2019 Hawai'i

Marine Debris Action Plan Research Workshop

October 2019

Photo Credit: NOAA

2019 Hawaiʻi Marine Debris Action Plan Research Workshop

October 2019

Acknowledgements
The National Oceanic and Atmospheric Administration Marine Debris Program would like to acknowledge and thank the National Institute of Standards and Technology for their partnership in co-planning and facilitating the 2019 Hawaiʻi Marine Debris Action Plan Research Workshop. Thank you to Hawaiʻi Pacific University and the Center for Marine Debris Research for providing the space and facilities to hold the workshop, and countless volunteer hours with preparations and cleanup. We would also like to thank the following businesses for supporting the workshop with food and beverage contributions: Tiki's Grill & Bar, Morning Brew, Down to Earth, and Da Spot.

For citation purposes, please use:
National Oceanic and Atmospheric Administration Marine Debris Program (2019). 2019 Hawaiʻi Marine Debris Action Plan Research Workshop. Silver Spring, MD: National Oceanic and Atmospheric Administration Marine Debris Program.

For more information, please contact:
NOAA Marine Debris Program
Office of Response and Restoration
National Ocean Service
NOAA Inouye Regional Center
NOS/Office for Coastal Management
1845 Wasp Blvd., Bldg 176
Honolulu, HI 96818

https://MarineDebris.noaa.gov/

Mark Manuel, Pacific Islands Regional Coordinator
mark.manuel@noaa.gov

Table of Contents

Executive Summary

Around the world, general awareness of marine debris is increasing everyday. This growing awareness also brings new questions and highlights a need for an increased understanding of the issue. Researchers around the world are working across disciplines to increase our knowledge of marine debris and its effects. In Hawaiʻi, dedicated researchers take advantage of being uniquely positioned in the central Pacific gyre to explore new areas of the issue.

The Hawaiʻi Marine Debris Action Plan (HI-MDAP) establishes a comprehensive framework for strategic action to reduce the ecological, health and safety, and economic impacts of marine debris in Hawaiʻi by 2020. Goal 5 of the HI-MDAP is to conduct high quality research to understand marine debris. Strategy 1 of the goal is to develop an understanding of marine debris physical and chemical traits, life cycle, transport, quantity, impacts, and accumulation rates of marine debris. Action 5.1.1 is to identify and support marine debris research priorities through a collaborative workshop with a goal for island specific collaboration. To accomplish this action, the first HI-MDAP Research Workshop was held in 2017.

In an effort to encourage continued information sharing and collaboration, the National Oceanic and Atmospheric Administration Marine Debris Program and the National Institute for Standards and Technology partnered to co-facilitate the 2019 HI-MDAP Research Workshop. The workshop was held on July 25-26, 2019 at the Hawaiʻi Pacific University Makapuʻu Campus. The two-day workshop brought together Hawaiʻi-based researchers in the field of marine debris to accomplish the following workshop objectives:

- Communicate and share Hawaiʻi-based research projects and results from a variety of science perspectives.
- Update and reassess research priorities set in the 2017 HI-MDAP Research Workshop.
- Identify research gaps and resource needs.

Workshop participants represented non-profit, state, federal, private, and academic groups presented on diverse topics ranging from the microplastic ingestion, innovations in reusing marine debris, tracking technologies, and many more. The 2019 HI-MDAP Research Workshop was much larger than the previous 2017 workshop. Fifty-eight participants attended the workshop, there were 22 research presentations given, and 5 posters were shared. The workshop brought people together, across islands to have important face-to-face interactions and dialogue on research, information sharing, and collaboration to move towards marine debris solutions. Researchers in Hawaiʻi are passionately engaging in new and exciting research that will not only inform the issue of marine debris in Hawaiʻi, but around the world.

Breakout Group Discussion

Workshop participants joined breakout group discussions to update and reassess research priorities set in the 2017 HI-MDAP Research Workshop, and identify research gaps and resource needs.

Update and reassess research priorities set in the 2017 HI-MDAP Research Workshop

The research priorities set in 2017 were:

- Polymer characterization to assess microplastics and the mechanism in which these polymers are transferred and affect human health.
- Invasive species and the diseases they can carry.
- Economic studies on marine debris damage to coral reefs and other key species in Hawai'i.

Discussion facilitators guided conversations with the following questions:

1. Are the 2017 priorities still relevant? If not, what are your suggested updates?
2. Are there new areas/topics of interest or concern?

Research priorities were organized into five categories: biology, chemistry, physics, policy/economics, and "other". Workshop presentations and subsequent breakout group discussions evidenced the wide array of research interests and needs. It was determined that the 2017 research priorities were still relevant. With so many equally important research areas identified, the workshop facilitators and participants did not find it necessary to further rank the documented priorities. The 2019 research priorities can be found on page 7.

Identify research gaps and resource needs

In order to advance research, gaps need to be identified to inform future opportunities and the resources needed to sustain current research and support new endeavors.

Discussion facilitators guided conversations with the following questions:

1. What are the research gaps and needs in Hawai'i and suggestions to overcome them?
2. What types of resources (outside of funding) are needed to improve these research gaps? What resources are currently needed for your specific research?

Many of the research gaps identified during the group discussion align directly with the 2019 research priorities. Research gaps and priorities can be found on page 10.

Minimal Waste Effort

To reduce the amount of potential marine debris created during the workshop, the planning team took initiatives to be as waste free as possible. There were no printed materials (e.g., agenda, handouts) for participants and no single-use name tags used. Participants were encouraged to bring reusable water bottles and coffee cups. The workshop planning team provided reusable plates and utensils for lunch and light refreshments. As a result of the aforementioned efforts to minimize waste, a total of 995 individual items were diverted through refusal, reuse, and recycling.

Future Steps

The two-day workshop demonstrated the need and importance of gathering in person. Increased collaboration and communication repeatedly arose in discussion amongst attendees. Researchers expressed an interest to continue holding and participating in Hawai'i Marine Debris Action Plan workshops and the need to communicate "one story" from Hawai'i researchers. Participants will continue communicating updates through established HI-MDAP bi-annual coordination calls and quarterly newsletters. In 2020, researchers and other Hawai'i Marine Debris Action Plan community members will come together for the 2020 HI-MDAP workshop. The information shared and discussions held at this research workshop can inform future planning around the Action Plan's research goal and others.

Researchers in Hawai'i are continuing to conduct diverse research that leads to our increased understanding of, and the solution to, the global marine debris issue. Workshop participants look forward to supporting these efforts through advancing the Hawai'i Marine Debris Action Plan and partnering on future research workshops.

2019 Hawai'i Marine Debris Action Plan Research Workshop Partcipants (Photo credit: CMDR).

Research Priorities

Workshop partcipants during the tour of the Center for Marine Debris Research lab (Photo credit: CMDR).

Biology
• Calling out environmental impacts (at multiple levels: population, anatomical, physiological, toxicological - all can be acute and chronic)
• Continue biomonitoring, such as bio-indicators, for exposure in Hawaiian species
• Human health exposure - plastic quantities in seafood and seawater
• Continue researching marine debris as a vector for invasive species and disease as well as other microbial communities » Invasive species impacts on the environment » There is a need for larger spatial data (species collection)
• Continue monitoring the exposure of plastic ingestion in Hawai'i species » Is plastic ingestion actually harming marine life?

Chemistry
• Additives (e.g., PBA, PBS, estrogenic compounds, flame retardants, UV stabilizers, phthalates) and sorbed environmental contaminants » Develop methods to detect and quantify the ecological and physiological impacts at species and population level » Transfer or bioaccumulation - direct and indirect impacts to wildlife and human health
• Plastic degradation rates post ingestion and in the environment

Chemistry
• Develop and use methods to understand, identify and quantify the degradation of products and recycling byproducts through exposure and risk assessment
• Use chemistry to source plastic pollution (e.g., polymer ID, additives, etc.) » Identify polymers that should not be used in terms of policy change
• Develop and use methods to quantify and characterize microplastics and microfibers in Hawai'i samples » Utilizing any environmental sample/medium (sand, sediment, biota)
• Study nanoplastics

Physical Oceanography
• More studies on the fate and transport of invasive species » Larger spatial scale
• Large scale coastal transport and accumulation processes of marine debris » Impacts to biota, "gathering place" for living and non-living things
• Monitor, predict, and explain marine debris physical habits within the ocean

Policy/Economics
• Environmentally-friendly disposal methods for collected marine debris and how to communicate them effectively » Ecological and economic viability
• Sustainable alternatives for public plastic disposal » Economic assessment * Comparable prices, packaging, realistic options (e.g., composting)
• Research active and derelict fishing gear » Dialogue between researchers, resource managers, and fishermen needed to address derelict fishing gear * Tagging, restrictions, buy-back
• Increase collaboration/engagement with fisheries to prevent and remove derelict fishing gear » Operational and economic impact to long line fleet due to external derelict fishing gear » Need easily accessible options for disposal in addition to accountability » Continue and expand the utilization of NOAA observers to encourage fisheries collaboration » Utilize United States Coast Guard capacity to gain information on fisheries regulations and enforcement
• Effectiveness of plastic bans (at the county level) and economic costs
• Circular economy needs
• Social science - policies and behavior change

Policy/Economics
• Economic impact studies on cost to tourism » Visitor perception and change in recreational value » Cost to keep beaches clean
• Economic impact studies on vessel interactions (e.g., cruise ships, cargo, recreational) with marine debris
• Economics vs. environmental tradeoffs of waste disposal options » Cost of recycling » Covanta Energy H-Power facility
• Research habitat or coastal impacts before and after marine debris removal efforts » How does that translate to economic impacts?

Other
• Increase communication between all facets of marine debris research » Connect researchers to tell one succinct, cohesive story about Hawai'i marine debris (e.g., continue workshops, use NOAA portal, open Hawai'i literature library, write a review article or special issue in a journal, develop formal organization
• Engineering - research and development
• Human health - collaborate with other groups/agencies (e.g., State of Hawai'i Department of Health, Center for Disease Control and Prevention, National Institute of Environmental Health Sciences)
• Compare marine debris quantities in Hawai'i to other locations
• Increase NOAA Marine Debris Monitoring and Assessment 100 m transect method use on O'ahu during cleanups at indicator beaches (e.g., Kahuku)
• Continue and expand long term monitoring projects » Comparison of marine debris accumulations and protocol standards on other Pacific Islands » Create standard method » Long term monitoring of beach cleanup data for a state-wide collection (not scientifically based or collected)
• Increase Hawai'i research publications
• Source identification (derelict fishing gear and consumer debris) - where is it coming from?

Research Gaps and Resources

Research workshop partcipants watch a demonstration by Ray Aivazian (Photo credit: CMDR).

Research Gaps

Source Identification and Inputs (primarily for large derelict fishing gear and items coming from vessels)

- Work directly with fisherman to figure out what is breaking or falling off ships
- Should have fishing experts identifying all of the types of nets to figure out the location and source fishery (domestic vs. international)
  - Utilize fishery observers on longline and purse seine vessels
  - Trace lost gear with satellite tags
  - Need a database for the origin of fishing gear
- Need to work internationally as we are mostly finding nets in marine environments that are presumably from foreign fleets
- Research on net conglomerates and smart Fish Aggregating Devices
  - Where they already are? Where did they come from? How to repurpose them?

Recycling and Disposal

- What is the best way to recycle, repurpose, and dispose of marine debris?
  - People do amazing beach clean ups, but then what do you do with the removed marine debris?
  - How do we inform the community and communicate these options?
- Research all the types of plastics that are recyclable and have a waste stream identified
  - False advertising of recyclable products
- Understanding the pros and cons of various disposal options for consumers and waste management agencies.

Research Gaps
Recycling and Disposal
• Emission study of Covanta Energy's H-power facility » What is being released? » Information should be shared and communicated to the public • Need more plant based alternatives that will actually degrade - find and promote these » How to make it affordable to be able to sell it in bulk? » Knowledge of future materials to be used in the market
Perspective of other countries that are commonly blamed as the source of marine debris
• What is their side of the story? Are they aware of where the debris is going? How are they disposing of debris? Are there educational programs that demonstrate world wide impacts of marine debris? • Look to Europe and Australia as examples » How they are handling education, plastic pollution, and waste management? » Utilize pre-existing educational films and alter them into different languages so that they can be spread globally for awareness. • Look to other islands that have similar problems in an attempt to get ahead » Could island coalitions be formed?
General public perspective on why we need or rely on plastic (e.g., plastic being sold around fruit)
• What do other people think about plastic? Do they see plastic pollution as a problem? Are there educational programs that demonstrate world wide impacts of marine debris? • Need for more social science studies to understand people's perceptions. Could guide mitigation efforts toward behavior change. • How do we empower people?
Human Health
• We lack information on the plastic impacts to humans. How much are we ingesting or inhaling? How toxic is it to humans, what is the toxicity? • How is plastic on beaches affecting people (kids) through direct contact, inhalation, etc.? • Need to demonstrate that plastic is harmful to humans, which could enable more policy change
Methodology and Standardization
• Standarde results of studies (e.g. units), so they are comparable • How to identify polymers and counting for really small pieces of plastic? • Need for standardized methodology to quantify micro/nanoplastic
Policy or Legislative Change
• There is a tax on the oil industry, but could there be a tax on a marine debris spill? • How to get politicians to prioritize/care about this more? • How to implement policy change and environmental law that can deal with plastic marine debris (if it doesn't already exist)? • Try to change global policy and trace back the plastic to the industries that produce it. • Need to tie in the risks to plastic pollution to get policy change (using the term "substantial threat") • Need to get plastic classified as a hazardous substance (complicated, multilayered problem)

Research Gaps

Economics

- Economic impact on coral reefs
  - » Direct negative impact of marine debris (e.g. net) on coral reefs, however, once removed how is the coral recovering? How to quantify recovery?
    - * Need to avoid other environmental stressors
      - – Are the stressors having additive effects?
- Evaluate the economic value of clean up efforts (as well as the cost of doing nothing)
  - » Important aspect for some companies, which can be an incentive to spend money. Need to know how much it is going to cost (i.e. cheaper to clean it up and maintain) to justify clean ups.
  - » Need to expand messaging to tourists
    - * May not care about what is happening underneath the water and don't understand marine debris impacts leading to degraded reefs

Biology

- Fate of invasive species on marine ecosystems
  - » Need to be more active, how can organizations at all levels (federal, state, non-profit, etc. help (e.g., collect samples)?
- Physiological impact of exposure on ecosystems
  - » May not see impacts now, but the entire food source could be impacted
  - » Need understanding of the biofilm and the "bad" things that are living on the plastic that animals (e.g. larval fish) are exposed to
- Can plastic be viewed as a habitat and what are the potential impacts?
  - » Microbial community living on plastic (microbiome)
    - * Vector of disease?
    - * Increased rate of coral and larval fish ingestion?
      - – Consumption and settling of biota
      - – Degradation and vertical movement (buoyancy)
  - » Remediation of plastics by microbes
- Impact of ingestion of microplastics on marine organisms
  - » Individual impacts: physiology, development, fecundity, mortality rates, sublethal effects
    - * Focus on key development periods
  - » Population impacts (food web dynamics)
    - * Dose-response curve, population trends
    - * Bioaccumulation
    - * Focal species
      - – Protected (ESA listed)
      - – Mid Level prey, sharks, small pelagics
      - – Commercial (Tuna) because of potential human health and safety

Chemistry

- Continue investigating the physiological effects of additives on wildlife
- Understanding the timeline of additives
  - » How much of the additives leach out into the environment?

Research Gaps

Chemistry

- Pollutants on a chemistry level
  - » As pollutants degrade what are the byproducts?
  - » Additive cocktail
  - » Metals and organic pollutants
- Need for a marine debris polymer library

Monitoring, Habitat Mapping, Detection

- Use of aerial systems to detect marine debris (e.g., Integrated Marine Debris Observing System)
- Creative use of bands - Can we utilize chlorophyll or red light for detection?
- Automated image analysis
- Subsurface detection of marine debris
- Use of side scan sonar (e.g., NOAA high resolution maps of navigational ports)
- Marine debris and habitat modifications
- Coral disturbances
- Coastal erosion issue and beach sand
- Change in sand temperature and resulting impacts to species
- Continue accumulation study or time series at Pohoiki Beach, Hawai'i Island
- One of the youngest beaches in the world

Communication

- Highlight Hawai'i marine debris problem in global context
- Increase knowledge sharing
  - » Only share once research is published
  - » Need to share research currently in progress (e.g., NOAA and academia)
- What are the 10 most important actions that could be done in the Hawaiian archipelago to stop or reduce marine debris?

Microfibers and Nanoplastics

- Nano-plastics and Microfiber impacts
  - » Larval fish
  - » Human health
- Nano-plastics and microfiber sampling and analysis methodology
- Increase research on sub 50 micron and smaller plastics
  - » Potentially greater impact/effect than the larger plastics

Fate and Transport

- Understanding of currents around the Hawaiian Islands
  - » Convergences, resuspension, beach dynamics
  - » Track accumulation versus redespostion on beach
- Movement of marine debris in deep water circulation (sub-mesoscale)
- Monitor movement (Integrated Ocean Observing System) of marine debris and beach dynamics
  - » Utilize drones, small portable sensors, satellites, drifters
  - » Need for underwater samples of deep Hawai'i shelf and reefs
- Microplastics concentration integration throughout water column

Resource Needs

Time

Collaboration

- With other neighbor islands and island nations
- With non-governmental organizations, NOAA, government, academia, and businesses to utilize minimal funding support
- International collaboration to deal with derelict fishing gear
- Interdisciplinary participation (potentially through workshops) to address broad nature of marine debris

Communication

- Utilize pre-existing educational films and alter them into different languages so that they can be spread globally for awareness.
- Share information on biodegradable and compostable products
    - » Ensure information is accurate and not falsely advertised
- Communicate funding opportunities and making funders aware of needs
    - » Create a list of foundations and sources for research funding
- Communication of similar research interest to eliminate redundancy and increase collaboration

Personnel/Staff

- State of Hawai'i Department of Land and Natural Resources, Department of Aquatic Resources needs a marine debris appointed position
    - » Limited staff numbers and training (e.g., not commercial divers)
        - * Can other agencies provide support? (e.g., United States Coast Guard academy cadets)
- Organizational Partnerships
    - » Pacific Islands Sustainability Consortium
    - » Economists, social scientists, BIG business, and circular economy
- Need for a more complete and accessible (less expensive) polymer library of marine debris
    - » Collaborators for research and development of new materials
        - * Evaluating degradation and toxicology
- Database of comparable marine debris pollution in comparable metrics (e.g., Hawaiian Islands, South Pacific Islands)
    - » Environmentally relevant levels of plastic exposure
    - » Relevant plastic standard to be used in exposure tests (SRMs)
- Integrate engineering, machine, etc. with native Hawaiian practices - integrity of indigenous practices but just upscaling/ speeding up the process with technology
    - » Looking more into the past and how things were done historically
- Idea - tourists pay a "beach tax" as they either enter or leave, so the money can go towards clean up
- Need for samples (e.g., plastic, biological, water, etc.)
    - » Underwater samples of deep Hawai'i shelf and reefs
    - » Utilizing various capture methods (e.g., gliders, tows, sediment traps)
        - * Compare Hawai'i to other regions and programs

Resource Needs

Methodology and Equipment

- Methodology
  - » Procedure of collection and storage of bacteria on the plastic
  - » Criteria for determining origin of debris
  - » Mechanism for catching the middle level pelagic fish
- Equipment
  - » Ability to conduct research locally versus shipping samples away or traveling to other locations for equipment
  - » Chemistry instrumentation and plastic industry partnership to better understand pollutants
  - » To monitor movement there is a need for drones, small portable sensors, drifters, satellite data and high frequency RADAR

Appendix I: Agenda

Day 1 - Thursday, July 25, 2019	
Time	**Session**
9:00am – 9:30am	**Morning Welcome**
9:30am – 10:45am	**Science presentations (15 min each)** Megan Lamson Nikolai Maximenko Michelle Hester Keith Flitner Ilana Nimz
10:45am – 11:00am	**Break - poster viewing**
11:00am – 12:00pm	**Science presentations (15 min each)** Miguel Castrence Jennifer Lynch Melissa Jung
12:00pm – 1:00pm	**Lunch with poster viewing and group photo** Jan Hafner Hank Lynch Jennifer Martin Katy Shaw Sheena Weller
1:00pm – 1:45pm	**Science presentations (15 min each)** Kayla Brignac Carl J. Berg Ray Aivazian III
1:45pm – 2:30pm	**NOAA MDP Research Priorities** **Pacific Islands Marine Debris Collaboration Portal overview**
2:30pm – 2:45pm	**Introduce 2017 HI-MDAP Research Priorities**
2:45pm – 3:00pm	**Break - poster viewing**
3:00pm – 4:30pm	**Center for Marine Debris Research lab tour and Ray Aivazian's Demonstration**

Day 2 - Friday, July 26, 2019	
Time	**Session**
9:00am – 9:30am	**Morning Welcome**
9:30am – 10:45am	**Science presentations (15 min each)** Amy V. Uhrin K. David Hyrenbach Nicolas Vanderzyl David Field Joelle Marchiani
10:45am – 11:00am	**Break - poster viewing**
11:00am – 12:00pm	**Science presentations (15 min each)** Jonathan Whitney Rachel Sandquist Lauren Chamberlain Mary Crowley
12:00pm – 1:00pm	**Lunch**
1:00pm – 1:30pm	**Science presentations (15 min each)** Jens Currie Sarah-Jeanne Royer
1:30pm – 2:15pm	**Breakout groups** • Group 1 & 2: Reassess 2017 Priorities • Group 3 & 4: Identify research gaps and resource needs
2:15pm – 2:35pm	**Break - poster viewing**
2:35pm – 3:20pm	**Breakout groups - switch topics**
3:20pm – 3:30pm	**Break**
3:30pm – 4:30pm	**Wrap up presentations from breakout groups and discuss strategic goals for research** **Mahalo and next steps**

Appendix II: List of Participants

List of participants who attended the 2019 Hawai'i Marine Debris Action Plan Research Workshop.

Name	Organization
Amy V. Uhrin	NOAA, Office of Response and Restoration, Marine Debris Program
Ana Chew	NOAA, Pacific Islands Young Scientists Program
Brenda Jensen	Hawai'i Pacific University
Cascade Mayer	Hawai'i Pacific University
Catherine Gewecke	State of Hawai'i, Department of Land and Natural Resources, Division of Aquatic Resources
Cheryl King	SHARKastics
Cynthia Welti	Kaua'i Chapter, Surfrider Foundation
Danielle Enright	Maui Ocean Center Marine Institute
David Field	Hawai'i Pacific University
Diana Felton	State of Hawai'i Department of Health
Donald Kobayashi	NOAA, National Marine Fisheries Service, Pacific Islands Fisheries Science Center
Carl J. Berg	Kaua'i Chapter, Surfrider Foundation
Eileen Nalley	Hawai'i Institute of Marine Biology, University of Hawai'i at Mānoa
Erica Brewton	United States Coast Guard
George Balazs	Golden Honu Services of Oceania
Hank Lynch	The Nature Conservancy
Hudson Slay	United States Environmental Protection Agency Region 9
Ilana Nimz	Oikonos Ecosystem Knowledge; Hawai'i Pacific University
James Callahan	Trans Pacific Marine Debris Survey
James Morioka	NOAA, National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Ecosystem Sciences Division
James Potemra	University of Hawai'i at Mānoa
Jamison Gove	NOAA National Marine Fisheries Service Pacific Islands Fisheries Science Center
Jan Hafner	International Pacific Research Center, School of Ocean, Earth Science, and Technology, University of Hawai'i at Mānoa
Jana Phipps	NOAA Intern
Jenna Karr	Center for Marine Debris Research/ Hawai'i Pacific University
Jennifer (Aleysa) Martin	Maui Ocean Center Marine Institute
Jennifer Lynch	National Institute of Standards and Technology; Hawai'i Pacific University
Jennifer Repp	NOAA Pacific Islands Fisheries Science Center Young Scientist Opportunity
Jens Currie	Pacific Whale Foundation
Joelle Marchiani	National Institute of Standards and Technology; Hawai'i Pacific University
Jonathan Whitney	Joint Institute for Marine & Atmospheric Research
K. David Hyrenbach	Hawai'i Pacific University

Name	Organization
Katy Shaw	National Institute of Standards and Technology
Kayla Brignac	Hawaiʻi Pacific University
Keith Flitner	Oceans United Inc.
Keith Korsmeyer	Hawaiʻi Pacific University
Kellie Teague	Hawaiʻi Pacific University
Kerrianne O'Malley	Hawaiʻi Pacific University
Lauren Chamberlain	Hawaiʻi Pacific University
Lisa Jeffers-Fabro	Kōkua Hawaiʻi Foundation
Mark Manuel	NOAA, Office of Response and Restoration, Marine Debris Program; Freestone Environmental Services
Mary Crowley	Ocean Voyages Institute
Megan Lamson	Hawaiʻi Wildlife Fund; State of Hawaiʻi Department of Land and Natural Resources Department of Aquatic Resources
Melissa Jung	Hawaiʻi Pacific University
Michelle Hester	Oikonos Ecosystem Knowledge
Miguel Castrence	Resource Mapping Hawaiʻi
Nadre Davani	Oceans United Inc.
Nicolas Vanderzyl	Hawaiʻi Wildlife Fund
Nikolai Maximenko	International Pacific Research Center, School of Ocean, Earth Science, and Technology, University of Hawaiʻi at Mānoa
Oliva Nigro	Hawaiʻi Pacific University
Rachel Sandquist	NOAA Hollings Marine Scholar Program; University of Miami
Raquel Corniuk	Hawaiʻi Pacific University
Ray Aivazian III	Seed, Windward Community College
Sarah Donohue	Hawaiʻi Pacific University
Sarah-Jeanne Royer	Scripps Institution of Oceanography
Shanelle Naone	NOAA, Office of Response and Restoration, Marine Debris Program; Freestone Environmental Services
Sheena Weller	Hawaiʻi Pacific University
Steven Colbert	University of Hawaiʻi at Hilo

Appendix III: 2019 HI-MDAP Research Workshop Presentation Abstracts

The Center for Marine Debris Research (CMDR) recorded presentations given at the workshop, they are available to view on their website. The following presentation abstracts are in the order they were given.

From Massive to Micro-Plastic: Lessons Learned from Coastal Cleanup Activities

Megan Lamson[1], Carl J. Berg[2], Cheryl S. King[3], Leah D. Sherwood[1,4], Nicolas M. A. Vanderzyl[1,4]

[1]Hawai'i Wildlife Fund, [2]Kaua'i Chapter, Surfrider Foundation, [3]SHARKastics, [4]University of Hawai'i at Hilo

Since 1996, Hawai'i Wildlife Fund (HWF) has removed over 300 tons of marine debris with the help of 1000s of volunteers over 100s of cleanup efforts (Hawai'i Island, Maui, Midway). Using these data, plus more from Surfrider Foundation (Kaua'i) and Sharkastics (Maui), we analyzed the efficiency of removal activities for massive (net recovery patrols) and macro-plastic debris (beach cleanups) from 2008 – 2017 on three islands (Hawai'i, Kaua'i, Maui). Mean recovery rates for all methods of removal averaged 20.3 ± 13.9 lbs./ participant-hour. Beach cleanups had approximately 8.8 times the participants and 10.6 times the participant-hours but collected only 1.8 times the weight of net patrols. Efficiency (weight/ unit-effort) was 3.9 – 6.3 times greater for targeted removal efforts than community events. With beach cleanups, groups of 31 – 40, volunteers collected the most weight/ person, while for net patrols, small groups of 6 – 8, experienced volunteers removed more.

In addition, HWF began coordinating NOAA Marine Debris Monitoring and Assessment Project accumulation surveys along a 100 m "relatively clean" stretch of coastline at Kamilo Point in Sept. 2016. Of the 27 surveys conducted to date, we have found an average of 2,915 ± 1632 debris items (2.5 – 100 cm), of which 96.2% were made of plastic. Accumulation rates appeared to differ seasonally with 2.0 times more debris items accumulating during summer months than winter months, but more data are needed. Lastly, field testing of the Hō'ola One micro-plastics debris machine in April 2019 provided more information to test the efficacy of both removal activities and to assess the composition of plastics in beach sand.

FloatEco: Study of Physical and Biological Processes Maintaining a Unique Floating Ecosystem of the North Pacific Garbage Patch

Nikolai Maximenko[1], Jan Hafner[1], Mary Crowley[2], Luca Centurioni[3], Gregory Ruiz[4], Linsey Haram[4], Andrey Shcherbina[5], James Carlton[6], Cathryn C. Murray[7]

[1]International Pacific Research Center, School of Ocean, Earth Science, and Technology, University of Hawai'i at Mānoa, [2]Ocean Voyages Institute, [3]Scripps Institution of Oceanography, [4]Smithsonian Environmental Research Center, [5]Applied Physics Laboratory, [6]Williams College, [7]Fisheries and Oceans Canada

Converging surface currents create in subtropical oceans areas of high-concentration of floating artificial debris ("garbage patches"). This debris can carry marine biota over long distances and provides a substrate for a new type of pelagic ecosystem, in which coastal species can survive and establish. To study the oceanic processes, responsible for the formation of such marine debris accumulation areas, the multi-institutional team of the interdisciplinary project FloatEco deployed in 2018 a set of Lagrangian tools, including nine

drifting buoys with drogues attached between 2 and 20 meters and trackers attached to real debris objects. Preliminary analysis of the trajectories showed that after deployment drifters spread consistently with the vertical shear of Ekman currents, sampled by different drifters at different depths. However, after the initial dispersion, drifters remain in a relatively small area, filled with mesoscale and submesoscale eddies, and their highly fractal trajectories (see Figure) reflect strong horizontal eddy mixing without any significant difference between the drifters of different geometry.

Two pairs of drifters were trapped for several weeks in cyclonic submesoscale eddies and converged to a distance of only 100 meters. Characteristics of the drifters suggest that the vertical scale of the submesoscale circulations was comparable to the mixed layer depth. High vertical coherence of such eddies may be homogenizing the ocean momentum, stratified by the wind stress.

Remarkably, real debris tagged with satellite trackers demonstrated a similar behavior and was wandering in the same area as drifters. Type and size of debris object as well as change with time of the debris geometry, derived from their observed responses to the local wind, and from interruptions in satellite transmissions, did not have a strong effect on debris residence in the garbage patch. One exception was a large fishing net that separated from the patch, passed by the Big Island, and was retrieved off north Maui.

Preliminary results of FloatEco suggest that mesoscale and submesoscale turbulence reduces the effects of the wind-induced vertical shear on the horizontal mixing. Physical mechanisms of this reduction are under investigation.

Biological samples, collected in the project, reveal major changes ongoing in the pelagic ecosystem of the North Pacific.

Insights from a Decade of Hawaiian Albatross Plastic Ingestion Research

Michelle Hester[1], K. David Hyrenbach[2], Cynthia Vanderlip[3], Jessie Beck[1], Myra Finkelstein[4], Andrew J. Titmus[2], Travis Wahl[2]

[1]Oikonos Ecosystem Knowledge, [2]Hawai'i Pacific University, [3]State of Hawai'i Department of Land and Natural Resources, [4] Microbiology and Environmental Toxicology Department, University of California

Black-footed (Phoebastria nigripes, BFAL) and Laysan (Phoebastria immutabilis, LAAL) albatross accumulate non-digestible material in their digestive tract, including natural prey remains and plastic items. For a decade, the BIOPs program (Biological Indicators of Ocean Plastic Pollution) has conducted collaborative research on the plastic ingested by adult and young-of-the-year Hawaiian albatrosses. We sampled boluses regurgitated by chicks before fledging and found evidence of species-specific (BFAL>LAAL; $p = 0.002$) and colony-based differences (Kure>Midway>Tern; $p < 0.001$) in plastic exposure among breeding colonies ($n = 150$; 25 per species/colony). BFAL chick bolus and stomach analysis ($n = 25$ chicks) combined with satellite tracking of provisioning parents ($n = 7$ BFAL and 14 foraging trips) from Kure Atoll revealed that parents feeding their chicks the highest plastic loads of any colony were foraging west of the Hawaiian Archipelago towards Japan (180-150°E, 30-40°N) and spent most of their time over pelagic waters (>2000 m deep; averaging 89 ± 9% of time at sea). These results highlight the need for colony-specific research on potential impacts of plastic ingestion. We also sampled stomach contents from healthy adult albatrosses incidentally killed in fisheries interactions (Hawai'i and Alaska-based U.S. longline fisheries). Both adult stomachs from bycatch and chick regurgitations from colonies have been collected annually allowing for a time-series of plastic ingestion metrics in Hawaiian albatrosses (2008 – 2019). Beyond important regional and basin-scale metrics of marine debris in seabirds, BIOPs researchers are collaborating to investigate one mechanism of injury, endocrine disruption, in albatrosses that ingest high levels of plastic. Results from this novel approach using in vitro cell models as a proxy for seabird cells, suggest that estrogenic activity of the ingested plastic was 20 to 90% of estrogen. To advance our knowledge of the impact of marine plastic pollution to ecosystem health, we recommend integrating the monitoring of long-term trends using standardized metrics, with the design of mechanistic studies to understand the potential biological impacts of plastic ingestion and ancillary contamination in marine birds.

A New Approach to Marine Debris Cleanup - A Technology Solution

Keith Flitner[1], Michel Berthiaume[1]

[1]Oceans United Inc.

Oceans United is taking an innovative approach to removing marine debris from the Great Pacific Garbage Patch, and all of earth's oceans. The solution now allows the cleanup missions at sea to be self-sustainable, with little to no carbon footprint, as compared to other existing methods which require transporting collected debris back to port.

Oceans United has developed innovative technology called Hybrid Hydrothermal Liquefaction (Hybrid-HTFL) that addresses that disposal issue of marine debris. The process has completed two independent third party tests, at scale, on a mixture of marine debris, including consumer plastics (single-use), paper, rubber, derelict fishing gear ("ghost gear"), driftwood and biomass. All grades of plastics, including contaminated plastics, will be treatable, including those types not normally addressed in recycling; eliminating the need to transport, sort, wash and dry the feedstock. This sea change will increase the industry average of recycled plastic from about five percent to over 99%.

Oceans United has completed the ship design details for the retrofit of both the collection system and the Hybrid-HTLF system. The high-throughput Hybrid-HTFL process design, called "P2F", will convert marine debris to ISO grade 2 diesel fuel (sulfur free), which will be used to power the ship's engines. Other P2F system benefits include its compact 20m by 20m footprint and safer lower operating temperature (as opposed to gas pyrolysis) that will apply to both sea and land applications.

Marine Debris Education & Ocean Literacy through the Eyes of Albatross

Ilana Nimz[1,2], Michelle Hester[1], K. David Hyrenbach[2], Kirsten Moy[1], Andy Collins[3], Jennifer Stock[3], Naomi Worcester[4]

[1]Oikonos Ecosystem Knowledge, [2]Hawai'i Pacific University, [3]National Oceanic and Atmospheric Administration, [4]State of Hawai'i Department of Land and Natural Resources

The Winged Ambassadors Education Partnership provides free downloadable curricula and resources to K-12 educators, teaching marine science and ocean stewardship through the eyes of seabirds. The five lesson plans cover a range of topics including seabirds and navigation, marine food webs, ocean currents and hotspots, marine debris and its impact on albatrosses, and data analysis. The final lesson includes a campus survey to examine potential sources of marine debris and to inspire behavioral changes and educational campaigns relating to campus litter and plastic use. Since 2012, an estimated 5,270 educators and 327,600 students in 38 countries have experienced the Winged Ambassadors curriculum.

Albatrosses, charismatic and threatened seabirds, are ambassadors for a clean ocean because they traverse vast oceanic regions searching for food and sampling floating litter. Along their journeys, they ingest plastic trash and feed it to their chicks, back at the nesting colony. As part of the digestive process, the chicks throw up indigestible pellets, known as "boluses", to rid themselves of fish bones, squid beaks and the ingested plastic trash. The Oikonos BARF program, a supplement to Winged Ambassadors, is unique in the world because it brings real boluses thrown up by seabird chicks from Kure Atoll into school programs. Since 2008, an estimated 2,150 educators and 167,700 students have been exposed to activities using real boluses from Oikonos, spanning 41 U.S. states and 7 countries. Exploring the contents of albatross boluses has proven to be an impactful, and often life-changing experience for students of all ages, because it allows them to touch and examine the plastic trash that these animals are eating in the ocean. In particular, the ability to identify ingested items, involving fisheries/aquaculture and every-day user items, allows students to discuss the various potential sources and pathways of this litter into the marine environment. Additionally, by connecting students in a city classroom with conservation scientists working in a remote island, this program provides role models and inspiration to nurture a new generation of environmental stewards.

Mapping Marine Debris with Machine Learning

Miguel Castrence[1], Kirsten Moy[2,3], Yutaka Hosoai[4], Katie Taladay[5,6], Ross Winans[5,6], Larry O'Brien[7], Sam Aruch[8]

[1]Resource Mapping Hawai'i, [2]Hawai'i Coral Reef Initiative, [3]Oikonos Ecosystem Knowledge, [4]Coupa Software, [5]Department of Geography and Environment, University of Hawai'i at Mānoa, [6]Lynker Tech, [7]Microsoft, [8]Natural Resource Data Solutions

Coastal ecosystems are under constant threat from marine debris, yet our understanding of amount and composition as well as the patterns and rates of accumulation on our shorelines is limited in scale and scope. Better management of marine debris on our shorelines requires better tools for mapping, measuring, and monitoring. While it's relatively easy to collect imagery, analyzing such large volumes of data can be very slow and subject to errors/bias, thus making it difficult for rapid marine debris detection and response. Using machine learning, we are automating the analyses of different types of images: aerial (manned aircraft) ortho-imagery for mapping debris densities and identifying regional hotspots; ground-level (smartphone) photos for real-time debris detection for quick assessments in the field before/after beach cleanups; UAS (drones) photos for quantifying small items. We are also developing online platforms to engage citizen scientists and serve coastal resource managers and community groups. We are building upon baseline data and lessons learned from a previous mapping effort of the main Hawaiian Islands (http://arcg.is/29tjSqk). These comprehensive, precise measurements of the quantity, location, type, and size of macro-debris in a wide range of shoreline types are an excellent source of training, test, and validation data to evaluate different machine learning algorithms. The project is working to achieve the greatest impact after being awarded a Con X Tech Prize in 2018 and a Microsoft AI for Earth grant in 2019.

Chemistry of Plastic Marine Debris

Jennifer Lynch[1,2], Melissa Jung[2], Kayla Brignac[2], Ashok Deshpande[3], Bridget O'Donnell[4], Wanda Weatherford[5], Sarah-Jeanne Royer[6,7], Nikolai Maximenko[6], Jonathan L. Whitney[8,9], Jamison M. Grove[8], Ray Aivazian III[10]

[1]National Institute of Standards and Technology, [2]Center for Marine Debris Research, Hawai'i Pacific University, [3]National Oceanic and Atmospheric Administration, [4]Horiba, [5]Chevron Phillips Chemical Company LP, [6]University of Hawai'i at Mānoa, [7]Scripps Institution of Oceanography, [8]NOAA, National Marine Fisheries Service, Pacific Islands Fisheries Science Center, [9]Joint Institute for Marine and Atmospheric Research, University of Hawai'i at Mānoa, [10]Seed, Marine Option Program, Windward Community College

The Center for Marine Debris Research (CMDR) has a strong focus on chemistry with objectives to improve methods and answer fundamental questions about plastic pollution. Chemistry is powerfully informative for questions regarding source, transport, fate, quantities, types, and sizes of plastic debris in the environment as well as toxicological impacts from additives, sorbed contaminants, and degradation products. CMDR is helping to standardize methods and reporting units. In doing so, we are beginning to compare debris quantities in Hawaii to other locations and recognizing Hawaii as one of the most plastic polluted locations on Earth. This presentation will briefly introduce the rationale behind nine other CMDR chemistry studies presented at this workshop. In addition, this presentation will present findings from three additional recent research collaborations that have significantly improved or applied polymer identification methods using plastic debris from Hawaiian beaches. The take-home points are 1) units matter, 2) Hawaii is consistently one of the most plastic polluted places on Earth, 3) polymer identification is not straight forward and requires multiple methods, and 4) polymer identification is helpful in understanding sources and fate in the environment.

Too Much of a Bad Thing: High Quantities of Plastic Ingested by Hawksbill Sea Turtles in the Central Pacific

Melissa Jung[1], George H. Balazs[2], T. Todd Jones[3], Thierry M. Work[4], Shandell Brunson[3], Alexander R. Gaos[3], Jennifer Lynch[5]

[1]College of Natural and Computational Sciences, Hawai'i Pacific University, [2]Golden Honu Services of Oceania, [3]NOAA, National Marine Fisheries Service, Pacific Islands Fisheries Science Center, [4]U.S. Geological Survey, National Wildlife Health Center, Honolulu Field Station, [5]Chemical Sciences Division, National Institute of Standards and Technology

For all sea turtle populations, plastic debris ingestion has been recognized as a concerning and increasing anthropogenic threat that needs continual monitoring and research. All seven species have been documented to ingest plastic debris, but hawksbill sea turtles, listed as Critically Endangered on the International Union of Conservation of Nature (IUCN) Red List, ranked the highest for plastic ingestion amounts in a recent global meta-analysis with the Central Pacific and Southwest Atlantic as hotspots. Despite many hawksbill sea turtle populations declining and the urgent need to monitor plastic ingestion in this species, only 13 studies, including 86 individuals, have documented plastic ingestion by hawksbill sea turtles around the world with only two sea turtles representing the Central Pacific hotspot region and most individuals being older, neritic phase sea turtles. This limited information leaves large data gaps regionally and globally that need to be filled to determine geographical areas and life stages that deserve specific attention for conservation of the species. We examined gastrointestinal tracts of 15 hawksbills from the Central Pacific. The color, type, and size were recorded for each piece. The number of plastics from each turtle was counted, weighed, and standardized by turtle weight (kg). White (70.8%) was the most common color and fragments (87.6%) were the most common type ingested. Debris sizes ranged from 1X1X0.5 mm sheet to 14X0.5X0.1 cm rubber band. The percent frequency of occurrence of ingestion was 66.7% with an average of 9.13 pieces/turtle, 0.256 g/turtle, and 1.76 g/kg of turtle (calculations include non-detects). Combined with the ingestion amounts from the two previous hawksbills examined, an average of 3.0 g/kg was observed, confirming a recent global meta-analysis revealing that hawksbills in the Central Pacific are the most at risk across species and locations. Within this population, small post-hatchling pelagic turtles (3.64 g/kg, 4-9 cm SCL) and pelagic juvenile turtles (4.38 g/kg, 28-41cm SCL) had greater concentrations per body weight of ingested plastic compared to larger neritic turtles (0.010 g/kg, 46-71 cm SCL). Increased monitoring of rare hawksbill sea turtles is crucial along with determining if the amounts of plastic ingested are harmful or not. Efforts within hawksbill populations should focus on younger pelagic-phase turtles, in particular post-hatchlings in hotspot regions like the Central Pacific.

Marine Debris Polymers on Main Hawaiian Island Beaches, Sea Surface, and Seafloor

Kayla C. Brignac[1,2], Melissa R. Jung[2], Cheryl King[3], Sarah-Jeanne Royer[4], Lauren Blickley[5], Megan R. Lamson[6], James T. Potemra[1], Jennifer Lynch[2,7]

[1]School of Ocean, Earth Science, and Technology, University of Hawai'i at Mānoa, [2]Center for Marine Debris Research, Hawai'i Pacific University, [3]SHARKastics, [4]International Pacific Research Center, School of Ocean, Earth Science, and Technology, University of Hawai'i at Mānoa, [5]Swell Consulting, [6]Hawai'i Wildlife Fund, [7]Chemical Sciences Division, National Institute of Standards and Technology

Polymeric differences of plastic debris were assessed across four compartments of the Main Hawaiian Islands (sea surface, windward beaches, leeward beaches, and seafloor) to better describe sources and fate. Plastic debris pieces (n=4,671) were collected from 11 beaches, three sea surface tows, and three seafloor dives. Fourier-Transform infrared spectroscopy identified the polymers of 3,551 pieces. Significant differences ($p<0.05$) in concentration, types, polymer composition, and weathering were found among four compartments. Windward beaches had one to two orders of magnitude more plastic pollution (g/m2) than leeward beaches, despite smaller human populations on windward sides. Sea surface and windward beaches were dominated by severely weathered, less dense floating polymers (polyethylene and/or polypropylene comprised 92.7% and 93.5% on average, respectively, of the total debris mass), while leeward beaches and the seafloor debris consisted of less weathered and more dense sinking polymers (e.g., 41.0% and 44.7% of total mass consisted of the sum of polystyrene, nylon, cellulose acetate, polyethylene terephthalate and phthalates, respectively). These results are some of the first to provide evidence of polymeric stratification in the marine environment; and emphasize that the majority of marine debris in Hawaii is floating in from distant sources, rather than from Hawaii's residents or tourists.

Beyond Beach Cleanups; The Problem of Getting Rid of Plastic Waste in Context of GHG Emissions and Global Climate Change

Carl J. Berg[1]

[1]Kaua'i Chapter, Surfrider Foundation

The Kaua'i chapter of Surfrider Foundation collects over 10,000 lbs. a month of marine debris. Approximately 80% is the most dangerous marine debris in the ocean; nets, ropes, lines and derelict fishing gear, stuff that entangles, and when it breaks down, poisons marine life. In an effort to promote recycling, marine debris was sorted into nets (nets/ropes/lines), hard plastic (buoys, floats, baskets, bins and other derelict fishing gear), tires, metal, and trash. Nets and hard plastic were stored separately at our Surfrider Marine Debris

Processing Center, tires and metal recycled at County facilities and trash taken to County dump. Nets and hard plastic were shipped to H-Power under the Hawai'i "Nets to Energy" program. We tried "Nets to Fuel". We also experimented with shipments to mainland recycling programs such as Parley, Method, TerraCycle etc. Additional selected items were given to artists for projects large and small and to educators. With a greater awareness of the effect greenhouse gas (GHG) emissions have on Global Climate Change, I looked for a method of recycling that cumulatively created the least amount of GHG equivalents through transport, transformation, and reuse. I also looked at byproducts of the processes and the end products themselves including microplastic, microfibers, toxic gases, toxic ash and final products that continue to be toxic in their new form. Most recycled products simply extended the poisonous life cycle for a year or two. Currently the eco-friendliest way to get rid of poisonous plastic is to bury it in a dump with an impervious bottom liner and sealed top to collect methane for energy reuse. Alternatively, we collaborated with ByFusion Inc. to build a structure of their ByBlocks which are made of shredded mixed plastic, cleaned, and fused into blocks the size of cement blocks but general shape of Legos. Each solid block weighs 10 kg and contains the equivalent of 555 plastic water bottles. The walls were sealed with stucco to prevent UV degradation of the plastic, effectively sequestering the plastic from the environment for decades. ByFusion is refining its patented block-building process to better shred marine debris and incorporate more in the blocks. Best performance to date is at 25% +5% marine debris while up to 50% has been obtained. The ByFusion process seems ideally suited for island communities with large amounts of marine debris and plastic waste from local industries, homes and the tour industry.

Accumulation and Separation of Shoreline Marine Debris through Buoyancy

Ray Aivazian III[1], Pavica Srsen[1], Will Smith, Dr. Floyd McCoy[1], Dr. Christopher Guay[1], Jennifer Lynch[2,3]

[1]Marine Option Program, Windward Community College, [2]Center for Marine Debris Research, Hawai'i Pacific University, [3]Chemical Sciences Division, National Institute of Standards and Technology

Plastic debris continues to wash upon Hawaiian shores at an alarming rate. Using currently available methods, in order to analyze the macro (>2.5cm) and meso(2.5cm-5mm) samples of this debris, a screen or sieve is utilized, but the smaller micro (<5mm) pieces are left behind, unaccounted for. This process does not give us an accurate representation of shoreline accumulation as everything below 5mm is generally being ignored. Current methods used to analyze samples, smaller than 5mm, require that the sediment and debris be removed from the beach and analyzed in the lab. However, by implementing new methods and materials proposed here, we can capture, separate and analyze this fraction of synthetic particles. By placing samples into seawater on location, we use positive buoyancy on the accumulated debris in order to separate it from the sand, rocks, coral and other dense debris. Through buoyancy, microplastic particles can be collected and quantified without the removal of these natural resources from the beach. Furthermore, since positively buoyant debris consists both of natural debris (e.g. wood) and synthetic debris (i.e. plastics), through the process of separation using buoyancy, natural debris is still being captured. Current methods of separating natural and synthetic debris are complex, requiring special training and equipment, thus rarely performed. But, if this mixture of natural and synthetic marine debris is submerged in water in a vacuum chamber, separation can easily be achieved. Theoretically, this is accomplished due to the density difference of the natural and synthetic debris after gases are removed. As the vacuum pump removes air from the chamber it also removes gases from pockets of the submerged natural and synthetic material, forcing water into the pores and waterlogging the materials. When pressure is released in the chamber the denser natural material sinks to the bottom while the synthetic debris will stay floating on top. The remaining buoyant debris can then be skimmed off and placed in a series of sieves to analyze the accumulation by size and weight. In the same way sedimentary samples are analyzed using the Wentworth Grade Scale, smaller sub size categories need to be implemented for microplastic samples as well. Through this entire process a larger spectrum of synthetic marine debris can be quantified while helping our environment and ecosystem better than before. Preliminary results using these methods show that James Campbell beach sand contains approximately 150 g of extracted debris per meter square. This is 100-times higher than other locations across the globe.

Marine Debris as Bycatch: Using Fishery Observer Data to Estimate Trends Over Time in the North Pacific Subtropical Convergence Zone

Amy V. Uhrin[1], William A. Walsh[2], and Jon Brodziak[3]

[1]NOAA, Office of Response and Restoration, Marine Debris Program, [2]Walsh Analytical Service, [3]NOAA, National Marine Fisheries Service, Pacific Islands Fisheries Science Center

Marine debris is abundant across the remote North Pacific Ocean, accumulating in convergence zones that coincide with the fishing grounds of the Hawai'i-based pelagic longline fishery. Longlines are prone to snagging marine debris, providing a mechanism for debris reporting by fishery observers. Here, we consider marine debris as bycatch, and apply a zero-inflated negative binomial model used in standardizing catch per unit effort (standardized CPUE) for biological bycatch species in this fishery, to estimate debris trends in the North Pacific Subtropical Convergence Zone (STCZ). During 2008-2016, observers reported 1,326 debris items, half of which were derelict nets. Our modeling results suggest that the relative abundance of marine debris caught by longlines is declining over time. Standardized CPUE of debris was highest in the STCZ and increased moving toward the Great Pacific Garbage Patch. Despite substantially less effort in the shallow-set sector of the fishery (~ 50-100 m depth), standardized CPUE was four-fold greater than that of the deep-set sector (~ 250 m). Observations from this fishery provide an opportunistic, yet regular, mechanism for assessing distribution, abundance, and trends of marine debris. Some longline fishermen voluntarily haul snagged debris from the ocean. Incentivizing at-sea debris removal may elicit further cooperation.

Towards Ecosystem Metrics of Plastic Ingestion by Hawaiian Seabirds

K. David Hyrenbach[1], Michelle M. Hester[2], F. David Horgen[1], Jennifer Lynch[3]

[1]Hawai'i Pacific University, [2]Oikonos Ecosystem Knowledge, [3]National Institute of Standards and Technology

Since 2009, we have studied marine plastic debris (MPD) ingestion in seabirds from the Main Hawaiian Islands to assess community-wide patterns in locally-breeding species and to develop ocean pollution metrics. Between 2009 and 2018, we necropsied over 1,000 birds of 12 species and documented ingestion in 7 species, belonging to 4 families (Diomedeidae, Hydrobatidae, Procellariidae, Phaethontidae) and representing a variety of foraging guilds. We documented low levels of MPD ingestion (< 50% incidence) in White-tailed Tropicbirds and Newell's Shearwaters; high levels (50 - 75% incidence) in Hawaiian Petrels and Wedgetailed Shearwaters; and very high levels (> 75% incidence) in Band-rumped Storm-petrels, Bulwer's Petrels, and Laysan Albatross. In particular, we propose that the Wedge-tailed Shearwater (Ardenna pacifica) is an ideal bioindicator of plastic in the epipelagic food web. During the breeding season, this species forages with subsurface-predators near (< 200 km) nesting colonies, is characterized by high rates of plastic ingestion in chicks (72.5%) and adults (71.4%), and can be readily sampled by salvaging fledging chicks and accidentally-killed adults. To place the plastic ingestion by these "tuna-birds" in a broader ecological

context, in 2012 we started quantifying the diets of island-associated predatory fishes caught by pole-and-line around the Main Hawaiian Islands, and documented MPD ingestion in five species (mahi-mahi, albacore tuna, skipjack tuna, yellowfin tuna, and kawa kawa). Albacore (85.7%) and skipjack (40.0%) had the highest MPD frequency of occurrence. In spite of the broad diets of these predatory fish, there were significant species-specific differences in their diet, as revealed by their stomach contents and the stable isotopic ratios (δ13C, δ15N) of their muscle tissue. Furthermore, while albacore and skipjack ingested plastic items made of lighter polymers, albacore contained disproportionately more polypropylene and polyethylene. These results suggest that these tuna species sample different food web components. Altogether, this research underscores the value of seabirds as bioindicators of plastic pollution, within a broader framework incorporating information from other pelagic predators and their shared prey. Moreover, coupling plastic ingestion studies with tracking, dietary, and isotopic analyses provides a wider context for investigating the flow of pollutants in North Pacific marine ecosystems.

Microplastic Accumulation Patterns in Sand at Three Hawaiian Beaches

Nicolas Vanderzyl[1], Steven L. Colbert[1], Tracy N. Wiegner[1]

[1]Marine Science Department, University of Hawai'i at Hilo

Microplastics (< 5 mm) are a pervasive contaminant in the ocean, and global concentrations are anticipated to increase with increasing marine debris. Microplastic concentrations are greater in sediment than water, and highest in backshore and subtidal zones.Yet, no comparative study across cross shore zones has been conducted to date on Hawai'i Island, HI. A comprehensive analysis along six shore zones at: 1) Hapuna Beach State Park, 2) Hilo Bay, and 3) Pohoiki, investigated if a cross shore microplastic concentration gradient existed. Samples were collected from the: 1) berm crest, 2) high tide line, 3) swash zone, 4) low tide line, 5) surf zone, and 6) shore break zone. Additionally, recent volcanic activity has formed a new beach, Pohoiki, permitting an investigation into the pervasiveness of microplastics in new sediment four months after its conception. Microplastics were extracted via density flotation, and visually sorted by: 1) fragment, 2) fiber, and 3) nurdle. Sediment grain size was also quantified to investigate any association with microplastic concentrations. Microplastic concentrations were similar at Hapuna and Hilo Bay, while significantly lower at Pohoiki. Fibers had the highest concentrations among all shore zones and sites, and all samples contained microplastics. Overall, microplastics were evenly distributed among all shore zones at Hapuna and Pohoiki, while a cross shore gradient was found at Hilo Bay. Although microplastic concentrations were highly variable among zones, this study documented higher concentrations backshore at Hilo Bay, suggesting an area of focus during future beach clean-ups. This study also found microplastics present at a newly formed beach. This further emphasizes the extent of global microplastic pollution.

On the Potential to Understand and Document Accumulation and Effects of Microplastic and Debris in Convergence Zones around Oahu

David Field[1], Jenna Karr[1], John Yeh[2]

[1]Hawai'i Pacific University, [2]Hawai'i Undersea Research Laboratory

While the large scale gyres result in high concentrations of microplastics and other debris across large areas of the subtropical gyres, small scale concentration zones around the Hawaiian Islands result in even higher concentrations. Concentration zones should be well understood since they may result in increased plastic consumption by organisms and may ultimately offer good opportunities for removal. I discuss two different types of concentration zones known around Oahu. First, a convergence zone off of Kaneohe Bay that may be associated with a density gradient associated with the shelf edge. Here, microplastic concentrations have been documented at 1-2 orders of magnitude higher than the background levels of the Pacific garbage patch. Next, a convergence zone near Makai Pier is described, along with observations and efforts to remove large debris by the HURL team. Both of these phenomenon offer great opportunities for HPU Marine Science students to carry out interdisciplinary research as part of classes, practicums, and/or thesis research on physical circulation patterns, characterization of local plastic debris, and predation by biota. Education and outreach activities could stem from these activities. I aim to initiate discussion about what questions can be asked, the observations that can be made, and which of these are of highest priority.

Chemical Weathering and Additives in Plastic Marine Debris in the Hawaiian Islands

Joelle Marchiani[1,2], Kayla Brignac[1], Jennifer Lynch[1,2]

[1]Chemical Sciences Division, National Institute of Standards and Technology, [2]Center for Marine Debris Research, Hawai'i Pacific University

Marine plastic pollution is a growing issue, and researchers need best methods for quantifying and characterizing plastic in complex environmental samples. Weathering of plastic polymers leads to the leaching of additives into the environment which potentially have detrimental health effects. The three main objectives of this study were to: (1) mine existing attenuated total reflectance Fourier transform infrared (ATR FT-IR) spectra of Hawaiian marine debris for polymer additives, (2) mine existing spectra for a carbonyl band which is indicative of photo-oxidative weathering and (3) conduct an outdoor natural sunlight weathering experiment to determine when a carbonyl band develops. For objective 1, spectra of 36 samples of Hawaiian marine debris (out of ~3500) show strong phthalate additive bands, of which the plasticizer diisononyl phthalate (DINP) was most common. Future spectral library searches determine whether FT-IR is an effective technique for identifying presence of additives in Hawaiian marine debris. For objective 2, the carbonyl band could potentially be used to aid in aging littered plastics. Methods to calculate the relative abundance of carbonyl groups were compared from previous publications to identify the best calculation. While it is well known that weathered polyolefins (polyethylene [PE] and polypropylene [PP]) form carbonyl groups, to the best of our knowledge, no publications have investigated whether carbonyl bands form in other polymers. Preliminary results on 9 samples suggest that carbonyl bands are not stronger for the most weathered Hawaiian PE or PP samples; however, future analysis of the external surface of the debris (rather than clean internal surface) and an increased sample size will improve this assessment. For our outdoor weathering experiment, three replicates of 6 polymer standards were placed on a glass surface over sand in direct sunlight in Waimanalo, Oahu, Hawaii: polyethylene terephthalate (PET), high density PE (HDPE), low density PE (LDPE), PP, polystyrene (PS), and polylactic acid (PLA). Polymers placed alongside these in darkness served as controls. Preliminary results from the weathering experiment indicate there were no statistically significant changes in mass in the first 18 days for the 6 polymer types. No carbonyl bands formed, and no visual changes to the polymer surfaces were apparent under a dissecting microscope. Future time points will determine when plastic debris develops a detectable carbonyl band.

Prey-sized Plastics are Invading Larval Fish Nurseries

Jonathan Whitney[1], Jamison M. Gove[1], Margaret A. McManus[2], Joey Lecky[1], Felipe C. Carvalho[1], Jennifer Lynch[3], Jiwei Li[4], Philipp Neubauer[5], Katharine Smith[2], Jana E. Phipps[1], Donald R. Kobayashi[1], Karla B. Balagso[1], Emily A. Contreras[1], Mark E. Manuel[6], Mark A. Merrifield[7], Jeffrey J. Polovina[1], Gregory P. Asner[4], Jeffrey A. Maynard[8], Gareth J. Williams[9]

[1]NOAA, National Marine Fisheries Service, Pacific Islands Fisheries Science Center, [2]Department of Oceanography, University of Hawai'i at Mānoa, [3]Chemical Sciences Division, National Institute of Standards and Technology, [4]Center for Global Discovery and Conservation Science, Arizona State University, [5]Dragonfly Data Science, [6]NOAA, Office of Response and Restoration, Marine Debris Program, [7]Scripps Institution of Oceanography, [8]SymbioSeas, [9]School of Ocean Sciences, Bangor University

Life for the majority of the world's marine fish begins at the ocean surface. Here among the plankton, food availability and predation drive larval fish survivorship and development prior to recruitment to natal habitat. Larval fish represent the next generation of adults that supply sustenance to humanity worldwide. However, little is known about the habitat preferences of larval fish during this vulnerable life-history stage. Here we provide the first ecosystem-scale evidence that surface slicks, a ubiquitous coastal ocean convergence feature, are important nurseries for larval fish from many ocean habitats. Slicks had higher densities of marine phytoplankton (1.7-fold), zooplankton (larval fish prey; 3.7-fold), and larval fish (8.1-fold) than nearby ambient waters across our study region in Hawai'i. Slicks contained substantially larger and well-developed larval fish with competent swimming abilities compared to ambient waters, suggesting a physiological benefit to increased prey-resources. Remarkably, slicks also contained 126-fold higher densities of plastics resulting in a 60-fold higher ratio of plastics to prey than in ambient waters. Scaling-up across the 1000 km2 coastal ecosystem in Hawai'i revealed that slicks occupied 8.3% of ocean surface habitat and contained 42.3% of all larval fish and 91.8% of all plastics. Dissections of 658 larval fish found that 7.7% of individuals in slicks had ingested plastics, a 2.3-fold higher occurrence than larval fish from ambient waters. Plastics were found in 8 of 9 taxa dissected, including swordfish (Xiphiidae), a commercially-targeted species, and flying fish (Exocoetidae), a principle prey for tuna and seabirds. Whether plastic ingestion by larval fish has physiological or population-level effects is unknown. Regardless, that larval fish are consuming non-nutritious, toxin-laden particles at their most vulnerable life-history stage is concerning. Compounding the effects of climate-induced habitat loss and overfishing, the invasion of larval fish nurseries by prey-sized plastics may represent another human-induced threat to global fisheries production.

Chemical Compatibility of Plastic Polymers in Preservation and Digestion Treatments for Extracting Microplastic from Biological Tissue

Rachel Sandquist[1], Jennifer Lynch[1,2], Jenna Karr[2], Jonathon Whitney[3], Jamison Gove[3], K. David Hyrenbach[2], Keith Korsmeyer[2]

[1]National Institute of Standards and Technology, [2]Hawai'i Pacific University, [3]National Oceanic and Atmospheric Administration

Plastics are abundant in diverse marine habitats of Hawaii, including the nearshore habitat of planktonic larval fish that are economically and ecologically important. It has been documented, using micro-dissection and Raman microscopy methods, that larval fish in this habitat are ingesting microfibers. We are on a quest for higher throughput, automated methods to monitor the quantities and identities of microplastic debris in environmental samples. Instead of micro-dissection, we considered methods for chemically digesting biological tissues away from ingested microplastics. These methods use chemicals that are poorly compatible with some plastic polymers. Certain polymers in our samples are expected to dissolve in the chemical treatments, leading to significantly underestimated quantities. The goal of this study is to test the compatibility of 14 polymers with commonly used and novel preservation and digestion techniques, in triplicate and in the absence of biological tissue. Polyethylene terephthalate, high density polyethylene, polyvinyl chloride, low density polyethylene, polypropylene, polystyrene, cellulose acetate, nylon, polymer containing a high proportion of phthalates, polyurethane, polylactic acid, cotton fibers, and polyester fibers will be used as representatives of the most common polymers found in Hawaiian marine debris. We will test their stability in four digestion methods: acid, base, hydrogen peroxide, and bleach, as well as in two preservatives, 95% ethanol for 1 week and 1 month and formalin for 1 day. Changes in particle count, mass, shape, surface texture, and infrared spectra will be measured. Preliminary data shows 1 week exposure to 95% ethanol significantly reduces the mass of cotton, polyester, and phthalates. The data will be used to demonstrate the extent of underestimated polymer quantities in previous studies and to select optimal methods for future analysis of a large repository of preserved larval fish sampled from nearshore Hawaii.

Seabirds Sample Plastic Pollution: Bonin Petrels (Pterodroma hypoleuca) as Bioindicators of Plastic in the North Pacific

Lauren Fraser Chamberlain[1], Melissa Jung[2], K. David Hyrenbach[1], Jennifer Lynch[2]

[1]Hawai'i Pacific University, [2]National Institute of Standards and Technology

Bonin Petrels (Pterodroma hypoleuca) are characterized by high incidence of marine plastic ingestion (> 90%). We contend that Bonin Petrels are ideal bioindicators of pelagic plastic pollution for the Northwestern Hawaiian Islands due to their breeding phenology, stomach anatomy, and foraging ecology. Our goal is to create baseline data for this species, develop necropsy protocols for the future, and gain insight into the types of plastic sampled by these seabirds. Necropsies were performed on 80 Bonin Petrel specimen collected from Midway Atoll to characterize body condition and plastic ingestion. Samples remained separate by age class and stomach chambers. Plastic items were categorized by type, size, and polymer composition. Overall, 98% of hatch-year birds (HY) (n=40) had ingested plastic: 90% had plastic in the gizzard and 68% had plastic in the proventriculus. 95% of after-hatch-year (AHY) birds (n=40) had ingested plastic: 93% had plastic in the gizzard and 20% had plastic in the proventriculus. In birds that had plastic, average plastic was 0.0179 g ± 0.0238 SD for hatch-year birds (n = 39) and 0.0097 g ± 0.0200 SD for after-hatch-year birds (n= 38). By mass, fragments were the most abundant plastic type (HY: 51%; AHY: 58%), followed by line (HY: 27%; AHY: 23%), sheet (HY: 22%; AHY: 4%) and foam, which was only found in adults (15%). Bonin petrels ingested floating polymer types, which accounted for the following relative mass: low-density polyethylene (42%), high-density polyethylene (14%), polyethylene (11%), polypropylene (14%), polypropylene/polyethylene (12%), polystyrene (5%), and unknown (2%). The differences in plastic incidence and mass by age class and stomach chamber underscore the need to consider these factors when using Bonin petrels as samplers. Fragments make up the majority of the ingested plastic and low-density polyethylene is the most abundant polymer type, giving insights into the composition of the plastic floating in the birds' foraging region.

Ocean Voyages Institute 2019 25-day Ocean Cleanup Expedition

Mary T. Crowley[1]

[1]*Ocean Voyages Institute*

Welcome and thank you so much for giving me the opportunity to present to you about our Spring 2019 25-day ocean cleanup expedition.

During our cleanup expedition, Ocean Voyages Institute collaborated with Nikolai Maximenko and Jan Hafner of the University of Hawaii, coordinating the Nasa-funded FloatEco project that studies physical processes controlling long-range drift of marine debris and its accumulation in some areas of the ocean as well as biological processes controlling the evolution of the pelagic floating ecosystem.

To begin with, I am going to share a short film clip on our expedition.

- Film Clip 5 min

Introduction:

- Brief history of Ocean Voyages Institute, previous expeditions and work.
- Marine Debris Collection Think Tank.
- GPS Satellite Trackers utilized to track ghostnets and to allow recovery vessel to easily find ghostnets.

Main Presentation:

- 2020 Expedition - a very scalable expedition with plans to increase the scale of expedition by 10x by operating cleanup efforts at sea over a 3-month period and utilizing additional vessels with refinements and additional technology.

I hope that any of you with questions will come to me at any point. I look forward to collaborating with all of you on a full range of ocean cleanup initiatives.

Marine Debris in Maui County: Progress in Understanding the Scope, Impact, and Effectiveness of Policy

Jens J. Currie[1], Jennifer Roberts[1], Stephanie H. Stack[1]

[1]*Pacific Whale Foundation*

Marine debris is a problem that extends to the environmental, social and economic spheres of Hawaii. Mitigating these impacts is a multidisciplinary, requiring research and monitoring to guide effective policy. To improve our understanding of the impacts of marine debris and policy in Maui Nui, systematic shoreline and boat-based surveys were undertaken along the coast and leeward waters of Maui from 2013-2019. This research program focused on determining the: (1) sources, distribution, and fate of marine debris; (2) risk marine debris poses to wildlife; and (3) efficacy of policies and campaigns on reducing debris accumulation. Our initial study showed that on the island of Maui the highest accumulation rates occurred on windward shorelines, with intensity of the trade winds being the most significant contributor. In Maui Nui leeward waters, local currents and eddies were responsible for at-sea distribution, with the highest accumulation off of southeast Lanai. Across all survey platforms, plastics were responsible for 85% of all debris collected, with cigarette filters being the highest single item. When we examined the risk of marine debris to marine wildlife, we found that within the leeward waters of Maui Nui humpback whales and bottlenose dolphins were the most at-risk of debris ingestion and/or entanglement, with high overlap observed between debris and species distribution. Finally, when we studied debris mitigation, we found that current policies in Maui County had varying degrees of success in reducing marine debris with no tools in place for monitoring or policy evaluation. The success of policy was found to relate to legislative scope (consumer vs producer responsibility) as well as enforcement effort. To complement policy, raising public awareness through campaigns was found to be an effective way of reducing marine debris, with up to 50% reduction observed on some beaches in response to outreach efforts. Although a global movement to reduce marine debris exists, there remains a disconnect between legislative action and scientific research to underpin solutions, policy, and mitigation measures. To effectively mitigate marine debris will require improved practices for policy and legislation, education, outreach and awareness, source identification, and continued monitoring and assessment. With sound practices in place, scale-appropriate solutions to reduce the input of marine debris into the environment can be developed.

Plastics and Microfibers in the Environment

Sarah-Jeanne Royer[1], Dimitri Deheyn[1]

[1]*Marine Biology Research Division, Scripps Institution of Oceanography, University of California*

Plastic pollution has been a growing concern recently as it is found everywhere, impacting all forms of life, including humans. While many studies have investigated the extent of plastic pollution in aquatic environments and wildlife, very few studies have looked at synthetic microfibers, which are ubiquitous in the environment, including in the oceans and the atmosphere. Microfibers are invisible to the naked eye given their small size, and thus we breathe, eat and drink them without being aware of it.
Here, we propose a quick overview of the effect of plastic in our environment with a special emphasis on microfibers. In collaboration with Lenzing, we describe the methodology used to assess the degradation of microfibers in the environment and the ongoing study at Scripps Institution of Oceanography (SIO) in San Diego, California, USA. The infrastructures for testing the degradation of microfibers in the environment and in the laboratory are ideal at SIO but some challenges and open questions remain. These types of research across academia and industry, and across disciplines (from material science to biology and ecology) are necessary to address the urgent need for increasing our knowledge regarding plastics and synthetic microfibers in the ocean, especially in the wake of environmental and human health issues.

A Journey of a Ghost Net from the Sea to Maui Shore

Jan Hafner[1], Nikolai Maximenko[1], Mary Crowley[2], John Hocevar[3], Campbell Farrell[4], Andy Sybrandy[5]

[1]International Pacific Research Center, School of Ocean, Earth Science, and Technology, University of Hawai'i at Mānoa, [2]Ocean Voyages Institute, [3]Greenpeace, [4]Love the Sea, Pacific Gyre[5]

Since the last summer many ghost nets in North Pacific were tagged with satellite trackers by volunteer sailors. The goal is to retrieve them and collect biological samples later when sufficiently large ship is available. The trackers are provided by Ocean Voyages Institute. One of the trackers is the tracker number OVI-MST-0029, which was attached to a large ghost net by Greenpeace in November 2018. The deployment location was about 1,200 km (~650 nm) NE of Hawaii. Then the tracker with the ghost net was slowly drifting in westward direction. By the end of March 2019 it approached the Hawaiian Islands with a real possibility of landing on Hawaiian shores. Then we all got excited, a ghost net landing in Hawaii with recorded prior trajectory! A 10 day forecast of the tracker movement was calculated to plan for search and retrieval.

In early April 2019 the tracker approached the northern part of Big Island with predicted landfall on east shores. A couple of search parties were on standby and ready for action. However, the final trajectory prior to landing was complex, and the forecast in coastal zone uncertain. The tracker actually made two approaches to the northern tip of Big Island before landing at the north shore of Maui in mid of March. Then search parties were launched to locate and pick the tracker with its net. It was finally retrieved by Campbell Farrell (Love the Sea) on 17 April 2019!

Probably, this case is the first of ghost net landfall with documented trajectory, at least in Hawaii. With more cases like the tracker OVI-MST-0029 we can possibly learn more about the pathways of nets and derelict fishing gear landing on Hawaiian shores.

Fish Aggregating Device (FAD) Satellite Buoys Wash Ashore on Palmyra Atoll and Hawaii: A tool to Source and Prevent Nets from Entangling Reefs?

Harry Lynch[1], Jennifer Lynch[2], Stefan Kropidlowski[3], Sarah-Jeanne Royer[4,5]

[1]The Nature Conservancy, [2]Center for Marine Debris Research, Hawaii Pacific University, [3]U.S. Fish and Wildlife Service, [4]University of Hawai'i, [5]Scripps Institution of Oceanography

Drifting fish aggregating devices (dFADs) are commonly used in the purse seine tuna fishery to attract fish. dFADs are commonly made of bamboo rafts and floats wrapped in nets with stretches of nets hanging vertically in the water column. Fishing fleets track the location of floating dFADs using attached satellite transmitter buoys. Derelict fishing nets make up a considerable percentage of marine debris impacting the coral reefs of the Hawaiian Islands and Palmyra Atoll. Some net masses are identifiable as dFADs associated with purse seine fishing, and some of those still have attached satellite tracking buoys. Since 2014, at least 30 buoys have been recovered from marine debris in the Main Hawaiian Islands and Palmyra Atoll. Date, location, serial numbers, attached net descriptions, and photos are recorded in a database. This poster discusses how dFAD buoys can play a role in marine debris tracking, sourcing, site remediation, and prevention. Physical oceanographers could make use of previous tracks of recovered FAD buoys to predict future dFAD grounding events, if the data were made available. If abandoned buoys can be reprogrammed, the devices could be repurposed for future offshore tracking scientific studies. The unique identifiers on the buoys could be used to source the abandoned fishing gear to a particular vessel or fleet. Ideally, concerned parties could work collaboratively with the fishery to prevent abandoned dFADs from washing ashore. The fishery, satellite transmitter manufacturers, and state/federal agencies could decide together to make real-time GPS locations accessible when the dFAD drifts outside of sanctioned fishing grounds, allowing the salvage of the dFAD before it causes ecological damage in shallow coastal waters. Use of dFADs offer an opportunity to work with the fishing industry to minimize environmental harm.

Lawai'a Pono: Engaging Recreational Anglers in Sea Turtle Conservation and Evaluating Impacts

Jennifer (Aleysa) Martin[1], Ku'ulei Gunderson[1], Thomas Cutt[1]

[1]Maui Ocean Center Marine Institute

Maui Ocean Center Marine Institute (MOCMI), coordinates response to sick, injured, or expired sea turtles on the island of Maui, Hawai'i in partnership and coordination with NOAA Fisheries. Recreational fishing gear is identified by NOAA as the primary cause of strandings of sea turtles in Hawai'i. To prevent pollution and decrease harmful interactions between sea turtles and fishing line, MOCMI launched the Fishing Line Recycling Program (FLRP) in June 2018. The FLRP provides an accessible method for fishers to take a proactive approach to prevent pollution and reduce entanglement hazards by properly discarding their line. Fishing line recycling bins and educational signage are installed at 24 high-traffic fishing locations along Maui's shoreline, and on three sites in Hilo, Hawai'i Island. The fishing line is routinely collected, sorted of hooks and weights, and shipped to the Berkley Conservation Institute where it is melted down and repurposed. Since July 2018, a total of 17,507.16 meters of fishing line has been collected from MOCMI fishing line recycling bins. MOCMI staff and interns conduct surveys each week to gather baseline knowledge of fishers' awareness of proper methods for discarding line and willingness to participate in a conservation initiative. To date 101 fishers have been surveyed. With more targeted outreach and increased contact with the recreational fishing community, we have been able to improve our understanding and engagement. As we evaluate the impacts of the FLRP, we hope that our findings will help determine best management practices in regards to fishing gear.

Identification and Quantification of Chemical Additives in Marine Debris

Katy Shaw[1], Jennifer Lynch[1], John Kucklick[1]

[1]National Institute of Standards and Technology

The marine debris community is lacking reliable and reproducible methods to accurately determine chemical additives in plastic marine debris. Development of these methods has been named one of the top priorities in the 2018 Science and Technology for America's Oceans: A Decadal Vision report. Approximately eight million tons of plastics are released into the ocean every year, potentially leaching harmful amounts of additive chemicals into the ocean and organisms consuming the plastic. The majority of these additives are physically and not chemically-bound to the plastic, thus rendering these chemicals leachable into surrounding environments. Targeted classes of additives include antioxidants (diphenylamine), UV stabilizers (benzotriazoles), plasticizers (phthalates, aliphatic esters), and flame retardants (polybrominated diphenyl ethers). The first aim of this study is to develop methods utilizing gas chromatography- mass spectrometry

(GC-MS) and liquid chromatography- tandem mass spectrometry (LC-MS/MS) to measure common additives in plastic. A second aim of this research is to use the optimized method(s) from aim 1 to measure chemicals in new consumer goods that are commonly found in marine debris as well as weathered marine debris. A database of what chemicals or additives are found in plastics will be developed. The database will provide other scientists not only what chemical additives are within each plastic type, but the quantity, information we are currently lacking. The final goal is to develop laboratory based leaching studies to determine rates at which targeted chemicals desorb from plastic in seawater and during animal digestion. The crucial component of this proposal is the development of novel analytical techniques to quantify additives in plastics. Other studies have qualitatively assessed chemicals in plastics, but a quantitative method is lacking. GC-MS and LC-MS/MS are commonly available analytical instruments, and their use in this project will ensure labs around the world will have access to the methods developed here. The resultant data will provide researchers with the tools needed to identify chemical additives in polymers as well as biotic and abiotic environmental samples.

Identifying Polymers of Plastic Marine Debris to Monitor the Effectiveness of Maui's Expanded Polystyrene Foam Food Service Containers Ordinance

Sheena Weller[1], Joelle Marchiani[2], Kellie Teague[1], Angelica Moua[1], Kayla Brignac[1], Melissa Jung[1], Cheryl King[3], Jennifer Lynch[1,4]

[1]Center for Marine Debris Research, Hawai'i Pacific University, [2]Summer Undergraduate Research Fellowship, National Institute of Standards and Technology, [3]SHARKastics, [4]National Institute of Standards and Technology

Some of the largest documented quantities of marine debris occur in Hawaii. Municipal bans on single-use plastic items are becoming more common, but the effectiveness of these policies on marine debris have rarely been studied. Maui County in Hawaii enacted a ban on expanded polystyrene (EPS) foam food service containers, which went into effect on Dec. 31, 2018. The ban includes cups, plates, bowls, clamshells, and serving trays, with goals to protect wildlife, reduce plastic waste and combat climate change. The objective of the current study was to use polymer identification methods to determine whether the ban has an effect on the plastic marine debris composition on two Maui beaches: Kaehu on the northern windward side and Kealia on the southern leeward side. Three sections along the high tide drift line were surveyed monthly at both beaches from seven months pre-ban and continue. Plastic debris items >1 cm in length along the drift line were collected from the beach surface until 50 items were collected. Survey length was then measured. Plastic items were categorized by type - specifically noting if they were from an EPS foam food container, color, length, mass, weathering, and then analyzed for polymer composition via attenuated total reflectance Fourier transform infrared spectroscopy (FTIR). Preliminary results on 1511 pre-ban debris pieces show that debris amounts, types and polymers differ substantially between the two beaches. Plastic debris abundance was an order of magnitude greater on Kaehu (9 g/m) compared to Kealia (1 g/m), which is typical of windward vs. leeward beaches. The proportion of PS (regardless of expanded or extruded) on Kaehu (≈25 %) was larger than Kealia Beach (≈10 %), and the proportions did not change substantially throughout the pre-ban months. The percentage of all debris items that were visually identified as EPS food service containers was greater on Kaehu (12 %) compared to Kealia (3 %) in pre-ban months. The percentage did not change four months post-ban on Kaehu but significantly decreased on Kealia (0.3%). Additional analyses of post-ban samples will reveal how quickly and where the new policy improves the plastic pollution on Maui beaches. Since a large percentage of debris washing ashore on Hawaiian windward beaches is from distant sources, local legislation concerning particular single-use items are expected to make a small, but important, noticeable improvement in the marine debris issue on Hawaiian coastlines.

Wilbur L. Ross, Jr.
United States Secretary of Commerce

Dr. Neil Jacobs
Assistant Secretary of Commerce for Environmental Observation and Prediction, performing the duties of Under Secretary of Commerce for Oceans and Atmosphere

Nicole R. LeBoeuf
Acting Assistant Administrator for Ocean Services and Coastal Zone Management

Photo Credit: NOAA