishing for Energy, Marine Debris to Energy, etc.) to create a dataset that can act as a resource, as well as up-to-date reviews of innovative and potential future debris management methods (e.g., gasification). This dataset and information, housed on the SEA-MDI website, could be a resource for new and existing MD removal projects desiring to explore and/or utilize alternative disposal methods.

OUTCOMES

SEA-MDI initially developed a logo (Figure 1), as well as a website with an active blog and a summary of the state and regional projects related to marine debris (http://sea-mdi.engr.uga.edu/) (Figure 2). A Twitter feed called *Debris Tracker* is joint effort of the ***Marine Debris Tracker*** App and SEA-MDI. The consortium currently consists of twelve (12) entities/members committed including 1) NOAA Marine Debris Program, 2) Southeast Coastal Ocean Observing Regional Association (SECOORA), 3) Centers for Ocean Sciences Education Excellence (COSEE)-Southeast, 4) Gray's Reef of the NOAA's National Marine Sanctuary Program, 5) US Navy, 6) US Fish and Wildlife Service's Coastal Program, 7) National Park Service-Southeast Coastal Network, 8) SC Dept. of Health and Environmental Control, Policy and Planning Division, 9) NC Sea Grant, 10) GA Sea Grant, 11) SC Sea Grant and 12) The Ocean Conservancy. The ***Marine Debris Tracker*** App is nearing completion on development and release is expected by the publishing of these proceedings with the Android platform, soon followed by iPhone. The website interface for ***Marine Debris Tracker*** is complete and located at: http://www.marinedebris.engr.uga.edu/. The website will accompany the App upon release.

There will be significant future outcomes associated with the completion of all the proposed SEA-MDI efforts and partnerships.

PRIORITY ACTIONS

SEA-MDI highlights the work already completed in the individual states of NC, SC and GA, but also illustrates the need for a regional approach. It also brings to light the benefits (and need) of using innovative and culturally relevant tools to engage the public (especially those not currently engaged) in marine debris issues and prevention.

FIGURES AND TABLES

Figure 1. SEA-MDI Logo

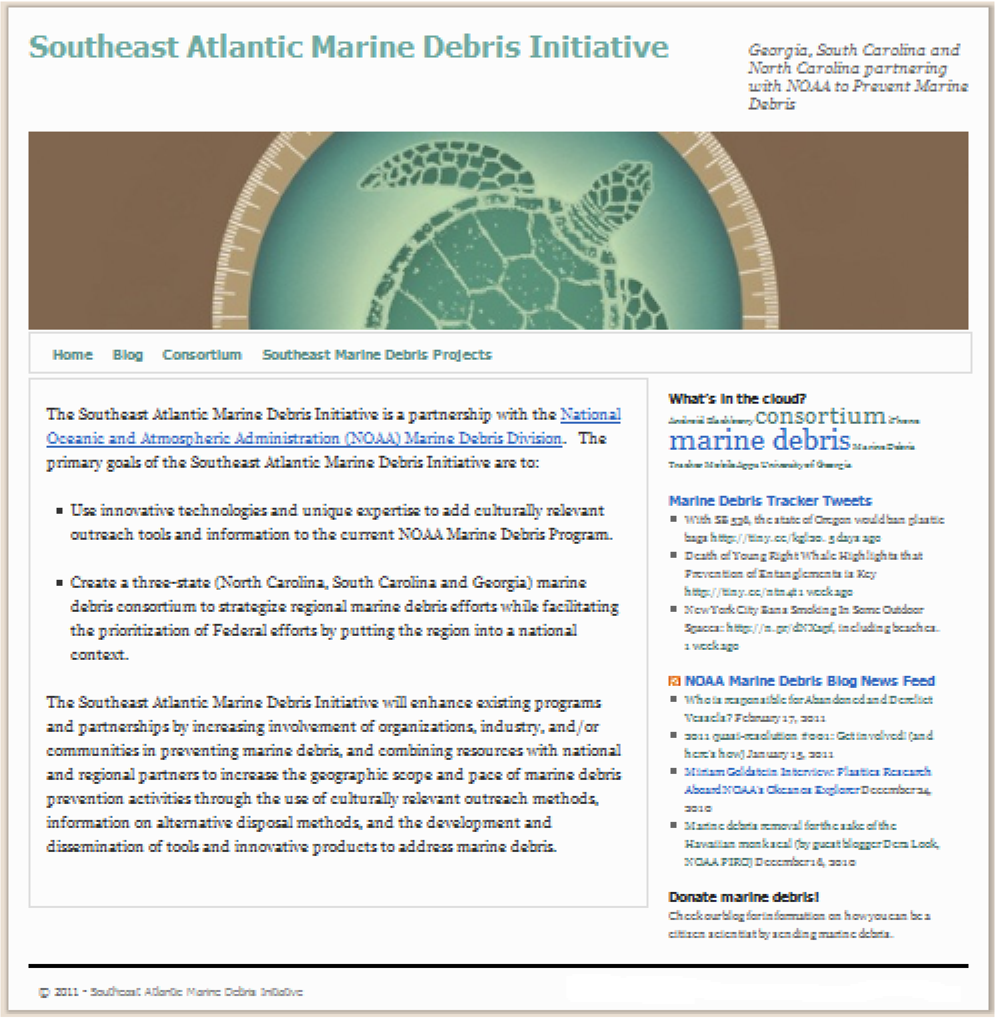

Figure 2. The public website for SEA-MDI (http://sea-mdi.engr.uga.edu/)

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18. Unmanned aircraft use for marine debris survey

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ABSTRACT
Airborne perspective provides valuable information for marine debris research and monitoring as well as for response and removal projects. Aircraft operations are costly and introduce additional risk and safety exposure to personnel. With the advent of unmanned aircraft systems and advancements in sensor, computer, power and communication technology, the need for manned aircraft flights is being reduced. Airborne perspective useful for marine debris work can be gained from a variety of unmanned platforms including: ship launched small aircraft, larger land-based aircraft and tethered balloons. Much of today's sensor technology is affordable and miniaturized to allow for integration into small autonomous aircraft. The use of unmanned sensor-equipped aircraft has the potential of greatly reducing operation costs and personnel risk in marine debris research and removal projects.

19. Collaborative removal: highlighting challenges of city-sourced marine debris through local, grass-roots solutions.

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KEYWORDS
Collaboration, Community, Volunteers, Marine, Debris, Metropolitan, Education, Media, Awareness, Active

BACKGROUND
By creating a concept for large-scale collaborative removal of litter from a specific coastal environment, this story of success managed to highlight the challenges of city-sourced marine debris through local, grass-roots solutions.

Over two years, two similar coastal clean-up events were held on New Zealand's Aotea / Great Barrier Island. Through large-scale collaboration, detailed data collection, education programs and extensive media coverage, the challenges of (and – importantly – solutions for) city-sourced marine debris were brought to attention of the public to enable policy-makers.

METHODOLOGY
Events were organized on the ground through networking and collaboration with local (island-based) groups and groups from the mainland (Auckland). Volunteers were enlisted to participate in the events through social media networks, email mailing lists, personal and organizational contacts and extensive media coverage. By running this project over two years at the same time of the year along the same stretch of coastline, results proved a consistent flow of metropolitan pollution on the prevailing southwesterly winds onto the beaches of this sparsely inhabited island.

Following the two events on Aotea / Great Barrier Island, the marine debris collected by volunteers was loaded firstly into large, easy-to-transport storage sacks and then (using forklifts and Hiab cranes) onto barges for transport back to the mainland for recycling and transfer to landfill. This method significantly helped to highlight the source of the rubbish and media reports brought this information – "bringing the city's trash back to the source" – to a huge number of people.

Data collection was an important focus for this project. Space was allocated at a local transfer station and teams of workers were organized to manually count and categorize the rubbish to gain a detailed understanding of the make-up and source of the waste. As a registered agency with the Department of Corrections, Sustainable Coastlines engaged Community Offenders (Periodic Detention workers) in the data collection process: another important step in the wide-ranging collaborative approach for this project.

OUTCOMES
The principal outcome was in identifying that around 85% of the volume of debris on the coasts of Aotea / Great Barrier Island originates in the greater Auckland metropolitan area – constantly carried there on the prevailing southwesterly wind. Through active participation and exposure through mass media channels, millions of people were made aware of the problems that arise from tangible actions such as littering on the street, while being exposed to simple, local, grass-roots solutions.

This also served to highlight the common responsibility of metropolitan residents, industries and policy-makers in preventing this litter from entering the waterways of the region, and media outlets called on all stakeholders for action.

Some key figures:

2009 event
700 volunteer participants, including 330 students from 4 local and 7 visiting schools.
30,000 liters (7,925 gallons) of marine debris removed from coastlines.
Around 1.3 million media impressions, including two television interviews / stories and extensive press and radio media.

2010 event
1000 volunteer participants, including 650 students from 4 local and 15 visiting schools.
32,900 liters (8,690 gallons) of marine debris removed from coastlines.
Around 2.5 million media impressions, including three television interviews / stories and extensive press and radio media.

PRIORITY ACTIONS
1. Communicate that the responsibility for the health of our oceans and coastlines lies not just with industry and policy-makers, but also with us all as individuals.
2. Create projects that involve as many sectors of the community as possible in local, simple, positive and – importantly – fun actions.
3. Engage media to raise mass awareness of the issue *always alongside* simple solutions.

FIGURES AND TABLES

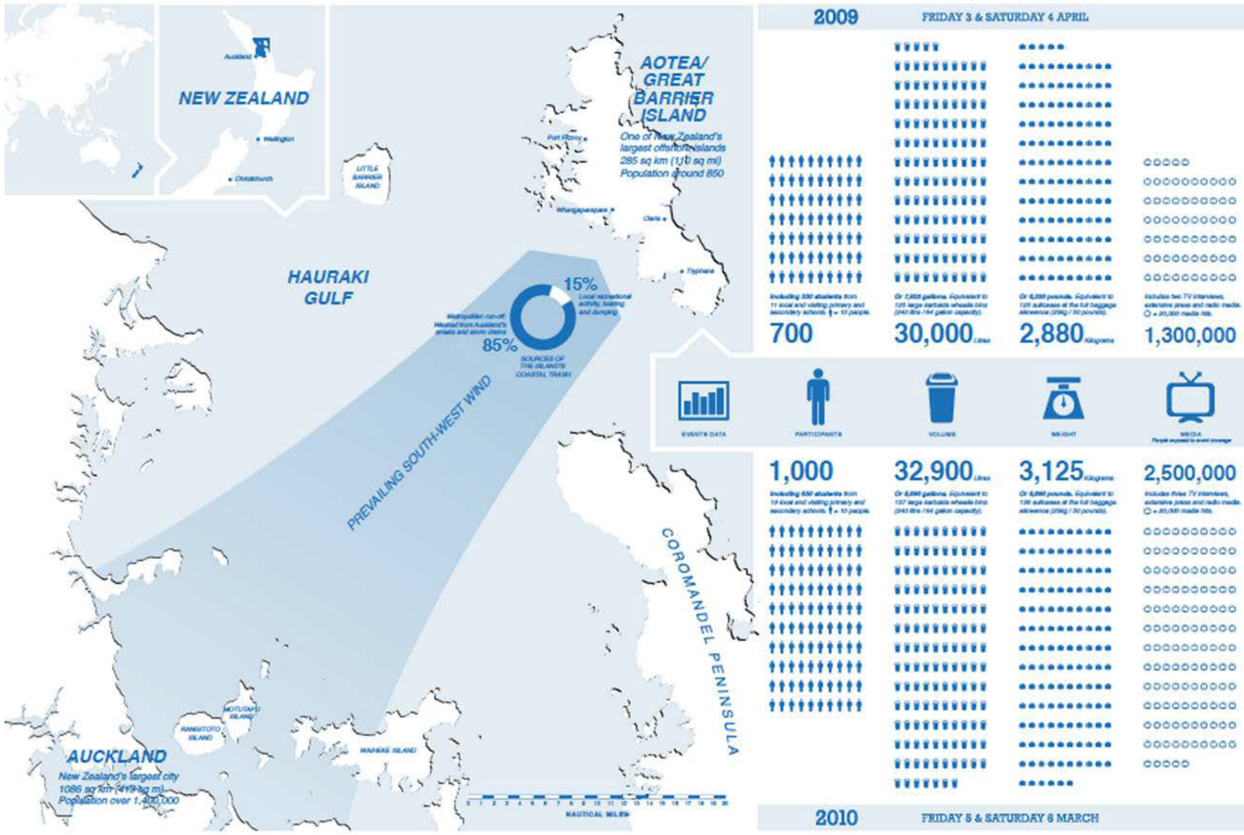

Figure 1.
Highlighting the problem: education through data, active participation and mass-media.

20. Success and challenges of marine debris monitoring in Tainan

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KEYWORDS
marine debris monitoring, coastal cleanup, Styrofoam, plastic bags

BACKGROUND
Having engaged in the marine debris monitoring program since Oct. 2005, Tainan Community University in Taiwan has led thousands of volunteers working on coastal cleanup and marine debris monitoring on the 3rd Sunday of each month for the past five years. The data shows that the top two marine debris items of the Tainan coast were Styrofoam and plastic bags. In addition, Styrofoam beverage cups are also one of the serious pollution of the Tainan coast.

METHODOLOGY
Volunteers clean up marine litter on the beach and collect data on what they find on the 3rd Sunday of each month. This monitoring problem has been launched since Oct. 2005
Approximate length: 1-2 paragraphs.

OUTCOMES
The local government was urged to ban the use of them because of the monitoring data provided. Campaigns against the use of Styrofoam cups were launched and the city mayor's approval was given to promote the limit of the use. Numbers of coastal cleanup volunteers increase every month and public awareness rises by the continual endeavours. Touring art exhibit made of debris items collected from the beaches and exhibit of informative posters travel to the local elementary schools and communities to educate the importance of marine environment protection. The above mentioned achievements were also spread to other areas of Taiwan to engage more Taiwanese to protect the ocean.

21. Automated identification of derelict fishing gear in the Stellwagen Bank National Marine Sanctuary from HabCam optical imagery

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ABSTRACT
Derelict Fishing Gear (DFG) presents a threat to the wildlife and fishery productivity of NOAA's Stellwagen Bank National Marine Sanctuary (SBNMS). A non-invasive optical sampling device, the Habitat Mapping Camera (HabCam), developed and operated by The HabCam Group, a consortium of commercial fisherman, scientists and engineers (http://habcam.whoi.edu) was used to survey SBNMS over the past three years producing ~15 million images (~7.5 km^2 coverage). Manual identification of manmade objects in a subset of the images yielded 21 categories of which 12 were DFG. Example categories include nets (trawl, gill), lines (cable, monofilament, rope, wire), tackle (lures, plugs), and lobster pots (Cowie-Haskell et al, this symposium). However, since manual classification is not scaleable to large image datasets, automated machine vision approaches to identifying DFG in HabCam images are being developed as a pre-filter to flag images to be screened manually at a later time. DFG typically represent defined geometric patterns such as line segments or repeated intersections of lines as in nets and lobster pots. The Hough Transform, 2D FFT, autocorrelation, and Gabor wavelet filters were used to identify such patterns in image training sets containing both positive and negative DFG of specific types. Lines, ropes, wire, gill and trawl nets, and lobster pots were correctly identified with 92% accuracy if the target could be segmented from background (i.e., high signal to noise), but turbidity often limited good segmentation. Approximately one month of computer time will be required to scan the entire 15 million image dataset from SBNMS, but preliminary results show promise of developing automated screening tools to speed DFG classification.

22. Distribution and abundance of trap debris in Florida Keys National Marine Sanctuary

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KEYWORDS
marine debris, fishing gear, derelict traps, spiny lobster, Florida Keys, manta tow

BACKGROUND

During the 2010-2011 season, permits existed for over a million stone crab traps and for 488,072 spiny lobster traps in the Florida Keys. Tens of thousands of traps are lost annually through routine fishing mishaps (e.g., snapped buoy lines, GPS failure, and trap degradation) and the cumulative accumulation of decades of trap debris remains a central issue in Florida Keys National Marine Sanctuary (FKNMS). Heavy recreational boat traffic in the region leads to a number of buoy line cutoffs resulting in lost gear. Although Florida fishermen are required by law to retrieve their own traps prior to the close of the season, trap loss and abandonment is a common occurrence. Trap loss is greatly exacerbated during years with hurricanes. Although implementation of the Trap Certificate Program in 1993 has lead to a substantial reduction in the number of traps in the fishery (over 50% in the last 16 years), these efforts are inadequate to keep pace with the debris accumulation rate.

Derelict lobster traps and trap-generated debris are known to have an impact on seagrass and coral habitats (Uhrin et al., 2005; Chiappone et al., 2005; Miller et al., 2008; Lewis et al., 2009). A Trap Retrieval Program has been in place in the Florida Keys since 1985, with limited effectiveness (< 5% removed annually); most removal efforts target only those traps that are visible from the water's surface (i.e., attached buoy line). In addition, industry funding is inadequate to support the removal of buoyed, abandoned traps and does not promote removal of orphaned trap debris. To effectively manage the commercial trap fishery in the Florida Keys, and the continuing trap debris problem, improved efforts are needed to quantify the distribution and abundance of derelict traps and trap-generated debris and to identify habitats and areas that accumulate or retain debris. The objectives of this study were to: (1) generate estimates of the abundance, form, and spatial distribution of trap debris in FKNMS; (2) describe habitat-mediated patterns of trap debris accumulation; and (3) relate spatial patterns of trap debris accumulation to known spatial patterns of commercial trap fishing effort.

METHODOLOGY

A detailed discussion of the towed-diver methodology and a map of the study area can be found in Uhrin et al., "Towed-diver Derelict Spiny Lobster Trap Surveys in Florida Keys National Marine Sanctuary" (this Proceedings). We sampled all benthic habitats ≤ 15m deep in the FKNMS, from northern Key Largo to southwest of Key West, partitioned into six zones reflecting historic trap-use patterns and consisting of the Upper, Middle, and Lower Florida Keys on both the Atlantic Ocean and Florida Bay sides of the island chain (Matthews 2001). Within each trap-use zone, twenty locations were randomly selected for sampling. Debris surveys were conducted by paired SCUBA divers utilizing tethered manta boards to steer themselves under water. Each tow board was equipped with a reusable data sheet and bottom timer. Divers were towed for 1km while documenting the type of habitat encountered at one-minute intervals. Habitat categories were generalized from the existing digital habitat database of the Florida Keys (FWC and NOAA, 2000) to include bare substrate, algae, seagrass, hardbottom, and coral reef. Marine debris was described and categorized based upon source and composition and included: 1) commercial trap debris; 2) monofilament line; 3) cement; 4) plastic; 5) glass; 6) metal; 7) wire; 8) rubber; 9) fabric; 10) lumber; and 11) unknown. Debris generated by the commercial trap fisheries (spiny lobster + stone crab) was further categorized as follows: 1) whole traps [fishing vs. nonfishing]; 2) intact trap bottoms/trap frame; 3) cement slabs; 4) plastic throats; 5) wood slats/parts; 6) rope; and 7) trap sides. Total incidences of debris encountered and percent of total incidences of trap debris were estimated for each category. The total area surveyed in each habitat type was estimated by first summing the amount of time spent in each habitat and dividing by the total amount of time spent towing to yield a percentage of habitat based on time. Each habitat percentage was then applied to the total area surveyed to translate time spent in habitat to hectares of habitat surveyed. The total area surveyed in each zone was calculated by multiplying the total number of tows for that region by 0.8 hectares (tow area). Trap debris density was expressed as incidences of debris per hectare by habitat and by zone.

OUTCOMES

Estimates from this study identify commercial trap debris as the primary form of submerged marine debris in the FKNMS. Out of 797 total incidences of marine debris sighted during our surveys, 596 (~75%) were related to the trap fisheries. Trap debris was dominated by wood parts, closely followed by rope. More incidences of trap debris, per hectare of habitat surveyed, were recorded from reefs (15.7 incidences /ha); the least amount of trap debris was observed in algae (2.7/ha) and seagrass (4.0/ha; Figure 1).

The rugose, complex nature of reef habitat may entrap debris, yielding more trap-related debris per unit area on reefs than would be expected given the lower relative number of traps fished in this habitat. Most notable was the high prevalence of trap parts on reef versus intact traps. Hard coral surfaces may facilitate abrasion and breakage when traps come into contact with the reef. Additionally, the reefs of the FKNMS are high diver-use areas and divers may interfere with derelict traps in an attempt to release confined animals. More intact traps were observed in Florida Bay, an area of high trap and boat use perhaps leading to buoy cutoffs that render traps lost. Florida Bay also has more softbottom habitats (i.e., seagrass) compared to the Atlantic Ocean.

The highest incidence of trap debris was observed from the Middle Ocean zone (13.2/ha); the least amount of trap debris was observed from the Middle Bay zone (1.7/ha; Figure 2). It was surprising that the least amount of trap-related debris was recorded from the fishing zone that typically experiences the most intense fishing pressure. Surveys in this zone were completely dominated by deeper, softbottom habitats, further from shore, which perhaps are unable to entrap debris as well as reef or hardbottom. Less offshore boat traffic is observed here as well. When some level of rugosity is introduced, debris sightings rise. This was evidenced by increased debris sightings in the Upper and Lower Bay where hardbottom was encountered. It is also possible that heavier trap parts (i.e., cement slabs) sink into the soft sediments and become buried or overgrown with time, rendering them undetectable. Interestingly, no trap slabs were recorded from the Middle Bay. Additionally, fewer surveys were conducted in the Middle Bay, resulting in a lack of inshore tows, where hardbottom is typically encountered.

PRIORITY ACTIONS

Given the lack of technical solutions to reduce buoy cut offs, the excessive number of traps in the fisheries, and the unpredictability of storms, continued trap reduction appears to be the most effective mechanism to reduce debris.

Changes to the fishery fee structure are needed to address the cost of debris removal and mitigation for damages from both lost traps and routine fishing practices. One method to address the hidden cost of lost traps is to make annual tag replacement contingent upon returning the previous season's trap tags. Lost trap tags would imply lost traps, and appropriate trap retrieval fees would apply. In the mean time, targeted removal of submerged debris on reefs would address immediate trap-induced risk to corals and remove debris from areas where it accumulates.

FIGURES AND TABLES

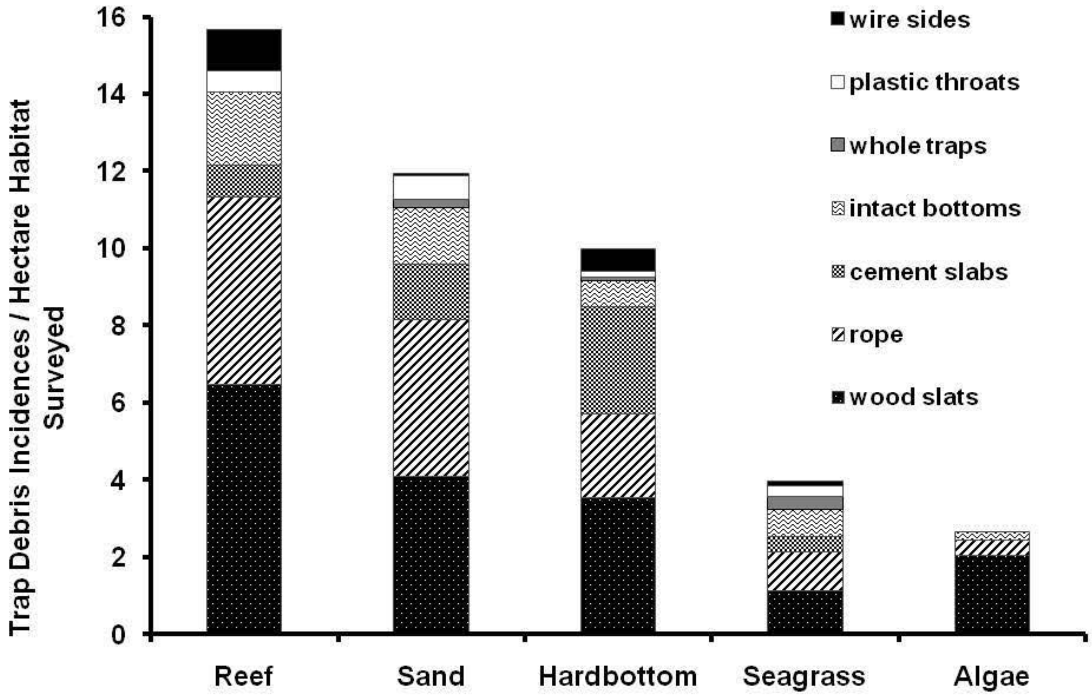

Figure 1. Trap debris incidences per hectare of habitat surveyed in the FKNMS.

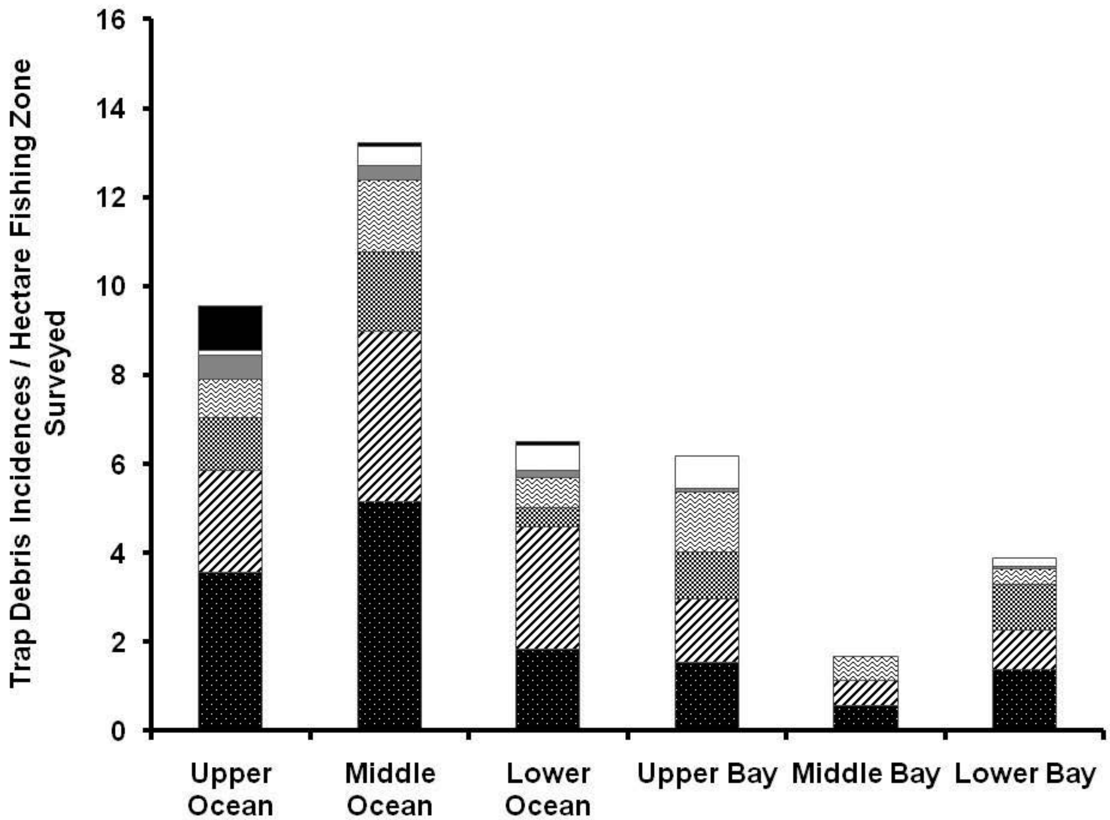

Figure 2. Trap debris incidences per hectare of fishing zone surveyed in the FKNMS.

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23. A total systems analysis of the Great Pacific Garbage Patch

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KEYWORDS
Marine debris, North Pacific Gyre, Great Pacific Garbage Patch, total ecology, management, governance.

BACKGROUND

Marine debris directly impacts humans by diminishing ecosystem integrity, endangering navigation, and degrading fisheries. Marine flora and fauna are affected via ingestion of and entanglement in debris, contamination from pollutants associated with debris, and the potential for non-native species to be transported to foreign areas on pieces of trash. Increasing quantities and the long residence time of plastic in the ocean compound these negative effects on both people and marine life.

One of the most apparent manifestations of the marine debris issue is the "Great Pacific Garbage Patch," a swirling mass of mostly plastic trash located in the North Pacific Ocean. In this poster we describe the "total ecology" of the Great Pacific Garbage Patch issue, which consists of the biophysical, human, and institutional ecologies (Orbach 1995). We will begin with the biophysical ecology of the Great Pacific Garbage Patch, which we define as the non-human, biophysical resources and environments related to the issue. We will then discuss the human ecology, which we define as those humans and human behaviors that affect, are affected by, or are otherwise concerned with the Great Pacific Garbage Patch. Finally, we will describe the institutional ecology of the issue, which we define as those institutions that govern or affect the behavior of those people in the human ecology; that is, the institutions through which policy solutions must be formulated. The "total ecology" of the Great Pacific Garbage Patch issue is the combination of these three ecological systems mapped onto one another, as laws and policies affect the people who affect the marine environment. We will end with management recommendations from the local to the international scale and a discussion of the feasibility and desirability of cleanup within the Great Pacific Garbage Patch.

METHODOLOGY

To make a full assessment of the Great Pacific Garbage Patch issue, we drew from a wide variety of sources, including papers from peer-reviewed journals; government and intergovernmental reports; conference proceedings; news articles; and reports by non-profit organizations. After reviewing the available information and multiple viewpoints on the issue, we distilled the most essential components from our research into this report, and then based our policy and management recommendations on this knowledge foundation.

OUTCOMES

Biophysically, the Great Pacific Garbage Patch is a complex and dynamic problem that poses several risks to wildlife and ecosystem functioning, many of which we do not fully understand. It occurs in a vast area in the North Pacific Ocean where scientists have measured significantly higher concentrations of marine debris than in other parts of the ocean (Pichel *et al.* 2007). Debris collecting there is overwhelmingly plastic, a synthetic material created and used worldwide at an increasing rate (Matsumura & Nasu 1997).

The Great Pacific Garbage Patch is the result of a wide array of both sea- and land-based activities, in particular commercial and recreational fishing; shipping; illegal dumping at sea; beach and coastal recreation; littering; poor landfill and sewer management; and accidental resin pellet spillage. Marine animals living and foraging near the Great Pacific Garbage Patch may accidentally ingest or become entangled in plastic debris, which can cause serious welfare problems or even death (Ryan 1988). Plastic is highly persistent in the marine environment and readily absorbs chemicals from the surrounding water (Mato *et al.* 2001). When the debris breaks down due to photodegradation and wave action, the resulting chemicals and plasticizer additives are released into the environment, which may affect marine animals via hormone disruption (Teuten *et al.* 2009). Additionally, floating debris acts as a vehicle for species transportation to new areas, where they could disrupt food webs (Gregory 2009). The repercussions of sinking plastic on benthic species and ecosystem functioning are unknown but potentially great (Goldberg 1997; Gregory & Andrady 2003).

The Great Pacific Garbage Patch is not a unique phenomenon: concentrated debris in other major oceanic gyres has been observed, especially in the North Atlantic Gyre (see e.g., Carpenter & Smith 1972; Morris 1980; Barnes 2003; Martinez *et al.* 2009). Marine debris is a ubiquitous issue globally, and an increase in debris that is washed ashore is being recorded on virtually every coast in the world (see e.g. Ryan & Moloney 1993; Ribic *et al.* 1997; Torres & Jorquera 1999; Barnes *et al.* 2009; Ryan *et al.* 2009). This is certainly a reflection of the steadily rising global consumption of plastic goods, most of which are single use consumer items that are not recycled.

Humans interact with and are affected by the Great Pacific Garbage Patch in several ways, which may manifest themselves to a larger extent as the problem grows in severity. Debris that is accidentally or intentionally released from inland, coastal, or at-sea activities has the potential to become entrapped in the Great Pacific Garbage Patch, which occurs north of the Hawaiian archipelago and contains major shipping lanes and important fisheries. Debris inside the Great Pacific Garbage Patch impacts these coastlines, fisheries, and ships. Derelict fishing gear snags both reefs and endangered marine animals, costing millions in cleanup and in marine mammal management programs (Donohue *et al.* 2002). Ships are damaged when debris clogs their engines or propellers, costing millions in damages each year (Moore 2008). Several species of tuna, particularly albacore, bigeye, and bluefin, are important to commercial fisheries occurring within and around the North Pacific Gyre, and these species could be affected by marine debris in ways that we do not yet understand (Food and Agriculture Organization n.d.). Therefore, the Great Pacific Garbage Patch is the result of human impacts on the environment, which in turn impacts humans. It is important for people to understand that anybody who improperly discards trash is a potential contributor.

Law and policy concerning marine debris is in place internationally, at the national level in many Pacific Rim nations, and at the U.S. state level for west coast states, Alaska, and Hawaii. These laws currently suffer from funding, implementation, compliance, monitoring, and enforcement challenges, and are not as effective as they were intended to be (National Research Council 1995). New avenues are being explored around the world to restrict plastic trash generation, such as fees and bans on thin plastic grocery bags. In addition, several non-profit and scientific groups have researched the Great Pacific Garbage Patch to shed light on the problem and inform the public. The International Coastal Cleanup is an annual international event organized by the Ocean Conservancy that raises awareness about the extent of marine debris (ICC 2010). The organization details the types and amounts of trash collected at this annual event in a report available to the public, which provides valuable insight into the major components of marine debris. Meetings and conferences have brought together an array of stakeholders who have provided recommendations for more effective policy solutions. Private-public partnerships allow for programs aimed at reducing marine debris to be funded and guided by the government and have seen positive results. Corporate initiatives have been employed to improve business practices and reduce marine debris. We propose several policy and management recommendations that aim to reduce introduction of trash to the ocean, and analyze the arguments in support and in opposition to a large-scale cleanup of marine debris within the Great Pacific Garbage Patch.

PRIORITY ACTIONS

Our comprehensive literature review and analysis of the state of the scientific research regarding the issue have aided us in making management and governance recommendations at all scales. Recommendations focus on several areas of improvement: changes that plastic producers can make; laws and programs involving consumers; increased local action; improved waste management and recycling programs; increased volunteer programs and voluntary pollution reduction measures; strengthened educational programs and awareness-building; better incentives for fishing vessels and cargo ships; and heightened attention to the issue from both national and international governance bodies.

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24. Derelict trap retrieval and trap debris removal programs in Florida

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ABSTRACT
Lost and abandoned (derelict) spiny lobster, stone crab, and blue crab traps can impact essential fish habitat, can become hazards to navigation, and have the potential to continue to catch and kill animals until they degrade or become too fouled for animals to enter and become trapped. Derelict trap and trap debris removal efforts include state-supervised trap retrieval programs where commercial fishers are contracted and compensated to locate, remove, and dispose of buoyed traps left in the water during the closed fishing seasons, and state-authorized community-based volunteer cleanup events that remove derelict traps and trap debris during the open or closed fishing seasons. Owners of commercial traps removed by the trap retrieval program are assessed a $10 retrieval fee for each trap removed, which must be paid in full before the trap owner can renew their commercial Saltwater Products License(s) or trapping licenses (endorsements). The trap retrieval program is funded by a dedicated $25 fee on each commercial spiny lobster, stone crab, and blue crab endorsement and from trap retrieval fees collected from prior years. Florida has enacted strict laws regarding trap theft (or the theft of trap contents) and the unauthorized molestation of traps, lines, or buoys, which apply regardless of trap condition and during both the open and closed seasons. While these laws were designed to protect commercial trap fishers, they also establish a complicated definition of what is considered a "derelict trap" making it difficult to remove traps that have become lost or abandoned during the open seasons. Recent outreach efforts and the implementation of new regional blue crab trap closures have resulted in an increase in the effectiveness and number of community-based volunteer group cleanups around the state.

25. Marine biodegradable product testing

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KEYWORDS
Marine Biodegradable, Biodegradation, ASTM 6691, ASTM D7081, Polyhydroxyalkanoates

BACKGROUND
Consumers are increasingly thinking about the disposal of their waste and increasing sustainability. While many products are compostable and/or biodegradable, these same products may not degrade as rapidly in the marine environment. Some of the reasons for this are the ocean environment has colder temperatures, higher pressures, fewer nutrients and lower oxygen concentrations then the terrestrial environment. Therefore, test methods needed to be developed to analyze biodegradation and toxicity in the marine environment.

METHODOLOGY
Any material that could potentially fall into the ocean needs to be examined for biodegradation and toxicity. If a material does not biodegrade in the marine environment, it may contribute to the problem of marine debris. To ensure that the product does biodegrade and is non-toxic, standard methods have been developed and symbols identifying biodegradable products in the marine environment must be developed.

rganizations like the American Society for Testing and Materials (ASTM) and the International Organization for Standardization (ISO) approve established test methods that are globally accepted. There is an ASTM method and specification that relates to marine biodegradation. The method is ASTM 6691, Standard Specification for Determining Aerobic Biodegradation of Plastic Materials in the Marine Environment by a Defined Microbial Consortium or Natural Sea Water Inoculum. It verifies that marine microbes will biodegrade a material with the criteria of acceptability of 30% mineralization in 180 days at 30˚ C. The specification is ASTM D7081, Standard Specification for Non-Floating Biodegradable Plastics in the Marine Environment. It sets the criteria for biodegradation, disintegration and toxicity of a product.

Tier I Testing (ASTM 6691)

The first level of laboratory testing determines if marine microbes will biodegrade a product. Respirometers in the laboratory measure the rate at which microbes convert a test sample carbon into carbon dioxide. If carbon dioxide increases as a function of time, it is viewed as evidence that the microbes are multiplying and metabolizing the sample. A mineralization rate of at least 30% needs to be reached for a product to pass this test. The tested product is compared to the data of negative and positive controls. Typical controls include cellulose, chitin and Kraft paper. Comparison of the test product to the controls determines if there is a difference in the relative time it takes to decompose the sample. If the product degrades at a rate comparable to the controls, which all degrade in the ocean, it is deemed safe.

Tier II Testing

The second level of testing examines the weight loss of a product over time in the marine environment. The product is examined in static and/or dynamic aquarium conditions. The difference being that in the dynamic aquarium, the tanks are submitted to continuously flowing sea water. The dynamic system resupplies oxygen and removes metabolic by-products. A dry weight for both test methods is taken from each 1 $inch^2$ sample before the test. The static conditions utilize natural sea water with nutrients in 125 ml Flasks with a 1 $inch^2$ sample, shaken at 200 rpm and kept at 20˚ C. Flasks are harvested as a function of time to measure the dry weight of the remaining sample. The dry weights, before and after the test are compared.

Tier III Testing

If products have successfully passed the first two tiers, they are then tested for weight loss in coastal settings and/or the deep ocean. A sample product is placed in a nylon mesh bag and submerged to various depths (i.e. 20, 40, 4,000 and 4,500 meters). These samples are harvested at different time periods (i.e. one month, 6 months and 1 year), to compare the before and after dry weight. Dry weight is measured in the same way it was in Tier Two testing. Samples in the Tier III testing have much slower weight loss than the Tier II testing which is due to the temperature, pressure and the microorganisms in the marine environment.

Marine Toxicity Tests

It is not enough that a material simply breaks down in the marine environment; a material must not be toxic to the marine life and environment. In order to assure that the product will not cause any harm to the sea and the sea life, its toxicity must be analyzed. In order to assess the toxicity of the materials, the Polytox™ Rapid Toxicity Test is used. Polytox™ is a U.S. Environmental Protection Agency recommended test for determining the toxicity of waste water.

Symbol

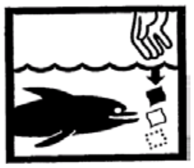
The U.S. Navy is also working on a symbol that will designate products that pass standard ASTM D7081. The Symbol has been copyrighted. Currently, work is being done with third party certifier's in order to ensure the proper use and proliferation of the symbol.

OUTCOMES

Environmentally minded manufactures of common marine debris contributors could begin incorporating marine biodegradable products into their products with confidence. Successful marine biodegradable alternatives are emerging. A good example is polyhydroxyalkanoates (PHA) as a conventional plastics alternative.

PRIORITY ACTIONS
If you have an item that may marine biodegrade and are interested in having it tested, please contact us.

FIGURES AND TABLES



This Symbol designates that a product will degrade according to ASTM 7091

26. An international assessment: the effectiveness of governmental and nongovernmental efforts in the prevention, mitigation and removal of marine debris

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ABSTRACT
Thirteen beaches among nine coastal areas within Hawaii, Australia, the Maldives, South Africa, England, Wales and Iceland were surveyed for accumulation of marine debris between May and August of 2009. A quantitative assessment of the surveys included an analysis of the general composition and variety of litter at each location as well as a look into the probable geographic and industrial origin of each item. A qualitative analysis was also completed that investigated the governmental and nongovernmental contributions to the mitigation, prevention and removal of marine debris in the relevant regions. This included an evaluation of the efforts of governmental organizations as well as the stringency and enforcement of local regulations. The initiatives of nongovernmental organizations and the level of awareness and involvement of the general public were also investigated for each location. These analyses were used to determine the effectiveness of each country's overall management of marine litter and the degree to which the environmental, cultural and socioeconomic impacts of the debris have been addressed within this management. The countries visited were regarded under one of the following classifications: those that have demonstrated a sound balance between governmental and public support of the issue, those whose general public is particularly proactive in the mitigation and removal efforts of marine debris despite minimal governmental involvement and finally those countries whose governments are unwilling or unable to prioritize such environmental concerns and whose general public have not taken an active role in the management or prevention of ocean pollution, typically due to a lack of awareness of the implications of it.

27. Ghost nets: a wicked problem

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ABSTRACT
"Wicked problem" is a phrase originally used in social planning to describe a problem that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize. Moreover, because of complex interdependencies, the effort to solve one aspect of a wicked problem may reveal or create other problems. "(Wikipedia) The ghost net issue represents a multi-scale, multi stakeholder "wicked problem". Exploring the efforts of two northern Australian fisheries to reduce ghost nets in the Gulf of Carpentaria, we reveal that no matter the goodwill of the fishers they cannot work in isolation. Understanding the linkages and causes of the problem is essential to finding long term solutions.

28. Plastics recycling in relation to the marine debris problem: a review

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KEYWORDS
Plastics; Recycling; Ocean; Pollution; Chris Jordan; Plastiki; Beach Debris; Material Recovery Facility (MRF); Chemical Leaching; MARPOL; Prevention; Throwaway Living; Closed Loop

BACKGROUND
Plastic debris presents itself as one of the largest threats to the world's oceans and beaches in the 21st century. The mentality that has persisted since the invention of plastics has been one of "throwaway living" with an "out of sight, out of mind" perspective. Unfortunately, people around the world still maintain this throwaway culture and most often have no idea where their trash ends up. Garbage gets thrown onto the sides of roads, into waterways and eventually, works its way out to sea, because, as Captain Charles Moore once said, "The ocean is downhill from everywhere" (Berton, J. 2007). When it reaches the ocean, it can persist (just as it does on-land) for years upon years: plastic does not simply break down in the same way that glass or aluminum do but rather, it photo-degrades into smaller and smaller pieces. Aside from those that live or work on the coast or at sea, most people might have no idea that this is an issue, which is why educating the public and raising awareness are two key elements in managing and preventing future water contamination. Recycling is one method of prevention and will be discussed throughout the course of this paper along with background pertaining to the marine debris problem and adverse environmental impacts it causes.

After reviewing multiple papers on the issue of marine debris, it is apparent that the majority of plastic debris recorded and collected is primarily land-based in origin consisting of consumer products. The United Nations Environment Programme (UNEP) defines land-based plastics as any plastic item that once originated on land, be it from landfills, rivers, canals, untreated sewer water, tourism, industrial facilities or storm water. Sources originating at sea are also an important, though comparatively smaller aspect of problem and include plastic debris from fishing vessels, pleasure craft and research vessels as well as accidental spillage of virgin plastic resin pellets from container ships. The focus of this paper will be on consumer plastics, or those that at one point originated on land. It can be inferred that since the problem originates on-land, implementing programs to "catch" plastic waste before it washes out to sea will be the best solution. Currently, recycling programs, which are ubiquitous in developed countries around the world, are ineffective at keeping plastic waste from entering the ocean. With careful planning and implementation, they have the potential to become an effective solution to the plastic debris problem.

METHODOLOGY

The objective of this project was to examine various studies within the field of marine pollution and to then come up with solutions, based on what problems are currently associated with plastic waste. Researched topics included: negative effects of plastic waste into the environment, toxicity, plastic type and recycling methods, a history of plastics and recycling, beach debris data and real world solutions being implemented on both a local and global scale.

Perhaps the most pertinent observation that can be made from analyzing the aforementioned topics is that plastics persist in the environment, due not only to the chemistry of plastics but also the environment in which they reside. It is important to understand that because of the longevity of plastic material - which can persist for decades or longer - virtually every synthetic polymer ever produced still persists today, in one form or another (Hopewell, et. al 2009). Because of this, it is even more imperative that communities come together, on a local scale (working towards a global goal) to put into place solutions that will have a positive impact on our world's oceans.

OUTCOMES

In a perfect world, plastics would be used for long-term applications only and single-use items would be composed of more energy-saving and natural materials. But due globalized markets with imports and exports being shipped thousands of miles to their final destination, plastics remain a practical, energy and cost-saving option for transporting goods worldwide. Shipping products in plastic packaging saves on fuel costs and because of the plastics' lighter weight (when compared to glass, for instance) can actually decrease fossil fuel emissions during shipment. Because of this, plastic use will inevitably continue and it is crucial that recycling programs be enhanced to keep plastics from escaping to the environment. Recycling of pre-consumer plastics continues to thrive at the industry level because there are much fewer types to deal with; the plastics recovered pre-consumer usually consist of large containers that can be reused. Problems associated with release of pre-production plastics to the environment are comparatively small, but occur mostly as accidental spillage of virgin plastic resin pellets. These "nurdles," once spilled from a land-based processing facility or at sea, often are the main component of pre-consumer beach debris data. While pre-consumer plastic recycling is efficient, post-consumer recycling is much less so, and it remains the biggest challenge due to the variety of plastics available and fewer options for reuse. It is the consumer side where efforts must be focused.

The potential for recycling as a means of preventing human refuse from entering waterways and eventually the ocean is enormous. Unfortunately, in the United States and elsewhere recycling is often an underutilized solution to the marine debris problem. For example, on average over 28 billion PET water bottles are produced every year of which 86% are thrown away and only about 3 billion bottles are recycled (Algalita Marine Research Foundation). When analyzing recycling data, it is important to consider scale: millions of tonnes recycled sounds like a large number but when compared to the billions of tonnes of plastic produced annually, it often becomes understated.

Incentives are proven to be extremely effective at increasing recycling rates. Bottle deposit legislation creates a get-money-back scheme in which the consumer pays the deposit on the bottles and upon returning them to a facility, is rewarded by getting that money back.

Unfortunately, today there are still only 11 states that have implemented bottle deposit laws: California, Connecticut, Delaware, Hawaii, Iowa, Maine, Massachusetts, Michigan, New York, Oregon and Vermont. Interestingly enough, not all of these states are located near major water-bodies, which means recycling can still be effective even if one is removed from the immediate dilemma (see Figure 13). If programs that offered a monetary incentive or even discounts (offering a certain percentage off groceries for bringing reusable bags) were put into place in grocery stores, efforts to reduce consumption and recycle what was already in the system might increase.

PRIORITY ACTIONS

Advocating for effective and more omnipresent recycling programs is not the be all and end all solution to the marine debris problem; as with all potential solutions, recycling must be thought of as one step in the larger goal of fighting the marine debris problem. The EPA coined the phrase "Reduce, Reuse and Recycle" for a reason and the disposal of plastic should be taken care of in that order. In this way, we can reduce our dependence on useless plastic items and lessen our impact on land and at sea.

FIGURES AND TABLES

Figure 1) Chris Jordan (2009) – "Midway: Message from the Gyre." Image depicts a deceased Laysan Albatross chick. The image was taken as it was observed – no alterations were made.

ASTM D5033 definitions	equivalent ISO 15270 (draft) definitions	other equivalent terms
primary recycling	mechanical recycling	closed-loop recycling
secondary recycling	mechanical recycling	downgrading
tertiary recycling	chemical recycling	feedstock recycling
quaternary recycling	energy recovery	valorization

Figure 2) Different terminology for recycling (Hopewell, Dvorak and Kosior, 2009).

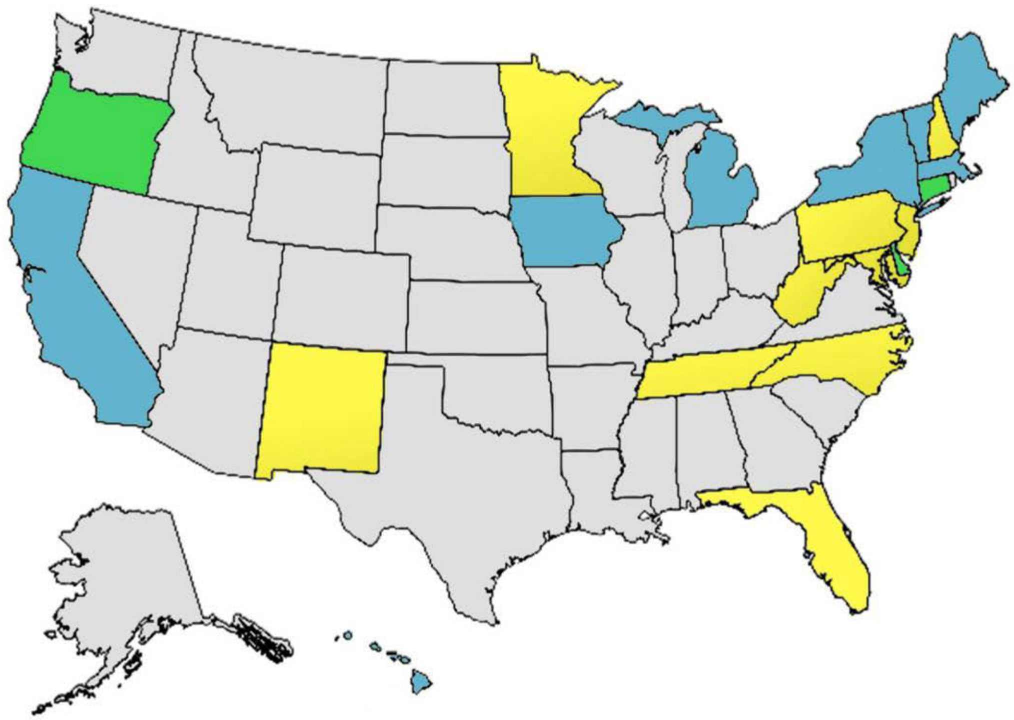

Figure 3) Comparison of U.S. states that currently have bottle bill legislation in place. Blue states represent those with implemented laws (California, Connecticut, Delaware, Hawaii, Iowa, Maine, Massachusetts, Michigan, New York, Oregon and Vermont), yellow states are those with pending legislation and green states are those with current campaigns for new bottle laws. Gray states currently have no state-imposed bottle-bill legislation (Bottlebill.org).

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29. Municipal solid waste management in coastal towns of Gujarat State, India

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KEYWORDS
Municipal Solid Waste Management (MSWM), Urban Local Body (ULB), Tons per Day (TPD), Vermi-compost, fuel palates, Sanitary Landfill (SFL) sites

BACKGROUND

Gujarat is one of the fastest developing State of India, with 6% of total geographic area and 5% of total population of the country. Due to Gujarat's geographic location, its interface with marine environment is comparatively more than any other Indian State, having 1600 km long sea coast, the longest shoreline for any Indian State. To reduce the adverse impact of Municipal Solid Waste on the environment, its scientific treatment and disposal is important. Gujarat is leading in implementation of Municipal Solid Waste Management Rules 2000 enacted under the Environment Protection Act 1986 of the Government of India. In conventional approach the MSW used to dump in low lying area near the cities or into ocean, after implementation of MSWM Rules, it is being managed in scientific manner, this approach makes huge positive impact on the environment and especially in coastal areas which is proximate to more sensitive marine environment.

Since formulation of MSWM Rules, scientific management of domestic waste has became an important job for the city Government for maintaining health and sanitation condition of cities as well as reducing waste's impact on the environment. Rapidly changing lifestyle, urbanization and population growth increases the quantum of daily generation of MSW. Earlier, city waste was used to dispose unscientifically by burning and dumping in to the environment, which used to create irreversible impacts and damages to the surrounding ecosystem. MSWM Rules applies to all Urban Local Body (ULB) of the State. Out of 167 ULBs, 30 are coastal ULBs, which are far from sea coast up to 15 km. Coastal ULBs include city like Surat, which is second largest city of the State, with population of 4000,000, and smaller cities with population as low as 15000. The list of cities with their daily waste generation is shown in Table 1, and their location in Fig. 1.

METHODOLOGY

The MSWM has four components, starting from waste collection to its scientific treatment and disposal, as per following.

1. **Collection:** door-to-door collection of solid waste, its segregation and its conveyance to primary collection centre are part of this component. Mainly MSW comprises wet organic kitchen waste and dry recyclable waste.

2. **Conveyance:** from primary collection centre MSW is conveyed to treatment site through mechanical compaction. The compacted waste is easier to handle and reduces conveyance cost.
3. **Treatment:** waste is converted into useful produces like compost, fuel pallets etc. by providing scientific treatment. The organic waste is converted in to compost by using earthworms; this compost is known as vermi-compost and can be used in agriculture, horticulture purpose. Recyclables are separated and remaining material is converted into fuel pallets, which is used as alternative fuel. The residual useless material is known as inert, are separated after due treatment to the collected waste.
4. **Disposal:** through scientific treatment, all useful material from waste is converted in to products, the remaining inert are disposed into Sanitary Landfill (SLF) Site, which is developed in clusters, each cluster includes 10-12 ULBs, inert from nearby treatment plants are conveyed to SLF for ultimate land filling. SLFs are constructed in such manner that inert buried in to it does not harm to the environment.

For all 167 ULBs of the State similar pattern of MSWM is being followed with minimum one treatment site to each ULB. The Public Private Partnership (PPP) mode of working is being promoted, in which, first two components of MSWM are managed by the Government and the rest two components are managed by private firm. PPP mode reduces cost to the Government and provides effective treatment to waste.

OUTCOMES

The well structured MSWM programme and planned implementation of MSWM Rules lead to scientific management of Municipal Solid Waste. In Gujarat 7000 Tons per day waste is being managed after implementation of this programme. The third of total generated waste i.e. 2350 Tons per day has very direct impact on marine environment; this programme has eliminated such problem by and large. Presently efforts are made to make the programme more cost effective, regular inspection audits, review of better practices are done at State level. Different modules of Information, Education and Communication (IEC) for ULB staff, elected representatives and for citizens are also under implementation to make MSWM further improved in the State. It is one of the most comprehensive environmental programme implemented in the last decade, many other Indian States adopted same strategy to implement the MSWM Rules.

PRIORITY ACTIONS

MSW is one component of land based source of marine debris, there are many other specific activities, which generates debris, which ultimately leads to marine pollution. Gujarat being important industrial State also targets to identify major waste generating activities having impact on Marine Environment and is developing models to cover all them with proper planning and strategy.

FIGURES AND TABLES

Table 1: Details of Coastal ULBs of Gujarat State and and their Daily Waste Generation

Sr. No.	Name of ULB	District	Class	Waste Generation
1.	Mandavi	Kutch	C	11
2.	Gandhidham	Kutch	A	38
3.	Maliya	Rajkot	D	10
4.	Jamnagar	Jamnagar	MC	250
5.	Sikka	Jamnagar	D	2
6.	Salaya	Jamnagar	C	3
7.	Okha	Jamnagar	B	20
8.	Dwarka	Jamnagar	D	12
9.	Porbandar	Porbandar	A	45
10.	Chhaya	Porbandar	C	7
11.	Mangrol	Junagadh	B	21
12.	Chorvad	Junagadh	D	3
13.	Veraval	Junagadh	A	40
14.	Sutrapada	Junagadh	D	2
15.	Kodinar	Junagadh	C	9
16.	Una	Junagadh	B	7
17.	Jafarabad	Amreli	C	3
18.	Mahuva	Bhavanagar	B	26
19.	Talaja	Bhavanagar	C	18
20.	Bhavnagar	Bhavanagar	MC	200
21.	Khambhat	Anand	B	25
22.	Jambusar	Bharuch	C	13
23.	Bharuch	Bharuch	A	82
24.	Surat	Surat	MC	1400
25.	Navsari	Navsari	A	25
26.	Bilimora	Navsari	B	18
27.	Gandevi	Navsari	D	6
28.	Valsad	Valsad	A	41
29.	Pardi	Valsad	C	7
30.	Umargam	Valsad	D	7
	Total			2351

Fig. 1: Map Showing Locations of ULBs of Gujarat State

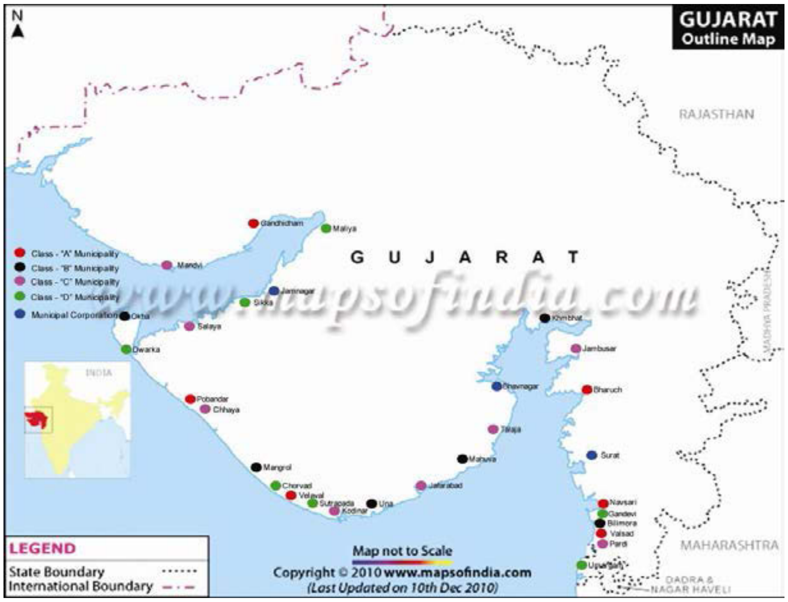

Fig. 2: Photos showing different components of MSWM in Gujarat


Photo 1: Vermi Compost Plant at Kodinar


Photo 2: Fuel Pallets Made out of Waste at Treatment Plant, Bhavnagar


Photo 3: Sanitary Landfill (SLF) Site in Gujarat

Photo 4: Solid Waste Transfer Station in Surat

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Primary Data Collection by Gujarat Urban Development Company (GUDC) for Municipal Solid Waste Management (MSWM) Project, 2008

30. Derelict fishing gear removal from the Northwestern Hawaiian Islands

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ABSTRACT
Derelict fishing gear (DFG) in Hawai‘i’s coastal and marine habitats presents a potentially lethal entanglement hazard to numerous marine species, most notably the critically endangered Hawaiian monk seal, the threatened green sea turtle, and the endangered humpback whale. In addition to presenting an immediate threat to wildlife, DFG also damages coral reef ecosystems, acts as a potential vector for the introduction of non-native species, and presents a hazard to boat navigation. The impacts of derelict fishing gear on coral reef ecosystems are evident across the Hawaiian Archipelago, especially in the Northwestern Hawaiian Islands (NWHI). From 1996 to 2009, the National Oceanic and Atmospheric Administration’s (NOAA) Pacific Islands Fisheries Science Center (PIFSC) Marine Debris Team surveyed and removed DFG from approximately 142 km^2 of shallow-water habitat (less than 10 meter deep) using manta tow boarding and swim survey techniques. Approximately 682 metric tons of DFG were removed from various atolls and reefs within the NWHI. Throughout this 14-year removal effort, additional long-term spatial and non-spatial data were collected, including coordinate locations and depth of DFG found/removed, size, color, type, and fouling level of DFG, and substrate classification. Data that were collected are valuable for understanding the characteristics of DFG and to help in planning and preparation of future removal efforts. This unique survey and large-scale removal project aspires to increase the awareness of the marine debris problem in the NWHI and hopes to prompt the significant social and political will necessary to reduce the source of DFG from the world’s oceans.

31. State-level responses to abandoned and derelict vessels in the USA

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KEYWORDS
abandoned, derelict, vessel, marine debris, workshop

BACKGROUND
Abandoned and derelict vessels (ADVs) are consistently identified as problematic to coastal managers, negatively impacting marine waterways and communities. While seaworthy vessels provide many services such as recreation and commerce, ADVs also have significant negative impacts on navigation, tourism, human health and the environment. Responsible ownership, maintenance, and operation are the norm for the boating community, but once a vessel becomes abandoned or derelict actions to mitigate its impacts are necessary. A robust state ADV program, working in coordination with marinas, boat owners, nongovernmental organizations, and Federal and other state agencies, can help overcome these challenges.

METHODOLOGY
The State-level Responses to Abandoned and Derelict Vessels workshop was held September 15 to 17, 2009. A representative from each coastal state (including the Great Lakes) was invited to attend. The term "state" should be interpreted as including the territories and commonwealths of the United States of America. The workshop was strategically designed to bring together Federal agency representatives and state coastal managers to facilitate discussion on ADVs and share challenges and successful practices. The workshop allowed Federal agencies to share information with state representatives on their mandates and authorities, and for states that have adopted ADV abatement programs to share information about their successes and challenges. This information exchange provided tools and suggestions for other state managers without a formal ADV program to emulate and apply in their own region.

OUTCOMES
The U.S. National Oceanic and Atmospheric Administration (NOAA) produced a proceedings document following the workshop to capture lessons learned and to promote future discussion on ADV challenges and successes (Parry and McElwee, eds. 2010). This document is organized to provide two levels of detail for any audience interested in abandoned and derelict vessels (ADVs). Section I is designed as a reference tool to provide introductory and high-level information on the components of a state-level ADV program. In Section II, a significant amount of information is included for each of the identified components of a successful state ADV program. During the workshop, attendees shared numerous ideas during the discussion of each program component–first in small teams, and then with the entire workshop. Support and criticism for each idea was shared openly, and the detailed description found under each idea is

taken directly from the expert attendees. Information on ADV-relevant mandates and authorities from a select group of Federal agencies can be found in Section III, including case study examples. Section IV provides concluding remarks, as well as specific suggestions for future ADV efforts that were proposed by workshop attendees.

In addition to the state-level guidance developed at the 2009 ADV workshop, the National Association of State Boating Law Administrators developed a document outlining Best Management Practices to address ADVs (NASBLA, 2009). Additionally, the Sea Grant Law Center produced updated guidance on select state laws governing ADVs (SGLC, 2009).

PRIORITY ACTIONS

While Federal agency mandates and authorities to respond to ADVs exist, their application and interpretation do not cover each and every scenario presented by ADVs. Moreover, participants at this workshop agreed that state agencies, while requiring both financial and technical assistance to develop and strengthen ADV programs, were the most appropriate level of government to combat this issue.

State and local bodies must continue to strengthen existing ADV programs, and share information of both successes and challenges with other states. Whereas financial support is the most obvious solution to an immediate ADV situation, the larger challenge – particularly in light of the financial concerns at the Federal level – is capacity development to address ADVs holistically.

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32. Okinawa, Ryukyu Islands JAPAN: cleanup 20 year report & update on regional marine litter initiatives

沖縄（琉球列島）における20年間のクリーンアップの報告と地域海岸漂着物に対する現状

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BACKGROUND

The world oceans' eleventh hour is upon us. Trash on our beaches is a clear symptom of the unhealthy and cancerous state of our oceans. The years leading to the 1992 Earth Summit saw a quantum leap of environmental activity. After 20 years we hope that our efforts can synchronize so that humanity steps up to a new level of international partnerships.

Okinawa's island-wide beach cleanup efforts flourished in early 1990s lead by volunteer groups with help from quasi-governmental organizations, local municipalities, and private companies. This effort significantly increased awareness in marine conservation among the general public, government officials and created some large-scale cleanup campaigns.

Concerning the national/international efforts for marine conservation, the Okinawa Prefecture Regional ("CHIKI") Green New Deal Task Force Steering Committee for the Removal and Disposal of Marine Litter (ML.CHIKI GND) (working translation) was created in 2009 with actors from different sectors to formulate a comprehensive plan to solve the problem of marine litter in Okinawa Prefecture (Ryukyu Islands).

We are now at "another" start line armed with a new level of partnerships never seen before. How do we create a springboard to sustainability with this initiative and proceed for lasting impact? How can we take advantage of this new commitment with "local" and "global" tools in this ongoing Global Ocean Triage?

METHODOLOGY

All the information in this presentation has been gathered: 1) from 20 years experience as a lead member of a local pioneering beach cleanup group and a chairman of an NPO; 2) Ryukyu ICC Coordinator since 1993; 3)by attending and making presentations in various national/international conferences, such as 2010 NOWPAP ICC & Workshop on Marine Litter Management; 4) reviewing research on marine litter in Okinawa; and 5) from secondary literature reviews.

OUTCOMES
Any sustainable actions require complementing partnerships among all stakeholders. For example, Prefecture governments have a pattern of funding jumpstart programs then jumping ship after a three year lifespan. Dedicated staffs are transferred automatically.
NPOs and volunteer groups that have a wealth of knowledge in formulating and carrying out effective programs lack funding and manpower (fig. 1). Identifying comparative advantages of each stakeholder is the key to long-lasting impact and long term working relationships.

In Okinawa, volunteer groups and NPOs have kept the cleanup momentum going while the NPO legal status was being lobbied. The Japan Coast Guard had been surveying marine litter from the year 2000. The local Division of the Japan Coast Guard the 11th Division HQs (11th JCG) had joined the effort and started to partner with volunteer groups. This collaboration led to the founding of the Okinawa Clean Coast Network (OCCN) in September 2002 (fig. 2). OCCN has provided the main mast for cleanup activities with its centralized reporting (fig.3, 4). The campaign was moved to June in 2003. This unique partnership has been presented to foreign senior officials visiting Okinawa for training with the Japan International Cooperation Agency (JICA).

There is also a joint effort by different sectors to make a Ryukyu Islands Clean Beach Platform in order to create individual "Site Health Charts" to determine the baseline for each and all beaches in the archipelago. Free IT tools such as Google Earth, Google Ocean along with standard GPS functions on mobile phones and car navigation.

The three-year ML.CHIKI GND is in operation in Okinawa with the budget of about $70 million for 2009-2011 to formulate a regional plan for cleanup and disposal of marine litter and raising social awareness. At the end of its lifespan, this initiative may be an example of complementing partnership among all stakeholders.

Our ocean has been treated as a dump. Now we need to take the next step. It is about the choices we make and eventually what every "one" does every day. Small adjustments can lead to efficiency from zoom in local to zoom out to global. By 2012 at the "Blue" Earth Summit the course must be charted for a return to health, for a World Ocean Renaissance.

PRIORITY ACTIONS
One of the key factors for sustainable platforms for long-term monitoring of marine debris is that it's tied in to social action, requires education for sustainable development (ESD) and needs to make awareness about marine litter programs "FUN" for lasting impacts. Proper funding needs to be ensured to support NPOs and volunteers for they play a central role in this effort. Collaboration of already existing resources is another key factor for a faster and lasting impact, therefore, all information to be provided as open source is strongly recommended.

"Trash Travels" and as such, Marine Litter Issues by default necessitate cross-boundary collaboration. Language barriers need to be overcome in order to take full advantage of international initiatives and interlinking of existing networks. NPOs need to facilitate and funnel international cutting edge policy and apply it locally.

The ML.CHIKI GND is collecting public comments and will meet on March 24th 2011.

For this local initiative to tackle the marine litter problem globally, the Ryukyu Islands should be included in the geographical scopes of the UNEP Regional Seas Program as a special activity area following the Large Marine Ecosystems (Kuroshio LME # 49) and the open sea.

FIGURES AND TABLES

Figure 1: Sample poster from 2000 Campaign

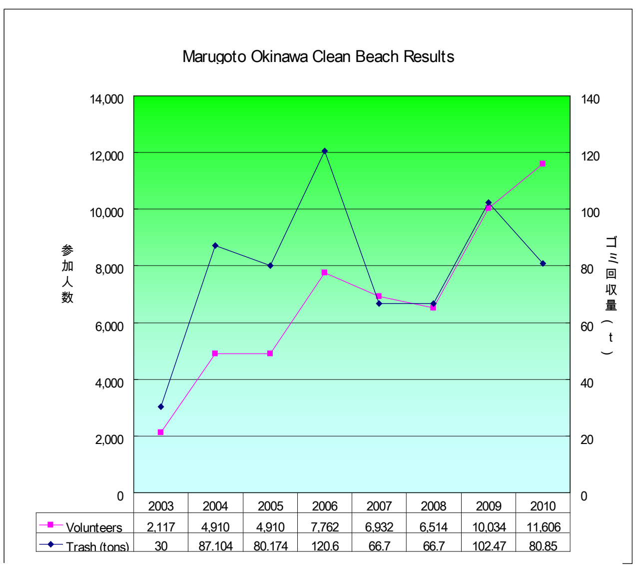
Figure 2: OICBC & OCCN Inaugural Joint Cleanup September 2002

Total Volunteers	**5,260**
(OICBC Volunteers)	(1,291)
(OCCN Volunteers)	(3,969)
Total Weight	**27,455 kg**
(Weight by OICBC)	(8,560kg)
(Weight by OCCN)	(18,895kg)
Total Distance	**39.62 km.**
(Distance by OICBC)	(17.12km)
(Distance OCCN)	(22.5km)

(Source: 2002 Okinawa Cleanup Yuimaru Report (International Coastal Cleanup)

* OICBC used Marine Debris Data Cards
* OCCN Cleanup moved to June/July from 2003

Figure 3



Volunteers and Trash Data from 2003 to 2010 for June-July2010Year round cleanups reported by members from Aug.-May 50 sites/2,540 volunteers/ 12km.
2010 Total: 112 sites/ 14,146 volunteers / 92.85km.

Figure 4

Marugoto Okinawa Clean Beach Poster with cleanups from June to July. Appeal to volunteers to clean the same sites in Sept. ICC. With the Okinawa “6 O 9” Model

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Figure 3- 4, (2011) courtesy of OCCN Secretariat the 2010 OCCN General Meeting 2/18/11.

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33. Gore Point Marine Debris Cleanup and Monitoring Project

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KEYWORDS
Super Sacks, helicopter, barge, landing craft, sling, hoist, skiff, inflatable, Gore Point, Elizabeth Island

BACKGROUND
The problem statement is: Different geographic environments present unique logistical and physical challenges for marine debris collection and removal. This poster presentation illustrates the strategies and technologies adopted to meet the challenges inherent in removing marine debris (MD) from heavily fouled beaches in a remote Alaskan coastal environment. Two sites with remarkably different conditions requiring different removal strategies are highlighted.

Gore Point is a finger-like claw of land jutting southward From the Kenai Peninsula into the northern Gulf of Alaska. Gore Point snags marine debris from the southwesterly flowing Alaska Coastal Current and from storms that drive Pacific MD onto the Kenai Peninsula coast. Tons of plastic debris washed up on Gore Point for decades. In 2007, 20 tons of plastic debris were removed from Gore Point's ½-mile long East Beach.

Elizabeth Island Lake is a small anadromous salmon lake on remote Elizabeth Island at the southwest tip of the Kenai Peninsula. Elizabeth Lake has been inundated by marine debris driven by storms and surf nearly ½ mile inland. The poster illustrates efforts to clean the lake in 2010.

METHODOLOGY
Removal of marine debris by helicopter and a large landing craft from Gore Point will be highlighted. Removing nets and debris from floating log jambs in Elizabeth Island Lake utilizing chest waders, inflatable skiffs, and good old muscle will also be illustrated.

34. Exclusive beach cleanup applications for small islands

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KEYWORDS
Shoreline marine debris, safe disposal methods, dioxin free incineration, non-biodegradable plastics, small islands, exit survey, Priority Number One, Miyakojima Project

BACKGROUND
Increasing amounts of marine debris have become a high threat to people and endangered costal habitats of small islands. Surging marine debris on small beaches of remote islands is already beyond the stage of, "just wait for somebody's help".

"Priority Number One" marine debris research program is a viable beach cleanup application, developed by the Miyakojima Project, for small islands for contentious and proper marine debris collection by their own hands. This project also covers high efficiency approaches for local disposal and recycling studies for a low-costing and convenient logistic strategy to ship to recycling or disposal facilities on the mainland with minimal financial burdens.

METHODOLOGY
This application focuses on targeting the collection of highly hazardous non-biodegradable items from beach and shoreline environments of small islands.
By implementing "Priority Number One" beach cleanup methods, we:

a. Increase the volume of removal and disposal of marine debris effectively from remote areas.
b. Reduce the allocation of workload to enable cleanup by the people of the island. By doing so, it will allow them to achieve a periodical schedule to monitor cleanup. This is essentially important to "morning after the storm" cleanups to minimize incidental damage to marine habitats.
c. Prevent the re-entering of dangerous marine debris into the ocean during the next high tide, so that it will decrease the risk of a second threat to marine habitats and species.
d. Maximize the effectiveness of local removal and disposal by narrowing down the items of collection by priority. Explore and expand upon their current methodologies.

OUTCOMES
Database Platform for Small Islands
The website *www.prioritynumberone.net* is an open source application system and driver device

for the “Priority Number One” marine debris research program which provides resources to assist people of small islands throughout the world.
This platform will:

a. Raise urgent issues, including marine debris of small islands.
b. Introduce a variety of solutions from the original study and/or collected studies, directly from the laboratories, by the Miyakojima Project.
c. Provide a variety of other approaches with an emphasis on various methods and tools currently in use.
d. Introduce methodologies which are voluntarily submitted by the leading experts around the world in an extended effort to find the most effective disposal methods for small islands.

All applications introduced on the platform can be shared without cost to anyone in the world. Users of this platform may localize and utilize those applications to apply to the conditions and issues of other concerned islands.

Outreach Younger Generation
Increasing children’s awareness of the need to clean up marine debris and protect marine species is especially important to small communities. In many cases, family ties are very close on small islands, so children’s remarks in family conversations at home concerning this subject can create awareness within the family and also become a new trend for the entire community.

1. To advance outreach to children in islands around the world, the Miyakojima Project established *www.miyakojima-kids.net* to introduce a children’s version of “Priority Number One”. This is to help give children a clear vision that beach cleanup efforts to save their own island are also helping to save marine creatures and the eco system thousands of miles away from their homes.
2. Promote effective utilization of educational school excursions to Miyako Island. Every high school in Japan has a school trip or study tour during their junior or senior year. Miyakojima Project is preparing all the necessary study programs for high school students throughout Japan to travel to Miyako Island and research the marine debris. This will help them learn the seriousness of marine debris, methods of cleanup and disposal, actual research and collection at beaches, recording and analyzing techniques, and the dissection of local fishes to find any micro-debris in the stomach or intestine.
   A finalized version of “Priority Number One” has been drafted as a study program for high school students and will be placed for consideration to high schools all throughout Japan as a means of creating awareness about the shoreline environment.

Exit Survey at Okinawa Ryukyu Basin (Figure 1)
Miyako Island is geographically located at the junction of two ocean currents heading north. Consequently, the marine debris in the Southeast Asian region flows past Taiwan and accumulates near the sea of the Ryukyu basin, including Miyako Island.
Therefore, Miyako Island is one of the best places to test out this “Exit Survey Base at the Gateway” for marine debris before they are discharged into the Great Pacific Gyre.
The results of the trend and characteristics analysis (including the identification of nations that originally produced debris) of this “Exit Survey” data is an advanced notice to inform the

characteristics of incoming marine debris to mid-pacific islands and to the Pacific Northwest region of the United States.

To trace those characteristic regional features of East Asian marine debris, "Priority Number One" also started surveys at beaches of Washington State in the United States.
The arrow shows the flow of debris as it reaches the Pacific Northwest coast of the U.S. after three to five years.

As small remote islands already have enough challenges just to keep up their daily lifestyles, the "Priority Number One" marine debris program of the Miyakojima Project primarily serves to provide quality resources necessary to aid people of small islands around the world.
This platform is to relay information to people of the substantial amount of new approaches to solving this problem. "Priority Number One" was formed to find solutions that will keep beaches of the small islands clean and minimize incidental damages to habitats and marine species.
This may be the start of a solution to what is an insurmountable problem for all small islands.
The goal of this project is to increase local awareness, strengthen the community's power to protect their environment and eco system, preserve ocean resources and enable people of small islands to care for their islands by their own hands.

PRIORITY ACTIONS
With "Priority Number One", we pick up only non-biodegradable plastics and other synthetic debris for mitigation of removal. By applying this method, we can effectively remove highly hazardous debris from the shoreline to protect the local ecology and enable the increase of the volume of removal and disposal.

FIGURES AND TABLES
A small remote island does not have many options for marine debris disposal. "Priority Number One" also keeps a digitalized record of the economical impact of marine debris to small remote islands to find the most economical way of disposal. The following are the currently available methods and costs of disposal that can be applied at Miyako Island.

Table 1: Average disposal cost of marine debris by method at remote small islands.
(Cost calculations based on average volume of each cleanup; 600-700 kg)

Method of Disposal	Expense Account	Foamed Polystyrenes	Plastic Bottles	Other Plastics	Nets and Ropes	Total Cost
Local Disposal (Incineration)	Fuel Cost	$35.00	$42.00	$38.50	$57.75	
	Operators Cost	$25.00	$30.00	$27.50	$41.25	
	Total Expense	$60.00	$72.00	$66.00	$99.00	$297.00
Recycle in the Mainland (Non-compressed)	Flexible Container	$36.60	$19.58	$8.90	$35.60	
	Shipping Cost	$246.07	$73.92	$33.60	$134.40	
	Total Expense	$282.67	$93.50	$42.50	$170.00	$588.67

Recycle in the Mainland (Compressed)	Flexible Container	$17.18	$8.90	$8.90	$24.92	
	Shipping Cost	$82.03	$33.60	$33.60	$94.08	
	Total Expense	$99.21	$42.50	$42.50	$119.00	$303.21
Dissolving Agent Disposal	Cost of Citrus Oil (d-Limonene)	$156.00				
	Shipping Cost	$72.00				
	Total Expense	$228.00				

Cost calculation by: Miyakojima Project

Table 2: Marine Debris Research results and characteristic regional features of Miyako Island
Country-by-country report of plastic bottles collected at a small beach in Miyako Island.

Sampling Unit: 100 meter x 10 meter - Location: 24.89368, 125.281498		
Country	Quantity	Weight
Japan (Local)	91	--
China	670	--
Taiwan	52	--
Korea	46	--
Unknown	389	--
Total	1,248	51 kg

Survey Date: October 3, 2010 by Miyakojima Project

Figure 1: Geographical characteristic of Miyako Island for Exit Survey

REFERENCES

JCG (Japan Coast Guard), *Quick Bulletin of Ocean Conditions, Kuroshio Current*
NOAA Marine Debris Program, *Behavior characteristic of North Pacific Gyre*
OSCAR *(*Ocean Surface Current Analyses, NOAA), *Real Time Data Display*

35. Removal and disposal methods of marine debris in Japan

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ABSTRACT
A model survey for reduction of marine debris was conducted by the Ministry of the Environment, Government of Japan at 11 seacoasts to consider efficient methods for removal and disposal of marine debris, with consideration to the local condition. The survey includes detailed analyses of the types and quantities of marine debris, understanding actual situation of marine debris such as their seasonal fluctuations, and a trial of efficient collecting and disposal methods according to coast characteristics.

Firstly the seasonal data of marine debris quantity in each model area was categorized into 4 types, and efficient collection period was determined. In case where marine debris peak is obvious, collection after marine debris peak is effective to keep the seacoast clean for a long period of time. However, in case where seasonal fluctuation is not obvious and debris constantly reaches a beach throughout a year, collection should be performed frequently.

Secondly, the collection and transport methods of marine debris were considered based on the characteristics of seacoast. A vehicle approach road is essential for utilization of a back hoe, an all terrain vehicle, and it is shown that a back hoe is very efficient for collecting large driftwoods and fishing nets. Lack of an appropriate approach road limits the types of target debris that can be collected. Collection efficiency was 5 - 31 kg/h/person and it depends on debris density and collection/transport method.

Driving heavy equipment and vehicles onto a sand beach may cause hardening of the sand. Prior negotiation with the seacoast administrator and other related sectors will be necessary. Collection of seaweeds that drift on the beach should be considered on a case by case basis, taking into account the coasts ecosystem, as well as the protection of the landscape in the respective area.

The efficient use of driftwoods was considered. Disposal method of driftwoods includes incineration, landfill, and chipping. Chipping is an efficient use of driftwood, and it has the lowest disposal cost, followed by incineration and landfill.

36. Pacific Ocean cleanup

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KEYWORDS
Marine Debris Awareness, Pacific Ocean

BACKGROUND
The concept behind the production of the poster was to promote awareness among the community about the ever increasing problem with marine debris throughout the Pacific Ocean. The poster was made by using picture examples of actual marine debris, made from different materials. It also gives an estimation of the time for a particular material to breakdown within the ocean environment. In support of the pictures on the poster, information is included on the effect that debris can have on the marine environment and estimations on how much trash enters the world's oceans each day.

METHODOLOGY
It is hoped the visual aspect of the poster attracts the attention of the onlooker and encourages them to continue to read the content and thereby be informed about the problems that arise from marine debris. The poster title 'Pacific Ocean Cleanup' suggests the need for action.

OUTCOMES
The poster is an educational resource aimed to encourage further exploration of the subject of marine debris. The poster distribution was first targeted toward learning institutions catering for 7 to 18 year olds. Public events have been used as a means of distributing the poster, thus aiming at a greater cross section of the community. Getting involved is an outcome we hope the poster will encourage.

37. Abrasion stress to benthic coral reef organisms from lost fishing gear and other marine debris in the Florida Keys

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KEYWORDS
Angling gear, coral reefs, fishing, Florida Keys, habitat map, lobster traps, marine debris, marine reserves, stratified sampling, underwater surveys

BACKGROUND

Fishing is the most widespread exploitative activity on tropical coral reefs and poses significant threats to the biodiversity and condition of marine ecosystems. Marine fishery resources on a global scale are under intensive pressure from fishing and there is general agreement among fishery managers, environmentalists and scientists that habitat degradation is one of the most important threats to the long-term recovery of exploitable fisheries stocks. Fishing can influence the population structure of species by affecting their abundance, size, growth and mortality, but can also modify species interactions by altering structural complexity. Various ecological effects occur when traps and bottom trawls are used, but impacts may also occur when large numbers of anglers use hook-and-line gear to fish. Lost fishing gear can destroy benthic organisms and entangle both benthic and mobile fauna. While the direct and indirect effects of fishing on marine ecosystems are a continuing concern (Jennings and Polunin 1996), the spatial extent and effects of lost fishing gear and other debris on organisms and ecological processes is still largely unknown in many coastal ecosystems (Auster and Langton 1999).

Baseline data on fishing gear and other marine debris were collected as part of a larger assessment of benthic community structure in the Florida Keys National Marine Sanctuary (see http://people.uncw.edu/millers), a 9,500 km^2 marine protected area administered by NOAA in south Florida. Diver-based visual surveys of marine debris conducted at 131 sites Keys-wide during 2000-01 quantified the prevalence, extent, and biological impacts of marine debris to benthic coral reef organisms (Chiappone et al. 2002, 2004, 2005). Subsequent surveys were carried at 145 sites Keys-wide in 2008 and 120 sites in the upper Florida Keys region during 2010. This decade-long effort in the Florida Keys attempted to address not only the spatial extent and abundance of marine debris, especially lost fishing gear, but also the impacts to benthic coral reef organisms affected by abrasion stress from debris entangled on the seabed (Figure 1).

METHODOLOGY

The present study used *in situ* underwater observations to document the spatial distribution of lost fishing gear and other marine debris in benthic habitats of the Florida Keys National Marine Sanctuary (FKNMS). Undertaken as part of an ongoing assessment and monitoring program of benthic coral reef organisms in the FKNMS (Miller et al. 2002), surveys were conducted in 2008 and 2010 that continued earlier surveys of marine debris abundance and impacts to benthic coral reef organisms (Chiappone et al. 2002, 2004, 2005). Marine debris surveys were incorporated into an existing sampling survey design program for benthic coral reef organisms (Miller et al. 2002, see http://people.uncw.edu/millers). The Florida Keys survey domain was partitioned into strata based upon: 1) benthic habitat type (cross-shelf position), 2) geographic region (along-shelf position), and 3) management zone, including areas inside and outside of existing no-fishing zones. A geographic information system (GIS) containing digital layers for benthic habitat, bathymetry, and no-take marine reserve boundaries was used to facilitate delineation of the sampling survey domain, strata, and sample units. Existing resolution of benthic habitats is such that the survey domain was divided into a grid of individual cells 200 m by 200 m (40,000 m^2) in area that that serve as primary sampling units. A two-stage sampling scheme was employed to control for spatial variation in measured variables at scales smaller than the grid cell minimum mapping unit. Grid cells containing targeted reef and hard-bottom habitats were designated as primary sample units. A second-stage sample unit was defined as a belt transect of fixed area (15-m x 1-m or 4-m in dimension) within a primary sample unit. No-fishing zones in the Sanctuary are incorporated as an additional stratification variable that delineates areas open and closed to consumptive activities.

Marine debris surveys were conducted at 373 sites during 2000-2010 throughout the Florida Keys (Figure 2), encompassing benthic habitats from the shallow patch reef environment to 15-m depth on the fore-reef. The type and amount (length, if applicable) of marine debris, as well as counts of benthic coral reef organisms that were obviously impacted by abrasion stress, were quantified. Coral reef sessile invertebrates affected by marine debris were categorized into five groups, which comprise the majority of sessile invertebrate cover on Florida Keys reefs: milleporid hydrocorals (*Millepora* spp.), scleractinian corals, gorgonians (Octocorallia), sponges, and the colonial zoanthid *Palythoa*. The underwater surveys consisted first of locating randomly selected, pre-determined coordinates with a differential global positioning system. Once on-site, a two-person benthic diver team oriented four transect tapes usually 15-m in length, marked in 1-m increments, along the bottom. A 1-m or 4-m wide belt centered on each 15-m long transect tape was surveyed at each site.

OUTCOMES

Diver-based surveys at 45 sites in 200 and 63 sites in 2001 in the Florida Keys initially quantified the impacts of lost fishing gear to coral reef sessile invertebrates, specifically debris encounters that caused partial or complete mortality from abrasion (Chiappone et al. 2002, 2005). Surveys of 45 sites during 2002 showed that 54 of the 110 occurrences (49%) of marine debris caused tissue abrasion, other damage, and/or mortality to 161 individuals or colonies of sessile invertebrates, represented by sponges, branching gorgonians, milleporid hydrocorals, and the colonial zoanthid *Palythoa.* Gorgonians (37%) and sponges (28%) were the most commonly affected, followed by fire corals (19%), scleractinian corals (9%) and colonial zoanthids (8%). No significant differences were detected in the mean number of impacted organisms per 100 m^2

for any of these taxa among the habitats sampled. Between no-fishing zones and reference sites, significant differences ($P < 0.05$) in mean impact frequency were detected for sponges (mid-channel patch reef zones > reference sites), scleractinian corals (offshore patch reef zones > reference sites), and colonial zoanthids (mid-channel patch reef zones > reference sites). Hook-and-line gear (68%), especially monofilament line (58%), followed by debris from lobster traps (26%), especially rope (21%), caused the most abrasion stress. Hook-and-line gear accounted for the majority of damage to branching gorgonians (69%), fire coral (83%), sponges (64%), and colonial zoanthids (77%). Lobster trap debris was also important, accounting for 64% of the stony corals impacted, 22% of gorgonians, and 29% of sponges. Branching gorgonians and sponges were disproportionately affected compared to other taxa groups.

During 2001, lost hook-and-line fishing gear accounted for 87% of all debris (N=298 incidences) encountered and was responsible for 84% of the 321 documented impacts to sponges and benthic cnidarians. Branching gorgonians were the most frequently affected (56 %), followed by milleporid hydrocorals (19%) and sponges (13%). A follow-up assessment at 145 sites throughout the Florida Keys in 2008 yielded similar results, with hook-and-line gear and lobster/crab trap debris accounting for most (94%) of the impacts to benthic coral reef organisms. During 2010, the debris items encountered caused abrasion damage (tissue loss) to 118 different coral reef benthic organisms. Lost hook-and-line gear caused impacts to 72 different organisms (61%), followed by trap debris (37 impacted organisms, 31%) and other debris (9 impacted organisms, 8%). Similar to the 2000-2008 surveys, the most recent data indicate that while lost hook-and-line fishing gear was the most prevalent in the habitats surveyed, the impact of lost lobster/crab trap debris, especially entangled rope from lost traps, was proportionally greater than for hook-and-line and other debris types. The most frequently impacted organisms during 2010 were gorgonians (44% of the total impacts) and milleporid hydrocorals (26%), followed by scleractinian corals (16%), sponges (12%), and *Palythoa* (2%).

PRIORITY ACTIONS

Marine debris that becomes entangled on the seabed represents a low-level, chronic, and pervasive stressor to coral reef organisms. Several factors influence the damage to the benthos, including debris type, debris dimensions, sessile invertebrate density, and invertebrate morphology. While the magnitude of tissue loss may not be large per occurrence, such impacts may render organisms more susceptible to predation, competitive overgrowth, and disease.

FIGURES AND TABLES

Figure 1. Examples of marine debris impacts to benthic coral reef organisms in the Florida Keys National Marine Sanctuary.

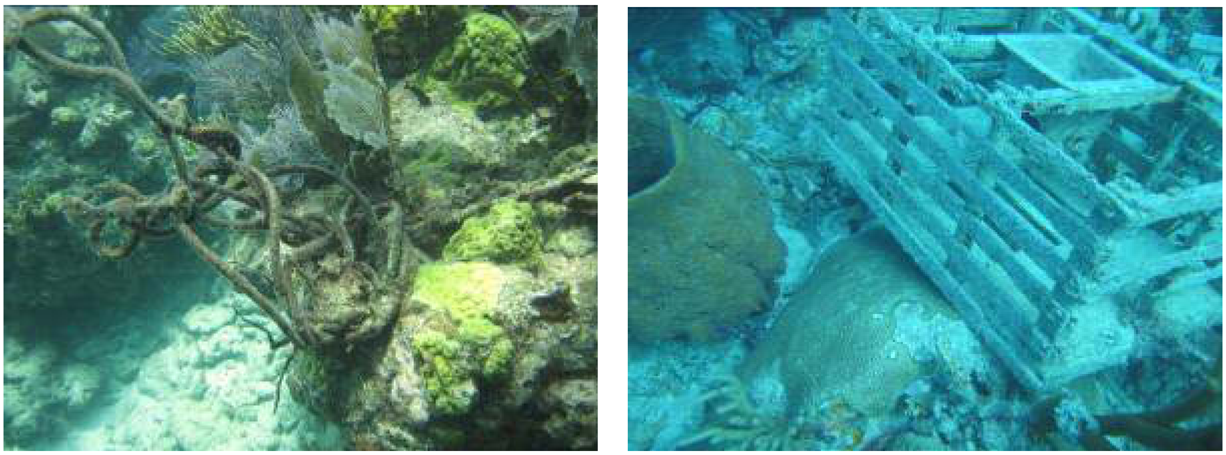
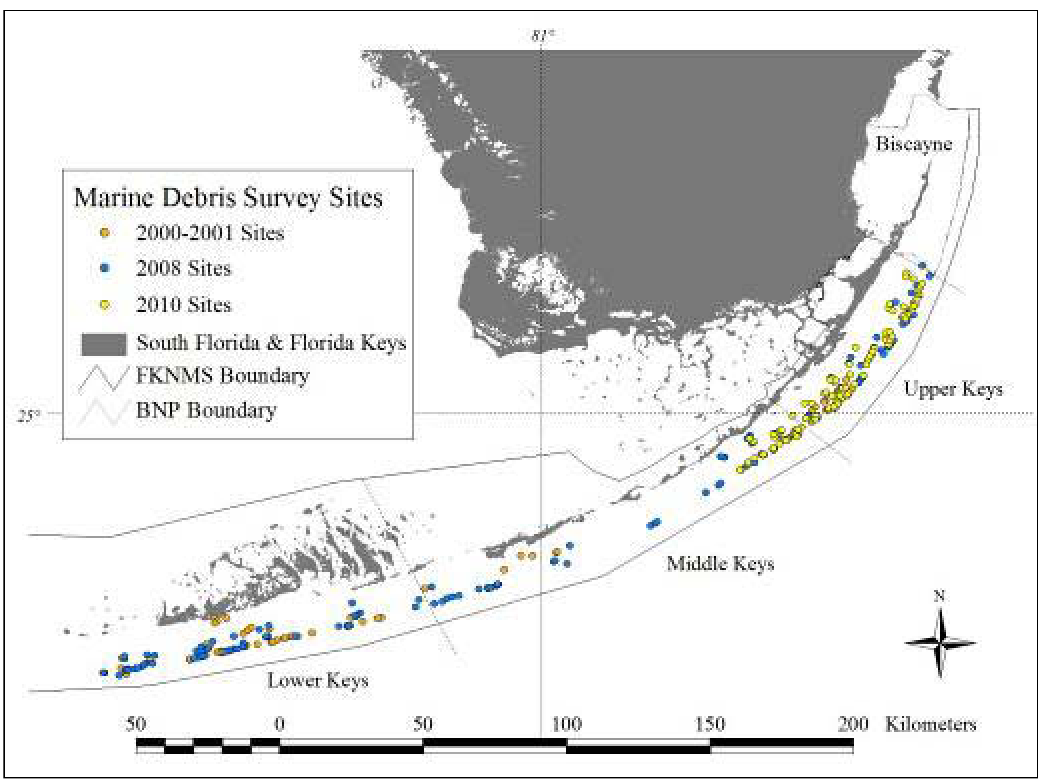


Figure 2. Sampling locations for marine debris and impacts to benthic coral reef organisms in the Florida Keys National Marine Sanctuary during 2000-2010. Diver-based surveys using belt transects quantified the abundance of marine debris using a stratified random sampling design based upon benthic habitat type, along-shelf position, and management zone. Data were also collected on benthic coral reef organisms exhibiting abrasion stress from entangled debris.



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38. Use of disposable lighters as an indicator item to monitor marine debris

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KEYWORDS
Disposable lighters, Indicator item, East Asia, Pacific Ocean, Monitoring

BACKGROUND

The accumulation of marine debris is caused by highly complicated and endless factors. One way to tackle this issue is to collect the trash from the all affected areas and keep collecting until we see no trash on the coasts or underwater. However, it is not a method for the fundamental solution. First of all, to solve this issue, we must clarify the outflow factors (include the action of people) and sources of marine debris. Therefore it is necessary to develop a method to monitor discharge areas, flow and extent of impact of marine debris.
To clarify the outflow factors and sources of marine debris, we have been monitoring the marine debris on the coasts of Japan and East Asia region, using disposable lighters as an indicator item.1-5)

METHODOLOGY

Disposable lighters (Fig.1) as the indicator item have the following characteristics.
(1) They can easily be found on the beach due to their popularity in the society.
(2) They can drift for a long period on the sea because of robust hollow construction.
(3) Their outflow (production and consumption) regions can be distinguished by punched marks on the tank bottom.
(4) Their outflow locations can also be identified by printed information (for example, shop address) on the tank surface.

We asked nation-wide beachcombers to collect lighters washed up on beaches. Washed up disposable lighters were collected from 1,220 beaches on the coasts of Japan, Korea, China, Russia and Midway Island, USA in the East Asia Sea, Sea of Japan and the Pacific Ocean from 1998 to 2011. They were classified into 79 zones based on the prefectures and islands.

OUTCOMES

For the past 14 years, a total of 55,094 lighters were collected from 1,220 beaches (Table 1). Fig.2 shows the sampling sites of disposable lighters and their percentage distribution of five outflow regions (Japan, Korea, China, Taiwan, Russia). Over half of the total distinguished lighters collected from the coasts of East Asia Sea from Yonaguni Island (Okinawa Prefecture) to Yaku Island (Kagoshima Prefecture) were identified to originate from China and Taiwan. And on the coasts of Sea of Japan from Kyushu to Tsugaru peninsula (Aomori Prefecture), it accounted for about 10-20% of the total distinguished lighters. Over half of total distinguished lighters collected from the west area of Sea of Japan from Shimane Prefecture to Fukui Prefecture were identified to originate from Korea, whereas on the coasts of East China Sea from Okinawa Prefecture to south Kyushu and the coasts of Sea of Japan in areas north of Niigata Prefecture, it accounted for about 10% and 20%. Over 80% of the total distinguished lighters collected from the Pacific coasts of the north from Shikoku were identified to originate form Japan. And on the coasts of Seto Inland Sea and Tokyo Bay, almost all lighters originated from Japan.The outflow locations of lighters which drifted ashore on the Japanese coasts were at the coastal areas from Zhejiang to Guangdong (China) and all area of Taiwan, Korea and Japan. Lighters that flowed out of those areas were found on the north shore of Sea of Japan. The above results suggests that it is possible to monitor the source of outflow, distribution of influence area and annual change of marine debris from the coast of both countries. Coasts of Japan and Korea were alike and affected by marine debris that flowed out of China. On the other hand, the each country was strongly affected by own country.

However, lighters from the East Asia not only reach neighboring countries, but also be transported as far away as the Central North Pacific, or even to the West Coast of the United States. There they threat lives of wildlife. A parent albatross eats many plastic pieces by mistake in the North Pacific. The parent bird brings those pieces of trash to its chicks and feeds. As a result, many young birds eat them and die in a nest of Midway atoll. We have collected total 1,808 lighters from stomachs of the corpses (include the coast) at 2002, 2009 and 2010. As a result of having analyzed those, most lighters had determined that they were outflow mostly from East Asia, and Japanese lighters occupied 62.3% (Taiwan 18.3%, Korea 10.6%, China 8.8%) of the total number of lighters found.

PRIORITY ACTIONS
One can easily expect from this fact that, not only lighters, but any kind of marine debris would affects natural environment. It would be an eye sore to us humans, but it can be menace to any being, especially to endangered species. Therefore East Asian countries must step up joint efforts to solve the problem of marine debris in the Northwest Pacific.

FIGURES AND TABLES

Fig.1 Disposable lighters that had printed characters on the tank surface (From left, Japan, Korea, Taiwan, China, Hong-Kong).

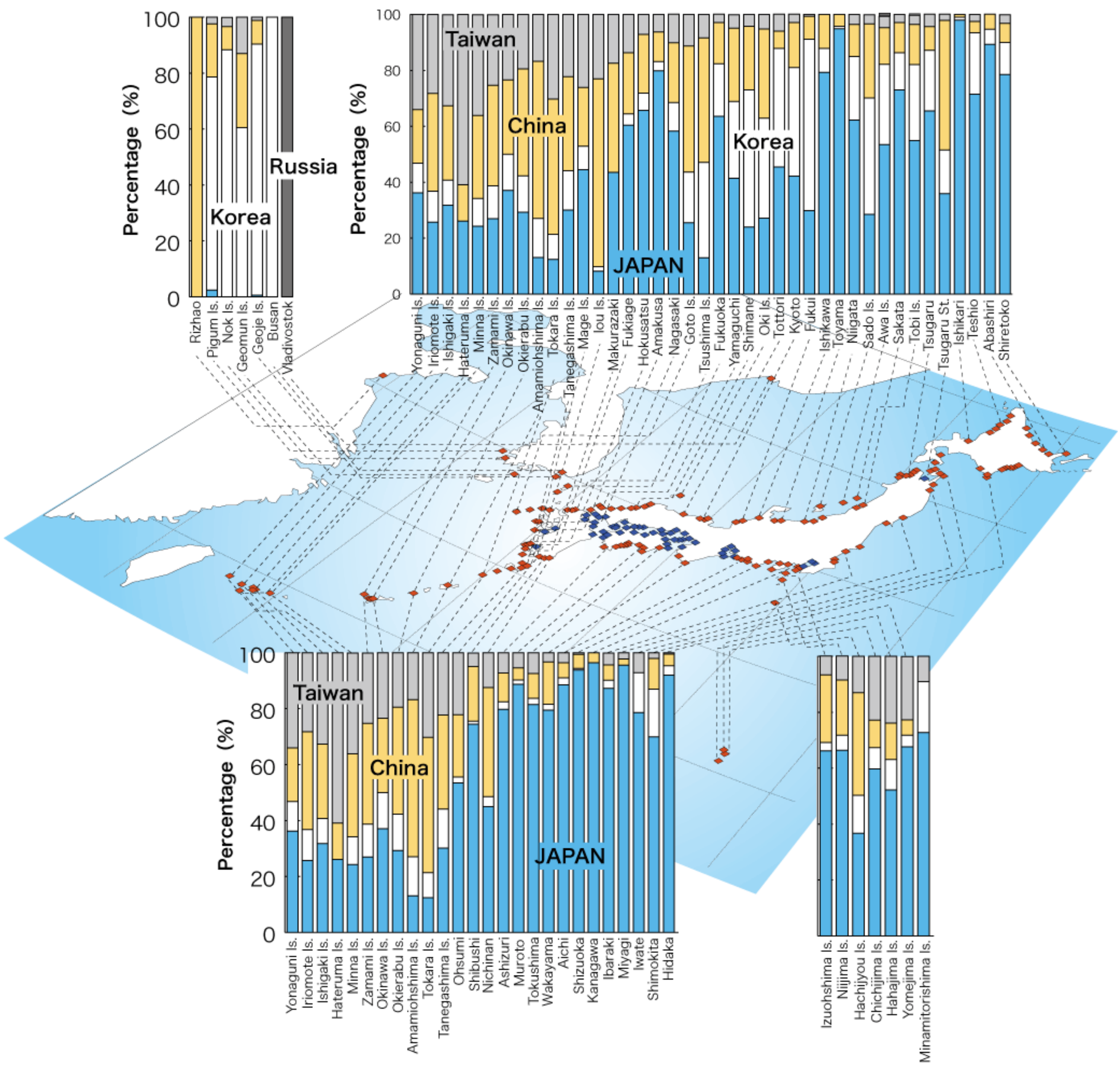

Fig.2 Sampling sites of disposable lighters and percentage distribution of five outflow regions (Japan, Korea, China, Taiwan, Russia) for total distinguished lighters.

Table 1 Sampling overview of disposable lighters on the coast

Country	Coast area	Sampling Sites	Collected Lighters	Lighters that the outflow region was distinguished	Rate (%)	Lighters that the outflow location was distinguished	Rate (%)
Japan	East China Sea	256	11,649	8,905	76.4	1,256	10.8
	Japan Sea	351	22,614	18,091	80.0	2,033	9.0
	Okhotsk Sea	12	320	272	85.0	24	7.5
	Pacific Ocean	213	9,474	7,513	79.3	673	7.1
	Inner Bay	359	8,652	8,082	93.4	595	6.9
	River	11	225	210	93.3	21	9.3
Korea		8	599	462	77.1	81	13.5
China		1	28	23	82.1	4	14.3
Russia		3	23	18	78.3	0	0.0
USA	Midway Atoll	2	1,483	1,180	79.6	150	10.1
	Hawaii & other	4	27	15	55.6	0	0.0
Total		1,220	55,094	44,771	81.3	4,837	8.8

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40. The chemical signature analysis of plastic ingested by Laysan Albatross breeding at Kure Atoll

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KEYWORDS
GC-MS, Laysan albatross, chemical signature, plastic ingestion, seabird, Hawaii, polymer

BACKGROUND
The widespread presence of plastic particles in the marine environment has profound effects on the birds inhabiting the world's oceans (Azzarello and Van Vleet 1987). Seabirds that utilize large areas of the North Pacific are known to ingest this material along with their natural prey (Nevins *et al.* 2005; Ryan 2008; Hyrenbach *et al.* 2009). A concern for the breeding seabirds ingesting plastic debris at sea is that the debris is regurgitated and fed to the developing chicks at the colony (Fry *et al.* 1987; Ryan 1990). The ingested plastic can cause potential mechanical problems such as obstruction, lesions, and may be linked to dehydration (Sievert and Sileo 1993). The surface-feeding procellariiformes have been shown to be the group of seabirds that ingest plastic most consistently, with an incidence of ingestion of up to 100% (Blight and Burger 1997; Colabuono *et al.* 2009). The Laysan albatross is a surface-feeding procellariiform known to ingest plastic debris (Pettit *et al.* 1981; Fry *et al.* 1987; Auman *et al.* 1997a; Young *et al.* 2009). The 2 million Laysan albatross that breed in the Hawaiian Islands (both the main and northwestern islands) each year are susceptible to plastic ingestion since they range over vast areas in search of dispersed prey and are known to forage in the same frontal systems that aggregate marine debris at sea (Hyrenbach *et al.* 2002; Pichel *et al.* 2007; Kappes *et al.* 2010). Each piece of plastic debris that is ingested by the albatross chicks contains the plasticizers added during manufacturing (Oehlmann *et al.* 2009), and has the potential to contain numerous other noxious hydrophobic chemicals that can be collected while floating freely in the ocean (Endo *et al.* 2005; Rios *et al.* 2007; Teuten *et al.* 2007; Colabuono *et al.* 2010). The ingested plastic debris found in seabirds is currently classified based on the physical characteristics of each piece. The larger plastic pieces show a very high resistance to aging and minimal biological degradation because of the complex polymers used in the their creation (Klemchuk 1990; Rios *et al.* 2007). Laysan albatross generally ingest larger pieces of plastic debris, and have been found to ingest items such as a cigarette lighters, toothbrushes, golf balls, children's toys and even tampon applicators (Edwards 2005). These items may be identifiable due to their size and remarkable shape, but there is also a percentage of the ingested debris that is unidentifiable and referred to as "fragments" (Vlietstra and Parga 2002; Nevins *et al.* 2005). These small, broken, post-consumer shards of plastic may come from a number of sources and have the potential to be any of the various types of plastic.

METHODOLOGY

The plastic from the Laysan albatrosses was collected on Kure Atoll, from the boluses casted within a known Laysan albatross breeding area by Cynthia Vanderlip (DLNR – DOFAW), under her manager's permit in the spring – summer (April – June) of 2005. The samples were transported back to Hawaii Pacific University where they were sub-sampled for 200 items. Since the Laysan albatross ingest mostly fragments, all suitable pieces of foam, sheet, line and nurdles were selected for analysis (all found for the entire colony; 71 samples total). The remaining 129 samples were randomly selected from the fragments.

Samples of approximately 0.05 grams and larger were preferentially chosen for this study. All plastic samples were ground into particles of less than 2mm in diameter using stainless steel food grinders (washed with soap and water, rinsed with acetone, wrapped in aluminum foil, and combusted at 500C for at least 12 hours). Samples were extracted for at least 24 hours in a hexane: dichloromethane (1:1) mixture. Sample clean up entailed passing sample through a combusted (500C for 12 hours) glass 9-inch Pasteur pipette filled with approximately 0.25g of silica (pore size 100-200) and eluted with hexane and dichloromethane. Samples were concentrated to approximately 0.05ml and injected into a 7890A GC System and 5975C inert MSD with triple axis detector (Agilent Technologies) equipped with a methyl silicone-coated fused-silica capillary column HP-5MS (0.25mm i.d. X 30m, 0.25um film thickness, J&W Scientific). Samples were analyzed by comparing the mass spectra of the developed "tracer chemicals" in the reference chromatograms to the chromatograms of the plastic samples for assurance that the compounds are of the same structure/components.

OUTCOMES

A total of 200 items were analyzed by this novel approach: 129 fragments, 44 pieces of foam, 10 pieces of line, 6 pieces of sheet and 11 nurdles. Of the total ingested plastic debris analyzed the largest proportion was comprised of polypropylene (Type 5) at 48% of samples. Polypropylene was the most common resin type in both nurdles and fragments (66.7% and 62.7% respectively). Polystyrene (Type 6) was the second most common type of plastic found at 27% of total samples identified. Polystyrene was also the most common resin type in foam samples (84%). The most common resin type for the line samples was poly vinyl chloride (Type 3). Finally, the most common resin type in the sheet samples was low density polyethylene (Type 1) (Figure 1). The most abundant type of plastic found cannot currently be recycled (PP, Type 5).

Plastic fragments are the most commonly ingested artificial item by the Laysan albatross. Since stomach content analyses for plastics began, some items have become iconic, and used as common examples for the discussion of ingested plastics. A few of these items are bottle caps, fishing floats and lighters. A total of thirty-five identifiable bottle caps were processed and analyzed from the plastic samples taken from Kure Atoll. They were identified to be PP, PVC or PETE. The highest proportion of bottle caps analyzed was found to be PP followed by PVC and then PETE (Figure 2). A total of eight fishing floats were processed and analyzed from the plastic samples taken from Kure Atoll in 2005. They were analyzed to be PP, PS and a combination of PETE and PS (Figure 2). There were a total of five lighters processed in the samples that were taken from the Laysan albatross at Kure Atoll in 2005. The samples were found to be a higher proportion of PVC than PETE (Figure 2). The remaining plastic fragment samples that were analyzed were sixty-four unidentified pieces. The unidentifiable fragments were determined to be PP (twenty-three samples), PVC (nine samples), PETE (six samples) and there were also three samples that were identified as mixtures of various resin types.

PRIORITY ACTIONS

Using this method to further identify the ingested plastic debris can be useful in determining the type of plastic that is most frequently ingested by various species of marine organisms, as well as the plastic that is the most common contributor to marine debris. Identification of these plastics, in this case polypropylene (Type 5) and polystyrene (Type 6) can be the basis for redirected point source reduction efforts to limit the amount of plastic debris entering the ocean environment.

FIGURES AND TABLES

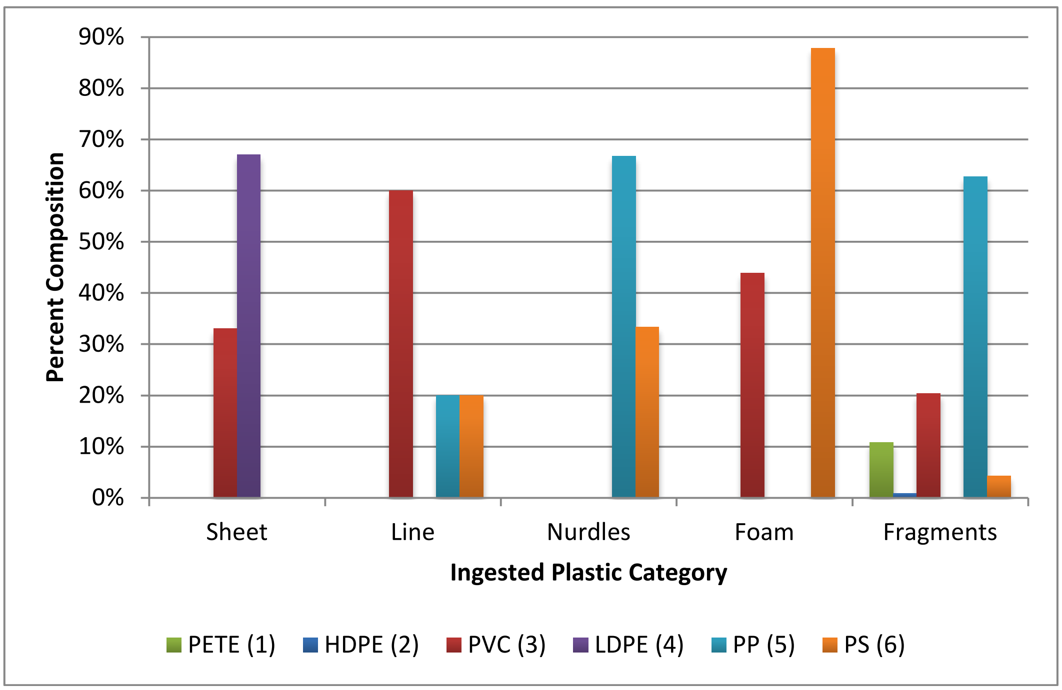

Figure 1. Percent composition of each of the ingested plastic categories. The percent composition of the ingested plastic categories, separated by the SPI resin types. Percentages equal more than 100% since the plastic samples that were found to consist of more than one resin type are included in this comparison.

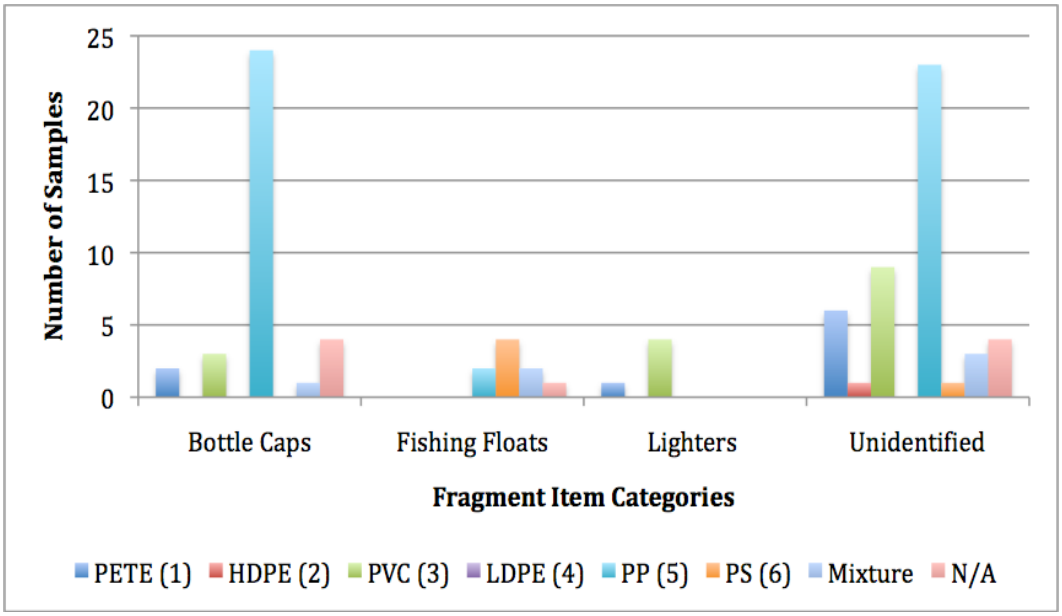

Figure 2. Number of ingested pieces of the various fragment items. The number of ingested plastic pieces of each of the fragment item categories, separated by the SPI resin type each was identified to be. Mixture corresponds to samples that were identified as more than one SPI resin type. N/A corresponds to samples that were not identifiable.

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41. Four easy-to-ship and easy-to-use aluminium neuston trawls designed and fabricated by Algalita Marine Research Foundation for use on different vessels of opportunity: results of field tests and preliminary intercalibration efforts

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KEYWORDS
Plastic Marine Pollution, Citizen Science, Neuston Net, Sampling Methodology, Algalita Marine Research Foundation, Trawl net, Ocean Plastic, Plastic pollution monitoring, Marine monitoring, intercalibration, 5 Gyres Institute

BACKGROUND
Different sampling equipment for neuston trawls is necessary for different types of vessels, travelling at different speeds. Four different designs have been fabricated and tested on *Oceanographic Research Vessel Alguita,* and vessels of opportunity during cruises in the Pacific, Atlantic, and Indian Oceans. This poster depicts the different trawls and their protocols for use on different vessels. Examples of the two easy to ship (suitcase) devices will be on display. Intercallibration of the various trawl systems is an ongoing project of Algalita Marine Research Foundation. A GIS database archives and displays the results for the user base and the general public.

METHODOLOGY
A standard manta trawl has a nominal aperture of 1meter x 20 cm (Brown, et al, 1981). The tow net is appx. 3m long, with a mesh of 0.5-0.333mm, depending on the trawl speed and the size of targeted debris/biota, with a removable cod end/collection bag. There are three other trawl designs available for loan or purchase through AMRF's Traveling Trawl Program: the Suitcase Manta Trawl, the Folding Manta Trawl and the Hi-Speed trawl. The suitcase manta and folding manta trawls are both designed to fit in a standard suitcase. All three manta trawls capture a volumetric measure of the sea surface (neuston) using wings to keep the trawls fishing at the top of the water column, and using a splash guard to knock the crests of waves into the net. The standard manta and the suitcase and folding mantas are deployed at slow speeds, typically less than 3 knots. The Suitcase Manta Trawl has a net aperture of 60cm x 25cm, whereas the Folding trawl is 50cm x 25cm. Their 2-meter nets have a 333 micron mesh, and a detachable cod end. The manta design was first used by the California Cooperative Oceanic Fisheries Investigations during their 1977-78 cruises. (NOAA-TM-NMFS-SWFSC-392) The Hi-speed Trawl measures surface abundance of marine debris, rather than a quantified volume of seawater. The Hi-speed Trawl has a vertical net aperture, rather than the horizontal net aperture common to the manta design. At tow speeds of 8-10 knots there is tremendous turbulence on the sea surface. The vertical net aperture allows for a 45cm. range of vertical movement, therefore capturing the sea

surface at all times, but not a known volume. This allows for a measure of surface abundance rather than density of marine debris. The net aperture is 45cm x 14cm. The 3-meter net has a 500 micron mesh and a detachable cod end. This net length and mesh size allows for large volumes of water to be sieved as the trawl travels at relatively high speeds. This design is similar in several respects to the Sameoto sampler, as well as the Marine Resources Monitoring, Assessment, and Prediction Program neuston array (MARMAP), in that they are all designed to fish with part of the aperture out of the water. The three designs, Manta, Sameoto and MARMAP were compared in a paper by Jump et al., for their ability to collect larval fishes in the Gulf of Alaska. (Jump et al., 2007). AMRF is currently analyzing samples collected for the purpose of comparing the three designs available through the Traveling Trawl Program for their ability to collect neuston plastics.
These three designs are portable, of solid aluminum construction, and easy to store on any vessel. When disassembled, both the Suitcase and Folding Manta trawls fit in a standard suitcase.

OUTCOMES

The protocols for sample collection are modified from those used by the Algalita Marine Research Foundation, and based on recommendations from NOAA's marine debris program.(see http://swfsc.noaa.gov/textblock.aspx?Division=frd&id=1342) Researchers and citizen scientists use the traveling trawls to conduct short tows at the sea and air interface (neuston). The choice of trawls depends on vessel characteristics and capability. With a flowmeter the volume of water (m^3)strained through the net can be determined by V = R x a x p, where R = total number of revolutions of the current meter during the tow, a = area (m^2) of the mouth of the net, and p = length of the column of water needed to produce one revolution of the current meter. (NOAA-TM-NMFS-SWFSC-392) Without a flowmeter, the surface area is determined by the width of the net multiplied by the tow distance measured by the GPS start and stop locations. Samples are collected in a cod end attached to the end of the net, and then transferred to a collection jar.

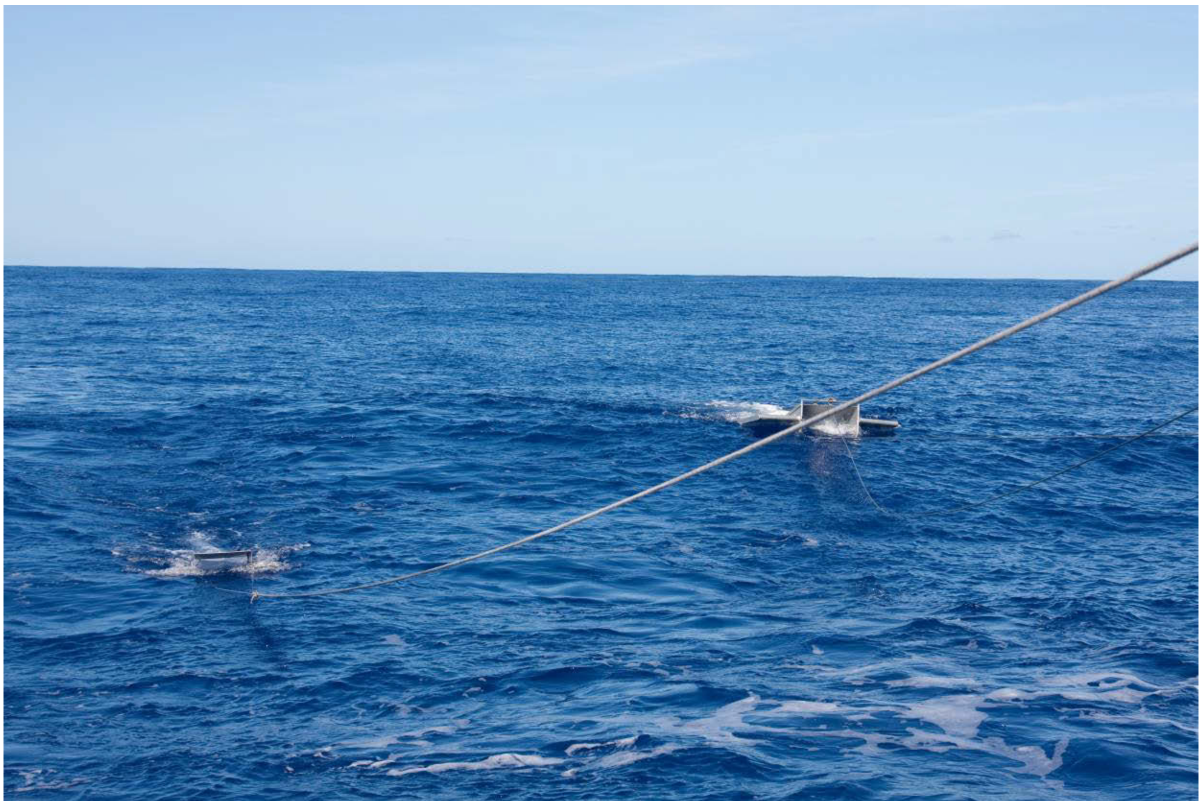
Challenges have included the engineering of these trawls for ease of deployment by vessels of opportunity, solo citizen scientists, deployment from small sailing vessels, development of easy-to-use protocols, and shipping the trawls to participants in foreign ports. By reducing the complexity of trawl set up, deployment, retrieval, disassembly and storage of the trawl, the participants are motivated to use the equipment and provide greater quantities of meaningful data.

With these challenges overcome, and as data comes in, the results are presented in two ways on a GIS database where results can be shared online. Data will be imported directly onto one of two separate websites. One where rigorously quantitative data from qualified sources will be posted, and another for citizen scientists.

PRIORITY ACTIONS

The Traveling Trawl Program will allow sailors, marine scientists, governmental and non-governmental organizations worldwide to participate in geospatial data gathering and make valuable contributions to understanding impacts of plastic marine pollution. Given the enormous spatial extent of plastic pollution of the world ocean, it is necessary to enlist academic researchers, government monitoring programs, and citizen scientists in order to inform governmental and industry responses worldwide. By designing and producing durable and easily portable neuston sampling trawls, AMRF and the 5 Gyres institute are facilitating the gathering of a comprehensive data set that will assist in ultimately quantifying the ocean's plastic load.

FIGURES AND TABLES



Suitcase and Standard Manta Trawls

Suitcase Manta Trawl

Folding MantaTrawl

Hi-Speed Trawl

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42. Polychlorinated biphenyls (PCBs) in plastic pellets from Santos, Brazil

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KEYWORDS
Polychlorinated biphenyls, chemical compounds, plastic pellets, beaches, Santos, Brazil.

BACKGROUND
Most of the anthropogenic chemicals and waste materials, including toxic organic and inorganic chemicals, contribute to the degradation of aquatic environments (Cesar *et al.*, 2006). Polychlorinated biphenyls (PCBs) are synthetic organic compounds obtained from the chlorination of biphenyls and theoretically up to 209 congeners can be generated in the process (Montone *et al.*, 2001). The use of products containing PCBs on large scale occurred specially for its physicochemical properties as high dielectric constant and high thermal stability (Penteado and Vaz, 2001). These compounds are present in aquatic systems worldwide as a consequence of their wide-spread usage, long-range transport and persistence (Ogata *et al.*, 2009). Because of hydrophobic properties, PCBs are sorbed to plastic pellets float on the sea surface (Ogata *et al.*, 2009).
Plastic resin pellets are small granules that usually occur in the form of cylinder or a disk with 2 to 5 mm diameter (Costa *et al.*, 2010; Ogata *et al.*, 2009). Plastic pellets can be unintentionally released to the environment, both during manufacturing and transport and are carried by surface run-off, streams and river waters, eventually leading to the ocean (Takada, 2006).
The main objective of this study was to evaluate the concentration of PCBs in plastic pellets collected on the surface of sandy beaches of Santos Bay – Brazil.

METHODOLOGY
The Santos Bay is located in Southeastern Brazil (Fig.1) in a region called Baixada Santista and their beaches are extended by 7 km. The largest Brazilian industrial complex is installed in that densely urbanized region, with the predominant presence of its petrochemical, steel, and fertilizer industries; the major Port of Latin American can also be found here (Cesar *et al.*, 2006). Plastic pellets were sampled in November/2009 in the upper portion of backshore in 30 randomly chosen points with 1 m^2 each one. The sampling was performed in the sand surface using tweezers and kept the pellets in aluminum envelopes identified by a vellum label. The analysis was performed in pools with about 1g (dry wet) and contained pellets with different colors. Each sample was soxhlet-extracted with dichloromethane/*n*-hexane with PCB-103 as surrogate. The extract was clean up by adsorption chromatography using a column of alumina deactivated with

water. PCB congeners were identified and quantified by gas chromatograph with mass spectrometer (GC/MS).

OUTCOMES

Concentration of total PCB (sum of 51 congeners) ranged from 241 to 3618 ng g^{-1} (Tab.1) and these levels were higher than those presented by Endo *et al.* (2005) which ranged from below the detection limits to 2300 ng g^{-1}. The samples presented the predominance of hexachlorobiphenyls followed by pentachlorobiphenyls and heptachlorobiphenyls. The highest mean concentrations were found for congeners 138, 149 and 153 (Fig.2) as also described by Frias *et al.* (2010) but in lower levels to Portuguese coast.

PCBs contamination in Santos region is usually associated to industrial complex as described by Bícego *et al.* (2006) and Lamparelli *et al*. (2001) based on the concentration found in sediment sample. The same cannot be attributed to PCBs found in plastic pellets since it was not possible to know the source and pathways of those fragments. Due to the great variability of PCBs concentrations found in plastic pellets from a same area, it is important to consider samples coming from different sources in a single beach.

PRIORITY ACTIONS

It is necessary to know better the sources and ways by which plastic pellets could come from before releasing on the beaches, because the chemicals, such as the polychlorinated biphenyls, adsorbed by plastic pellets can also come from several sources.

FIGURES AND TABLES

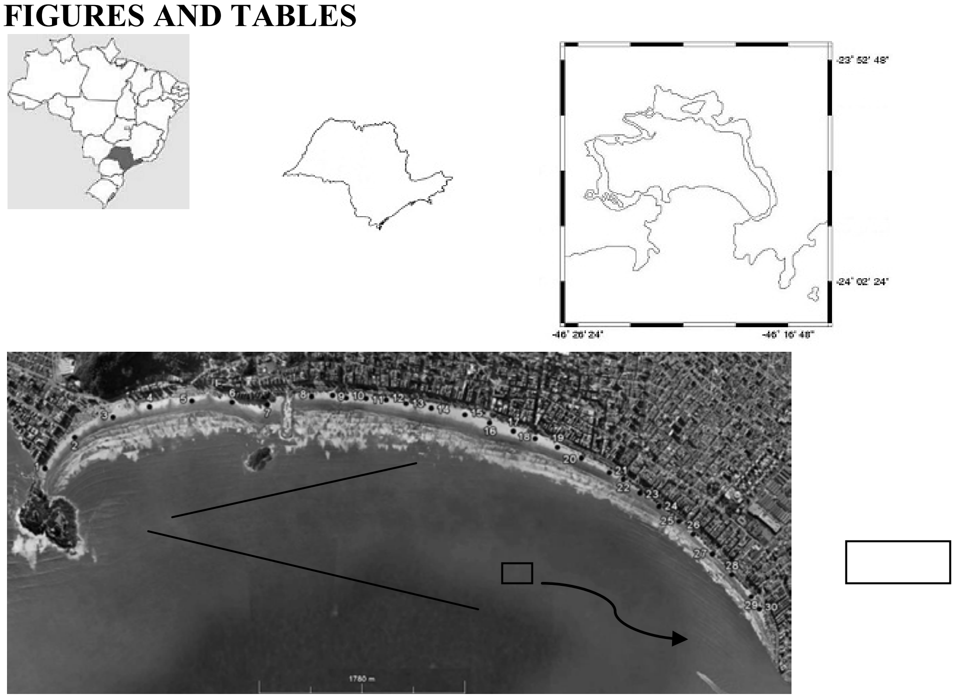

Figure 1 – Location of Santos Bay (Cesar *et al.*, 2006) and satellite image from sampling points in Santos Bay (Google Earth)

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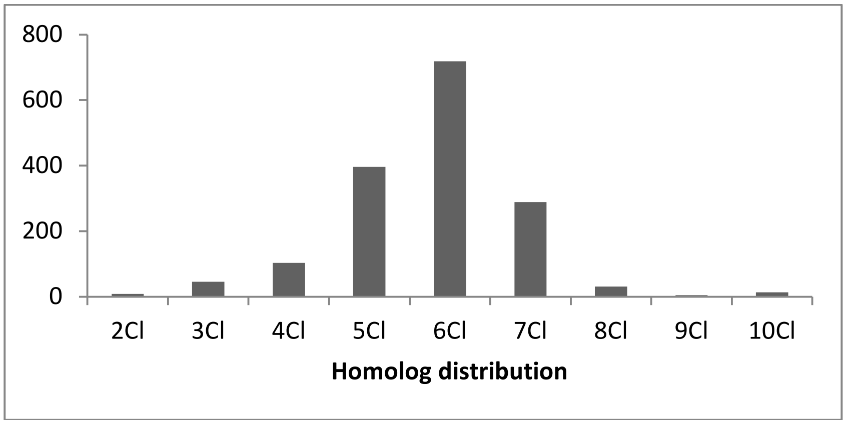

Figure 2 – Mean of homolog distribution of PCBs in plastic pellets from Santos Bay

Table 1 – Total PCB concentrations in plastic pellets of Santos Bay (ng g^{-1})

Samples	Σ PCBs
1	1017
2	1468
3	1606
4	1280
5	581
6	1122
7	-
8	1062
9	536
10	694
11	-
12	1386
13	842
14	-
15	560
16	316
17	526
18	3618
19	848
20	909
21	241
22	891
23	338
24	841
25	696
26	1095
27	435
28	373
29	1009
30	321

(-) sample not analyzed

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43. Plastic marine debris and toxic chemicals in the ocean

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KEYWORDS
Plastic debris, toxic, PBT, PCB, bioconcentration, bioaccumulation, food web,

BACKGROUND
EPA has undertaken a literature review to determine what is known about the interaction between toxic chemicals and marine debris, especially plastic debris. Is plastic debris a source for toxic chemicals in the oceans? Is it a sink for toxic chemicals already present in the oceans? Is there a more complex relationship between toxic chemicals and plastic debris in the oceans?

METHODOLOGY
Marine debris, especially plastic debris, is widely recognized as global environmental problem. There has been substantial research on the impacts of plastic marine debris, including entanglement, ingestion, "ghost fishing", and damage to vessels. These impacts are largely due to the physical presence of plastic debris. In recent years there has been an increasing focus on the impacts of toxic chemicals as they relate to plastic debris. Toxic chemicals, especially persistent, bioaccumulative, and toxic substances (PBTs), such as PCBs and DDT, have been measured in water, on plastic debris, in a variety of marine species, and in humans. This research, along with research on species ingesting plastic debris, provides a significant body of work to suggest a strong link between plastic debris and toxic chemicals.

OUTCOMES
Some plastic debris acts as a source of toxic chemicals. Toxic substances that were added to the plastic during manufacturing, especially phthalates, Bisphenol A, and nonylphenol compounds, leach from (that is, they are released from) plastic debris, exposing wildlife to endocrine disrupting chemicals. These chemicals can be taken up by fish and other marine species, impacting them and potentially becoming a significant source for these chemicals in human diets.

Most plastic debris also acts as a sink for toxic chemicals. Plastic adsorbs PBTs from the water or sediment, but then releases those substances when ingested by any of a variety of marine species. Through this "plastic concentrating mechanism", plastic acts as a potent vector to transfers PBTs from the oceans to the food web, thereby increasing the risk throughout the marine food web, up to and including humans. This risk increases with either increasing concentration of PBTs or increasing the amount of plastic marine debris in the ecosystem. Further research is required to better understand how much of burden of toxic chemicals in the food web is due to this vector. However, current evidence demonstrates a clear link. It may be that as much as half the PBTs present in fish consumed by humans is present because of this mechanism. These health risks are over and above the risks to marine species from the physical presence of plastic debris.

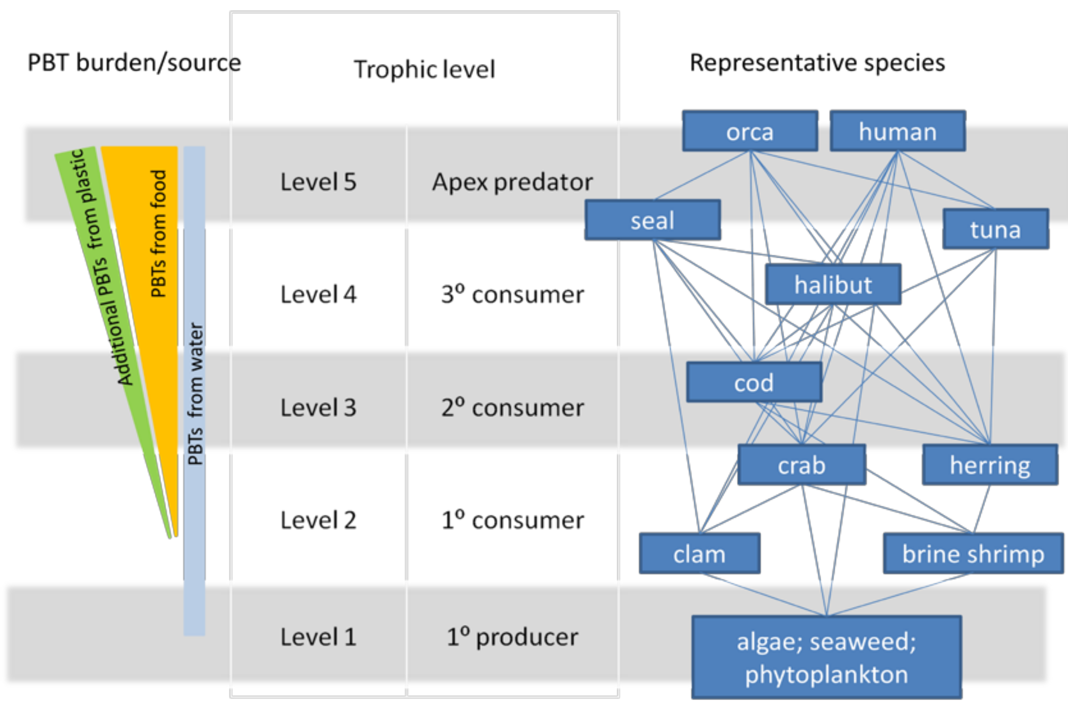
PRIORITY ACTIONS

1) Conduct additional research on how much of the PBTs present in marine species is attributable to the "plastic concentrating mechanism" which is necessary to determine how much human health risk is due to plastic and PBTs in the ocean.

2) Develop urgent prevention strategies for both plastic debris and PBTs to decrease any potential human health risk.

3) Choose materials so that their biodegradation profile match their useful lifetime. For example: single-use food service items do not need to persist for decades. These choices must recognize that plastic degradation through fragmentation (as opposed to complete biodegradation) could potentially exacerbate the problems associated with toxics and marine debris.

FIGURES AND TABLES



Relationship between trophic level and PBT burden from water, food, and plastic. PBT Burden column (at left) shows source of PBTs at each trophic level as well as qualitative contributions from three sources: Blue – bioconcentration directly from water; Orange – bioaccumulation due to PBTs in prey/food; Green – bioaccumulation from ingesting plastic.

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44. New ocean contamination generated from marine debris plastics

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KEYWORDS
plastic, marine debris plastics, decomposition, chemical contamination,
polystyrene (PS), polycarbonate (PC), epoxy resin (EPX), styrene oligomer,
bisphenol-A(BPA), toxicity

BACKGROUND
Plastics can be molded into any desired shape and be produced in large quantities. They thus have come into use as material indispensable for modern life. Total world plastic production was less than 1 million tons in 1960, but since 2009, yearly production has exceeded 2.5 million tons[1)]. Due to human carelessness, plastics find their way into rivers and then into the sea[2), 3)].

METHODOLOGY
Field works: 5g sea sand and 2.5L water from sites throughout the world were extracted with10mL dichloromethane. The extracts were evaporated under reduced pressure and analyzed by GC/MS.

The thermal decomposition:
The material plastics for thermal decomposition were purified by reprecipitation or solvent extraction to remove the low molecular chemicals. The thermal decomposition apparatus is shown in Fig.1. The details were shown prebiously[4)].

OUTCOMES
1. Macro Contamination
As much as 150,000 tons of plastic debris washes up onto the shores of Japan[5)]. At present, macroscopic pollution can be observed visually as due to plastic waste along every coast of the world. The results are shown in Fig. 2

Marine debris foamed polystyrene (PS) breaks up into small particles through water action, as show in Fig.2, photo (1).

Ishigakijima island situated south west of Japan is a very important nesting site for sea turtles. Each year, some fifty dead sea turtles are found in the water surrounding Ishigakijima. Fig.2

photo(2) shows a dead sea turtle taken from Kabira-bay, at Ishigakijima in whose alimentary canal many plastic fragments were found present (Upside). Plastic material consumed by these turtles possibly undergoes degradation within the environmental of the turtle's body. Biologists are convinced that these plastics contribute decisively to the death of wild-life in the sea. But to date, adverse chemical effects of plastics have yet to be clarified in sufficient detail.

2. Micro Contamination

Thompson[6] suggests that plastic decomposes from large lump into smaller lumps in the ocean. Whether plastic decomposition is restricted to such lumps is a matter of speculation. Is that all? We analyzed sea water and sands from United Kingdom(1) to U.S.A(18-28)., throughout the world. The results were shown in Fig.3

In Fig.3 , the up side were showed the results of sea water and the down side were sands of styrene oligomer, generated from PS. The all samples were found to contain significant amounts of the styrene oligomer, (it's means styrene monomer・phenylethylene/SM/Fw:104, styrene dimer・2,4-diphenyl-1-butene/SD/Fw:208, and styrene trimer/2,4,6-triphenyl-1-hexene/ST/Fw:312) 0.01 to 150 ppm, generated from polystyrene (PS). Fig.3 clearly shown the new chemical contamination generated from marine debris plastic.

3. Thermal Decomposition

Noxious chemicals from the rivers and oceans of the world have been extensively examined and the results clearly demonstrate the presence of nonylphenol[7] and phthalic acid ester (PAE)[8], BPA[9] . But the elucidation of sources for chemical generation from plastics in the ocean is thus difficult.

To study plastic decomposition, polyethylene glycol (PEG) was used as a heating medium or extractant[10]. The apparatus was shown in Fig.1.To styrene oligomer concentrations were found less than the ppm level for a liquid/liquid distribution system in which water was used to remove the heating medium. PS was found to decompose at 30°C to produce the styrene oligomer[10],[11],[12].

The decomposition compositions generated from PS were the same as indicated by field analysis shown in Fig.3.

The quantities of ST from PS decomposition were measured and the velocity constants were determined within the temperature range, 30°C to 250°C. Arrhenius plots of the velocity constants, the activation energy (ΔE), 42.0 kJ/mol, was calculated using ST generated from PS. PS was clearly shown to be unstable with heat application.
Plastics such as PS , are not metabolized subsequent to ingestion, since they are polymers. But low molecular weight compounds such as styrene oligomer generate from PS decomposition are toxic and can be metabolized. SM has been found to possess carcinogenicity[13]. The toxicity of ST and SD hast yet to be determined. But ST was generated SD and SM. This study clearly shows new micro contamination to arise unbeseen to the human eye, from compounds generated by plastics decomposition in the ocean.

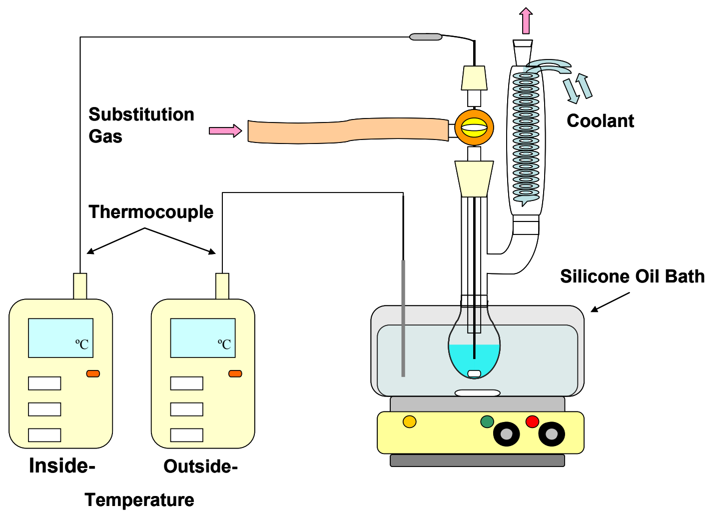

Fig.1 Apparatus for Low Temperature Thermal Decomposition on Plastics

Photo(1)：Washed Up Polystyrene and Woods at Tsushima in Japan (Saido, July, 2008)

Photo(2)：Dead Sea Turtle and Plastics at Ishigakijima island / Kabira Bay in Japan (Abe, June, 2004)

Fig.2 Macro Contamination with Marine Debris Formed Polystyrene

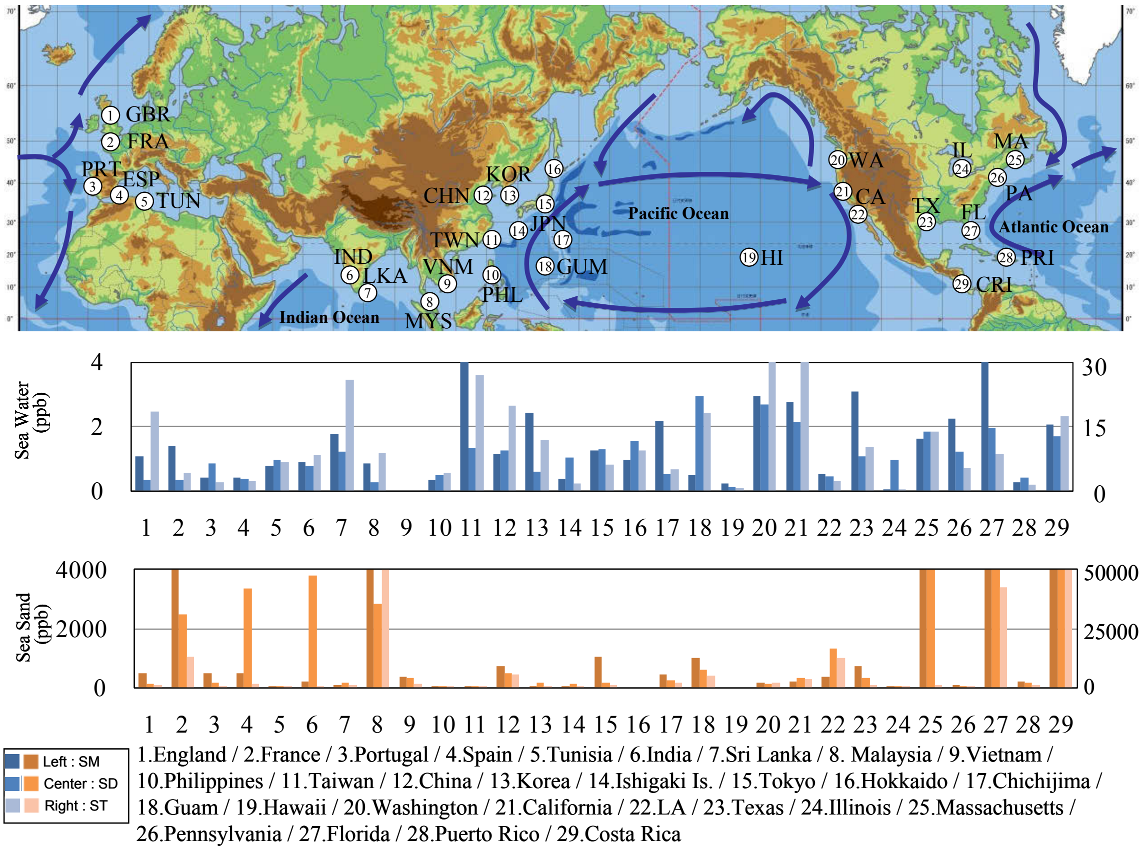

Fig.3 Analytical results in the world.

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45. Organic pollutants adsorbed to microplastics debris from two beaches of the Portuguese Coast

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KEYWORDS
Microplastics, PAHs, PCBs, DDTs, Plastic pellets, Portugal

BACKGROUND
Microplastics pose a threat to coastal environments due to their capacity to adsorb persistent organic pollutants (POPs). Plastic pellets (less than 5 mm in size) are potentially dangerous to marine species due to magnification risk over the food chain (Thompson, 2009). The characteristics that make plastic so useful are the same that are prejudicial to the environment (high persistence, resistance to corrosion, low electric and thermal conduction). The high prevalence of these materials in the environment and the high aging resistance and minimal biodegradation (Corcoran, 2009) are factors for the persistence of microplastics in the beaches (Moore, 2008). Coastal economic activities such as tourism, fishing and industries, contribute severely to the proliferation of plastics in marine environment. This study aims to identify common plastic polymers; quantify adsorbed POPs, mainly PAHs, PCBs and DDTs in stranded microplastic pellets and also determine their size.

METHODOLOGY
Samples were collected between 2008 and 2009 from Cresmina (38º43’32.45’’N; 9º28’36.12’’W) and Fonte da Telha (38º34’2.53’’N; 9º11’37.71’’W) beaches both exposed to Northerly winds, immediately after spring tides. At the beach, sediment samples from the top 2 cm were collected at the tidal mark on shore, from two square areas of different sizes (50x50 cm and 2x2 m) along the shore line according to two objectives: (A) to determine the size of the micro debris sand from the 50 cm squares was collected into paper bags and (B) to determine the concentrations of adsorbed POPs, in plastic pellets, for which the 2 m square samples were sieved in situ through a metal mesh (2 mm) into a paper bag. At all times contact with plastic materials was avoided to prevent contamination.

Plastic pellets were set apart from the rest of the plastic debris. All samples were then weighed and plastic pellets sorted into four classes (aged, black, white and color) according to a similar classification made by Endo et al., 2005. Plastic polymers were identified through Fourier transformed infra-red spectroscopy (micro-FTIR). Microplastic samples were inserted into a Thermo® diamond anvil compression cell fit in a Nicolet Nexus® spectrometer interfaced with a Continuum microscope, with a MCT-A detector cooled by liquid nitrogen, which identifies polymers creating a spectrum. Pellets were analyzed with gas chromatography mass spectrometry (GC-MS) to quantify PAHs, PCBs and DDTs.

OUTCOMES

Regarding sizes, some of the fibers collected on the filters were approximately 1 µm in diameter and 15 µm in length. Other fibers ranged from 1 to 5 µm in diameter and were 500 µm in length. Pieces of polystyrene, polyethylene and polypropylene had sizes above 500 µm and below 1 mm, except one sample of polystyrene which had approximately 200 µm. All plastic samples were contaminated with POPs (PAHs, PCBs and DDTs), which are toxic, irritant and carcinogenic chemicals. From the four classes of pellets the higher concentrations were observed in black pellets. The highest concentrations of PAHs in the pellets sample referred to fluorine, phenantrene, pyrene and benzo(e)pyrene. Regarding PCBs the highest concentrations were observed in congeners 18, 26, 31, 101, 105, 118, 138, 153 and 187. FTIR spectroscopy identified the most common plastics from both beaches as polyethylene (PE) and polypropylene (PP), although samples of polystyrene (PS) were also present. In 33 samples analysed 12 were PE, 12 were PP, five were PS and four were other types of plastic. From a composite sample with three different pellets it was possible to identify a white pellet as PP (polypropylene, atatic), an aged pellet as PE (A–C 8) and a black pellet as PS (polystyrene butadiene). By adsorbing hydrophobic substances, microplastics pose a higher environmental risk to marine organisms and though this subject has not been addressed consistently, it is likely that the whole food chain is affected due to the presence of plastics in various sizes at all depths. Thus, the physical, chemical and biologic components of the ecosystem may be affected. This survey shows that microplastics can reach small sizes that may be mistaken for food items. Research in particles smaller than the ones reported is needed, to study the effects and impacts in organisms and in the environment.

PRIORITY ACTIONS

Research efforts on microplastic debris on shore and on the ocean should have as the main goals: (1) the size of microplastic debris due to degradation, (2) mapping the abundance of microplastic debris and (3) determining POPs concentrations and health effects on living organisms. This present work is part of a broader research project directed (1) to the characterization of POPs adsorbed to plastics along the Portuguese coast, a major route for oil tankers and freight ships, and (2) to the potential toxic effects of the ingestion of these particles by marine and estuarine organisms.

Further investigation on marine debris is required in order to relate plastic composition and weathering to the smallest sizes that may enter the ocean food chains, to the capability of these particles to adsorb pollutants. The situation relative to POPs adsorbed to beach stranded debris is essential to establish the potential environmental risk of coastal areas.

FIGURES AND TABLES

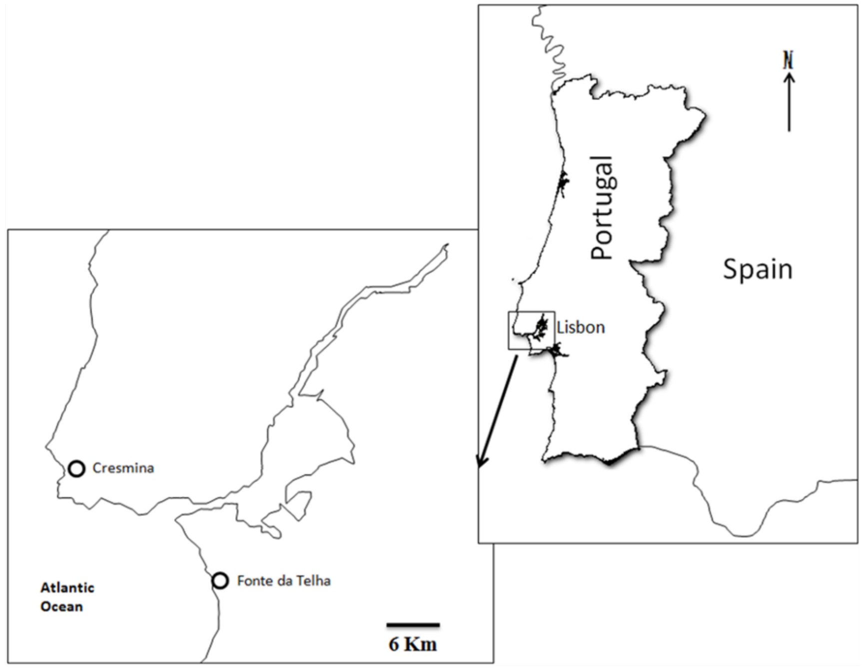

Figure 6 – Portuguese Coastline and sampling sites.

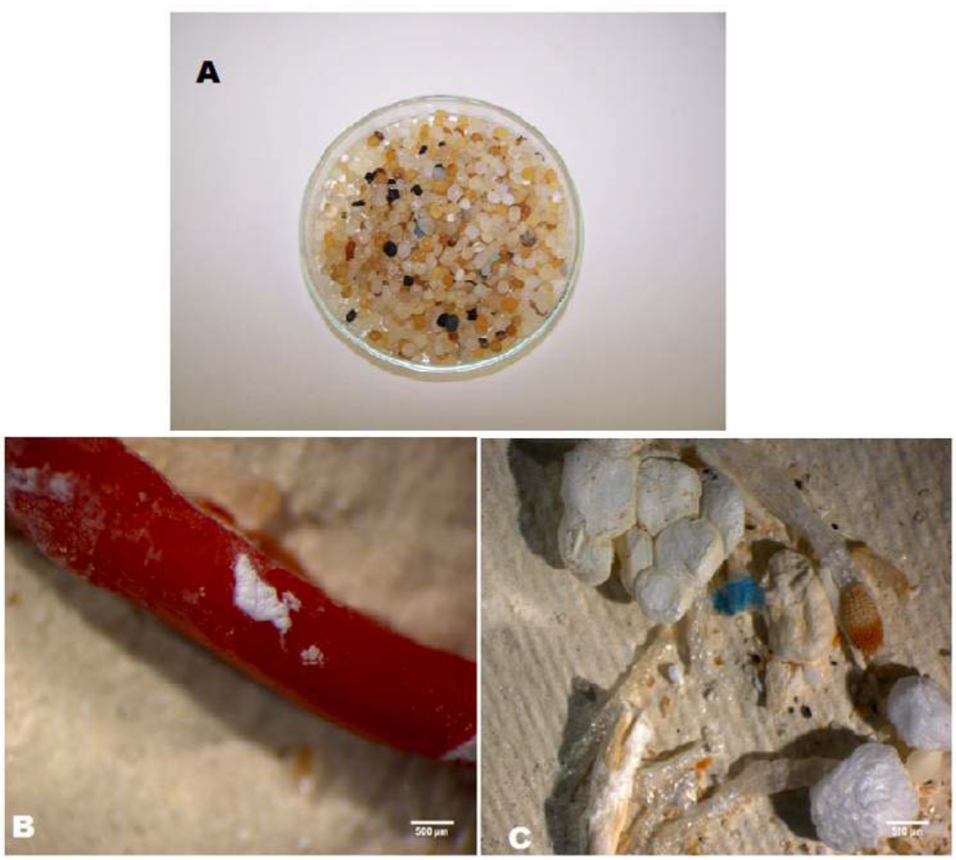

Figure 7 - plastic pellets (A) and size of different plastics (B and C)

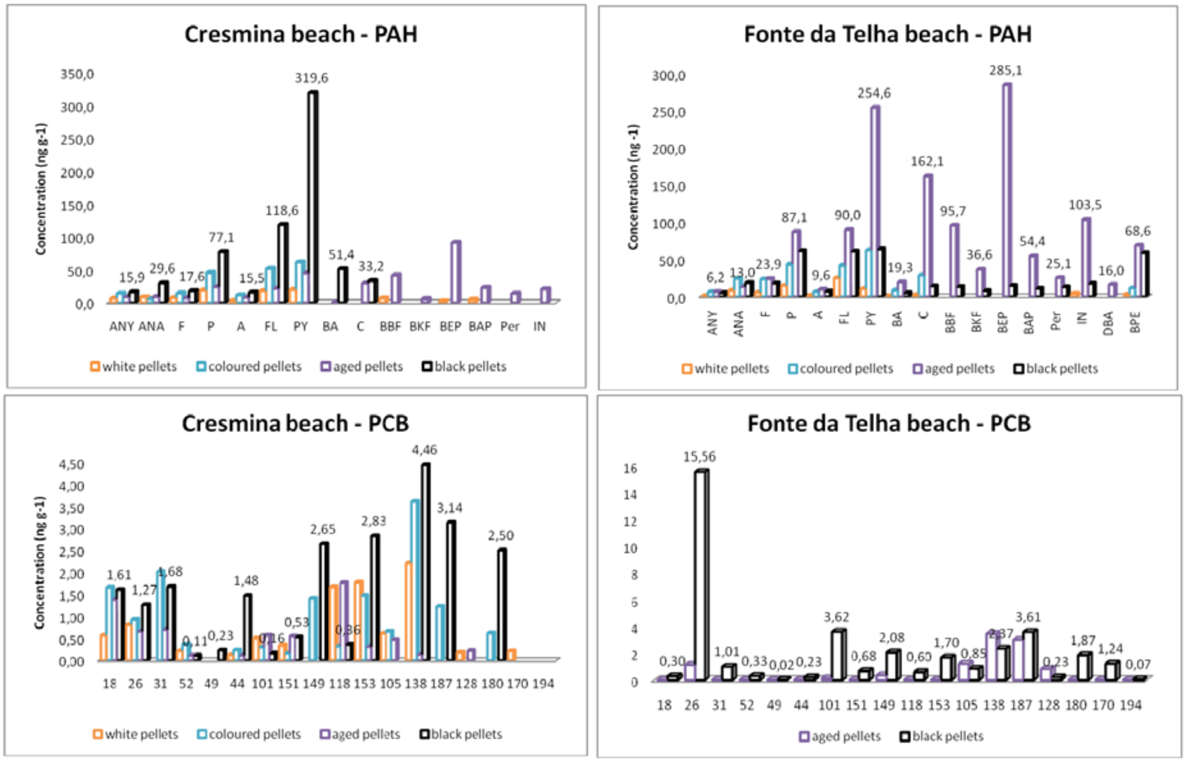

Figure 8 – POP concentrations (ng g^{-1}) in 4 classes of pellets in 2009

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46. Understanding the sorption and dissolution of contaminants from plastic resins

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KEYWORDS
Plastic, sorption, dissolution, kinetics, isotherms, resin, phenanthrene, PAH

BACKGROUND

Marine debris is one of the major pollutants affecting the marine environment. The buoyant nature of plastics has helped spread plastics globally by ocean and wind currents, extending from industrialized coast lines to some of the most remote areas (Derraik, 2002; Franeker, 1985). Plastic litter is more than just an eyesore, more than 267 species that feed or live in marine environments worldwide have been documented to ingest or become entangled in it (Liast, 1987).

Previous studies have demonstrated the ability of plastic resins to concentrate high quantities of toxic organic contaminants from the marine environment and some evidence suggests a correlation between plastic ingestion and contaminant load in some organisms.

Understanding the kinetics of sorption, desorption, and dissolution, of contaminants on plastics are fundamental to understanding their fate within the marine ecosystem and their relation to plastic debris as these kinetic processes dictate contaminant distribution, persistence, and ecological impact (Teuten, 2009). This project seeks to provide chemical equilibration constants, distribution constants, and kinetics of sorption of polycyclic aromatic hydrocarbons (PAHs) from the marine environment to plastics. This project also seeks to provide desorption rates of these contaminants as well as the dissolution rates of plastic additives into natural biological systems, like the digestive systems in marine animals.

METHODOLOGY

We chose flow through column experiments to investigate sorption and desorption kinetics of PAH on unplasticized polyvinyl chloride (uPVC) resin. The flow through column system consists of a reservoir of artificial seawater containing phenanthrene, a peristaltic pump (Masterflex L/S PTFE-Tubing Pump), column cooling compartment (Shimadzu CTO-10ASvp) to adjust to temperatures found in marine environment, and column containing (uPVC) resin. After effluent passes the column, the fluorescence of phenanthrene is measured online by fluorescence detector (Varian Cary Eclipse) outfitted with a flow-cell.

We loaded clean uPVC powder (230 µm purchased from, Goodfellow) as slurry into a stainless steel liquid chromatography column (Phenomenex) and sonicated to avoid formation of air bubbles. In order to characterize the column, we first performed a pulse experiment using a conservative tracer in order to determine the pore volume and Peclet number.

Due to the strong sorption of Phenanthrene to surfaces our flow through system was equilibrated with 100 ppb phenanthrene/artificial seawater solution prior to the sorption experiment. After the system had equilibrated, we added the column maintained at 10°C in the thermostatically controlled column compartment. We pumped the feeding solution through the thermostated column at a flow rate of 0.5 ml/min and monitored the phenanthrene concentration.

The amount of sorbed phenanthrene on the plastic is determined from the difference between the initial concentration (C_F) and concentration in the effluent (C_L). The ratio C_L/C_F over time gives a parabolic curve from which we determine the sorption isotherm, volumetric mass transfer coefficient, and equilibrium coefficient. From the equilibrium concentration we are able to calculate the mass of phenanthrene that would be sorbed to a resin at any given concentration in sea water and the mass transfer coefficient enables to calculate the rate at which phenanthrene is sorbed to the plastic surface at any given concentration in sea water. Both parameters are important in determining the sorption/desorption characteristics.

OUTCOMES

The experiment has demonstrated the ability of uPVC to accumulate large quantities of hydrophobic phenanthrene from seawater. Our data show uPVC resin to be capable of accumulating phenanthrene at concentrations as high as 60,000 ng per gram resin, this phenomenon is most likely due to the high surface area to volume ration of micro-plastics. The breakthrough curve in Figure 1 allows us to determine maximum adsorption capacity and the adsorption isotherm of phenanthrene from sea water to uPVC at 10º C as displayed in Figure 2 suggests that adsorption follows a Langmuir isotherm model. It seems that measuring breakthrough curves with column experiments is a suitable method for determining sorption characteristics of plastics. This work was funded by the National Fish and Wildlife Foundation and National Oceanic and Atmospheric Administration.

FIGURES AND TABLES

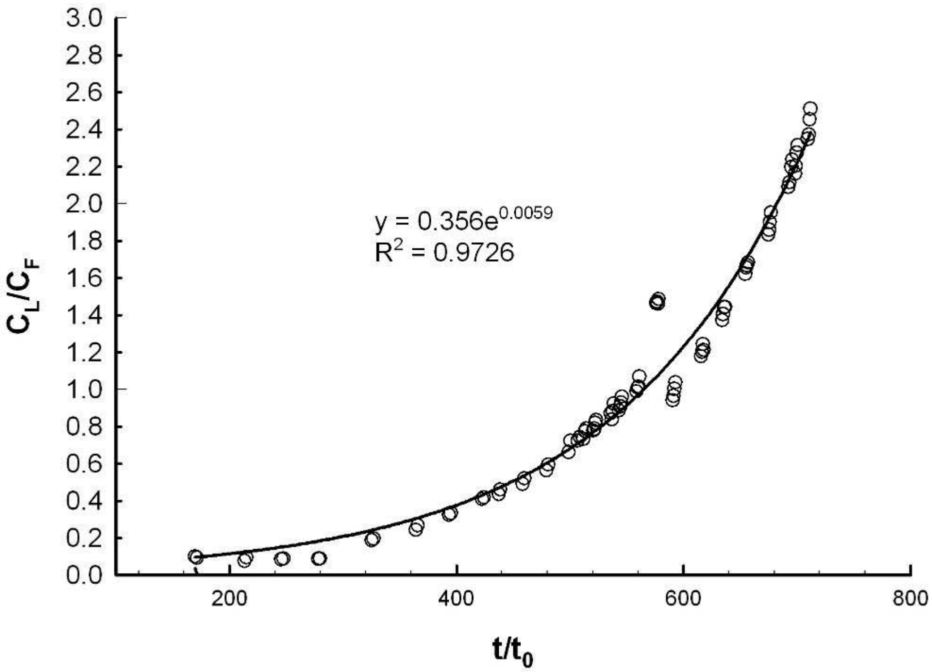

Figure. 1. Diffuse front of the phenanthrene breakthrough curve through a column packed with 230 µm uPVC (The abscissa t/t_0 denotes pore volumes eluted).

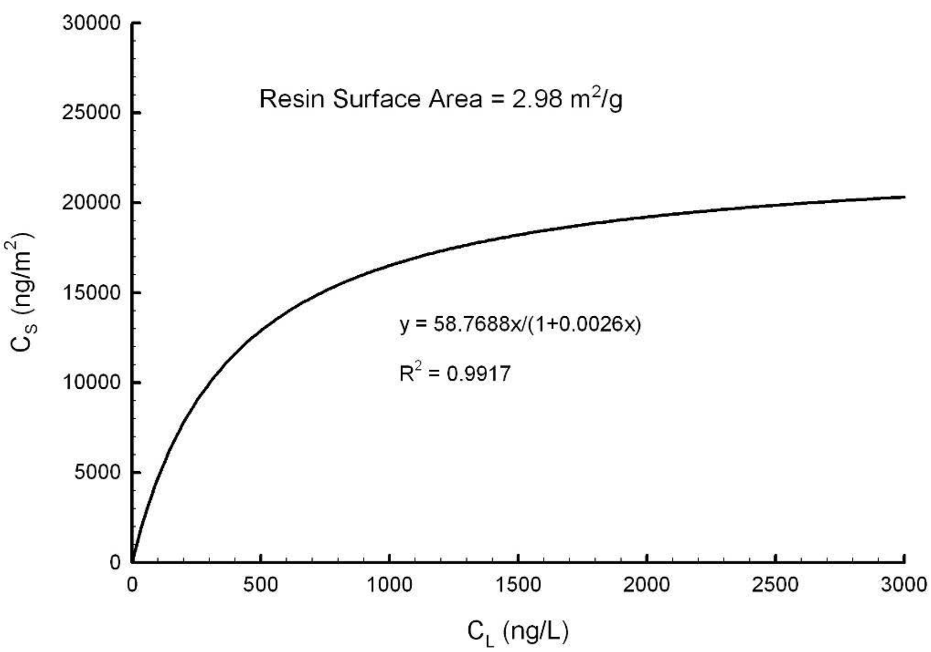

Figure. 2. Adsorption isotherm of phenanthrene on uPVC. Curve is calculated from the curve generated in Figure 1. Surface area is from literature values for average area of similar diameter plastic particles (2.98m2/g).

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47. Macro and micro plastic debris adsorb and transport endocrine disrupters in the ocean.

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KEYWORDS
Plastics pollution, Microscopic plastic, Persistent organic pollutants, Synthetic polymers, Marine debris

BACKGROUND
It is a reality that plastic particles have become a major environmental concern, occurring on beaches throughout the world. In marine systems plastic materials have been found to absorb and concentrate persistent organic pollutants (POPs) including organochlorine pesticides,PCBs, and PAHs leading to increased toxicity in aquatic organisms and wildlife. The accumulation of pollutants by plastic debris in the marine environment is well established but the consequences are not totally understood (Rios et al., 2007 and 2010).

Small pieces of plastic polymer (less than 5 mm in size) are often ingested by marine organisms and seabirds (Moore, 2008; Boeger, et al., 2010). Some studies show a high negative effect on marine animals and sea birds. The pollution caused by microscopic plastic is a potential hazard to marine life and can affect the human race. Both water and plastic samples were collected from the North Pacific Central Gyre, called the "Eastern Garbage Patch" (September, 2007).

METHODOLOGY
In general, 1 g of dry macro and micro plastic particles were placed in an extraction thimble, and a mixture of recovery standards was added before extraction. The organic soluble adsorbates were Soxhlet extracted for 24 h, concentrated under reduced pressure, separated and purified by two steps of liquid chromatography, each fraction was concentrated to 1 mL. Recovery standards were added before instrumental analysis. A quantitative assessment is provided for the endocrine disrupters adsorbed on macro, micro, and microscopic plastic by GC/MS in selected ion monitoring. The JEOL GC/Mate II™ double-focusing, reverse geometry mass spectrometer coupled with a GC-Agilent 6890 equipped with a BXP-5 capillary column. A Shimadzu model 8300 Fourier Transform Infrared Spectrometer (FT-IR) with a diffuse reflectance accessory was used to analyze the polymer on macro and micro plastic samples. Virgin pellets were used as standards to compare with the plastic debris samples.

36 individual polychlorinated biphenyls and 16 EPA priority polyaromatic hydrocarbon pollutants were analyzed. The samples analyzed were found to fall in the range of 80 to 98% recovery.

OUTCOMES
The total concentration of PCBs and PAHs detected in plastic particles samples in North Pacific Central Gyre are summarized in Table 1. The most common detected pollutants on these plastic fragments were PAHs. The ratio of the sum of the low and high molecular weight of PAHs makes possible to hypothesize the possible source or PAHs. Lower the ratio LPAHs/HPAHs, higher the possibility of pyrolytic (52% of the samples) source over the petrogenic (48% of the samples) source. However, the PAHs quantified could be have a mixed sources dominated by pyrolytic process. PCBs concentrations ranged from 1 to 223 ng/g. These results show that there are several sources of these pollutants.
The main synthetic polymers found in fragments particles were PE (polyethylene) and PP (polypropylene). These types of plastic are the most common used by the society. There are inexpensive plastics and they can float on the seawater and can be fragment in smaller pieces, Figure 1. Microscopic plastic particles were also discovered suspended in the sea water, Figure 2, and 3. The cases where the PCBs and PAHs were not detected on filters containing these microscopic plastic particles may be explained by the low mass content of each sample since the chemical properties are the same for microscopic as they are for macroscopic particles.

PRIORITY ACTIONS
It is known that it is not only the size of these micro (Figure 1) and microscopic (Figure 2, and 3) particles plastic that can cause physical damage to the organisms but also toxic effect from the chemical compounds adsorbed on the plastic including endocrine disrupters which are ingested by marine organisms. Since these pollutants at trace levels in the water accumulate on the plastic that enters the food chain, it is likely that these pollutants migrate from the plastic to the organism. The quantitation and identification of these pollutants is important information pertinent to the well being of sea organisms and those that eat sea creatures.
Further research needs to be done to determine the role of these fine particles in transporting toxic substances to filter feeding zooplankton and other organisms in the aquatic food chain.

FIGURES AND TABLES

Fig1. Small fragments of superficial plastics.

Fig 2. Microscopic superficial plastic.

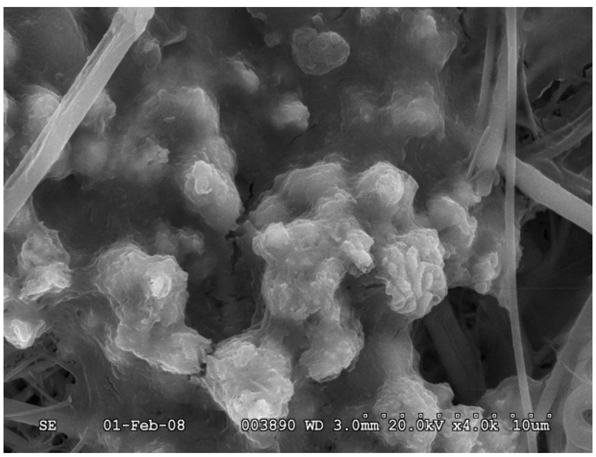

Fig 3. Microscopic plastic particle using SEM.

Table 1.Sum of PAHs and PCBs concentration

Type of sample	**Sample ID**	**ng/g □PAHs**	**ng/g □PCBs**	**PossibleSource PAHs**
Filter	H-01F	147	nd	Pyrolytic
Seawater	H-02	8	nd	Petrogenic
Seawater	H-04	1	1	Petrogenic
Seawater	H-08	0.4	nd	Petrogenic
Seawater	H-09	0.2	4	Petrogenic
Seawater	H-10	1	1	Petrogenic
Seawater	H-11	1	20	Petrogenic
Seawater	H-12	1	0.2	Pyrolytic
Seawater	H-13	3	19	Petrogenic
Manta Trawl	G07-11	75	nd	Petrogenic
Manta Trawl	GO7-17	846	nd	Pyrolytic
Manta Trawl	G07-14	117	nd	Pyrolytic

Small manta	P05	111	nd	Pyrolytic
Small manta	P06	78	87	Pyrolytic
Small manta	P11	35	nd	Petrogenic
Small manta	P12	176	nd	Petrogenic
Small manta	P13	92	73	Pyrolytic
Fragments	D19	6	nd	Pyrolytic
Fragments	D23	99	6	Pyrolytic
Fragments	D24	49	223	Petrogenic
Fragments	D25	32	46	Pyrolytic
Fragments	D27	4	nd	Pyrolytic
Fragments	P-01	249	nd	Petrogenic
Fragments	P-02	17	21	Pyrolytic
Fragments	P-04	67	nd	Pyrolytic

nd = not detected at LOD. 0.02 to 0.15 ng/g for PCBs, 0.05 to 0.8 ng/g for PAHs

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48. An investigation of plastic marine debris across the North Atlantic Subtropical Gyre

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KEYWORDS
Plastic, Marine Debris, North Atlantic Subtropical Gyre, Manta Trawl, plastic abundance, plastic density, spatial distribution, temporal distribution, pollution

BACKGROUND
Previous studies of plastic marine debris in the Sargasso Sea span nearly 4 decades, yet have focused on the western region primarily. This study shows evidence of spatial distribution of plastic marine debris further than previously known, and a temporal change showing a summer increase plastic particle abundance over winter samples in the same area.

METHODOLOGY
This study presents data gathered from 35 surface net tows conducted during 2 expedition legs through the North Atlantic Subtropical Gyre in the winter of 2010. 6 months later, 6 sites were revisited to study seasonal variation. In January 2010 the vessel "Sea Dragon" traveled over 4,850 kilometers from St. Thomas, Virgin Islands to Bermuda on Leg 1, and onward to Horta, Portugal on Leg 2. Sea surface samples were collected using a manta trawl with a 60cm x 25cm net aperture, a 333-μm mesh net, and towed at the air-sea interface. The net was towed off the starboard side using a spinnaker pole extended perpendicular to the boat, which extends the towline of the trawl 5 meters from the ship's hull, thus avoiding the ship's wake. Tows were typically 3 hours long and traveled 6-8 nautical miles at 1.5-1.75 knots. To measure the area and volume sampled, we used a flowmeter, and recorded GPS coordinates of the start and stop locations. Samples were preserved in 10% buffered formalin for transport to the lab. In the lab, individual particles of plastic were sorted into type categories (pellet, fragment, foam, film, and filament) and size categories (0.355-0.499mm, 0.500-0.709mm, 0.710-0.999mm, 1.0-2.79mm, 2.8-4.749mm, and greater than 4.75mm.)

OUTCOMES

Leg 1 of the expedition yielded 20 samples, with an average plastic weight density of .0125 g/m^3 and an average particle count density of .4488 $particles/m^3$. Average plastic particle abundance on Leg 1 was 68,446 $/km^2$. Leg 2 of the expedition yielded 15 samples, with an average plastic weight density of .0025 g/m^3 and an average particle count density of .3042 $particles/m^3$. Average plastic particle abundance on Leg 2 was 46,393 $particles/km^2$. On both legs, fragments far outweighed and outnumbered the other 4 type categories of plastic, by 80% or greater. The smallest size category (0.335-0.499mm) accounted for one third of the number of particles. On Leg 1, the distribution of particles by size favored the smallest size class, 0.335 – 0.499mm, by 32%, with nearly half of the particles, 48%, less than 1mm. On Leg 2, the percent distribution of particles less than 1mm was 15%, with 59% of the number of particles in the 1 – 2.79mm size class. Net tows 18, 19, 21-24 were repeated 6 months later in summer. The average weight density was .005g/m^3. This is a significant increase compared to the average weight density of .0022g/m^3 for all 35 winter samples.

PRIORITY ACTIONS

Further study is needed to examine plastic pollution in the eastern region of the Atlantic Ocean, as well as the effect of sea state on the vertical mixing of microplastic particles.

FIGURES AND TABLES

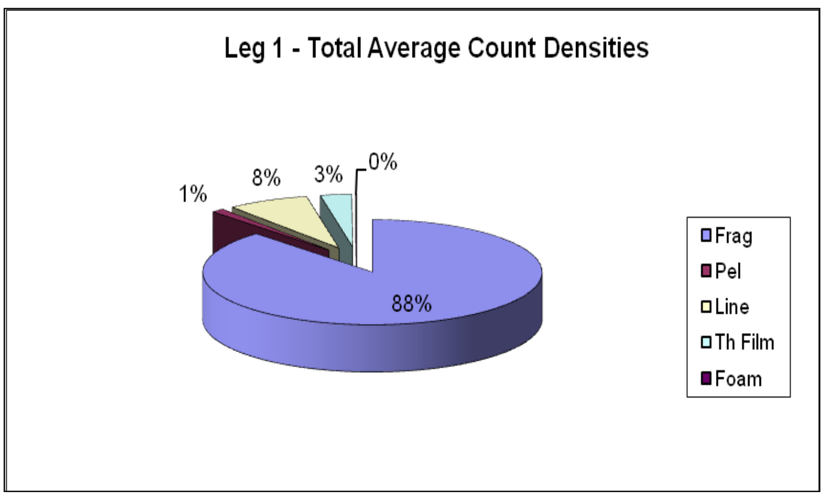

Figure 1. Pie chart showing percentage of plastic by physical type for Leg 1.

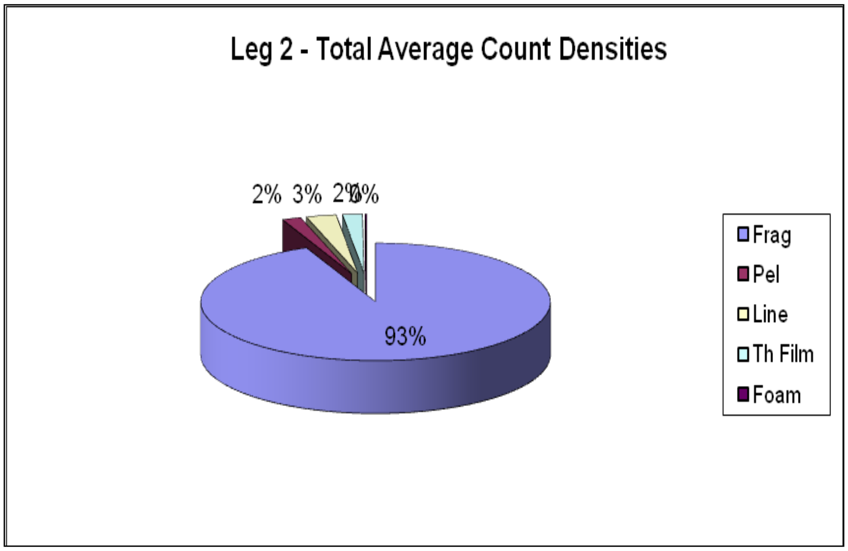

Figure 2. Pie chart showing percentage of plastic by physical type for Leg 2.

Leg 1						
Sample ID	Date	Latitude	Longitude	Count Density (number/m³)	Weight Density (g/m³)	Surface Abundance (number/km²)
1	1/9/2010	19.94321667	64.5649	0.535036548	0.000232847	81589.02019
2	1/9/2010	20.21733333	64.38283333	0.076975571	0.000462475	11738.19138
3	1/9/2010	20.4521	64.19675	0.186147994	0.023269719	28386.15886
4	1/10/2010	21.1293	63.83325	0.089309529	0.000119839	13619.02653
5	1/10/2010	21.473	63.58986667	0.064379568	0.000226044	9817.396426
6	1/10/2010	21.73666667	63.42266667	0.814401538	0.013811027	124190.0648
7	1/11/2010	22.14998333	63.14736667	0.146541728	3.95E-05	22346.50337
8	1/11/2010	22.84181667	62.75916667	0.13909166	0.000334272	21210.42438
9	1/12/2010	24.35763333	62.81291667	0.111882939	0.000196889	17061.30059
10	1/12/2010	24.35763333	62.81291667	0.014526672	0.000147908	2215.207399
11	1/13/2010	24.76571667	62.72206667	0.015773179	8.87E-05	2391.417078
12	1/13/2010	25.37513333	62.4785	0.042372964	3.19E-05	6461.556034
13	1/13/2010	25.56066667	62.4387	4.462674614	0.174475946	680524.0705
14	1/14/2010	26.09136667	61.71675	0.01615258	8.50E-05	2463.146057
15	1/15/2010	29.24903333	62.98573333	0.139199066	0.00126188	21226.80308
16	1/15/2010	29.74531667	63.21671667	0.277327371	0.005111071	42290.32307
17	1/16/2010	30.54773333	63.70643333	1.273042309	0.009090492	194129.3079
18	1/17/2010	31.1813	64.01473333	0.086072684	0.00097563	13125.43218
19	1/17/2010	31.53503333	64.26768333	0.287025575	0.001342135	43769.22573
20	1/18/2010	31.96436667	64.54481667	0.199178305	0.020266928	30373.18256
			Mean =	0.44885562	0.012578515	68446.38791

Table 1. Plastic density and abundance for each station during Leg 1.

Leg 2						
Sample ID	Date	Latitude	Longitude	Count Density (number/m³)	Weight Density (g/m³)	Surface Abundance (number/km²)
21	1/28/2010	32.32	64.4322	0.32518923	0.003911487	49588.89402
22	1/28/2010	32.07903333	64.63163333	0.364817553	0.004093468	55631.91308
23	1/29/2010	31.5865	62.77273333	0.218073554	0.00171342	33254.56489
24	1/29/2010	62.77273333	62.03675	0.106366243	0.001314556	16220.04627
25	1/30/2010	30.87345	61.3126	0.645678126	0.007923854	98461.02264
26	1/31/2010	30.073	58.70808333	0.323523588	0.002499342	49334.89618
27	1/31/2010	30.073	58.70808333	0.020321833	0.000267427	3098.92564
28	2/1/2010	29.68353333	56.69925	0.036360553	0.000835737	5544.708945
29	2/2/2010	29.53921667	54.9628	0.460492745	0.002577373	70221.65499
30	2/2/2010	29.27965	53.61165	0.455367678	0.002390259	69440.12107
31	2/3/2010	28.90703333	51.89313333	0.209122974	0.001154601	31889.66921
32	2/3/2010	28.77288333	51.07773333	0.967992793	0.003189502	147611.5677
33	2/3/2010	28.55221667	50.10263333	0.197162428	0.003113959	30065.77656
34	2/9/2010	35.67285	35.02365	0.07471	0.00037	11393.03
35	2/9/2010	36.2937	33.38883333	0.158326049	0.002419823	24143.52306
			Mean =	0.304233829	0.002518644	46393.35428

Table 2. Plastic density and abundance for each station during Leg 2.

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49. Long-term quantitative monitoring of plastic debris in the Pacific Ocean during repeated undergraduate research cruises.

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ABSTRACT
Sea Education Association has been sampling and quantifying marine debris from surface plankton nets in the Pacific Ocean since 2001. Repeated tracks through the North Pacific subtropical gyre and across the Equatorial Pacific continue to build upon one of the most extensive marine plastic debris data sets in existence, and help to quantify what has been popularized as the 'Great Pacific Garbage Patch'. We will discuss the abundance, distribution, and time evolution of plastic marine debris in the North and South Pacific from the ongoing 9-year time series, representing results from more than 1800 surface plankton net tows.

50. A characterization of marine debris in the Northeast Pacific deep ocean

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KEYWORDS
Marine debris, deep sea, Monterey Bay, Monterey Canyon, ROV survey, VARS

BACKGROUND
Marine debris is an ever-increasing global issue that has negative impacts upon both benthic and pelagic habitats in coastal and open-ocean areas. Marine debris is introduced to marine environments via improper disposal or accidental loss, either at sea or from land, and is subject to wide dispersal by ocean currents and tides. Debris often sinks and accumulates on the seafloor (Watters et al., 2010). Little is known about marine debris in the deep ocean due to technical challenges and prohibitive costs of conducting research in deep waters. In one of the few studies addressing this problem Galgani et al. (2000) performed a large-scale survey of marine debris off of the European coast and found the distribution to be extremely variable with greater amounts of large waste items found deep in submarine canyons due to stable conditions and decreased water movement. There are even fewer studies that have observed trends in marine debris accumulation over time periods longer than a decade (Barnes and Milner, 2005).

The Monterey Bay Aquarium Research Institute (MBARI) uses high-resolution video equipment to record over 300 remotely operated vehicle (ROV) dives per year to depths up to 4,000 meters. Over the past 22 years, more than 17,000 hours of underwater video have been archived and managed as a centralized institutional resource. This video library contains footage of the biological, chemical, geological and physical aspects of the Monterey submarine canyon and other areas including the Pacific Northwest, Santa Barbara Basin, Central California seamounts, Northern California, Hawaii, and the Gulf of California. Here, we present a characterization of marine debris observed in this video archive, with an emphasis on the Monterey Canyon and surrounding areas.

METHODOLOGY
Using MBARI's Video Annotation and Reference System (VARS), a video analysis and observation database (Schlining and Jacobsen Stout, 2006), we reviewed the types of marine debris observed in MBARI's ROV video archives from August 1988 to December 2010. Over

1600 observations of marine debris in the VARS database were characterized using 16 broad categories, including: abandoned research equipment, battery, clothing, other fabric, glass, concrete, manufactured wood, military debris, paper, rope, rubber, ship wreckage, plastic, metal, fishing debris and unidentified debris items.

The observations were normalized by dive effort within $50m^2$ grid cells where ROV surveys have been conducted. These normalized data were mapped in ArcGIS and show relative abundance of debris observed on ROV dives. Normalized observation data were also used to plot types of debris over time. Raw, non-normalized data were used to plot commonly observed debris across the database.

OUTCOMES

The correlation of ROV depth and multi-beam bathymetry shows that of the 20,672,561 grid cells used in this study, 48,581 grid cells have been visited and observed by MBARI's ROVs, or 0.5610% of the seafloor in this area (Fig. 1). Debris was observed in 726, or 1.4944%, of that area. Over half of the 1630 observations of marine debris were categorized as plastic and metal (Fig. 2). Within the plastic category, over half of the observations were plastic bags (53%). Within the metal category, 63% were some type of metal can (i.e. aluminum, steel, or tin). The next most abundant categories were rope and unidentified trash. In Figure 3, we show examples of common debris items observed.

Strong currents in Monterey Bay may move debris from uniform and relatively flat continental shelf areas to areas within the canyon system where it accumulates on high-relief physical barriers.If debris were randomly distributed throughout the study area, one would expect debris observations to occur on all ROV dive tracks and in similar abundance (Fig. 2). However, our mapped observations show debris accumulating within the high-slope canyons of the study area, thus canyons appear to act as conduits transporting anthropogenic debris downslope as is the case with sediment transport (Paull et al., 2005). In addition, physical obstacles occur within the canyon system, such as rocky outcrops, talus slopes, whale-falls, clam beds, and research equipment deployed on the sea floor. The higher rugosity of these high-relief features may trap debris, acting as barriers to debris transport and causing observed accumulation of debris. Within Monterey Canyon, there appear to be higher concentrations of debris in the areas where the canyon meanders as well.

The relative frequency of plastic appears to increase over time with a noticeable increase in 2000 (Fig. 4). This could be due to increase use of plastic bags or an increase in the size of human populations living along this coastal area, but is more likely attributable to acquisition of a second MBARI vehicle, ROV *Tiburon,* capable of diving deeper into the canyon (to 4,000 meters), and to the addition of high definition cameras on both ROVs, making it possible for smaller debris pieces to be identified. Light, small pieces of debris, such as plastic bags, which made up a large portion of our observations would easily be swept down canyon by currents and may occur more commonly in deeper sites.

The Monterey Bay region is one of the most well-studied areas of the world's deep ocean. Yet, in 22 years of exploration, MBARI has observed less than 1% of the region's seafloor. Our study suggests that debris accumulates most often in canyons and on other physical barriers. Much like the concentration of pelagic debris in the North Pacific Gyre (Moore et al., 2001), it is likely that there are areas on the deep seafloor where much of the debris accumulates. With vast areas of the deep sea remaining unexplored, it is expected that debris accumulation far exceeds the observations made in this study.

PRIORITY ACTIONS

The impact of marine debris in deep seafloor habitats on biological communities is largely unknown. Further surveys with an emphasis on categorizing debris will provide insight into extent of debris accumulation and the types of debris that can have a negative effect on organisms. Studies such as this should be shared with the broader research community, the public and policy makers to increase awareness and encourage funding for surveys in other ocean basins. Efforts should also be made to standardize methods for tracking and reporting observations of debris during all types of marine expeditions.

FIGURES AND TABLES

Figure 1. Locations of MBARI ROV dive tracks (red) and debris observations (yellow). The size of the yellow circles represents the relative abundance of debris found at that location.

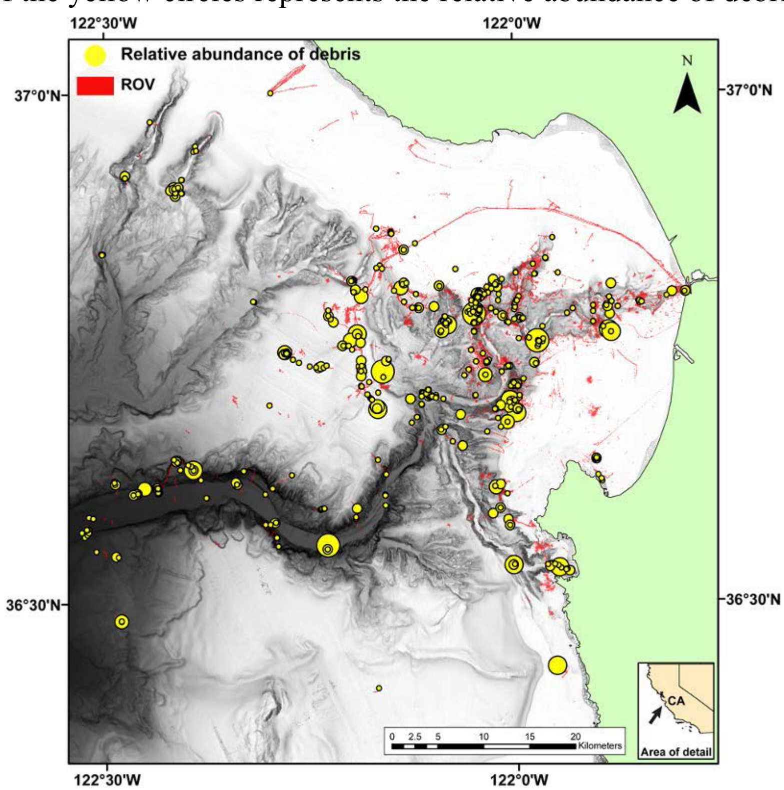


Figure 2. Percentages of total marine debris observations by category.

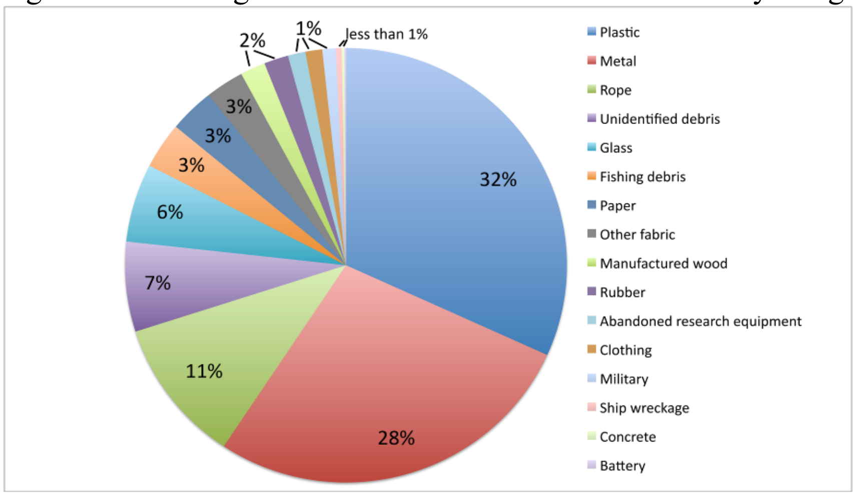


Figure 3. Examples of common marine debris observed on ROV video surveys. Clockwise from upper left: plastic bag wrapped around a deep-sea gorgonian, aluminum can, rope and fishing net, paper, tire with organisms living on and around it, and bottle.

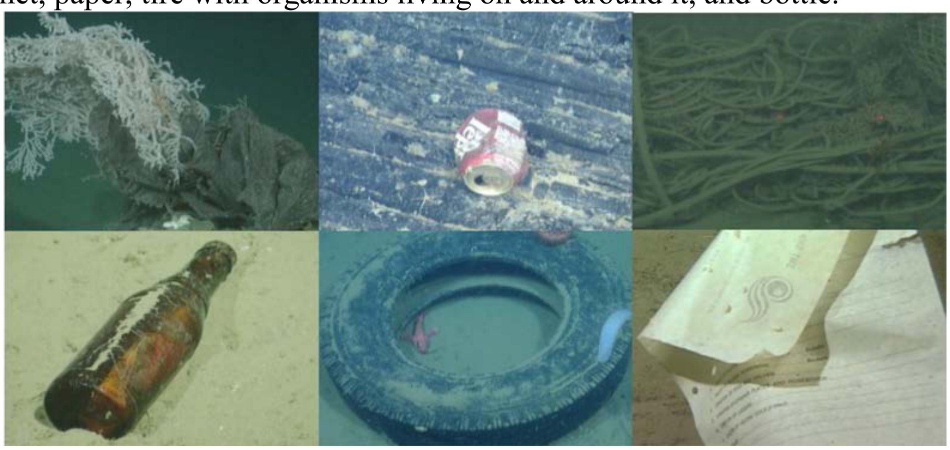
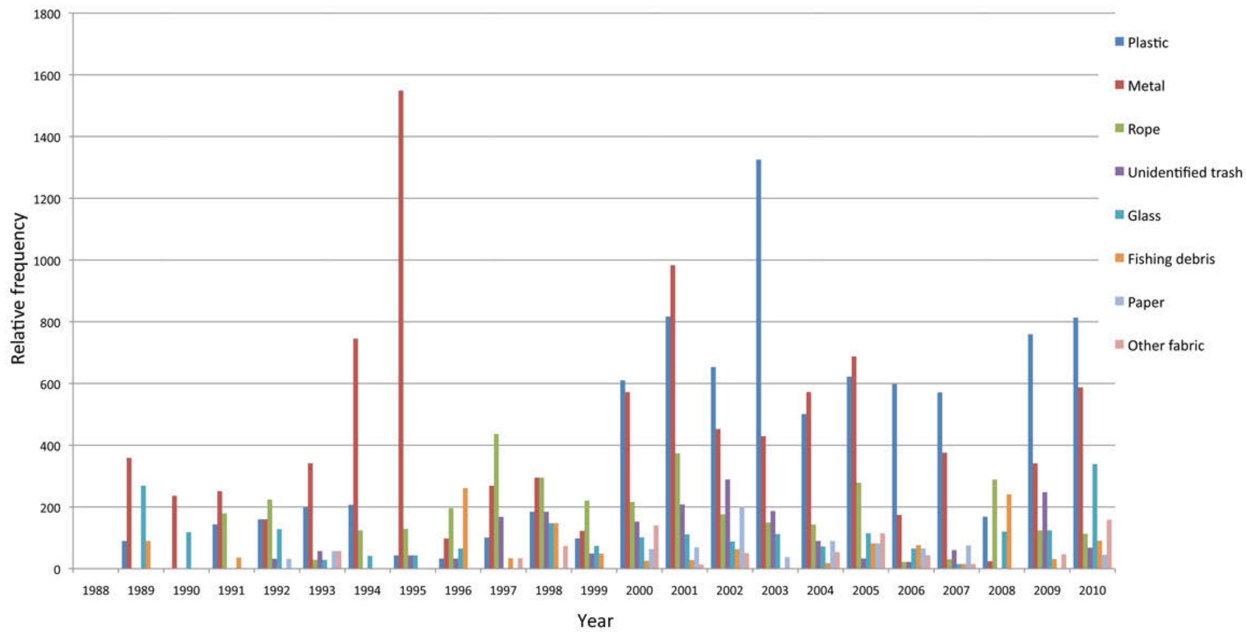


Figure 4. Relative frequency of debris observations normalized by ROV effort over time.



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51. A hazard assessment of coastal pollution on endangered leatherback sea turtles (*Dermochelys coriacea)*

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ABSTRACT
Critically endangered leatherback sea turtles (*Dermochelys coriacea)* migrate across the Pacific Ocean to forage on scyphomedusae populations off the Coast of California, Oregon, and Washington, exposing them to municipal, industrial, and non-point source coastal pollution. Maintaining good water quality in coastal marine environments is essential to the normal health and development of leatherback sea turtles, their scyphomedusae prey, and the planktonic life that supports scyphomedusae populations. Stormwater and nonpoint-source runoff is recognized by EPA as the leading sources of contaminants and marine plastics along the west coast of the U.S. Polluted discharges cause direct toxic impacts to marine species and can impact coastal ecosystems through delivery of heavy metals, chlorinated pesticides, disease causing pathogens, debris, and plastics. Global sea turtle research indicates poor coastal water quality results in increased disease, accumulation of heavy metals and organochlorine contaminants, and death from ingestion of plastic pollution. Warm, point-source discharges have attracted greater densities of marine life and sea turtles, putting them at increased risk from toxicity, and is sea turtles, increased risk of fibropapilomas believed to be caused by water quality impacts. Emerging water quality contaminants of concern in the marine environment include pharmaceutical drugs, anti-microbial agents, fire retardants, nanoparticles and plasticizers. A hazard assessment approach is presented to evaluate the effects of coastal pollution on the endangered western Pacific leatherback sea turtles. Marine debris and pelagic plastic pollution represents the greatest hazard to leatherbacks due to consistent exposures, documented lethal interactions, and increasing concentrations of plastic pollution in global oceans.

52. What's eating Kaho'olawe's marine debris? "Sharkastics" are providing many clues, and it's not fantastic news…

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KEYWORDS
Kahoʻolawe, Hawaiʻi, aerial, ingestion, seabirds, monk seals, turtles, sharks, plastics, sharkastics

BACKGROUND
Kahoʻolawe, the smallest of the eight Main Hawaiian Islands, is located ~7 miles southwest of Maui. Kahoʻolawe has an interesting history, always being valued culturally, going through a ranching phase, used for live-fire military practices (1941-1990), and now being actively restored from these impacts. An island-wide reserve has been established to protect the island's rich cultural and natural resources. The reserve is managed by the State of Hawai'i's Kahoʻolawe Island Reserve Commission (KIRC), which is holding it in trust until a native Hawaiian sovereign entity is established.

Kanapou Bay, which spans over eight kilometers (five miles), is located on the eastern side of the island and is especially heavily concentrated with marine debris. Since 2003, this has been the site of KIRC-coordinated large-scale annual cleanups. The shear expense of these cleanups has unfortunately limited their frequencies, making the desired thorough cleanup of the beach unattainable with the constant influx of debris. KIRC is very grateful for receiving a 2010 NOAA Community-based Marine Debris Removal Project Grant. The funded project focuses on the bay's 4.5-acre Keoneuli Beach, which is approximately 800 meters (0.5 miles) long. During the course of this 18 month project, the KIRC plans to remove an estimated 15 tons of debris from this beach and rocky coastline, effectively providing a clean slate for monitoring Kanapou's re-accumulation rate.

The detection, assessment and removal of an estimated 15 tons of marine debris from Kaho`olawe's Kanapou Bay will directly benefit the coastal ecosystem, including the adjacent nearshore environment and coral reefs that can be covered with and choked by derelict fishing gear, nets, a huge variety of plastics and other debris items. In addition, the project will promote the health of a wide variety of marine life, including several listed species: the endangered Hawaiian monk seal (*Monachus schauinslandi*), threatened green sea turtle (*Chelonia mydas*), endangered hawksbill sea turtle (*Eretmochelys imbricata*), endangered humpback whale (*Megaptera novaeangliae*), endangered Hawaiian dark-rumped petrel *(Pterodroma sandwichensis*) and endangered Newell's shearwater (*Puffinus auricularis newelli*). These marine creatures, along with non-listed species such as sharks and other apex predators, dolphins, rays, and other seabirds, can get entangled in marine debris.

In addition to potential entanglement hazards, it is a concern that these species may be consuming the plastics and other types of debris we've documented washing ashore during our coastal cleanups. Items of particular interest are what we've termed, "sharkastics", which are plastics that have evidence of obvious shark bites (jagged serrations and puncture marks) (Fig 1). It has been widely recognized that if animals are in fact consuming this non-biodegradable debris, toxins can be transferred and the objects can cause blockages and subsequent food and faecal impactions in the intestines causing medical complications including starvation. The extent of this problem hasn't been researched in Hawai'i, even though sharkastics are commonly been found throughout the Hawaiian Islands.

METHODOLOGY

The KIRC Ocean Resources Management Program is tasked with assessing and protecting the coastal zones and reserve waters (2-nautical mile boundary). To survey Kaho'olawe's ~47-km coastline, standardized, circumnavigational aerial surveys are flown every month (since 2003) using a long ranger helicopter in addition to vessel and land-based research. Helicopters provide an excellent platform for not only documenting marine debris accumulations, but also identifying marine animals (sea turtles, sharks, fish, manta rays, and seabirds) associated with them.

2010-2011 Kanapou cleanup events will utilize approximately 150 volunteers; record the quantity and type of marine debris; quantify the sharkastics issue; sort and divert as much as possible from the Maui landfill by recycling or re-using the applicable diverted marine debris in upland Kaho`olawe erosion control efforts; remove the debris by helicopter sling loads and KIRC's landing craft; feature the project in public outreach events, presentations, workshops and conferences; create a permanent educational display; prepare a short video to be used in presentations and as a public service announcement; and highlight the project on KIRC's website and newsletters.

For more information, please see presentation #0251: Cleaning Kanapou, Kaho'olawe: The Challenges of Marine Debris Removal from a Remote Hawaiian Island That Was Once a Military Bombing Range.

OUTCOMES

The KIRC Ocean Program conducted 87 monthly, standardized aerial surveys from 2003-2010 that circumnavigated Kaho'olawe's ~47 km coastline. A total of 576 turtles were found (range= 1-20, st dev= 3.6, mean= 6.2 turtles/survey) and a total of 73 of these turtles were found associated with floating marine debris (Fig 3). This equates to 12.7% of all turtles seen being associated with marine debris, a rather high percentage. This map also depicts a good representation of where the debris lines usually are within the KIR. Besides fish, no other species were seen amongst the debris.

It is unclear why turtles associate with marine debris lines, but they are found there in 'clusters', not just singly, so it seems something is drawing them to the debris. It is quite possible that they are attracted to these materials as potential sources of food, as floating objects generally attract a number of creatures, but since these turtles are likely green sea turtles who are predominantly vegetarians when they are mature, this leads to another theory. The majority of these turtles is small in size, so these turtles may have actually been floating with these materials pelagically during their "lost phase" of development and drifted in with the currents. They are thought to be omnivores at this point. It is a concern that these turtles are consuming plastics and other unnatural materials (Mascarahnas *et al.* 2004). Upon necropsy of hundreds of green and hawksbill turtles that have stranded throughout the Main Hawaiian Islands since the 1980s, finding plastics in stomach contents is very rare (personal communication, NOAA-NMFS' G. Balazs 2010). This doesn't mean that Hawaiian turtles aren't eating these materials; this may be more of a pelagic behavior so it goes unnoticed, they may be surviving the ingestion, or dying before stranding so they are not found/necropsied. Only one turtle has stranded on Kahoʻolawe (at Kanapou in 1999), but it was not necropsied, so this plastic ingestion question remains unanswered at this point.

Marine debris ingestion-related deaths of seabirds have been highly publicized in the Northwestern Hawaiian Islands, and seabird researchers in the Main Hawaiian Islands have begun to take a closer look at stomach contents and plastics are being found during necropsies (personal communication, DLNR-DOFAW's J. Penniman 2010). It has been widely proclaimed that sharks consume "anything and everything", and some studies support this but information is lacking in Hawaiʻi (Lowe *et al.* 1996). One small entangled shark (unidentified species) was found during a 2006 Kanapou cleanup, but it was buried in a culturally-sensitive way and not necropsied. Communication and collaboration with other researchers regarding this topic is ongoing with the hopes of bringing this issue to the forefront so it can be addressed and solved.

Upon close inspection, most plastic pieces and other types of marine debris have bite marks from sharks and/or possibly other animals (apex predator fish, monk seals, turtles, seabirds?). Out of thousands of pieces of plastic, we've collected hundreds of obvious cases of sharkastics: mainly plastic bottles and fishing-related products of all shapes, colors and sizes. Out of the 531 sharkastics collected from Kanapou during 4 cleanups in 2010, the highest frequency of pieces were white, faded blue/green and black (26.2%, 25.8% and 20.7% respectively) (Fig 2). This collection not only shows what these animals are biting/ingesting, but it may also be a good representation of the colors of plastic that are in the ocean environment. King is in the process of creating a large collage out of the collected pieces for education/outreach purposes. Once they make that connection that animals are probably eating our rubbish, these sharkastics have a big impact on people, which will hopefully trigger a positive behavior change that will help improve the health of our oceans.

PRIORITY ACTIONS

It is unknown at this point exactly how plastics affect species' survival within the Kahoʻolawe Island Reserve, but the high numbers of bitten items suggests that this issue needs to be researched further, with collaborations extending beyond Hawaiʻi (a primary goal of this conference). Technological advancements need to be made that can pick up the unfathomable millions and millions of tiny pieces of broken plastics that are floating and washing ashore. Equally as challenging: outreach and education about the numerous hazards to human and animal health caused by littering/polluting our waterways and oceans needs to reach international levels if this problem is ever going to get cleaned up.

FIGURES AND TABLES

Fig 1. Kanapou "sharkastics".

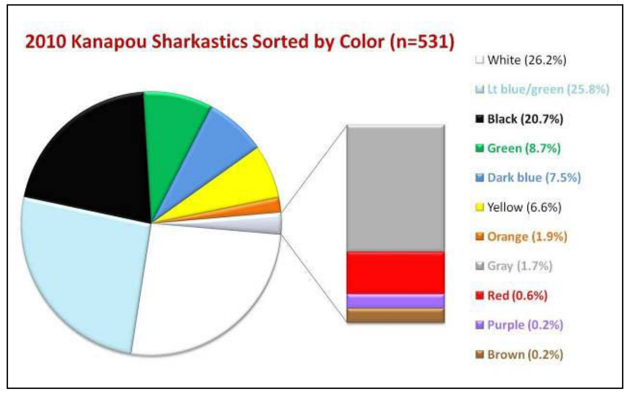

Fig 2. 2010 Kanopou sharkastics sorted by color.

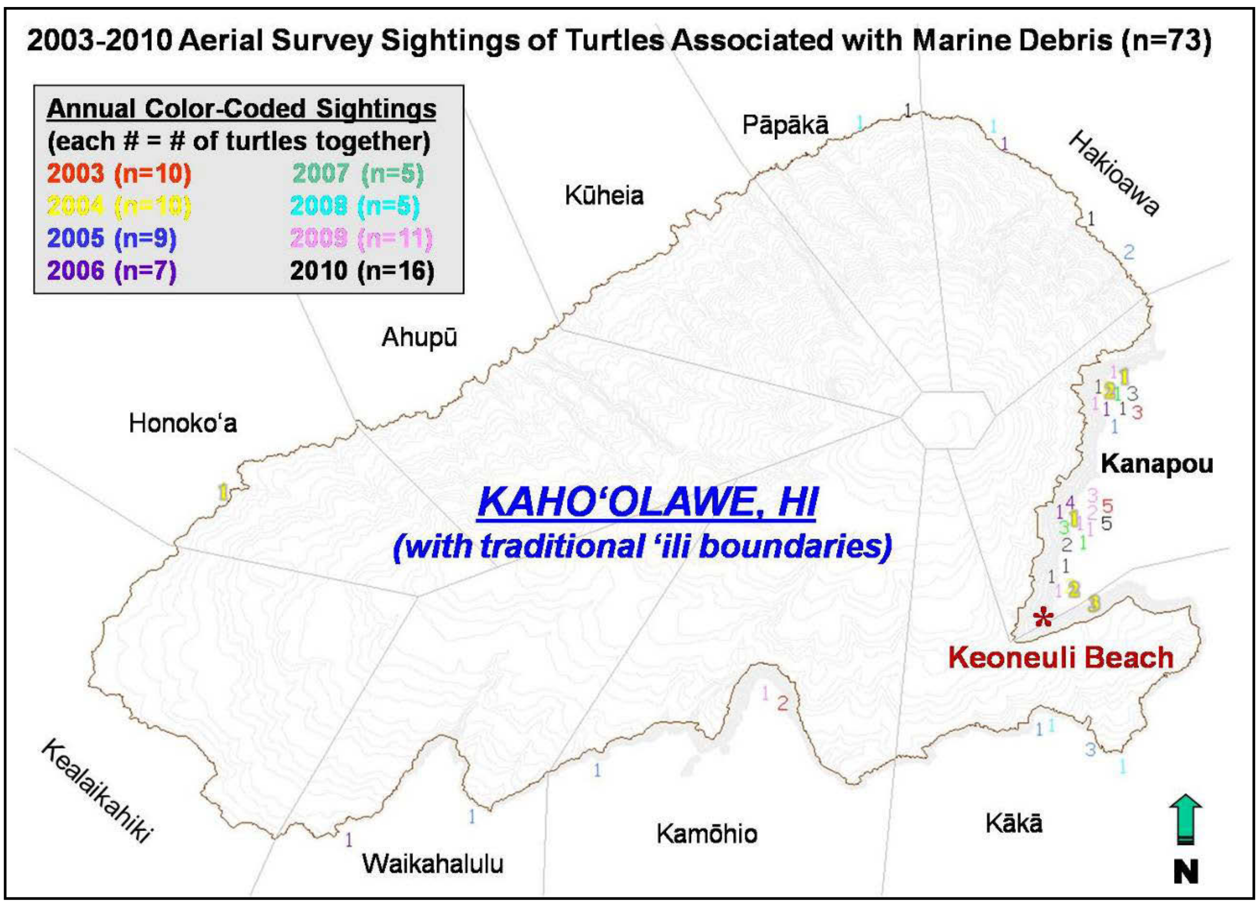

Fig 3. 2003-2010 Aerial survey sightings of turtles associated with marine debris (n=73).

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53. To eat or not to eat? The roles of choice and color in ingestion of marine debris by sea turtles.

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KEYWORDS
Sea turtles, marine debris, color, ingestion, preference,

BACKGROUND
Marine debris has become an increasingly significant problem in recent years, particularly with the advent of disposable plastics. In 1997, it was estimated that 6.4 million tons of debris entered the marine environment annually (UNEP 2005), and this number has certainly risen since then. With the increasing amount of debris in our oceans comes increasing impacts to wildlife. In Australia alone, at least 77 species are known to have been affected by marine debris, including 20 threatened and endangered species, and all six species of marine turtles (Ceccarelli 2009). Marine debris ingestion is a major concern for the long-term survival of sea turtles at all stages of their life cycle, leading to both lethal and sublethal effects (Bjorndal 1997). In order to reduce the impacts of ingested marine debris on sea turtle populations, we need to improve our understanding of the magnitude of the problem, as well as the ways in which turtles interact with debris. This study seeks to evaluate whether threatened species of sea turtles exhibit a preference for specific types and colors of plastic marine debris encountered at sea.

METHODOLOGY
Between 2005-2011, 115 necropsies were conducted on sea turtles that had been stranded in the Moreton Bay and Sunshine Coast areas of Southeast Queensland, Australia. Animals were either found dead on the beach, or died after being admitted to a rehab facility. Necropsies included a thorough investigation of gut contents for foreign materials. When anthropogenic materials were found, they were identified using a dissecting microscope, weighed, measured, and their color and buoyancy (positive, negative, or neutral) were recorded. Turtles were assigned to one of four different life stages, post-hatchling, new recruits, immature, or sexually mature, based on their curved carapace length and observations made during the necropsy.

A total of 25 beach rubbish surveys were conducted on four different beaches on N. Stradbroke Island, and four beaches on the Sunshine Coast between 2009-2011. All rubbish found between the edge of the water and the edge of the first dune was collected over a known distance, (usually 100m) and categorized. Plastics were also further categorized by color. Buoyancy was measured for all materials collected during 13 of the surveys.

OUTCOMES

A total of 36 turtles, or 31% were found to contain anthropogenic items within their gastrointestinal tract (GIT). Detailed rubbish observations are only available for 32 of the 36 turtles, so the following results reflect a total sample size of 32. The number of items found within each turtle ranged from 1-329, with an average of 33.2. The majority of the items found were soft plastics (35.2%), made up of a combination of film-like plastics (21.5%), plastic bags (7.8%), and other soft plastics (5.8%). Hard plastics trailed closely at 34.2%, followed by plastic rope, string, or twine (12.4%) (Fig 1).

The frequency distribution of rubbish type and plastic color found in the GIT of all turtles was compared to the distribution of items of rubbish found during all beach surveys. Chi squared analyses were performed on these data, which were found to be extremely statistically significant, with $P<0.0001$. This indicates that both the type of rubbish and the color of the plastics found are significantly different in the environment (beach surveys) as opposed to ingested by turtles, suggesting that turtles are selective about the type and color of rubbish that they ingest. It has been hypothesized that turtles ingest plastics because they resemble jellyfish (Mrosovsky et al. 2009). Jellyfish are generally either clear or opaque in colour, and soft in texture. Our study does indicate that turtles show a high preference for clear or opaque items, which make up 35% of the total rubbish ingested, as opposed to only 10% of rubbish found on the beach. Likewise, soft plastics make up 35.2% of ingested items, but only 6% of beach debris.

Green turtles, the most common species in our study (76%) are not exclusively gelatinovores. Pelagic juveniles are omnivorous, and the coastal-associated immature and reproductively mature turtles (benthic feeders) are generally herbivorous (Oliver et al. 2000). There are few studies of post-hatchling green turtle diet, but Boyle (2006) categorized the stomach contents of 47 individuals by taxonomic class. Without knowing the individual species ingested it is difficult to quantitatively characterize the color of these prey, but we can assume that many will be clear or opaque in color. In contrast, benthic feeders feed primarily on benthic algae and seagrasses. Forbes found that turtles at Heron Island, in the southern Great Barrier Reef, feed on species primarily from the phyla rhodophyta, chlorophyta, and phaeophyta (1993), which are green, red, or brown in color. Contrary to what we might expect if sea turtles "select" plastics from the environment based on their similarity to natural food sources, our data show that benthic feeders show a much stronger preference for clear/opaque rubbish (36.84%) than any other life stage, and indeed than any other color. The color most preferred by post-hatchlings was white, at 32.4%. (Fig 2). One possible interpretation of this result is that hatchlings are more opportunistic, while adults are more selective.

Green sea turtles have a visual system similar to that of humans, with three types of color receptors. Their main absorbance peak is at 520µm, with secondary peaks at 460 µm and 600 µm. They are, therefore, likely able to distinguish between the varying colors of rubbish (and food items) as categorized in this study, which would be critical if they are indeed "selecting" particular colors.

PRIORITY ACTIONS

Data from this study indicate that turtles do exhibit a preference for certain colors of marine debris. Further color and behavioral studies should be conducted to determine whether there is a corresponding avoidance of particular colors and types of debris.

FIGURES AND TABLES

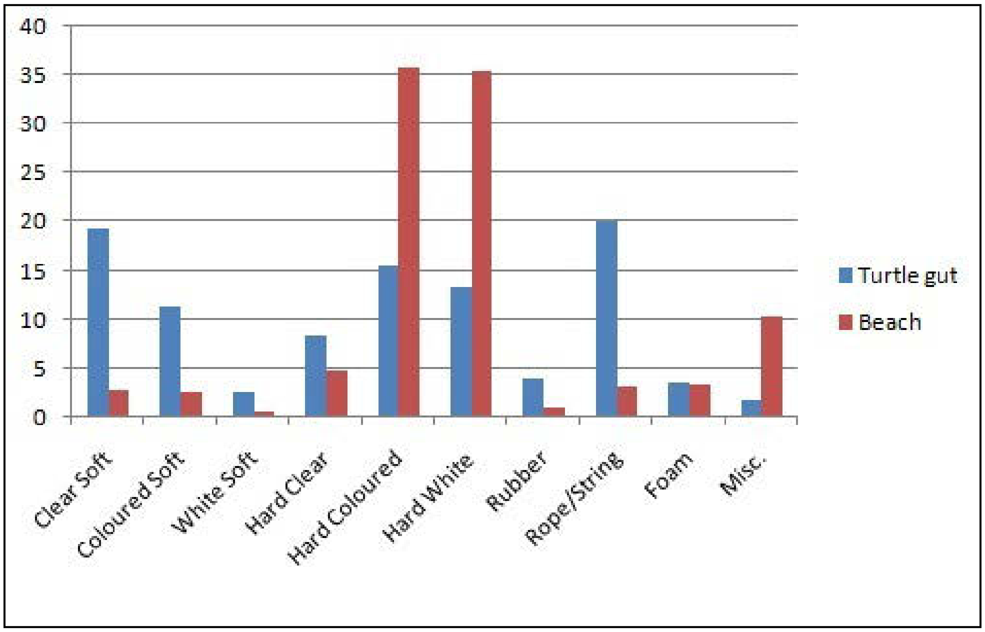

Fig 1. Proportion of total items of rubbish found in the gastrointestinal tract of turtles and on beach surveys.

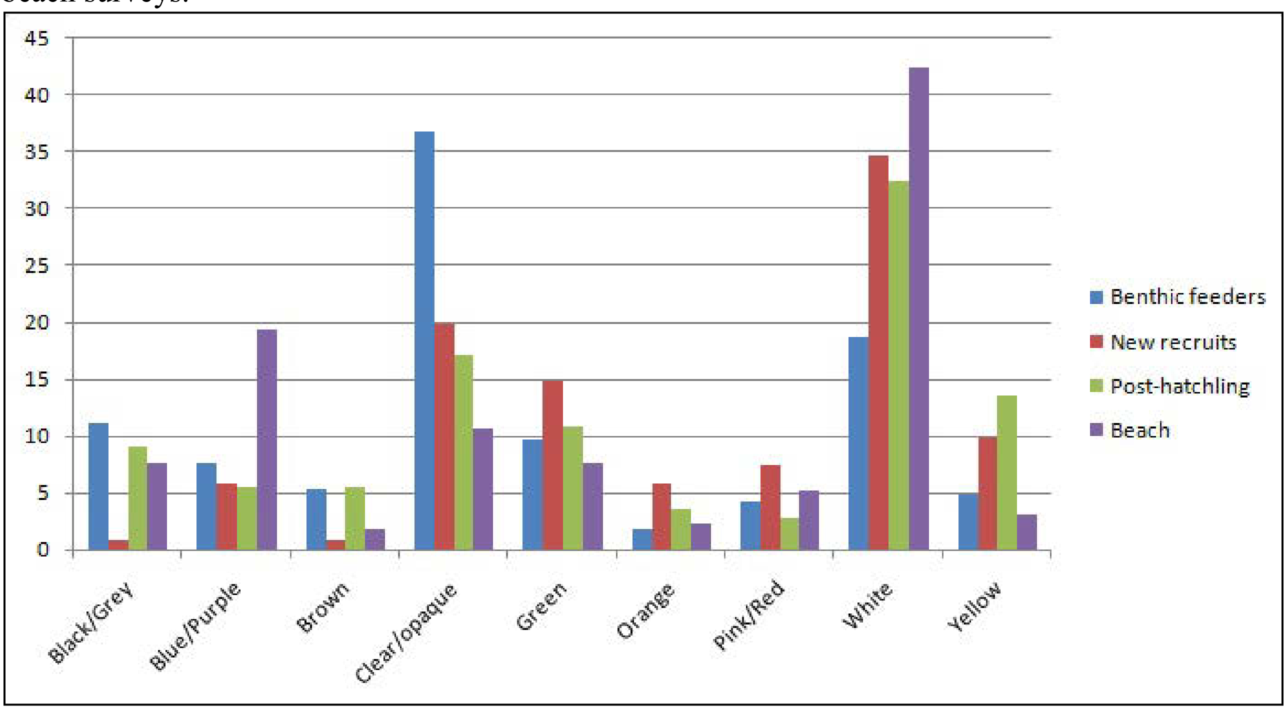

Fig 2. Proportions of colors of rubbish found in the gastrointestinal tract of turtles and on beach surveys.

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54. International Coastal Cleanup in Thailand

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ABSTRACT
The Department of Marine and Coastal Resources (DMCR) responsible for marine natural resource and coastal conservation. Even though we are the government sector, our policy is to establish local network and volunteer diving club in order to involve the user to help conservation and management. We recognize the impact of marine debris on marine lives, environment and people's livelihood. DMCR take the roll of Country Coordinator with Ocean Conservancy – International Coastal Cleanup since 2008 to expand the cleanup site to cover the area along the coast, build volunteer network, organize activities, raise public awareness and cooperate with other sector in tackle the marine debris problem.

In

55. Temporal and spatial distribution of marine debris on select beaches in the Gulf of Alaska over the last 20 years

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KEYWORDS
Alaska, MARPOL, Marine debris, Beaches, Fishing debris, Entanglement, Plastic bottles

BACKGROUND

Marine debris has long been recognized as a problem of international significance (Wolfe, 1987; Derraik, 2002). Plastics enter the sea from offshore (e.g., commercial shipping, fishing vessels) and onshore (e.g., sewer overflows, storms, litter) sources. Plastic debris adrift at sea can endanger marine life and when deposited onshore can mar the scenic quality of beaches and be hazardous to humans (e.g., medical waste). Marine mammals and seabirds can become entangled and drown in derelict fishing gear (e.g., trawl web, rope), and seabirds and sea turtles can mistakenly ingest plastic fragments as potential prey and block their digestive tracts (Carr, 1987; Laist, 1997; Robards et al., 1997; Derraik, 2002).

Marine debris washed ashore represent, to some degree, the types and quantities lost or discarded at sea as well as land. Therefore, beach surveys can provide information on the magnitude of the debris problem at sea, and may be the best method of evaluating the effectiveness of U.S. legislation implementing Annex V of the International Convention for the Prevention of Pollution from Ships (also known as MARPOL); the first international agreement to reduce the input of plastics and other garbage into the sea from ships and implemented in late 1988 (Ninaber, 1997). MARPOL was followed by a UN resolution banning high- seas drift-net fishing in December 1992. The success of these government actions in reducing marine pollution has been unclear. For example, in some post-MARPOL studies, Henderson (2001) found no reduction in the accumulation of marine debris in the Northwestern Hawaiian Islands, whereas Johnson (1994) reported a decrease in some types of plastic (e.g., trawl web) in the Gulf of Alaska. This study re-samples sites examined in the early 1980s in remote areas Alaska, and compares present day accumulations and composition of debris.

METHODOLOGY

The National Marine Fisheries Service sampled derelict fishing gear and other plastic debris on beaches in Alaska periodically from 1972 to1994 (Merrell, 1980, 1984; Johnson, 1989, 1990, 1995). Objectives of the present study were to resurvey some of the same beaches again in 2008 (Figure 1) in order to: 1) compare types and quantities of marine debris on beaches to earlier years (>10 years ago), 2) determine the pervasiveness of entanglement debris (e.g., trawl web), 3) compare abundance of marine debris from ship and land-based sources, and 4) evaluate the long-term effectiveness of MARPOL/UN resolutions.

Surveys were conducted in the intertidal zone up to the storm berm, where most water- borne marine debris accumulates. This does bias the survey, however, by undercounting marine debris (e.g., plastic bottles) which may be driven by wind into the terrestrial zone. Temporal and spatial comparisons were made by calculating the average number of marine debris items in each category found per km of shoreline at each location. Due to varying effort employed in different years, not all comparisons were valid across all years (Table 1). Composition and abundance of marine debris on all beach segments sampled prior to 1991 were combined and compared to the 2008 survey data. Statistical significance was calculated using a one-tailed t-test or a permutation test (Efron and Tibshirani, 1998) where appropriate.

OUTCOMES
There was an overall increase (not significant) in abundance of marine debris from pre- to post-MARPOL survey years (+46 items per km of shoreline, Figure 2). Composition of debris changed considerably over the 20 year period, however, with a decrease in ship-based debris (nets) and increase in land-based debris (bottles) (Figure 2).

The most prevalent marine debris category found was plastic bottles with overall abundance significantly increasing from pre-MARPOL levels by over 100 bottles per km of shoreline. This increase was not significant at each of the individual locations, however, due to the high dispersion of plastic bottles by wind and currents. Although the post-MARPOL survey did not enumerate the terrestrial deposition of marine debris, it was visibly noticeable.

Yakutat beaches had an overall increase in abundance of marine debris. Yakutat sites are near a settlement and are frequently used for recreation. The increase in personal items at Kruzof Island is also likely due to the recreational popularity of this location. Thus, land-based sources of debris are increasing the contribution of marine debris, particularly in areas near population centers.

PRIORITY ACTIONS
Governmental action aimed at reducing pollution at sea appears to have been effective in addressing ship-based marine debris sources, but not land-based sources. Future surveys (every 5 years) should be conducted to extend this 20 year data set to detect both changes in quantity and in composition of marine debris.

FIGURES AND TABLES

Table 1. Beach segments at each location used for temporal comparisons.

	Beach Segment								
Location	Survey Year	1	2	3	4	5	6	7	8
Kayak	1988	A	E	E	E	E	E	E	N
Kayak	1991	A	E	E	E	E	E	E	N
Kayak	2008	A	A	A	A	A	A	A	N
Middleton	1985	A	I	I	A	A	A	N	N
Middleton	1987	A	I	I	A	A	A	N	N
Middleton	1989	A	I	I	A	A	A	N	N
Middleton	2008	A	A	A	A	A	A	N	N
Sea Lion cove	1984	A	N	N	N	N	N	N	N
Sea Lion cove	1986	T	N	N	N	N	N	N	N
Sea Lion cove	2008	A	N	N	N	N	N	N	N
Yakutat	1984	A	A	A	A	A	I	I	I
Yakutat	1985	A	A	A	A	A	I	I	I
Yakutat	1988	A	A	A	A	A	I	I	I
Yakutat	2008	A	A	A	A	A	A	A	A

Legend:
A - Surveyed for All marine debris.
E - Surveyed for Entanglements only.
T - Surveyed for Trawl web only.
N - Not applicable for the location.
I – Incompatible survey methodology.

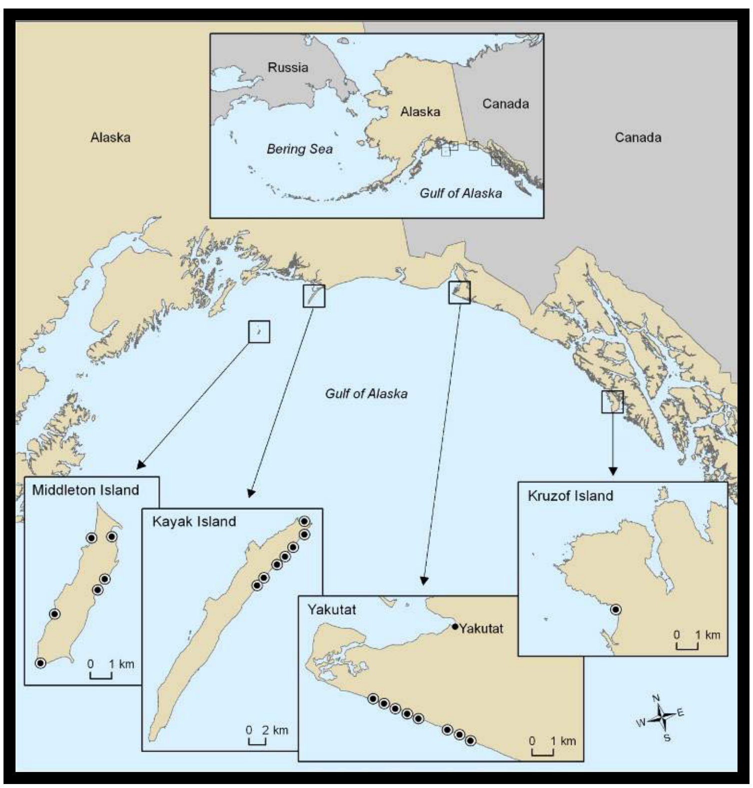

Figure 1. Map of the eastern Gulf of Alaska showing locations of survey sites.

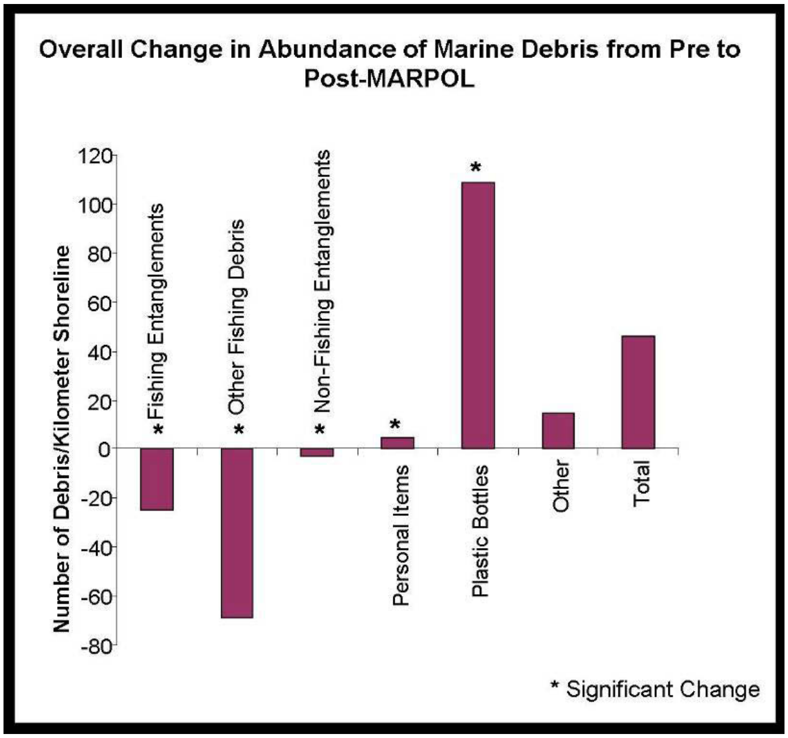

Figure 2. Overall change in abundance of marine debris found on survey beaches from pre- to post-MARPOL years.

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56. Assessment of solid waste pollution on the Slovenian coastline

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KEYWORDS
coastal monitoring, solid wastes, plastic, Slovenia, pollution

BACKGROUND

Slovenia is a European country with 46.7 kilometers long shore in the Mediterranean Sea, northern Adriatic (Figure 1). Port industry, intensive tourism and the biggest net migration in the country (Primorska region) present a great threat to marine life by being exposed to various marine debris. Till 2007 no scientific study of pollution of the Slovenian coast with marine debris was made nor the action plan to reduce pollution.

With research on coastal marine debris between may and september 2007 we evaluated quantity, quality and sources of the solid wastes on three different locations on Slovenian coast. This was the first ever done evaluation of pollution of Slovenian coast with marine debris. Clean Coast Index method was used, developed by Ministry of the Environment in Israel.

METHODOLOGY

For convenience and statistical reason we used beach survey as a method to evaluate marine debris on Slovenian coast. Adapted Clean Coast Index (CCI) method was adapted to get information regarding the level of cleanliness on three unauthorized beaches in Slovenia, each characterized by same coastal conditions (sandy/gravelled, narrow/wide, open/bordered by cliffs, etc.). One unit of our conduct had the same surface – 150 m2, like the ones in Israel. We collected all anthropogenic debris larger than 2 cm and used plastic particles to calculate the Index.

Calculation of CCI:

$$\frac{Z}{n \times \text{segment length} \times \text{coast width}} = \text{No. of plastic debris} / m^2$$

Z – No. of plastic debris in transect in total
n – No. of segments in one transect (n=3)
segment length [m] = 50 m

OUTCOMES

A total of 16,414 solid waste items of different material weighing 76,079 g were recovered from the 1,350 m of sampled beaches. The most abundant were cigarette butts (2,823 pieces). In terms of numbers of items per m2, plastic debris predominated with 81%.

The most polluted month was May. We concluded that this is due to inefficient initial beaches clean up carried out in April. 43% of all debris originate from land-based sources according to our research. The index was calculated from the formula for every transect. In comparison with the Israeli results, Slovenia has much higher index values. While in Israel the values hardly exceed the figure 5, one of the indexes in Slovenia reached even the value of 143.8!

PRIORITY ACTIONS

The main goal was to determine State of the Art of pollution with marine debris on Slovenian coast and set platform for subsequent monitoring actions and plans for the future.

FIGURES AND TABLES

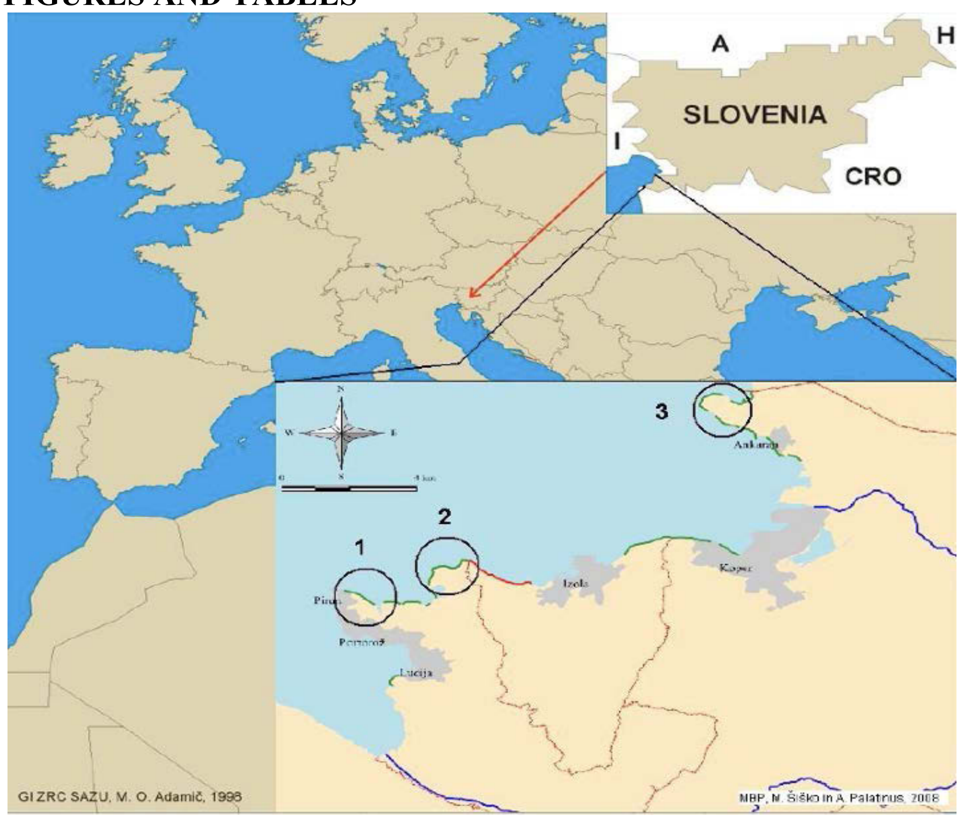

Figure 1: Location of Slovenia and studied beach areas

57. Anthropogenic debris on beaches in the Rio de Janeiro/SE Brazil

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ABSTRACT
Data on beach debris contamination is provided for 6 pocket beaches in Rio de Janeiro and Niterói municipalities SE – Brazil. Debris in the marine environment is usually litter associated with human activities, and is increasingly being recognized as an international pollution problem. In Brazil this environmental problem has increased considerably in the last decades. The aim of the present study were to determine the types and amounts of debris on the beaches in all the seasons along the year, in order to identify the sources (land or marine-based) of the debris, and to relate litter deposition to relative beach usage. The survey was conducted on six beaches, three in Rio de Janeiro (Ipanema, Leblon and Copacabana) and three in Niterói (Piratininga, Camboinhas and Itaipu). The beaches were chosen because it popularity as a tourist resort, and represents an area with high beach usage. A twelve month field investigation documents differences in the beach accumulation and composition of debris, popular tourist beaches, such as Copacabana and Ipanema, in Rio de Janeiro, and Piratininga and Itaipu, in Niterói, had the widest range of litter types. Temporal differences in the accumulation, and also all type of sources, mainly beach users debris, but also land and marine-based debris. Plastic comprised 62.3% (all types of plastic itens), glass 13.5%, paper 9.10%, fishing material 2.9%, modified wood 2.5%, expanded polystyrene and 2.0%, fabrics 1.8%, construction material 1.8%, footwear 1.5%, cans 1.3%, light bulbs 1.0%, of the 2371 pieces of debris that were collected. Debris was primarily consumer and household related items, and the greatest quantities of debris were found during beach user months, which also represent the rainy season. It was possible to observe that the majority of the beaches littler were related with the beach users; however, at least 40% of the littler were marine-based debris, probably from Guanabara Bay, a polluted coastal bay located nearby.

58. Trends in beach debris on Hawai'i 2000-2007

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ABSTRACT
Conducting surveys to monitor marine debris that collects along beaches is an established technique for evaluating the status of the debris, not just on those beaches, but also as an index of conditions in surrounding waters. The National Marine Debris Monitoring Program was designed to determine quantitatively if the amount of debris on the U.S. coastline was changing and what were its major sources. Hawai'i was one geographic region of that study. Following the design intent of the Program, our objective is to use Program data to determine whether there were trends in marine debris indicator items found on Hawaiian beaches from 2000 through 2007. The protocol was to measure the net accumulation of indicator items on a site's 500m stretch of beach every 28 days. Indicator items provided a standardized set that all surveys would collect; each item was assigned a probable source: ocean-based (e.g., nets, fish baskets, light sticks), land-based (e.g., metal beverage cans, straws, syringes), or general-source (e.g., plastic bottles and bags). Volunteer teams conducted all data collection for the monitoring program. Quality assurance procedures assured accuracy of debris identification, accuracy of recording information and counts on the data cards, and determination of missed/overlooked debris items. We analyzed 372 surveys from 5 sites on Oahu, Hawai'i. Overall, there was an average of 134 items found per survey (SE = 40). Debris composition, on average, was 29% land-based items, 33% general-source items, and 38% ocean-based items. Overall, total indicator debris, as well as land-based, general-source, and ocean-based indicators, declined over the 7 years. Ocean-based indicators declined 75% (2001 average = 94 items/survey compared to 2006 average of 25 items/survey), land-based debris declined 50% (2001 average = 32 items/survey compared to 2006 average of 16 items/survey), and general-source items declined 25% (2001 average = 37 items/survey compared to 2006 average of 28 items/survey). ENSO-events did not increase debris deposition as found in other studies; however, LNSO events decreased deposition for land-based and ocean-based debris. Less ocean-based debris was found April-September. The information from this program has established a baseline against which future changes can be measured.

59. Impact of marine litter in the northern part of Gulf of Mannar, Southeast coast of India

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KEYWORDS
Gulf of Mannar; Marine litter; coral reef; seagrass ecosystems; Southwest monsoon

ABSTRACT
Marine litter has become one of the problematic concerns in the Gulf of Mannar. This study was aimed to survey and evaluate the composition, abundance, distribution and quantification of the types, amount, sources and impact of marine litter on the beach of the Gulf of Mannar region. This is first of its kind in India especially in the Gulf of Mannar. Quantification, source and impact of marine litter in the Gulf of Mannar, India were surveyed from March 2006 to February 2008. Maximum shoreline marine litter was noticed in May and June 2007 and the minimum was noticed in Feb 2008. Occurrence of Shoreline marine litter during the Southwest monsoon period was the maximum and the Cool winter period was the minimum. The maximum shoreline marine litter was 94 - 95 items of 5,409 - 6,588g, and the minimum shoreline marine litter was 42 items of 2,088g. 80 % of the total litter included only three major items, viz., Plastic (48 %), polystyrene (18%) and cloth (15%). Fishing represented the largest source, Tourism/recreation was the second and Sewage Related Debris (SRD) was the third common source of marine litter. Stranded marine animals and impact on the ecosystems of coral reef, seagrass were also observed. Study findings revealed the factors such as proximity of a given beach to a population center, pilgrim and Southwest monsoon wind which most dominantly affect the litter distribution in the Northern Gulf of Mannar coastline.

60. Analysis of solid wastes in the Estuary of Santos and Sao Vicentes, Baixada Santista, SP, Brazil

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KEYWORDS
Pollution, Marine Debris, Estuary, Mangrove, Santos, São Vicente, Plastic.

BACKGROUND
Solid wastes are wastes in solid or semi-solid condition that results from the activity, which can be domestic, industrial, medical, commercial, agricultural or services (ROCHA, 2009). The disposal of solid waste is a global threat, mainly due to the persistence time of its components, particularly plastics (ROSSO and CIRILO, 2002). The cities of Santos and São Vicente are located within the complex of Baixada Santista, the central coast of São Paulo, an area characterized by intense human activity, including the largest port that export and import in Latina America and the industrial hub of Cubatão. The intense anthropogenic activity and the large population density means that this area is under great environmental impact, where the solid waste is a great concern, being produced daily in the cities of Santos and São Vicente approximately 443.9 tons of waste (CETESB, 2005). Currently floating solid waste are major sources of environmental degradation impacting not only scenic, but caused damage, injuries and even death of the biota (ARAÚJO and COSTA, 2002). Study to assess this issue are of great importance for making decisions about the proper disposal of such waste.

METHODOLOGY
For the study of solid waste floating in the estuary of Santos and São Vicente, Baixada Santista, SP, two methods were used for quantification and qualification of waste: notice board and analysis quadrants.

The observation method was carried out onboard the estuary of São Vicente (23 ° 58'19, 2 "S 46 ° 24'52, 1" W - 23 ° 56'12, 2 "S 46 ° 25'55" W) consisted of observation, classification and quantification of solid waste with the boat in motion by two observers at the bow of the vessel. The residues found were classified into five categories (Tetra Pak, Plastic Bottle, Plastic, Styrofoam and Other) and then calculated the index of relative abundance, from the number of each category of waste and observer effort in minutes (52 minutes observation).

The second method was the analysis of quadrants, adapted from Cordeiro (2006), which was used in the mangroves of São Manoel, continental area of Santos, site of major solid waste disposal. Volunteers were responsible for the action of removing waste in the mangrove, without the use of methodology and another group was responsible for waste removal in the quadrants. The totals were realized 4 quadrants of 9 m² (3m x 3m) which removed all items of this area, except for large timber. The residues were placed in plastic bags, divided into categories and weighed with the balance in the local. The category plastic was divided into subcategories: plastic food and non-food; which were conducted at the laboratory for further analysis. The results from all quadrants were analyzed by calculating the relative density per quadrant and total density.

OUTCOMES

The analysis of solid waste by means of observation on board of São Vicente had a higher relative abundance for plastic (4.96 items/minute), then the category called 'others' (0.51 items/minute), which composes of timber and tires (Fig.1). The plastic appears as the main debris found on beaches (FROST and CULLEN, 1997).

The results obtained by the volunteers at the Mangrove of São Manuel, Santos indicated that the plastics and shoes are the categories that have the biggest weight sampled (Fig.2).

The analysis method of quadrant of the wastes showed high relative density value to the item timber, which was not collected by the volunteers, just estimated, followed by plastics (food and non-food) and shoes (Table 1). The total relative density found in this study (9.4 kg/m²) was much higher than that found by Cordeiro (2006), which studied an area of mangrove in the estuary of São Vicente. This high value found in this study could be related to the presence of many construction timber in São Manoel.

The analysis of the subcategories plastic food and non food in the laboratory revealed that in the subcategories non-food the items 'plastic bag not identified' was the most abundant, followed by 'plastic bag of supermarket'. However, in the subcategories food, the items Tetra Pak and **'**packages of biscuits, bread and pasta' (Plastic Food) was the most abundant. Plastic bags were the items of greatest abundance in other studies in coastal areas (CORDEIRO, 2006).

PRIORITY ACTIONS

Through this analysis of pollution from solid waste floating, one important thing observed was that were have a greater number of timber, this coincides with the presence of stilts in the local. Followed by this, plastic is found as the major pollutant of São Vincent and the in the mangrove of São Manoel.

It is easy to see that items with no commercial value in the market for recycle are noted with plenty more frequency. And according to research done for the items with a (greater emphasis on its) commercial value is almost 100% recycled, to obtain income of scavengers. To reduce waste and encourage recycling in all kinds of materials to a minor degradation of the environment, it is necessary joint actions of awareness programs, environmental monitoring, government and society, therefore, is not a worsening situation.

FIGURES AND TABLES

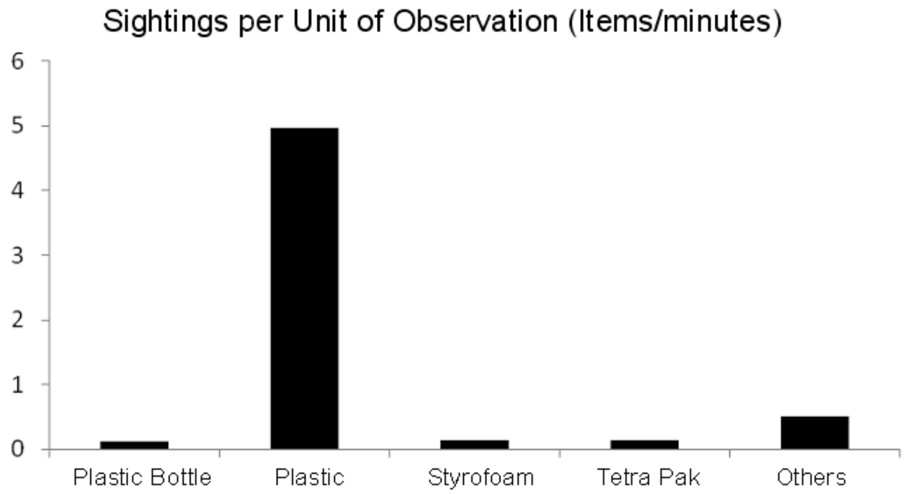

Fig.1 – Sightings per unit of observation (items/minutes) in the channel of São Vicente

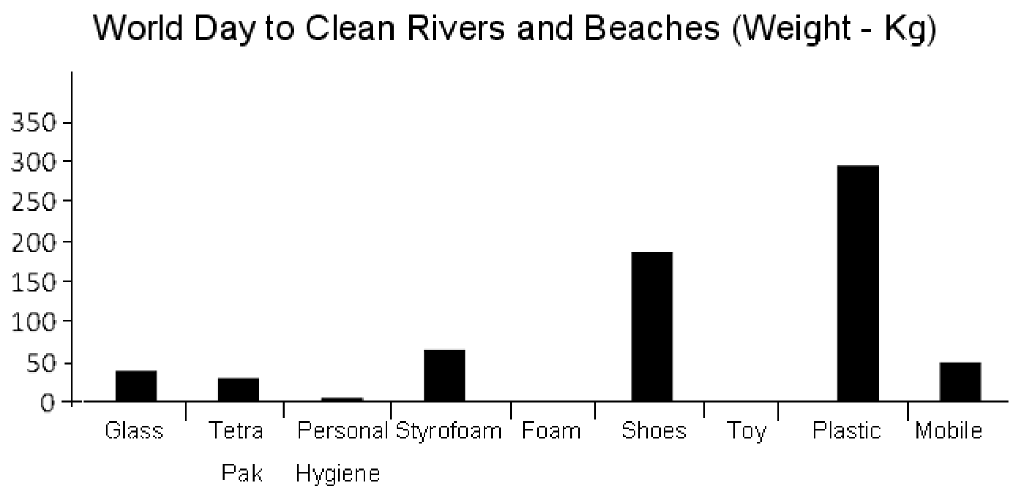

Fig.2 – Results of the solid wastes of the World day to clean rivers and beaches (weight – kg)

Table 1 – Results from the quadrants of the mangrove in São Manoel, with its density.

Items	*Q1(kg/m²)*	*Q2(kg/m²)*	*Q3(kg/m²)*	*Q4(kg/m²)*	*Total*
Vulcanized rubber	0,022	0,056	0,000	0,000	0,019
Tetra Pak	0,111	0,000	0,111	0,022	0,061
Personal Hygiene	0,111	0,167	0,444	0,222	0,236
Styrofoam	0,167	0,222	0,056	0,222	0,167
Timber	4,444	10,222	7,778	1,111	5,889
Shoes	0,556	0,278	0,444	0,222	1,000
Foam	0,111	0,278	0,056	0,000	0,111
Glass	0,111	0,100	0,056	0,233	0,125
Plastic Food	0,167	0,389	0,500	0,222	0,319
Plastic Non-food	1,667	1,278	1,611	1,000	1,389
Toy	0,111	0,011	0,011	0,022	0,039
Others	0,000	0,000	0,000	0,167	0,042

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61. Floating marine debris in Guanabara Bay – Rio De Janeiro/Se Brazil

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ABSTRACT
Guanabara Bay is considered to be one of the most polluted environments of the southern Brazilian coastline. This typical estuarine system is impacted by the heavy discharge of both industrial and domestic untreated waste from the Rio de Janeiro metropolitan area. This bay has experienced several impacts by heavy metal contamination, oil spill and untreated sewage contamination, one of the main concerns nowadays is the amount of debris pollution in it beaches and also the floating marine debris, due to their longevity cause multiple negative impacts on wildlife and environment. The aim of this work was to investigate the composition, distribution and size of floating marine debris in Guanabara Bay. Data have been collected during three days oceanographic cruises, during the summer of 2009. The reason for the time of the year (summer) was that in this period the area are affect by heavy rain which increases considerably the rivers discharge and also the human recreation in the bay. The tide current appear to have strong influence in the distribution of floating marine debris in Guanabara Bay, where normally the edge of the current was the place with great amount of debris, which was composed mainly by plastic bags (73%), plastic fragments (with all sizes) (8%), styrofoam (expanded polystyrene) (7%), paper (5%), modified wood (4%) footwear (3%). The majority of floating debris appears to have it origin in the land-base, only the styrofoam, which is intensively used as floatation device by fisherman, could have it origin in the marine base activities. The result also indicated that majority of large floating debris were recorded mainly in the inner part of the bay, while the great amount of small pieces of debris and the plastic bags tend to be more easy to find in the entrance of the bay.

62. Study on composition and amount of marine litter in coral reef areas

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KEYWORDS
Marine litter, Coral reef, Cleanup dive, ICC

ABSTRACT
Composition and amount of submerged marine litter at 11 stations within coral reef areas have been studied. The litter was collected in cleanup voluntary campaigns by Department of Marine and Coastal Resources. International Coastal Cleanup (ICC) data card was used to recorded litter data. A total of 1,768 items weighing 2,246 kg were collected during survey, with an average of 177 items and 187 kg per station. Fishing net was the most abundant by weight and accounted for 41% followed by glass bottle 39% and fishing rope 7%, respectively. However, by piece, glass bottle 25% accounted for the most collected item followed by fishing net 15% and beverage can 9%. Compositions of marine litter were different between stations offshore (Koh Kra, Koh Ma and Koh Talu) and stations near shore/near tourism area (Koh Lan, Koh Tao and Sapantawan). Beverage can, fishing net and fishing rope were the indicating factors. Generally, this study showed that ICC data card can help indicate origin of marine litter, however the form has to be adjusted in order to get better interpretation to Thailand's marine litter.

63. Composition of marine debris in Nigerian coastal waters.

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KEYWORDS
Nigeria, Coastal water, Marine debris, trawls, biological species, environmental impact, ecosystem, improper disposal, waste

BACKGROUND
Improper disposal of industrial and domestic wastes in our coastal waters with the resulting marine debris has a significant environmental impact on the biotic and abiotic components of the ecosystem.

Incidence of marine debris in trawl haul made off the coastal waters of Nigeria was investigated. Association of marine debris with biological species was analysed to show the extent of marine debris in the coastal waters of Nigeria. Living resources survey of the Nigerian Coastal waters was carried out between the 17th of May and 6th of June 2009 on board the MV Suzannah, by the Nigerian Institute for Oceanography and Marine Research, Lagos.

METHODOLOGY
A GPS was used to map out sampling points (21) and on board echo sounder was used to determine sampling depth. A trawl net was deployed and trawled for 30 minutes at each sampling point/transect. The fish caught were sorted out, weighed together, labeled and frozen. Marine debris was sorted out and also weighed. The fish was later identified to species level in the laboratory using the key provided by Schneider (1990).

OUTCOMES
Twenty one stations were sampled and over fifty biological species were caught in trawls, the highest number of species was caught in station B3 with a value of (43) and 26kg/hr of marine debris was recorded at this station while the lowest species number (18) was recorded in station E7 with 1kg/hr of solid waste. The highest weight of solid waste (marine debris) was recorded in station B1 with a value of 225kg/hr against weight of biological species which was 121.4kg. The most common species of fin and shell fish include; *Acacthurus monorovia* , *Caranx hippos*, Jelly fish, *Penaeus monodon*, Hermit crab, *Pseudotolithus typus* , *Chloroscombrus chrysurus*, *Ephinephelus aeneus*, *Grammoplites gruveli*, *Michochirus frechkopi*, *Brachydeuterus auritus*, *Antennarius spp*, and *Pseudotolithus senegalensis*.

PRIORITY ACTIONS

The quantity of marine debris is impacting negatively on fishing. Education and awareness should be created about the danger posed by marine debris. There should be communication on the proper disposal of solid waste. Periodic clean up campaigns should be carried out.

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64. Welcome to the beach of the future: the physical properties of plastic sediment

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KEYWORDS
Microplastic, Plastic Fragments, Beach Sediment, Permeability, Porosity, Heat Transfer

BACKGROUND
Beach cleanup operations can be effective in removing large plastic items from shorelines, but seldom remove micro- and meso-plastic fragments due to the extreme effort it would require. As these plastic sediments accumulate in the world’s beaches, how do they affect the physical properties of the beach? More specifically, how do they affect how water and heat move through the beach? How might these changes affect beach-dwelling organisms?

METHODOLOGY
We collected 5-cm-diameter cores from randomly placed transects on a heavily-impacted and a “control” beach on the southern portion of the island of Hawai‘i (n=15 cores for each beach). The impacted beach, Kamilo, is famous for the accumulation of plastic debris, and contains conspicuous plastic fragments despite intensive beach cleanup operations. The “control” beach, Waikapuna, was chosen because it is nearby, appeared to have similar sediment characteristics, but does not apparently receive significant amounts of plastic debris. Both beaches feature a mix of dark, basaltic sediments and white, calcium carbonate sediments.

The permeability of saturated cores was measured by timing the passage of standardized volumes of water at a constant head. The porosity of the cores was measured in 5 cm sections by saturating, weighing, completely drying and re-weighing each section. Plastics fragments were then floated from the sediments using a high-density salt solution (1.2 g/cm^2 NaCl) and then both plastic sediments and natural sediments were dried and sieved to measure grain-size distribution by weight. Plastic fragments were subsampled by core, depth, and fragment size class and then analyzed for composition using Fourier Transform Infrared Spectroscopy (FT-IR).

Because the grain size distributions of the impacted and control beaches were significantly different, we constructed artificial cores to eliminate the effect of varying grain size on our response variables. Artificial cores were constructed using 600 g of Kamilo Beach sediments and plastic fragments, used the average grain size distribution for Kamilo Beach throughout, and included varying concentrations of plastic fragments, including control (0% plastic by weight), Kamilo average (1.5%), “middle ground” (7.3%), maximum observed at Kamilo (15.9%), and “extreme” (29.4%). The vertical distribution of plastic in the artificial cores also mimicked the beach cores, with about 50% of the fragments in the top 5 cm. Plastic fragments were added with the same average size distribution as observed in the beach cores.

To measure the thermal conductivity and heat capacity, the artificial sediment cores were placed in Styrofoam cylinders with temperature data loggers at the bottom and set beneath heat lamps for 4 hours. They were then subjected to constant-head permeability measurements to determine the effect of the plastic fragments on water transfer through beaches.

OUTCOMES

The top 5 cm of Kamilo Beach averaged 3.3% plastic by weight, with a maximum observed value of 30.2%. Although plastic fragments were encountered in the deepest sections (20-25 cm), over half of the total plastic was located in the top 5 cm, and nearly 95% was found in the top 15 cm. Parallel to the shoreline, the abundance of plastic fragments was patchy. Waikapuna Beach, the "control", had an average of 0.1% plastic in its top 5 cm, with a maximum observed value of 0.8%. Of 248 plastic fragments and pellets analyzed using FT-IR, 85% were polyethylene, 14% were polypropylene, and 1% were polystyrene or polyurethane.

Kamilo Beach cores (123 $\pm$ 83 meters/day) were significantly more permeable than Waikapuna cores (40 $\pm$ 20 m/d) (t-test, $p<0.0001$). Since Kamilo's sediments were significantly coarser-grained than Waikapuna's (two-sample Kolgomorov-Smirnov test $p<0.0001$), we were unable to attribute this difference to plastic concentrations alone. Grain size did not impact the porosity of sediments, which did not significantly differ between beaches or depths.

Artificially-constructed cores that mimicked the average grain-size distribution of Kamilo Beach but contained varying percentages of plastic demonstrated that these fragments change the permeability and heat transfer properties of sediments. Permeability in control cores averaged 152 $\pm$ 9 m/d, and increased with increasing plastic composition up to 294 $\pm$ 52 m/d (Figure 1), significantly so in the two treatments with the highest plastic load (ANOVA, $p = 0.002$). Increasing plastic in the cores also insulated the subsurface environment against increasing temperatures. Sediments with plastics warmed more slowly, with as much as a 48% decrease in thermal conductivity, and reached lower maximum temperatures, with as much as a 41% decrease in heat capacity (Figure 2).

As small plastic pellets and fragments accumulate on the world's beaches, beach organisms may experience increased desiccation underneath patchily-distributed plastic loads due to increased permeability of the sediments. It is also possible that the insulating properties of these same fragments will reduce evaporation, balancing this effect. Reduced subsurface temperatures could also have effects on organisms with temperature-dependent sex-determination such as sea turtles. Buried eggs underneath high plastic fragment loads have the potential to hatch lower numbers of females, reducing the overall population growth rate.

PRIORITY ACTIONS
Beyond the already established effects of ingestion, chemical leaching, and pollutant adsorption of plastic pellets and fragments, they may also change the physical properties of beaches they contaminate by increasing permeability and lowering subsurface temperatures. Although extremely labor-intensive, removal of plastic pellets and fragments during beach clean-ups could alleviate these physical effects.

FIGURES

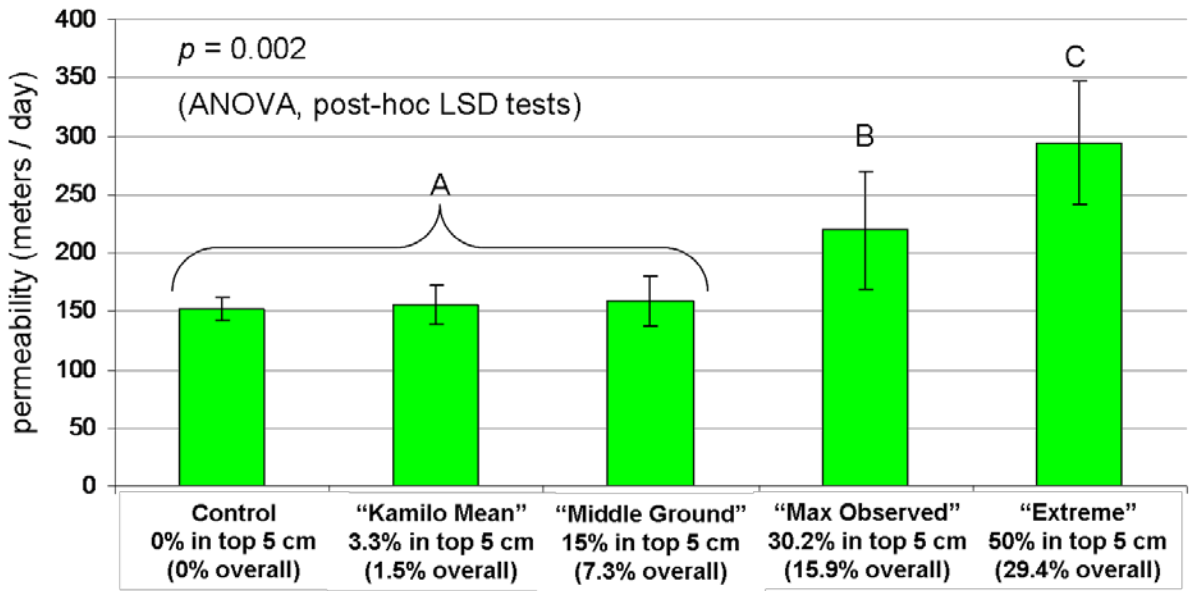

Figure 1: Constant-head permeability of artificially constructed sediment cores with standardized grain-size distribution and varying plastic fragment composition (by weight). All core construction materials were taken from Kamilo Beach, HI, and grain-size and plastic fragment distribution with depth were set to mimic average Kamilo Beach conditions. Three replicate cores were constructed for each treatment.

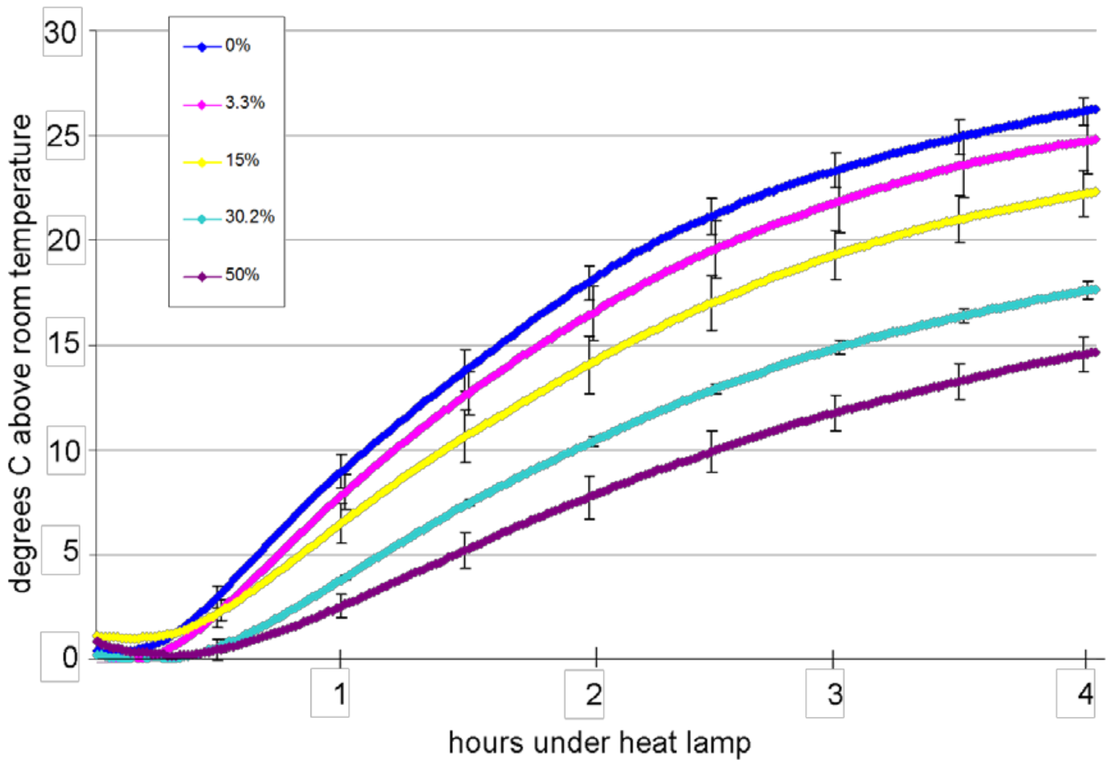

Figure 2: Insulating properties of plastic in artificially constructed sediment cores with standardized grain-size distribution and varying plastic fragment composition (by weight). All core construction materials were taken from Kamilo Beach, HI, and grain-size and plastic fragment distribution with depth were set to mimic average Kamilo Beach conditions. Three replicate cores were constructed for each treatment. Treatment levels are described in Figure 1. Cores were placed in Styrofoam cylinders with temperature loggers at the bottom and heated with a heat lamp for four hours. Temperatures within cores were standardized by a separate logger to account for variations in laboratory temperature during trials.

64.a. Ingestion of microplastics by common cockles (*Cerastoderma edule*) in an intertidal mud flat

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KEYWORDS
microplastics, in-situ, exposure experiment, method, cerastoderma

BACKGROUND
Microplastic particles arising from the degradation of large plastic debris or directly introduced into the environment are widespread in marine habitats (Colton *et al.* 1974, Gregory 1996, Thompson *et al.* 2004) and have raised concerns about potential threats to marine organisms. Microplastic particles may be ingested, and their physical presence may affect invertebrates in a similar way to that shown for large debris affecting e.g. birds (Ryan 1988, van Franeker *et al.* 2005). Plastic particles have also been shown to absorb persistent organic pollutants from water (Mato *et al.* 2001, Teuten *et al.* 2007), which could be transferred to organisms as a consequence of ingestion. Laboratory experiments on the blue mussel (*Mytilus edulis*) have shown that microplastic particles are ingested and remained in the organism for in excess of 48 days (Browne *et al.* 2008). However, experiments in the field are also important in order to establish the full extent of any biological response (Underwood 1995). Both field and laboratory studies of microplastics rely upon identifying plastic particles ingested and potentially translocated within the study organisms' tissues, therefore advances in techniques to assist in quantification of these processes are of considerable interest.

The aims of this study were therefore to determine the practicality of using fluorescent plastic tracers to monitor ingestion and uptake of microplastic particles in-situ and to identify a model system that is suitable for monitoring the effects of microplastics on organisms in-situ that could be used to complement the findings of laboratory experiments such as Browne *et al.* (2008).

METHODOLOGY
The common cockle (*Cerastoderma edule*) is a suspension-feeding sediment dweller and is common in temperate waters in the North-West Atlantic Ocean (FAO, 2011). Cockles have a large capacity to ingest particles 60 to 500 µm in size (Karlsson *et al.* 2003). They therefore represent a potential model organism for in-situ experiments into ingestion and translocation of microplastic particles.

Twenty cockles were exposed to 'Luminophore' polyamide powder in each of 4 quadrats in fine sediment and 4 quadrats in coarse sediment in an intertidal mudflat following a method previously used by Montserrat *et al.* (2009). The Luminophore particles were applied as a mixture in proportions that reflected the natural sediment (Table 1 and 2). After two weeks the animals were recovered and the stomachs were extracted, dehydrated and preserved in paraffin block. They were then cut into 10 µm thick sections using a microtome. The sections were examined using a fluorescence microscope, and luminophore particles were enumerated.

OUTCOMES

To date it has only been possible to make a preliminary examination of four animals. Scaling up from the 385 sections examined so far it would appear that each individual contained several hundred Luminophore particles. Retained Luminophore particles were often detected within the stomach tissue rather than the lumen (Fig. 1). From the initial Luminophore particle concentration and the particle intake rate observed by Karlsson *et al.* (2003) the retention rate of ingested Luminophore particles was less than 1 %.

Fluorescent particles can be traced in cockles' stomachs after 14 days exposure.This system provides a possible method to address ingestion and uptake of microplastic particles in the field.

PRIORITY ACTIONS

The findings of this study give further evidence that organisms at a low trophic level can ingest microplastic particles. It is therefore important to quantify the biological effects on organisms that ingest microplastic particles and to look at transfer between trophic levels.

FIGURES AND TABLES

Table 2: Proportion of both Luminophore particle size fractions (head indicates median size) added to the natural sediment.

Size µm	**> 1000**	**> 500**	**> 250**	**> 63**	**< 63**
Coarse	20%	24%	25%	12%	19%
Fine	6%	5%	10%	20%	58%

Table 1: Natural sediment composition.

Sediment type	**Luminophore**	
	129 µm	**41 µm**
Coarse	4.30%	6.40%
Fine	3.40%	10.30%

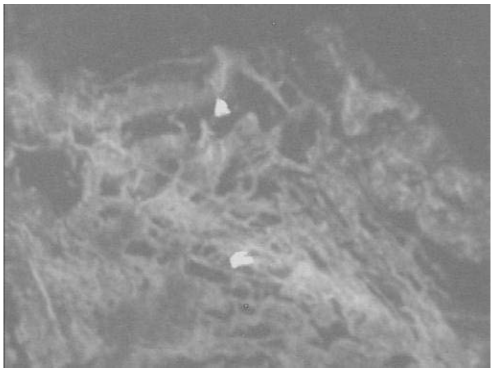
Fig 1: Luminophore particles in stomach section.

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65. Marine Debris Information Clearinghouse – a tool for collaboration and coordination

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KEYWORDS
Database, Discovery, Spatial, Mapping, Database, Information Sharing, Clearinghouse, Debris Types, Techniques

BACKGROUND
While the issue of marine debris has gained recent attention across the general public, there is a significant history of work on the topic. Through this work, there exists a large base of information on marine debris that was gathered through both research and removal activities. However, much of this information is not readily accessible or well known. This gap has been verified by input from partners across the marine debris community and was a key consideration of the Marine Debris Research, Prevention and Reduction Act which created the NOAA Marine Debris Program. Through this Act, the Marine Debris Program was mandated to develop, deploy and maintain a federal information clearinghouse on marine debris. This product, now under development, will serve as a point of access for information on marine debris projects, techniques, and best practices.

METHODOLOGY
The Federal Information Clearinghouse on marine debris (FICHMD) will be an online database system, accessible through the internet by the general public. The site will be developed through partnerships within NOAA integrating advanced data validation and visualization capabilities.

OUTCOMES
Through the Clearinghouse, users will be able to:

- Discover marine debris efforts by multiple variables including debris type, location and method.
- Locate and integrate best practices for marine debris projects.
- Share and request information from other people active on the issue of marine debris.
- Identify other researchers, agency staff and NGO's for collaboration on partnerships, next steps and best approaches.
- Identify and explore past and present marine debris projects in specific geographic areas.

Appendices

Agenda

SUNDAY, MARCH 20
7:30am MORNING BEVERAGE

8:00am 8-HR WORKSHOPS

- Addressing the causes of DFG in the Asian Pacific Region
  Instructor/Organizer: **Elizabethann English**, NOAA Fisheries Office of International Affairs

- Results chains: a tool for creating effective marine debris strategies
  Instructor/Organizer: **John Parks**, Marine Management Solutions LLC
  Co-Instructor/Organizer: **Kitty Courtney**, Tetra Tech, Inc.

- Hydrodynamics of marine debris
  Instructor/Organizer: **Nikolai Maximenko**, International Pacific Research Center, School of Ocean and Earth Science and Technology, University of Hawai'i
  Co-Instructor/Organizer: **Kara Lavender Law**, Sea Education Association

4-HR WORKSHOP

- Methods for measuring the impacts of derelict fishing gear and its removal
  Instructor/Organizer: **Kirsten Gilardi**, California Lost Fishing Gear Recovery Project – SeaDoc Society – UC Davis Wildlife Health Center
  Co-Instructor/Organizer: **Jennifer Renzullo**, SeaDoc Society – UC Davis Wildlife Health Center

1:00pm 4-HR WORKSHOPS

- Washed Ashore: plastics, sea life, and environmental art
  Instructor/Organizer: **Angela Haseltine Pozzi**, Washed Ashore project
  Co-Instructor/Organizer: **Wren Farris**, Artula Institute, Washed Ashore project

- The importance of adequate port reception facilities (for ship-generated wastes) in reducing marine debris
  Instructor/Organizer: **Capt. David A. Condino**, USMM, CIV – US Coast Guard, Office of Port and Facility Activities, CG-5442, Safety Branch
  Co-Instructor/Organizer: **LCDR Kevin Lynn**, USCG HQ

5:00pm WELCOME RECEPTION ON PUALEILANI TERRACE

- Introduction of Speakers
  Megan Forbes, NOAA MDP

- Welcome from 5IMDC co-organizing organizations
  David Westerholm, NOAA Office of Response and Restoration
  Amy Fraenkel, UNEP Regional Office of North America

- Speakers
  Kahi Kahakui, Cultural Speaker, Kai Makana
  Roz Savage, Ocean Rower, Advocate, UN Climate Hero

- Music
  Big Blue O

MONDAY, MARCH 21

All day **POSTERS, EXHIBITS, 6th GYRE ART EXHIBIT**

8:00am **MORNING BEVERAGE**

9:00am **OPENING PLENARY**

- Welcome and Introductions
  Kalani Souza, Cultural Speaker

- Opening Remarks
  U.S. Congressman Sam Farr, State of California
  Monica Medina, Principal Deputy Under Secretary of Commerce for Oceans and Atmosphere, NOAA
  Achim Steiner, Executive Director, United Nations Environment Programme (video)
  Commissioner Janez Potočnik, European Commission (video)

- Keynote Speaker
  Jean-Michel Cousteau, Ocean Futures Society

- Overview of 5IMDC and Conference Outcomes
  David Osborn, Coordinator, Global Programme of Action

11:30am **LUNCH (ON YOUR OWN)**

1:00pm **CONCURRENT SESSION 1**

1.a. Stories of success: place-based partnerships to prevent land-based sources of marine debris

Chair: C. Corbin

1. a. 1. Proactive collaboration to storm debris – tropical cyclone debris case study | P. MURPHY
1.a.2. Sleeping with the enemy! – Can an environmental NGO and the plastics industry work together to prevent marine litter? | S. KINSEY
1.a.3. Harnessing resources for a clean and healthy planet: a look at what industry is doing to end marine debris | A. MONTJOY
1.a.4. Preventing debris at the water's edge: working with marinas and boaters | S. SHINGLEDECKER
1.a.5. Protecting the marine ecosystem and human health in the Gulf of Guinea from uncontrolled disposal of plastics and other municipal wastes | K. CHANON

1.b. Stemming the tide of trash: model education and outreach programs to prevent marine debris (1/2)

Chair: S. Sikich

1.b.1. Measures implemented to reduce marine debris from New Zealand fishing vessels | A. LANE
1.b.2. Development and distribution of marine debris education kit for fishermen in Korea | J. LEE

1.b.3. Plastic free Hawaii: moving toward freedom from plastic…one community at a time | N. MCKINNEY
1.b.4. Anthropogenic marine debris in the SE Pacific: Citizens discover the problem on their beaches | M. THIEL
1.b.5. Engaging communities and volunteers in ongoing partnerships to reduce marine debris in the Great Lakes Region | J. CROSS

1. c. Wildlife entanglement in marine debris: assessment and response
Chairs: M. Williams, D. Schofield
1.c.1. Derelict fishing gear impacts on the marine fauna of Puget Sound and the Northwest Straits | T. GOOD
1.c.2. Northern Fur Seal entanglement on the Pribilof Islands | P. ZAVADIL
1.c.4. Steller sea lion (*Eumetopias jubatus*) entanglement in marine debris and ingestion of fishing gear in Alaska and British Columbia: identifying causes and finding solutions | L. JEMISON
1.c.3. Lose the loop: reducing Steller sea lion (*Eumetopias jubatus*) entanglements in marine debris | K. RAUM-SURYAN
1.c.5. Marine debris entanglements of birds: global patterns, impacts, and solutions | T. GOOD

1.d. Innovative disposal options for difficult situations
Chair: C. Laporte
Salon C
1.d.1 Waste conversion technology options for marine debris | B. BOONE
1.d.2. Hawaii's successful approach to marine debris disposal | C. MORISHIGE
1.d.3 Waste management practices on Pacific Islands and opportunities for marine debris reduction | P. GILMAN
1.d.4. Hydrothermal carbonization of marine debris: a novel waste management technique | N. BERGE
1.d.5. Garbage management on fishing boats – lessons from the New Zealand industry | A. LANE

2:15pm BREAK

2:45pm CONCURRENT SESSION 2

2.a. Reducing marine debris from shipping: the reality of regulation beyond the horizon
Chair: A. Lane
2.a.1. Protecting the Caribbean Sea from marine-based pollution: lessons from the MARPOL Annex V Special Area Designation | C. CORBIN
2.a.2. MARPOL Annex V – achieving consensus to change international law | P. MUDROCH
2.a.3. Open Oceans and Marine Debris: reforms to the Lax Enforcement of MARPOL Annex V | A. RAKESTRAW

2.b. Stemming the tide of trash: model education and outreach programs to prevent marine debris (2/2)
Chair: S. Sikich
2.b.1. Marine debris education in a non-formal education setting | K. WILLIAMS
2.b.2. Algalita Marine Research Foundation's Ship-2-Shore Education Program: connecting classrooms with plastic marine debris research | H. GRAY
2.b.3. Ocean garbage patches beware: We have the technology and are inspiring people to clean you up | R. MILLER
2.b.4. Curbing plastic bag pollution: grassroots and viral efforts to bag the bag | S. SIKICH

2.c. Addressing abandoned and derelict vessels
Chair: M. Wright, N. Parry

2.c.1. Derelict vessels as marine debris – environmental and administrative considerations | D. HELTON
2.c..2. Marine debris and abandoned vessels: identification, reduction and prevention through community-based education and action | A. VON HARTEN
2.c.3. Removal of the F/V Ocean Clipper on St. Paul Island | E. AMMANN
2.c.4. Delivering disaster recovery through increased responsiveness, efficiency and effectiveness by a state agency | N. BEWARD
2.c.5. Removing abandoned and derelict vessels (ADV) after a major natural disaster | D. BEAUCHENE

2.d. Panel: Waste reduction strategies for a zero-waste future
Moderator: M. Thiele
Panelists:

1. Saskia Van Gendt, U.S. Environmental Protection Agency
2. Peter Jones, Environmental advisor to Mayor of London
3. Betsy Dorn, Steward Edge
4. Monika Thiele, for Mushtaq Memon, International Environmental Technology Centre, Division of Technology, Industry and Economics, United Nations Environment Programme, Director of Global Partnership on Waste Management

5:00pm HAWAIIAN LUAU ON THE GREAT LAWN OF THE BISHOP MUSEUM

- Sponsors
  Western Pacific Regional Fishery Management Council and the Bishop Museum
- Introduction
  Eric Kingma, Western Pacific Regional Fishery Management Council
- Speaker
  Tim Johns, President and CEO, Bishop Museum

TUESDAY, MARCH 22
All day POSTERS, EXHIBITS, 6th GYRE ART EXHIBIT

8:00am MORNING BEVERAGE

8:30am PLENARY

- Speakers
  David Kennedy, Assistant Administrator for Ocean Services and Coastal Zone Management, National Ocean Service
  April Crow, Sustainability Director, Packaging, The Coca Cola Company

9:15am CONCURRENT SESSION 3
3.a. Outreach and education techniques and approaches (1/2)
Chair: E. Guilbaud-Cox
3.a.1. MARE 410 Marine Debris in the Pacific: teaching undergraduates at the University of Hawaii-Hilo | K. MCDERMID
3.a.2. Engaging urban communities to reduce litter and marine debris | A. GREENE
3.a.4 Visualizing marine debris: using drifter buoys and debris tracking data to visualize marine debris movement and distribution | M. MCBRIDE

3.b. Modeling marine debris movement and transport
Chair: N. Maximenko

3.b.1. Numerical simulation of plastic pellets dispersal in coastal systems as a tool for the identification of potential sources | A. MANZANO
3.b.2. Global Ocean Alert System focusing on the world's river mouth outflows as a source of marine debris | D. WOODRING
3.b.3. Plastic debris pathways and areas of accumulation in statistical Lagrangian model based on drifter trajectories | N. MAXIMENKO
3.b.4. Storm influenced marine debris movement into Prince William Sound, Alaska | C. PALLISTER
3.b.5. Influences of weather and tidal patterns on beach debris accumulation | S. WILSON
3.b.6. Numerical modeling with application to tracking marine debris | J. POTEMRA

3.c. Designing meaningful protocols for monitoring marine debris (1/3)
Chair: E. Adler
3.c. 1. What makes a good marine debris monitoring program? | C. RIBIC
3.c.2. A first UK marine litter assessment of northern European waters | T. MAES
3.c.3. NOAA protocols for marine debris monitoring and assessment along shorelines and in coastal surface waters | C. ARTHUR
3.c.4. Characterization of individual marine debris items by mass | J. JAMBECK
3.c.5. A standard protocol for monitoring marine debris using seabird stomach contents: the Fulmar EcoQO approach from the North Sea. | J. VAN FRANEKER
3.c.6. Plastic ingestion by North Pacific seabirds: progress review and future directions | D. HYRENBACH

3.d. Panel: At-sea detection of marine debris: capturing local knowledge and observations
Moderator: K. Souza
Panelists:
1. LT Kelley Sage, NOAA Corps officer
2. Capt. Robert Lamb, Matson's Manager of Marine Operations for Hawaii
3. CDR Trinque, U.S. Navy

10:45am BREAK

11:15am CONCURRENT SESSION 4
4.a. Outreach and education techniques and approaches (2/2)
Chair: M. Thiele
4.a.1. Expanding the reach of a one-day event: California Coastal Cleanup Day's year-round impact | E. SCHWARTZ
4.a.3. Raising awareness: the ripple effect of acting local and thinking global | A. HOWE
4.a.4. Marine debris can save the world | K. WILLIAMS
4.a.5. From cleanups to the classroom to community events: marine debris education in San Diego | A. GLASSCO

4.b. Risk analysis: using predictions of the source and distribution of marine debris to assess their impacts
Chairs: D. Hardesty, C. Wilcox
4.b.1. Understanding the types, sources, and at-sea distribution of marine debris in Australian Waters | B. HARDESTY
4.b.2. Impact of ingested marine debris on sea turtles of eastern Australia: life history stage susceptibility, pathological implications and plastic bag preference. | K. TOWNSEND
4.b.3. Evidence for increasing plastic ingestion in Northern Fulmars in the Pacific | H. NEVINS
4.b.4. Habitat associations of seabirds and marine debris in the North East Pacific at multiple spatial scales | A. TITMUS

4.b.5. Plastic ingestion by North Pacific seabirds: towards a hierarchical risk assessment | D. HYRENBACH
4.b.6. A risk analysis based approach to understanding ghostnet impacts on marine biodiversity | C. WILCOX

4.c. Designing meaningful protocols for monitoring marine debris (2/3)
Chair: C. Ribic
4.c.1. Eyeballs, nets, and digital scanners: the influence of methodology in assessing plastic debris in the North Pacific Central Gyre | M. GOLDSTEIN
4.c.2. Ocean Voyages Institute/Project Kaisei reports on four development projects of marine debris collection equipment | M. CROWLEY
4.c.3. Application of balloon aerial photography to measure total marine litter weight across a beach and the quantification of heavy metals carried by plastic litter | E. NAKASHIMA
4.c.4. EPA shoreline and pelagic marine debris monitoring methods | K. WEILER
4.c.5. Monitoring marine litter within the Marine Strategy Framework Directive (MSFD): Scientific and technical basis | F. GALGANI

4.d. Stories of success: place-based partnerships to assess and remove marine debris
Chair: N. Barnea
4.d.1. The Oregon partnership to address lost crab pots: project overview | N. BARNEA
4.d.2. Lessons learned from developing a derelict fishing gear program in Puget Sound: behind the scenes stories | G. BROADHURST
4.d.3. The Gulf of Carpentaria, Northern Australia | R. GUNN
4.d.4. The Gulf of Mexico Marine Debris Project: survey and mapping of marine debris after Hurricanes Katrina and Rita | N. BARNEA
4.d.5. CoastWalk: a regional model for a global community | P. CHANDLER

12:45pm LUNCH

- Speakers
  U.S. Senator Daniel K. Inouye, State of Hawai‘i
  Ian Kiernan, Chairman and Founder, Clean Up (Clean Up Australia and Clean Up the World)
- Announcement of Commitments
  Holly Bamford, NOAA
  Steven Russell, Plastics Europe, American Chemistry Council
  Karin Otsuka, Miyakojima Project
  Jenny Miller-Garmendia, Project Aware Foundation
  Hayden Smith, Waitemata Harbour Cleanup
  Megan Lamson-White, Hawai'i Wildlife Fund

2:00pm MEDIA ROUNDTABLE

The media roundtable, entitled *The Litter Debate: Surfing for Solutions to Marine Litter*, provided an opportunity for members of the media from around the world (on-site and via phone) to hear from UNEP and NOAA marine debris specialists, as well as from industry representatives and other experts about the current state of marine debris activities, the goals of the 5IMDC, and potential next steps for addressing this global issue. The presentations were followed by a Q and A period.

- Chair
  Elisabeth Guilbaud-Cox, UNEP Head of Communications

- Speakers
  April Crow, Coca Cola
  Kris McElwee, NOAA MDP
  David Osborn, UNEP
  David de Rothschild (via Skype)
  Steve Russell, American Chemistry Council

2:00pm CONCURRENT SESSION 5

5.a. In-water technology to detect derelict fishing gear in marine/estuarine ecosystems

Chair: P. Murphy

5.a.1. Quantifying the relationship between fishing effort and derelict fish traps (DFT) using autonomous underwater vehicles (AUV) in the U.S. Caribbean | R. CLARK
5.a.2. Towed-diver derelict trap surveys in Florida Keys National Marine Sanctuary | A. UHRIN
5.a.3. Utilizing high resolution side scan sonar to detect derelict fishing gear (nets, pots/traps) in Washington State's Salish Sea | K. ANTONELIS
5.a.4. Detecting derelict fishing gear in the Stellwagen Bank National Marine Sanctuary using the HabCam habitat mapping camera system | A. YORK
5.a.5. Sonars, robots and seeing through the dark: using integrated technology to find and remove marine debris from a variety of locations | R. MILLER
5.a.6. Lessons learned in planning and execution of a derelict crab pot detection project in SE Alaska | P. MURPHY

5.b. Panel: plastic Recovery for a trash-free ocean

Moderator: K. Christman

1. Jean-Pierre De Grève, PlasticsEurope, Deputy Executive Director
2. April Crow, The Coca-Cola Company, Global Sustainable Packaging Manager, Environment & Water Resources (invited)
3. Melissa Hockstad, SPI: The Plastics Industry Trade Association, Vice President, C74Science, Technology & Regulatory Affairs
4. Margretta E. Morris, Covanta Energy Corporation, Director, ES&CA
5. Representative from South Africa's plastics trade association (invited)

5.c. Results and synthesis of marine debris monitoring projects

Chair: T. Maes

5.c.1. Midway Island as a sentinel site for Pacific-wide marine debris | C. RIBIC
5.c.3. Characterization of beach litter in Cijin and its implications on solid waste management | T. LIU
5.c.4. Monitoring marine debris in Trinidad | P. WRIGHT
5.c.5. Trends in marine debris along the coast of the continental United States 1996-2007 | C. RIBIC
5.c.6. Plastic marine debris in the Portuguese coastline | J. MARTINS

5.d. Microplastic in the environment: causes and consequences (1/2)

Chair: M. Browne, R. Thompson

5.d.1. Microplastic: from domestic sinks to global sinks | M. BROWNE
5.d.2. Bio-plastics and their interaction with the environment | K. POLICH
5.d.3. Plastic marine debris in the Atlantic Ocean and Caribbean Sea: abundance, distribution, characteristics, and trends | K. LAW
5.d.4. Spatial and temporal distribution of microplastics in the Puget Sound, USA | J. BAKER
5.d.5. A summary of neustonic plastic density and abundance in the North Pacific Gyre, 1999-2009 | G. LATTIN
5.d.6. Abundance, distribution, and ecology of plastic microdebris in the North Pacific Central Gyre | M. GOLDSTEIN

3:30pm BREAK

4:00pm CONCURRENT SESSION 6

6.a. Managing marine debris in marine protected areas

Chair: S. Godwin

6.a.1. Design-based surveys of lost fishing gear and other marine debris in the Florida Keys | M. CHIAPPONE

6.a.2. The removal and disposal of a derelict vessel from a remote marine protected area in Hawai‘i | S. GODWIN

6.a.3. Indigenous protected areas: challenges and triumphs | S. MORRISON

6.a.4. Dealing with marine debris in MPAs at Europe’s extremities | D. JOHNSON

6.b. Preventing land-based sources of debris through solid waste management

Chair: D. Osborn

6.b.1. Waste management in small island states – spreading the success of innovative ideas, integrated systems and practical community action for large-scale change | S. JUDD

6.b.2. Avoiding unintended consequences – controlling land-based sources of marine debris while enhancing terrestrial waste management and recycling policy, law, and practice | L. MONROE

6.b.4. Global partnership on waste management | M. MEMON

6.b.5. Waste management and recycling in the Galápagos Islands | I. LARREA

6.c. Designing meaningful protocols for monitoring marine debris (3/3)

Chair: F. Galgani

6.c.1. A Global harmonized methodology for monitoring marine litter: the UNEP/IOC guidelines | E. ADLER

6.c.2. Marine debris monitoring and assessment in China | W. ZHANG

6.c.3. Tridimensional sampling method to estimate abundance of plastic pellets in sandy beaches | M. FISNER

6.c.4. Creating a citizen-science monitoring program to quantify microplastic marine debris in oligotrophic oceans | J. PASCHAL

6.c.5. Rapid assessment of beach litter pollution in the beaches of Busan, Korea: application of Litter Pollution Index | J. LEE

6.d. Microplastic in the environment: causes and consequences (2/2)

Chair: M. Browne, R. Thompson

6.d.1. Characterization of the microbial community structures associated with ocean polymers | C. STAM

6.d.2. Biological communities in concentrated debris regions: Who shares the ocean surface with plastic in the Eastern Pacific and North Atlantic? | S. MORET-FERGUSON

6.d.3. Reshape and relocate: seabirds as transformers and transporters of microplastics | J. VAN FRANEKER

6.d.4. GESAMP initiative on micro-plastic particles as a vector for persistent, bio-accumulating and toxic compounds | P. KERSHAW

6.d.5. How concerned should we be about the accumulation microplastics? | R. THOMPSON

6.d.6. Ingestion and incorporation of microplastic particles by common cockles (*Cerastoderma edule*) in an intertidal mudflat | N. BIBER

6:00pm MARINE DEBRIS ART SHOWCASE

- Sponsor
  Ocean Conservancy
- Speakers
  Amelia Montjoy, Vice President, Resource Development and Operations, Ocean

Conservancy
Ellik Adler, Coordinator, COBSEA - Coordinating Body on the Seas of East Asia, UNEP
Wayne Sentman, Field Education Manager, Oceanic Society
Pam Longobardi, Professor of Art, Georgia State University
Andrew McNaughton, Artist, Watamu, Kenya
Susan Middleton, Photographer and Author specializing in the portraiture of rare and endangered animals, plants, sites, and cultures

- Showcased Artists
  Pam Longobardi, **Susan Middleton**, **David Liittschwager**, **Andrew McNaughton**, **Michelle Lougee**, **Susan Scott**

WEDNESDAY, MARCH 23
All day **POSTERS, EXHIBITS, 6th GYRE ART EXHIBIT**

Morning **FIELD TRIPS**

- Pier 38 tour: Fresh fish auction, marine debris port reception bin, and "talk story" with Hawaii's longline fishermen
  Partners: Western Pacific Regional Fisheries Management Council, Hawai'i Longline Association, United Fishing Agency, Pacific Ocean Producers Fishing and Marine

- Hanauma Bay tour and snorkel
  Partners: Hanauma Bay Nature Preserve, University of Hawai'i Sea Grant College Program

- Hawai'i Nets to Energy Program tour
  Partners: Schnitzer Steel Hawai'i Corporation, Covanta Energy

- Pearl Harbor tour
  Partner: United States Navy

- Explore the Waikiki Aquarium
  Partner: Waikiki Aquarium

8:00am **4-HR WORKSHOP/FIELD TRIP**

- Learning shoreline assessment protocols for marine debris
  Instructor/Organizer: Sarah Opfer, NOAA Marine Debris Program
  Co-Instructor/Organizer: Courtney Arthur, NOAA Marine Debris Program

8:30am **4-HR GEF/STAP WORKSHOP (associated event)**

- Seeking Global and Regional Solutions to Marine Debris Problem
  Organizers: **Lev Neretin** and **Henk Bouwman**, Scientific and Technical Advisory Panel of the Global Environment Facility (GEF STAP)

12:00pm **Kōkua Hawai'i Foundation Student Workshop**

1:30pm **4-HR WORKSHOPS**

- Keep the Sea Free of Debris: developing effective outreach for land-based marine debris

Instructor/Organizer: **Carey Morishige**, NOAA Marine Debris Program/I.M. Systems Group, Inc.
Co-Instructor/Organizer: **Leon Geschwind**, TBG on contract at NOAA Pacific Services Center
Co-Instructor/Organizer: **Rhonda Suka**, Hawai‘i Institute of Marine Biology Fellow with NOAA

- Marine debris education: classroom and outreach lessons to teach students about marine debris
  Instructor/Organizer: **Jim Foley**, The Center for Microbial Oceanography: Research and Education

- Fine art, ecotourism, and science education: partnering to increase marine debris awareness within communities
  Instructor/Organizer: **Pam Longobardi**, Georgia State University
  Co-Instructor/Organizer: **Wayne Sentman**, Oceanic Society, Master's Candidate Harvard University Extension School

- Hawaii's youth: bridging ancient Hawaiian stewardship practices and present-day technology for a sustainable ocean
  Instructor/Organizer: **Teresa Espaniola**, www.gARTbage.org, environmental art educator, creator of the art project "The Outrigger Canoe, A Cultural Bridge"
  Co-Instructor/Organizer: **PuaLilia Keohuloa**, co-creator of the educational art project "The Outrigger Canoe, A Cultural Bridge"

7:00pm **MARINE DEBRIS MOVIE NIGHT**

- Sponsors
  UNEP, NOAA, Kona Brewing

- Welcome and Introduction
  Megan Forbes, NOAA MDP
- Hawai‘i Student Video Winner: Aqua Hazard
  Huliau Environmental Filmmaking Club (Island of Maui, Hawai‘i)
- Hawai‘i Student Video Winner: Green School Initiatives
  Sunset Beach Elementary School (Island of Oahu, Hawai‘i)
- Inside the Plastic Vortex
  Mario Aguilera, Scripps Institution of Oceanography, University of California-San Diego (USA)
- Plastic Future: the Midway Story
  Clare Fieseler, Duke University (USA)
- Plastics at SEA: North Atlantic Expedition 2010
  Scott Elliott, 590films (USA)
- Plastic State of Mind
  Ben Zolno, New Message Media, commissioned by Green Sangha (USA)
- The Young Man and the Ghost Net
  GhostNets Australia and Visual Obsession (2010, Australia)
- Entanglement of Stellar Sea Lions in Marine Debris: Identifying causes and finding solutions
  Kimberly Raum-Suryan, Sea Gypsy Research; Alaska Dept. of Fish and Game (USA)
- Millicoma Kids Care Public Service Announcement

Helen Farr, Millicoma Intermediate School, Coos Bay Schools, and The Artula Institute (USA)

- Trashing Your Livelihood
  Diane Scoboria, Marine Conservation Alliance Foundation (USA)
- Two Hands
  Edmund Coccagna, NOAA PIFSC CRED (USA)
- Gift from the Sea
  Kanyarat Kosavisutte, Green Fins Association (Thailand)

THURSDAY, MARCH 24

All day POSTERS, EXHIBITS, 6th GYRE ART EXHIBIT

8:00am MORNING BEVERAGE

8:30am PLENARY

- Speakers
  Alison Lane, Senior Associate, URS Australia
  Christopher Corbin, UNEP CEP, Jamaica

9:15am CONCURRENT SESSION 7

7.a. Monitoring and reducing the impact of 'ghost' fishing by derelict fishing traps

Chair: K. Havens

7.a.1. Derelict crab pots in the Chesapeake Bay, USA | K. HAVENS
7.a.2. Quantifying the impacts of derelict Blue Crab traps in Chesapeake Bay | S. GIORDANO
7.a.3. Survey and impact assessment of derelict crab pots in the Southeast Alaska commercial Dungeness crab fishery | J. MASELKO
7.a.4. Investigating the "ghost-fishing" capacity of derelict lobster traps | M. SMITH
7.a.5. Derelict spiny lobster traps in Florida Keys National Marine Sanctuary: tradeoffs between habitat impacts and ghost fishing | T. MATTHEWS
7.a.6. Derelict trap hotspots in Chesapeake Bay: integrating a spatially explicit model with waterman ingenuity to clean-up derelict traps | W. SLACUM

7.b. Many hands make light work: global and regional partnerships to prevent, mitigate and remove marine debris

Chair: D. Russo

7.b.1. Partnering for a regional strategy: West Coast efforts to comprehensively address marine debris | E. SCHWARTZ
7.b.2. Hawaii Marine Debris Action Plan: an archipelago-wide approach focused on results | K. MCELWEE
7.b.3. Regional action on marine litter in the North-East Atlantic | D. JOHNSON
7.b.4. A NETwork of partners | R. GUNN
7.b.5. The role of an MPA network in marine debris reduction in the wider Caribbean Region | E. DOYLE
7.b.6. Regional cooperation in dealing with marine litter: NOWPAP experience | A. TKALIN

7.c. Environmental impacts of chemicals in marine plastics (1/2)

Chair: H. Takada, H. Karapanagioti

7.c.1. Chemicals in marine plastics: global distributions and potential risk to marine ecosystem. | H. TAKADA
7.c.2. Surface properties of beached plastic pellets and the effect of salinity on their sorptive properties for phenanthrene and 1-naphthol | K. FOTOPOULOU

7.c.3. Partitioning and bioavailability of persistent organic pollutants in marine plastic debris | U. GHOSH
7.c.4. The role of plastic production pellets in the accumulation and transport of trace metals in the marine environment | L. HOLMES
7.c.5. Understanding the occurrence of floating and beached plastics and the interaction between plastic pellets and organic micropollutants in the Mediterranean Sea | H. KARAPANAGIOTI
7.c.6. Environmental and health impacts of marine debris: plastic and chemical contaminants in juvenile yellowtail jacks (*Seriola lalandi*) from the North Pacific gyre | M. GASSEL

7.d. Shoreline marine debris: removal and disposal methods (1/2)
Chairs: M. Ferguson, M. Sudnovsky
7.d.1. Aerial surveys and derelict fishing gear removal along Main Hawaiian Island nearshore environments: a case study | M. FERGUSON
7.d.2. Seven years "net" progress a.k.a. picking up the pieces on Hawai'i Island | M. LAMSON
7.d.3. Using volunteer and professional crews to clean remote northern Gulf of Alaska beaches | C. PALLISTER
7.d.4. Removal and disposal methods used in Alaskan marine debris cleanups | D. GAUDET

7.e. Talking trash: successes and challenges associated with policies to prevent plastic marine pollution
Chair: K. James
7.e.1. The Lay of the Land: single-use plastic pollution policy and legislative approaches in California, the USA and beyond | L. TAMMINEN
7.e.2. Working to end plastic bag pollution in California | K. JAMES
7.e.3. Plastics, litter, and the precautionary principle: carrots and sticks in San Francisco | R. HALEY
7.e.4. Surfrider Foundation law & policy advocating for local change: municipal ordinances addressing marine debris | A. HOWE

10:45am BREAK

11:15am CONCURRENT SESSION 8
8.a. Engaging fishermen to address derelict fishing gear
Chair: S. Morison
8.a.1. Engaging fishing communities through the Fishing for Energy partnership | E. DUGGAN
8.a.2. Measuring the cost of marine debris to Hawaii's longline fishery | J. HOSPITAL
8.a.3. Fishermen-led derelict gear recovery in California | K. GILARDI
8.a.4. Mobilizing fishermen to recover derelict lobster gear – overcoming misgivings and mistrust | L. LUDWIG
8.a.5. Rule changes and partnerships with commercial fishermen increases impact of derelict crab trap clean ups in Florida | E. STAUGLER
8.a.6. Engaging unemployed commercial fishers to retrieve lost Blue Crab pots in the Chesapeake Bay, USA | K. HAVENS

8.b. Coastal cleanup programs – a solution to the problem or just to the symptom?
Chair: R. Alkalay, G. Pasternak
8.b.1. "Clean Coast" Program – leverage for a long-time change | R. ALKALAY
8.b.2. Waitemata Harbour Clean-Up Trust video presentation | H. SMITH
8.b.3. Marine debris pollution along the coasts of Korea: results from a nationwide monitoring and clean-up campaign | S. HONG
8.b.4. How addressing symptoms can lead to a solution to the problem | R. GUNN
8.b.5. Laying a path to solve the marine litter problem | Y. OHKURA
8.b. 6. Marine debris data tracking: methods and uses efforts | L. Kasa

8.c. Environmental impacts of chemicals in marine plastics (2/2)
Chair: H. Takada, H. Karapanagioti

8.c.1. Microbial biofouling of plastic marine debris | G. PROSKUROWSKI
8.c.2. Adsorption of POPs to different types of plastic pellets deployed in San Diego Bay, California | C. ROCHMAN
8.c.3. Quantifying phthalates and bisphenol A in marine organisms | S. ALI
8.c.4. Chemicals in marine plastics and potential risks for a seabird like the Northern Fulmar (*Fulmarus glacialis*) | J. VAN FRANEKER
8.c.5. Effects of plastic debris ingestion on PCBs in seabirds | R. YAMASHITA
8.c.6. Marine debris and heavy metal contamination in Flesh-footed Shearwaters (*Puffinus carneipes*) | J. LAVERS

8.d. Panel: Building on maritime industry best practices to catalyze action
Moderator: Terry O'Halloran
Panelists:

1. Kathy Metcalf, Director, Maritime Affairs, Chamber of Shipping of America
2. Paul Londynsky, Vice President of Safety, Quality & Environmental Affairs, Matson Navigation Company, Inc.
3. David Condino, MARPOL MGR/Dep Branch Chief, Safety Branch/Ports and Facilities Division, US Coast Guard

12:45am LUNCH

- Introductions
  David Johnson, OSPAR Commission
- Speakers
  Daniella Russo, Social Advocate and Co-founder, Plastic Pollution Coalition
- Announcement of Commitments
  Claude Rouam, European Commission
  Shwetal Shah, Government of Gujarat, India
  Thomas Mace, NASA Dryden Flight Research Center
  Nissa Marion and **Lisa Christensen**, EcoVision Asia
  Emma Doyle, Caribbean Marine Protected Area Management Network
  Eben Schwartz, West Coast Governors Agreement on Ocean Health
  David Johnson, OSPAR Commission

2:00pm CONCURRENT SESSION 9

9.a. Panel: Ocean filmmakers
Chair: J. Schmidt

1. Sarah Sikich, Heal the Bay, a local CA nonprofit, on "The Majestic Plastic Bag."
2. Danielle Russo, Plastic Pollution Coalition Co-founder-to speak on "Bag It!"
3. Stiv Wilson, Communications Director, The 5 Gyres Institute
4. Stuart Coleman, Surfrider Foundation, showcasing various Surfrider PSAs

9.b. Citizen scientists and marine debris monitoring: standardizing methods and establishing a database (1/2)
Chair: J. Paschal

9.b.1. Volunteer beach cleanup data collection: sources of error and responses to the challenge | A. GLASSCO
9.b.2. Engaging ocean-going sailors to observe and record marine debris data in the North Pacific Gyre | J. CALLAHAN

9.b.3. Bringing together the marine debris community using "ships of opportunity" and a Federal marine debris information clearinghouse | C. ARTHUR
9.b.4. A mobile application for marine debris data collection and mapping | J. JAMBECK
9.b.5. Technology in the tropics: reinforcing community based science | G. HEATHCOTE
9.b.6. Citizen scientists and marine debris monitoring worldwide: materials, methods, and protocols | C. MOORE

9.c. Law, policy, and economic considerations for successful governance (1/2)
Chair: J. Bollock
9.c.1. Economics + marine debris: a review of economic instruments | K. REGISTER
9.c.2. You can't put a price on that: a market-based solution to marine debris collection | A. SCHROEDER
9.c.3. Open source legislative database and the Global Map Project | D. RUSSO
9.c.4. Using the Clean Water Act to address land-based sources of marine debris | H. SLAY
9.c.5. Marine debris emergency response and preparedness: lessons from the September 29, 2009 tsunami in American Samoa | K. MCELWEE

9.d. Ocean voyages to study and quantify pelagic debris (1/2)
Chair: N. Mallos
9.d.1. Forty years of at-sea marine debris data collection | P. JOYCE
9.d.2. SUPER HI-CAT: Survey of underwater plastic and ecosystem response between Hawaii and California | T. CLEMENTE
9.d.3. Quantifying concurrent distributions of marine debris and oceanic birds in the North Pacific Ocean using visual surveys | D. HYRENBACH
9.d.4. The Lone Ranger Mission: testing the latest advances of marine debris monitoring techniques, new methodologies, and environmental sensing technologies | A. NEAL

3:30pm BREAK

4:00pm CONCURRENT SESSION 10

10.a. The role of ocean filmmaking in educating the public about marine debris
Chair: J. Schmidt
10.a.1. PLASTIC OCEANS – a unique documentary that will challenge our addiction to plastic | L. BEWICK
10.a.2. Filmmaking in the North Atlantic gyre: into the vortex of research and education | S. ELLIOTT
10.a.3. Highlighting marine debris clean up success through educational film making | M. STUBELJ ARS
10.a.4. Communicating marine plastic pollution in the new media landscape | S. WILSON

10.b. Citizen scientists and marine debris monitoring: standardizing methods and establishing a database (2/2)
Chair: J. Paschal
10.b.1. Australian Marine Debris Project – the value of community data in a national database | H. TAYLOR
10.b.2. Prince William Sound Alaska marine debris monitoring program | C. PALLISTER
10.b.3. A baseline story of marine debris in Central California: assessing the abundance and types of beach litter in Monterey Bay, CA | C. ROSEVELT
10.b.4. The Clean Coast Index – 5 years of data collection along 65 beaches in the Mediterranean and the Red Sea | G. PASTERNAK
10.b.5. 25 years of global trash: 8.7 million people, 144 million pounds of trash, 291,000 miles of coastline | L. VIANA

10.b.6. Quantification of plastic marine debris balance using data collected by citizen scientists | N. MAXIMENKO

10.c. Law, policy, and economic considerations for successful governance (2/2)
Chairs: S. Werner, C. Rouam

10.c.1. Derelict fishing gear: addressing the management vacuum | M. HOLT
10.c.2. Regional fisheries management organizations and derelict fishing gear: current efforts and future needs | E. ENGLISH
10.c.3. Strengthening the global governance and regulatory framework to combat abandoned, lost or otherwise discarded fishing gear (ALDFG) | B. KUEMLANGAN
10.c.4. Which governance for plastic-free seas and oceans? A view from Europe | C. ROUAM
10.c.5. Policies and implementation of the integrated marine litter management in Republic of Korea | H. NOH
10.c.6. An integrated coastal zone management plan: a panacea for tackling environmental impacts from land-based sources of marine debris in Nigeria | J. ATU

10.d. Shoreline marine debris: removal and disposal methods (2/2)
Chairs: M. Ferguson, M. Sudnovsky

10.d.1. Cleaning Kanapou, Kaho'olawe: the challenges of marine debris removal from a remote Hawaiian island that was once a military bombing range | C. KING
10.d.2. The challenges of marine debris removal and disposal on St. Paul Island | P. ZAVADIL
10.d.3. Reducing waste generated at cleanups: ideas from California Coastal Cleanup Day | A. GLASSCO

10.e. Ocean voyages to study and quantify pelagic debris (2/2)
Chair: G. Hanke

10.e.1. Characterization of pre-production resin pellets from the Subtropical Convergence Zone of the North Pacific Gyre | A. NEAL
10.e.2. The OceanGybe Expedition – a global perspective on plastic beach debris | B. ROBERTSON
10.e.3. Lessons learned from ten North Pacific Subtropical Gyre voyages aboard Oceanographic Research Vessel Alguita to detect, quantify and remove plastic debris and ghost nets | C. MOORE
10.e.4. Ocean Voyages Institute/Project Kaisei – studying and monitoring of ocean trash in the North Pacific Gyre – a three-year overview | M. CROWLEY

FRIDAY, MARCH 25

Morning POSTERS, EXHIBITS

8:00am MORNING BEVERAGE

8:30am CONCURRENT SESSION 11

11.a. Public/private partnerships for reducing and preventing marine debris through education and outreach (1/2)
Chairs: K. Christman, S. Sheavly

11.a.1. The power of partnerships | A. CROW
11.a.2. Private sector efforts to create effective, collaborative partnerships to reduce litter | A. CARLSON
11.a.3. Marine debris solutions through public private partnerships: industry, government & NGO partners collaboratively provide recycling opportunities in public spaces | C. FLOWERS
11.a.4. Marine litter: *PlasticEurope's* proposed way forward | J. JOHANSSON

11.b. Diving for debris: methods and approaches for human-powered in-water marine debris removal

Chair: M. Manuel, K. Koyanagi

11.b.1. In-water surveys and removal of marine debris following a tsunami in American Samoa | M. MANUEL
11.b.2. Volunteer scuba divers and underwater marine debris removal, assessment, and data collection: challenges and opportunities | A. BUDZIAK
11.b.3. Dive methodologies used in California to recover lost fishing gear | J. RENZULLO
11.b.4. Derelict fishing gear removal in the Papahānaumokuākea Marine National Monument | K. KOYANAGI

11.c. Using social marketing to cause a sea change on marine debris pollution

Chair: S. Radway

11.c.1. Cigarettes, fishing nets, and Facebook: the utility of social media in ocean conservation | H. Gridley
11.c.2. Litter and recycling in America: a look at recent studies and trends, with recommendations for action | R. WALLACE
11.c.3. Social marketing and the California Thank You Ocean campaign | S. MARQUIS
11.c.4. Using social activation strategies to promote change | D. RUSSO

11.d. Don't fill our landfills: alternative disposal methods for marine debris and derelict fishing gear

Chair: C. Laporte

11.d.1. GhostNet gear: turning trash into treasure | J. GOLDBERG
11.d.2. Assessment of the viability of using marine debris as a feedstock in advanced gasification solutions for disposal and energy production | G. GRADMAN
11.d.3. Developing a 21st century waste to energy facility in American Samoa | M. NICHOLLS
11.d.4. Marine debris to energy: integrated marine debris and derelict fishing gear assessment, collection and management | J. KENNEDY

9:30am CONCURRENT SESSION 12

12.a. Public/private partnerships for reducing and preventing marine debris through education and outreach (2/2)

Chairs: K. Christman, S. Sheavly

12.a.1. CPIA –Working with Canada's plastic industry to support successful education programs and industry innovations related to plastics recovery | C. CIRKO
12.a.2. Supply and contamination issues affecting plastics recycling in North America | G. FISHBECK
12.a.3. The *Fishing for Energy* partnership: removing the barrier of derelict gear disposal | M. PICO
12.a.4. Mainstreaming marine litter management in Caribbean SIDS through government and civil society partnerships | C. CORBIN

12.b. Assessing the dangers and removal of sea-dumped munitions and other hazardous debris

Chair: P. Walker, F. Longinotto

12.b.1. Research effort to document military munitions disposal sites worldwide | R. STAUBER
12.b.2. Coral impact assessment and mitigation for a Remotely Operated Underwater Munitions Recovery System demonstration | M. PARRY
12.b.3. Assessing the dangers of removal of sea-dumped munitions and other marine hazardous debris | P. WALKER

12.c. Biological impacts of marine debris

Chair: D. Johnson

12.c.1. Marine debris: more than a low grade fever for marine mammals and sea turtles | V. CORNISH

12.c.2. Microbial comparison of epibiont communities on *Sargassum* and plastic debris vs. surrounding water in the North Atlantic gyre | L. AMARAL-ZETTLER
12.c.3. Plastic ingestion and cephalopod prey selection in Pacific Northern Fulmars (*Fulmarus glacialis*) collected in Monterey Bay, California in 2003 and 2007: are plastic and prey correlated? | E. DONNELLY

12.d. Aerial remote sensing of marine debris
Chair: W. Pichel
12.d.1. Large scale monitoring of surface floating marine litter by high resolution imagery | G. HANKE
12.d.2. SCUD –- Ocean surface current product in aid to pelagic marine debris studies | J. HAFNER
12.d.3. Aerial marine debris coastal survey method and standardization | T. VEENSTRA
12.d.4. Remote sensing for marine debris detection – GhostNet project experience in the North Pacific Subtropical Convergence Zone | W. PICHEL

10:30am BREAK

11:00am CLOSING PLENARY AND LUNCH

- Introductions
  Kalani Souza

- Speakers
  Kris McElwee, NOAA Marine Debris Program
  Mayor Peter B. Carlisle, City and County of Honolulu
  Jared Blumenfeld, Administrator, Environmental Protection Agency Region 9
  Holly Bamford, Deputy Assistant Administrator for Ocean Services and Coastal Zone Management, National Ocean Service, NOAA

- Honolulu Strategy Rapporteur Reports
  David Osborn, UNEP

  Land-based Sources of Marine Debris
  Christopher Corbin, UNEP CEP, Jamaica
  Seba Sheavly, Sheavly Consultants, US
  Katherine Weiler, Environmental Protection Agency, US
  At-sea Sources of Marine Debris
  Ellik Adler, UNEP COBSEA, Thailand
  Elizabethann English, NOAA, US
  Alexander Tkalin, UNEP NOWPAP, Japan
  Removal of Marine Debris
  Jenny Miller-Garmendia, Project AWARE Foundation, US
  Erika "Rikki" Gunn, GhostNets Australia, Australia
  David Johnson, OSPAR Commission, UK

- Closing Remarks
  Amy Fraenkel, Director, UNEP Regional Office for North America

- Special Guests
  Natalie McKinney and the **Kōkua Hawai‘i Foundation Student Ambassadors**
  Jack Johnson, Musician and Philanthropist

6:00pm CATCH THE DRIFT! FINALE EVENT AT OUTRIGGER WAIKIKI

- Sponsors
  Outrigger Enterprises Group and Kuloko Arts of Hawai‘i

Poster Presentation Sessions

Monday AM to Wednesday AM

Stories of success: place-based partnerships to prevent land-based sources of marine debris

1. Improving coordination and communication for rapid response to marine debris reported on beaches and reefs around Oahu, Hawaii | R. SELBACH
2. Success story of limiting land-based sources of debris | M. MAMUN

Wildlife entanglement in marine debris: assessment and response

3. An innovative use of a "capture cage" to disentangle California sea lions, *Zalophus californianus*, in Oregon | K. RAUM-SURYAN

Stemming the tide of trash: model education and outreach programs to prevent marine debris

4. Marine debris and service learning | K. WILLIAMS
5. Bringing marine debris education inland through community recreation centers | A. HAMILTON
6. Google Earth tours: an engaging and effective tool for intermediate students to investigate and communicate marine debris issues | S. KELLY
7. Nearshore seafloor mapping as a tool for developing curriculum based marine debris classroom programs | J. MECHLING

Biological impacts of marine debris

8. Plastic ingestion by planktivorous fishes in the North Pacific Central Gyre | C. BOERGER
9. Assessing impacts of benthic marine debris on coral communities in the inner Gulf of Thailand | T. YEEMIN
10. Incidence, mass, and variety of plastics ingested by Laysan and Black-footed Albatrosses recovered as by-catch in the North Pacific Ocean | H. GRAY
11. Inter-annual, inter-colony and species specific differences in plastic ingestion by Black-footed and Laysan Albatross chicks in Hawaii | A. TITMUS
12. Biodegradable cull panels decrease lethality of lost and abandoned blue crab traps | D. STANHOPE

Outreach and education techniques and approaches

13. EPA addresses and prevents marine debris through education, monitoring, and research tools | A. GREENE
14. Balloon releases: biohazard and preventable problem | K. REGISTER
15. Engaging Virgin Islanders in addressing the problem of marine debris | M. TAYLOR
16. Scuba Dogs Society battles the trash fish in Puerto Rico | A. MARTI
17. Southeast Atlantic Marine Debris Initiative (SEA-MDI) | J. JAMBECK

Aerial remote sensing of marine debris

18. Unmanned aircraft use for marine debris survey | T. VEENSTRA

Stories of success: place-based partnerships to assess and remove marine debris

19. Collaborative removal: Highlighting challenges of city-sourced marine debris through local, grass-roots solutions | C. HOWITT
20. Success and challenges of marine debris monitoring in Tainan | Y. TAI

In-water technology to detect derelict fishing gear in marine/estuarine ecosystems

21. Automated identification of derelict fishing gear in the Stellwagen Bank National Marine Sanctuary from HabCam optical imagery | B. COWIE-HASKELL
22. Distribution and abundance of trap debris in Florida Keys National Marine Sanctuary | A. UHRIN

Law, policy, and economic considerations for successful governance
23. A total systems analysis of the Great Pacific Garbage Patch | C. ORNELL
24. Derelict trap retrieval and trap debris removal programs in Florida | K. MILLER

Don't fill our landfills: alternative disposal methods for marine debris and derelict fishing gear
25. Marine biodegradable product testing | B. KETTL

Many hands make light work: global and regional partnerships to prevent, mitigate and remove marine debris
26. An international assessment: the effectiveness of governmental and nongovernmental efforts in the prevention, mitigation and removal of marine debris | G. KLEBER

Engaging fishermen to address derelict fishing gear
27. Ghost nets: a wicked problem | K. VIDLER

Preventing land-based sources of debris through solid waste management
28. Plastics recycling in relation to the marine debris problem: a review | R. COPE
29. Municipal solid waste management in coastal towns of Gujarat State, India | S. SHAH

Managing marine debris in marine protected areas
30. Derelict fishing gear removal from the Northwestern Hawaiian Islands | R. REARDON

Addressing abandoned and derelict vessels
31. State-level responses to abandoned and derelict vessels in the USA | N. PARRY

Coastal cleanup programs - A solution to the problem or just to the symptom?
32. Okinawa, Ryukyu Islands cleanup 20 year report & update on regional marine litter initiatives | E. HEINRICH-SANCHEZ

Shoreline marine debris: removal and disposal methods
33. Gore Point marine debris cleanup and monitoring project| E. PALLISTER
34. Exclusive beach cleanup applications for small islands | Z. OTSUKA
35. Removal and disposal methods of marine debris in Japan | W. TAKAHASHI

Using social marketing to cause a sea change on marine debris pollution
36. Pacific Ocean cleanup | M. PERCY

Wednesday PM - Friday AM

Monitoring and reducing the impact of "ghost" fishing by derelict fishing traps
37. Abrasion stress to benthic coral reef organisms from lost fishing gear and other marine debris in the Florida Keys | M. CHIAPPONE

Designing meaningful protocols for monitoring marine debris
38. Use of disposable lighters as an indicator item to monitor marine debris | S. FUJIEDA
40. The chemical signature analysis of plastic ingested by Laysan Albatross breeding at Kure Atoll | F. NILSEN
41. Four easy-to-ship and easy-to-use aluminium neuston trawls designed and fabricated by Algalita Marine Research Foundation for use on different vessels of opportunity: results of field tests and preliminary intercalibration efforts | C. MOORE

Environmental impacts of chemicals in marine plastics
42. Polychlorinated biphenyls (PCBs) in plastic pellets from Santos, Brazil | M. FISNER
43. Plastic marine debris and toxic chemicals in the ocean | R. ENGLER
44. New ocean contamination generated from marine debris plastics | K. SAIDO
45. Organic pollutants adsorbed to microplastics debris from two beaches of the Portuguese Coast | J. FRIAS
46. Understanding the sorption and dissolution of contaminants from plastic resins | B. APPLEGATE
47. Macro and micro plastic debris adsorb and transport endocrine disrupters in the ocean | L. RIOS MENDOZA

Ocean voyages to study and quantify pelagic debris
48. An investigation of plastic marine debris across the North Atlantic Subtropical Gyre | G. LATTIN

49. Long-term quantitative monitoring of plastic debris in the Pacific Ocean during repeated undergraduate research cruises | P. JOYCE
50. A characterization of marine debris in the Northeast Pacific deep ocean | S. VON THUN

Risk analysis: using predictions of the source and distribution of marine debris to assess their impacts

51. A hazard assessment of coastal pollution on endangered leatherback sea turtles (*Dermochelys coriacea*) | C. PINCETICH
52. What's eating Kaho'olawe's marine debris? "Sharkastics" are providing many clues, and it's not fantastic news… | C. KING
53. To eat or not to eat? The roles of choice and vision in ingestion of marine debris by sea turtles | Q. SCHUYLER

Results and synthesis of marine debris monitoring projects

54. International Coastal Cleanup in Thailand | S. PRAISANKUL
55. Temporal and spatial distribution of marine debris on select beaches in the Gulf of Alaska over the last 20 years | J. MASELKO
56. Assessment of solid waste pollution on the Slovenian coastline | A. PALATINUS
57. Anthropogenic debris on the beaches in the Rio de Janeiro/SE Brazil | J. BAPTISTA-NETO
58. Trends in beach debris on Hawai'i 2000-2007 | C. RIBIC
59. Impact of marine litter in the northern part of Gulf of Mannar, Southeast coast of India | M. SUBRAMANIAN
60. Analysis of solid wastes in the Estuary of Santos and Sao Vicentes, Baixada Santista, SP, Brazil | D. MARCHESANI
61. Floating marine debris in Guanabara Bay – Rio de Janeiro/SE Brazil | J. BAPTISTA-NETO
62. Study on composition and amount of marine litter in coral reef areas | P. SURASWADI
63. Composition of marine debris in Nigerian coastal waters | N. OGUGUAH

Microplastic in the environment: causes and consequences

64. Welcome to the beach of the future: the physical properties of plastic sediment | H. CARSON

64.a. Ingestion and incorporation of microplastic particles by common cockles (*Cerastoderma edule*) in an intertidal mud flat | N. BIBER

Citizen scientists and marine debris monitoring: standardizing methods and establishing a database

65. Marine debris information clearinghouse – a tool for collaboration and coordination | P. MURPHY

The Sixth Gyre: Art, Oceans, and Plastic Pollution

Monday, March 21 – Thursday, March 24, 8am–4pm

Artists:
Pam Longobardi, USA
Susan Middleton, USA
David Liittschwager, USA
Andrew Hughes, UK
Dianna Cohen, USA
Andrew McNaughton, Kenya
Michelle Lougee, USA

Organizers:
Pam Longobardi, Artist, Professor of Art, Georgia State University
Wayne Sentman, Field Education Manager, Oceanic Society, San Francisco, CA

Sponsors:
NOAA Marine Debris Program
United Nations Environment Programme
Ocean Conservancy
Oceanic Society
Georgia State University
Surfrider Foundation Atlanta Chapter
Scenic Treasures Safari (Kenya)
Earth-Art by Amanda
Flo Water LLC
UniquEco Designs
In The Bag

Marine Debris Awareness Week Proclamation

In recognition of the global problem of marine debris as well as the Fifth International Marine Debris Conference, Governor Neil Abercrombie and Lt. Governor Brian Schatz of the State of Hawaiʻi proclaimed the week of March 20–26, 2011 as “Marine Debris Awareness Week.”

STATE OF HAWAII 1959 UA MAU KE EA O KA AINA I KA PONO

Proclamation

Presented to

National Oceanic and Atmospheric Administration

WHEREAS, the National Oceanic and Atmospheric Administration ('NOAA') is a national agency with roots dating to 1807 that is dedicated to informing citizens about the changing environment around them; and

WHEREAS, the United Nations Environment Programme ('UNEP') is the voice for the environment in the United Nations system and encourages partnership in caring for the environment and improving peoples' quality of life without that of future generations; and

WHEREAS, NOAA has joined with UNEP to organize the Fifth International Marine Debris Conference, which will take place in Honolulu from March 20 – 25, 2011; and

WHEREAS, the increasing amount of pollution and debris in our oceans and seas has been recognized by both organizations as well as numerous scientific bodies as deleterious to our marine ecosystems and ultimately detrimental to our own well-being and quality of life; and

WHEREAS, this event is the first of its kind to take place in over a decade and is intended to raise public awareness, forge new partnerships, and inspire action to bring about a world free of the impacts of marine debris;

THEREFORE I, NEIL ABERCROMBIE, Governor, and **I, BRIAN SCHATZ**, Lieutenant Governor of the State of Hawai'i, do hereby proclaim March 20-26, 2011 as

“MARINE DEBRIS AWARENESS WEEK”

in Hawai'i, to raise public awareness about this important issue and to encourage further research as well as individual actions to reduce waste that pollutes our oceans.

DONE at the State Capitol, in the Executive Chambers, Honolulu, State of Hawai'i, this twenty-second day of February 2011.

NEIL ABERCROMBIE
Governor, State of Hawaiʻi

BRIAN SCHATZ
Lt. Governor, State of Hawaiʻi

Global Marine Debris Project Map

This map and the following list showcase some of the marine debris projects that 5IMDC participants have been advancing worldwide. Conference participants voluntarily entered information through a kiosk in the Exhibit and Poster Hall about the location of their project and the methods being used to address marine debris.

Country	Project Title	Group	Project Type	Contact
Australia	Turtles in Trouble	Earthwatch / University of Queensland	Research	kathy.townsend [at] uq.edu.au
Australia	Whitsunday Islands Marine Debris Removal	Eco Barge Services	Removal	libby [at] ecobargeservices.com
Australia	South West Marine Debris Project	Blue Ocean Care Society	Removal	
Australia	GhostNets Australia	GhostNets Australia	Removal, Research, Prevention	riki.ghostnets [at] northerngulf.com.au
Australia	Marine Debris Dynamics Research Project	CQ University	Research	s.wilson [at] cqu.edu.au
Bahamas	Bahamas National Trust	Bahamas National Trust	Removal	www.gcfi.org
Belize	Bacalar Chico Marine Reserve Cleanup		Removal	www.gcfi.org

Brazil	Sao Vicente Estuary and Sao Manoel Mangrove	Centro Universitario Monte Serrat - Santos	Research, Removal	dri_marchesani [at] yahoo.com.br
Canada	Great Canadian Shoreline Cleanup	WWF Canada	Removal	
Greece	Uptake of chemicals by plastic pellets	University of Patras	Research	karapanagioti [at] upatras.gr
Greece	Plastic Pellet Sampling & Analysis	University of Patras	Research	karapanagioti [at] upatras.gr
Grenada	WINDREF - St George's University	St. George's University	Removal	www.gcfi.org
Grenada	Sustainable Grenadines (SusGren)	Sustainable Grenadines	Removal	www.gcfi.org
India	Municipal Solid Waste Management (MSWM)	Municipal Solid Waste Management	Prevention	
Israel	Clean Coast Program	Clean Coast Program	Education & Outreach	www.environment.gov.il
Jamaica	Montego Bay Marine Park	Montego Bay Marine Park	Removal	www.gcfi.org
Mexico	ICC - Tampico	Ocean Conservancy	Removal	covadong8 [at] yahoo.com
Mexico	ICC - Cancun	Ocean Conservancy	Removal	covadong8 [at] yahoo.com
Netherlands	Fulmar EcoQUO Study	IMARES	Research	jan.vanfraneker [at] wur.nl
New Zealand	Pollen Island (Motu Manawa)	Pollen Island Care Group		seahorse2000 [at] xtra.co.nz
New Zealand	Sustainable Coastlines	Sustainable Coastlines	Removal, Prevention	info [at] sustainablecoastlines.org
Portugal	POIZON		Research	psobral [at] fct.unl.pt
Portugal	NOVAcoast		Research	jcrf [at] fct.unl.pt
Portugal	Waste Management		Removal, Disposal	mgm [at] fct.unl.pt
Republic of South Africa	St. Brandon's Rock	Northwest University	Research	henk.bouwman [at] nwu.ac.za
Slovenia	Cista Obala Eco Vitae	Eco Vitae	Removal, Research	andreja.palatinus [at] ecovitae.org
South Korea	Regional Action Plan	NOWPAP RCU	Strategic Planning	
Taiwan	Characterization of Marine Debris in Cijin Island	Nation Science Council	Research	tkliu [at] mail.ncku.edu.tw
Taiwan	Miyakojima Project	Miyako Island Project	Removal	otsuka [at] miyakojima-project.net
UK	2011 Benthic Marine Litter Trawl	CEFAS	Research	thomas.maes [at] cefas.co.uk
UK	Marine Conservation Society	Marine Conservation Society	Removal, Research	sue.kinsey [at] mcsuk.org
USA	Clean The Bay	Clean the Bay	Removal	wmackie [at] cleanthebay.us
USA	Red Cedar River Clean Up	Michigan State University Students	Removal	gabrielle.kleber [at] gmail.com
USA	Clean Virginia Waterways	Clean Virginia Waterways	Removal	registerkm [at] longwood.edu
USA	IPRC, University of Hawaii	University of Hawaii	Research	maximenk [at] hawaii.edu
USA	Puget Sound Derelict Gear Removal	Northwest Straits Foundation	Research, Removal	broadhurst [at] nwstraits.org
USA	Roosevelt Island Cleanup		Removal	www.oceanconservancy.org/cleanup
USA	Shrimp and Fishing Grounds Debris Removal	Crowder/Gulf	Removal	dbeauchene [at] crowdergulf.com
USA	Clean Oceans Projcet	Clean Oceans Project	Research, Removal	capthomer [at] theoceanscleanupproject.org
USA	Hawaii Marine Debris Action Plan		Strategic Planning	carey.morishige [at] noaa.gov
USA	Kanapou Cleanups	Kaho'olawe Island Reserve Commission	Removal	cking [at] kirc.hawaii.gov
USA	Waiehu Turtle Nesting Beach	Hawai'I Wildlife Fund	Removal	mauihawksbills [at] gmail.com
USA	Beach Litter Survey in Montery Bay	Cal State Monterey Bay	Research	crosevelt [at] csumb.edu
USA	Shrink Wrap Recyclying and Removal	Woods Hole Sea Grant, WHOI	Removal, Prevention	
USA	NOAA PIFSC Coral Reef Ecosystem Marine Debris	NOAA National Marine Fisheries Service		
USA	Florida Keys Debris Monitoring	University of North Carolina Wilmington	Research	chiapponem [at] uncw.edu
USA	Alabama Beach Restoration	Crowder/Gulf	Removal	mwright [at] crowdergulf.com
USA	Clean Marine Project	South Carolina Sea Grant	Removal, Prevention	ambervh [at] clemson.edu
USA	Project for a Clean Ocean	Rozalia Project	Removal, Prevention	rachael [at] rozaliaproject.org
USA	Adopt a Beach Program	Alliance for the Great Lakes	Removal, Research, Prevention	jcross [at] greatlakes.org
USA	Southeast Atlantic Marine Debris Initiative	Regonal Consortium	Research, Removal, Prevention	claporte [at] uga.edu
USA	Lost Lobster Trap Recovery	Gulf of Maine Lobster Foundation	Removal	laura [at] gomlf.org
USA	Kealia Cleanups	Hawai'I Wildlife Fund	Removal, Prevention	mauihawksbills [at] gmail.com

Conference Participants

First Name	Last Name	Affiliation	Email
Ellik	Adler	UNEP/COBSEA	ellik.adler [at] unep.org
Ashley	Ahearn	Freelancer for Public Radio International	aahearn [at] gmail.com
Young Ho	Ahn	SBS Seoul Broadcasting System	
Jacqueline	Alder	UNEP	jacqueline.alder [at] unep.org
Shareen	Ali	University of Alaska Anchorage	n_shareen [at] yahoo.com
Ronen	Alkalay	Marine and Coastal Enviroment Division	ronene [at] environment.gov.il
Kyle	Antonelis	Natural Resources Consultants, Inc.	kantonelis [at] nrccorp.com
Caio Marco	Antonio	ASSU-Ubatuba	caio [at] assu.org.br
Benjamin	Applegate	University of Alaska Anchorage	anbla [at] uaa.alaska.edu
Courtney	Arthur	NOAA Marine Debris Program	courtney.arthur [at] noaa.gov
Jessica	Aschettino	Volunteer	jma803 [at] yahoo.com
Farah	Atyyat	Al Ghad Daily Newspaper	farah.alatiat [at] alghad.jo
Joel	Baker	University of Washington, Tacoma	jebaker [at] uw.edu
Holly	Bamford	NOAA National Ocean Service	holly.bamford [at] noaa.gov
Egalenzibo	Bandele	Ministry of Environment/Congo, DR	egalenz [at] yahoo.com
Nir	Barnea	NOAA Marine Debris Program	nir.barnea [at] noaa.gov
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