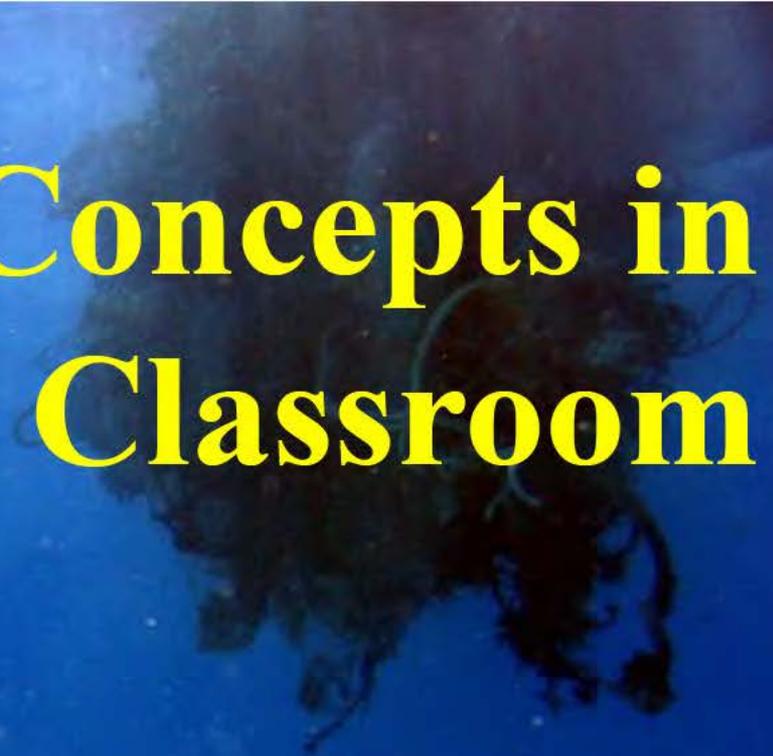


Marine Debris Concepts in the Classroom



Sherry Lippiatt, PhD
Marine Debris Program
National Oceanic & Atmospheric Administration

Marine Debris

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Table of Contents

- The NOAA Marine Debris Program
- **Marine Debris: The What and Where**
- Impacts of Marine Debris
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- “Garbage Patches” and other accumulation zones
- **Monitoring for marine debris**
- A Year’s Worth of Ideas
- **Sample Curriculum**
- Resources for Teachers
- **Q&A**



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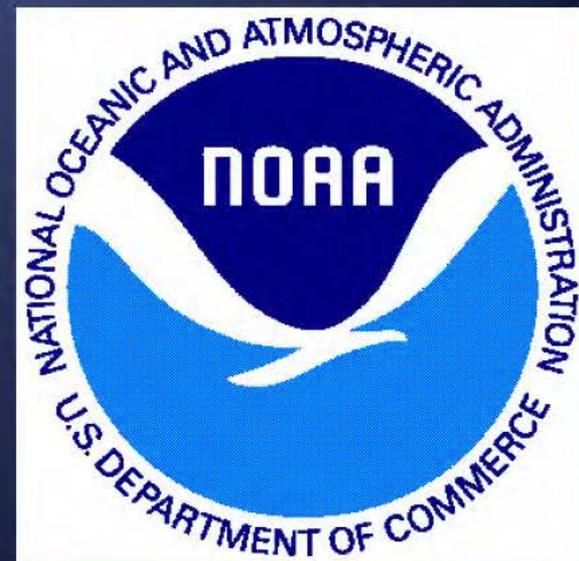


- **NOAA:**

- The **National Oceanic & Atmospheric Administration**'s mission is to understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet our nation's economic, social, and environmental needs.

- **The NOAA Marine Debris Program:**

- Designated by Congress as the centralized U.S. capability within NOAA for coordinating and supporting national and international efforts to research, prevent, and reduce the impacts of marine debris.



Marine Debris

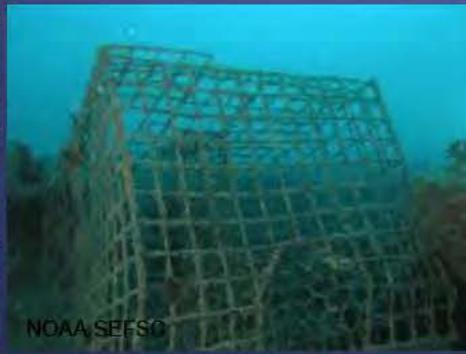
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What **is** marine debris?

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Marine Debris is “any persistent **solid material** that is manufactured or processed and directly or indirectly, intentionally or unintentionally, **disposed of or abandoned into the marine environment** or the Great Lakes.”

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K. McElwee, NOAA

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Marine Debris: Where does it come from?

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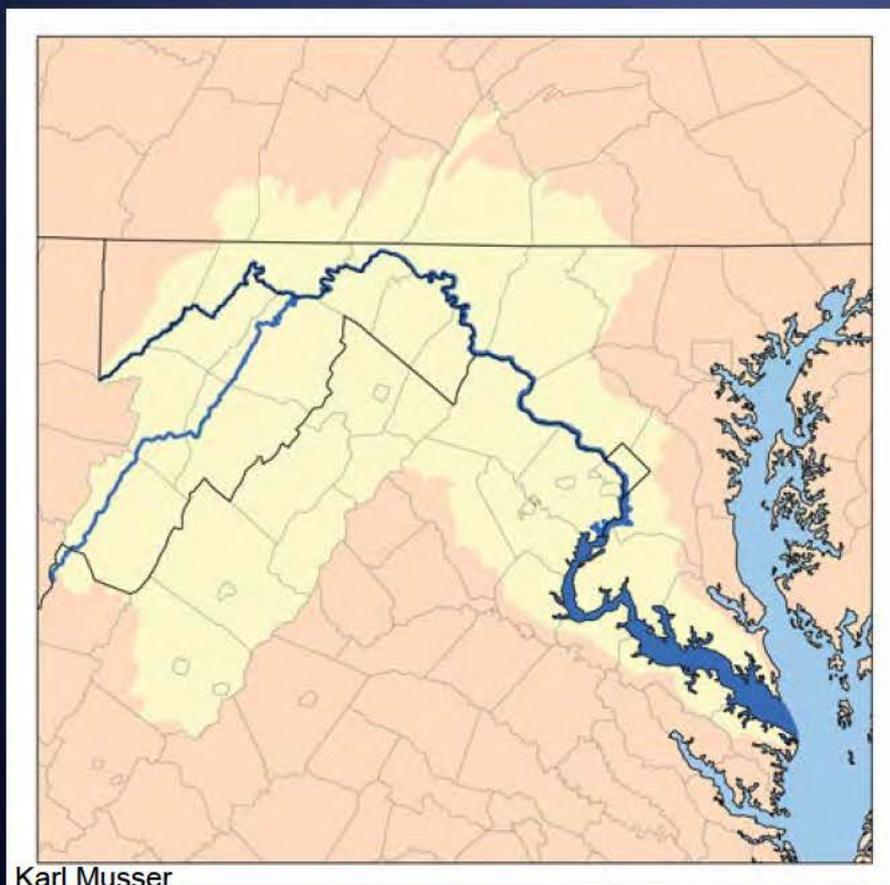


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Watershed Scale



Karl Musser



www.fairfaxcounty.gov

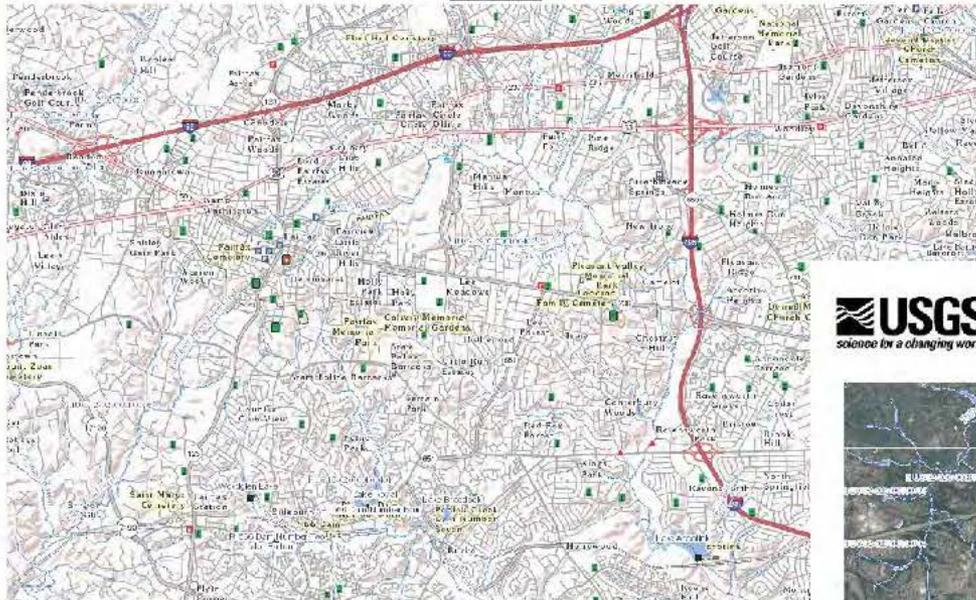
We all live downstream. Be part of the solution upstream.

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Fairfax roads

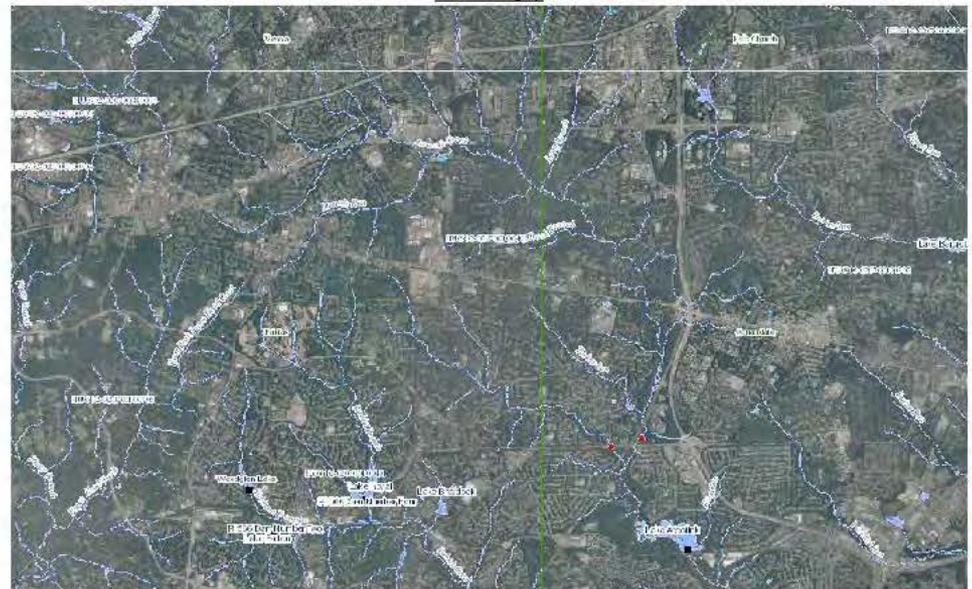


Fri Aug 26 11:17:33 MDT 2011

Marine debris is a global problem with local solutions.



Fairfax imagery



Fri Aug 26 11:18:35 MDT 2011

USGS National Map Viewer
<http://viewer.nationalmap.gov/viewer/>

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Marine Debris: Why should we care?

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Marine Debris: Impacts

- Social
 - Human health
 - Tourism
- Economic
 - Fisheries
 - Shipping / commerce
 - Tourism
- Environmental
 - Physical
 - Chemical
 - Biological



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Marine Debris Research: Microplastics

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Plastic: The Basics

• Characteristics:

- Lightweight / floatable (but not all!)
- strong/durable
- low cost
- Worldwide distribution
- Majority of the debris **seen in environment** is made up of plastic



J. Champagne, PMNM

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What are Microplastics?

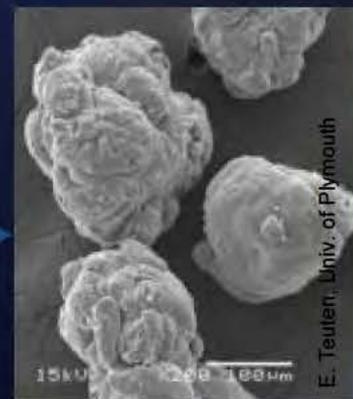
Plastic debris $\leq 5\text{mm}$

- Identified in oceans worldwide
- Ingested by a number of marine species

Where do they come from?

- **Direct input:** Exfoliants, roto-moulding, pre-production plastic pellets
- **Indirect:** Fragmentation of larger plastics

Degradation rate depends on:
Density, temperature, polymer type, UV



E. Teuten, Univ. of Plymouth

Does plastic marine debris degrade?

ANSWER: Yes...and No.

- Degradation definition
- Plastic bottle → Microscopic bits of plastic debris? **YES.**
- Plastic bottle → $\text{CO}_2 + \text{H}_2\text{O}$? (mineralization) **NO.**
- Bio-plastics and/or biodegradable plastics?

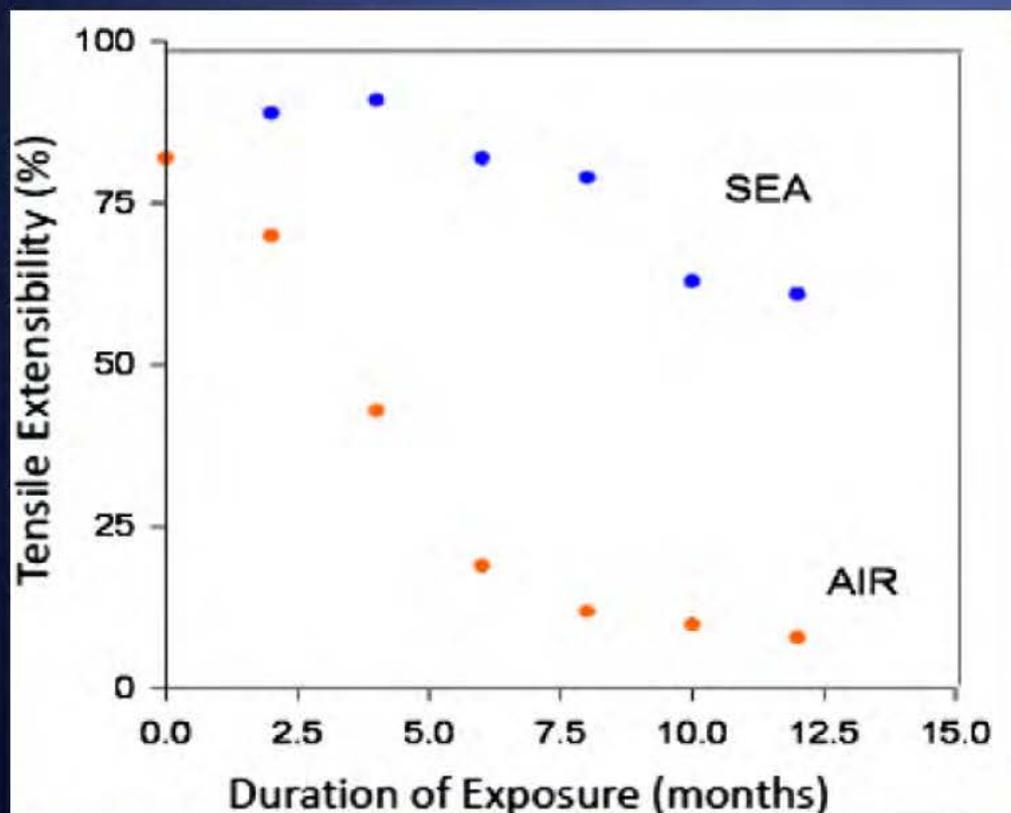
READ THE FINE PRINT...

- Under what conditions? (composting, soil, marine)
- Degrades to what? (microplastics? CO_2 ?)

- Main material : Starch-Rich Source From Crops.
- Non-toxic and void of strange smell.
- Starts decompose after 180 days under the soil with need of oxygen and inducement.

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Andrady 2011. Change in tensile extensibility of PP tape exposed to air and floating in seawater.

Fragmentation of synthetic polymers:

- Biodegradation
- Photodegradation*
- Thermal degradation
- Thermooxidative degradation*
 - O₂ must be present
 - Kick-started by photo-deg.
- Hydrolysis

- Polymers in marine environment primarily fragment via **photo- and thermooxidative degradation**.
- More rapid degradation in beach environments.

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Plastics & Pollutants

Persistent organic pollutants (POPs)
e.g., DDT, PCB present in seawater

WHAT WE KNOW

- POPs are in the water
- Plastic debris can absorb & transport pollutants
- Plastic debris is ingested by sea life

WHAT WE DON'T KNOW

- Are the contaminants bioavailable? Desorb contaminants?
- Significant vector compared to other sources?
- Food web effects?
- Leaching of additives? (e.g., flame retardants, BPA)



James Leichter, Marine PhotoBank

Marine Debris

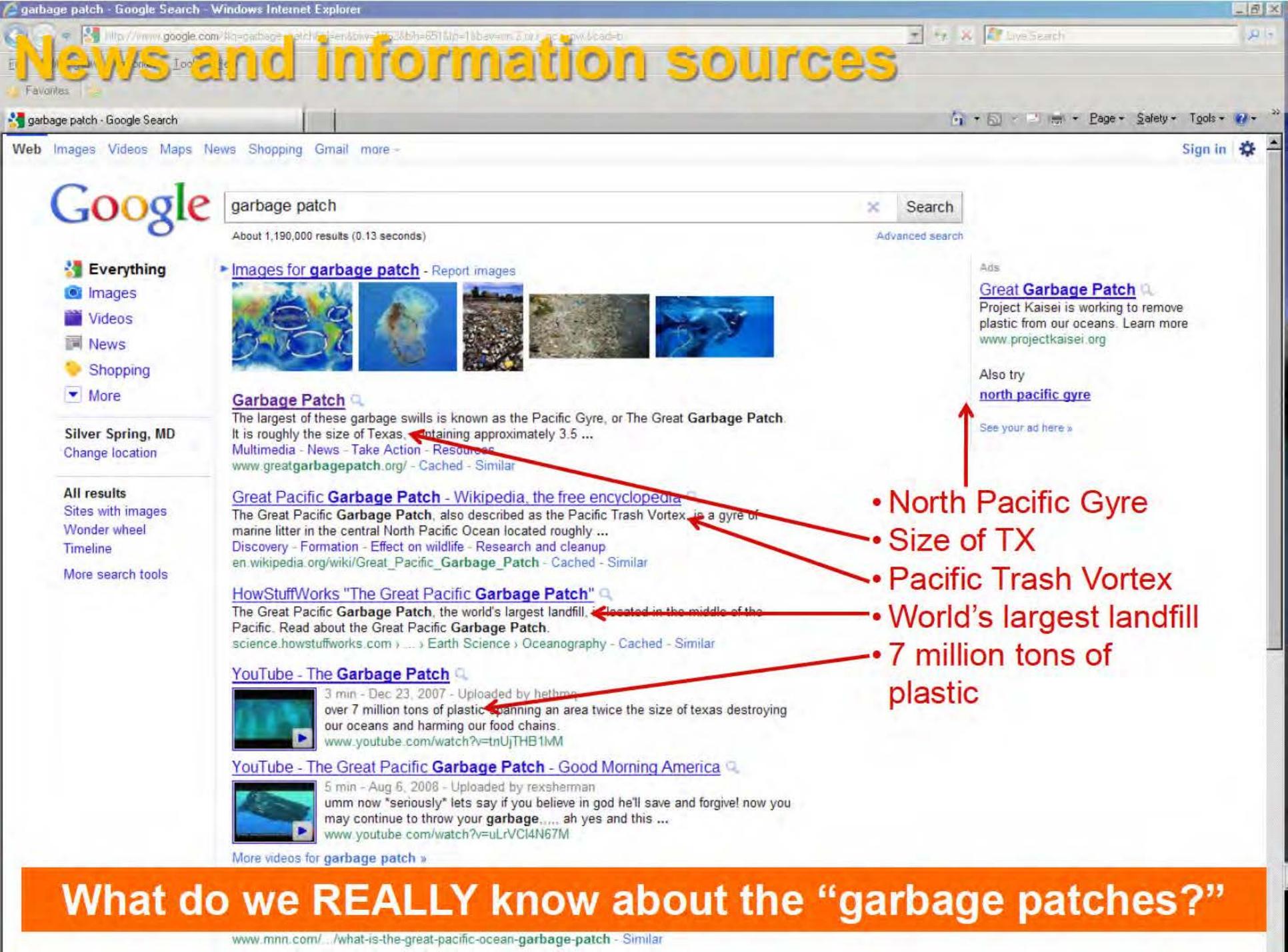
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What we know about... The “garbage patches”



NOAA PIFSC ORED



News and information sources



garbage patch Search

About 1,190,000 results (0.13 seconds) Advanced search

- Everything
- Images
- Videos
- News
- Shopping
- More

Silver Spring, MD
Change location

- All results
- Sites with images
- Wonder wheel
- Timeline
- More search tools

Images for garbage patch - Report images



Garbage Patch

The largest of these garbage swills is known as the Pacific Gyre, or The Great Garbage Patch. It is roughly the size of Texas, containing approximately 3.5 ...

Multimedia - News - Take Action - Resources
www.greatgarbagepatch.org/ - Cached - Similar

Great Pacific Garbage Patch - Wikipedia, the free encyclopedia

The Great Pacific Garbage Patch, also described as the Pacific Trash Vortex, is a gyre of marine litter in the central North Pacific Ocean located roughly ...

Discovery - Formation - Effect on wildlife - Research and cleanup
en.wikipedia.org/wiki/Great_Pacific_Garbage_Patch - Cached - Similar

HowStuffWorks "The Great Pacific Garbage Patch"

The Great Pacific Garbage Patch, the world's largest landfill, located in the middle of the Pacific. Read about the Great Pacific Garbage Patch.

science.howstuffworks.com - Earth Science - Oceanography - Cached - Similar

YouTube - The Garbage Patch

3 min - Dec 23, 2007 - Uploaded by hethma
over 7 million tons of plastic spanning an area twice the size of texas destroying our oceans and harming our food chains.
www.youtube.com/watch?v=tnUjTHB1MM

YouTube - The Great Pacific Garbage Patch - Good Morning America

5 min - Aug 6, 2008 - Uploaded by rexsherman
umm now *seriously* lets say if you believe in god he'll save and forgive! now you may continue to throw your garbage..... ah yes and this ...
www.youtube.com/watch?v=uLrVCI4N67M

More videos for garbage patch »

Ads

Great Garbage Patch
Project Kaisei is working to remove plastic from our oceans. Learn more
www.projectkaisei.org

Also try
[north pacific gyre](#)

See your ad here »

- North Pacific Gyre
- Size of TX
- Pacific Trash Vortex
- World's largest landfill
- 7 million tons of plastic

What do we REALLY know about the "garbage patches?"

www.mnn.com/.../what-is-the-great-pacific-ocean-garbage-patch - Similar

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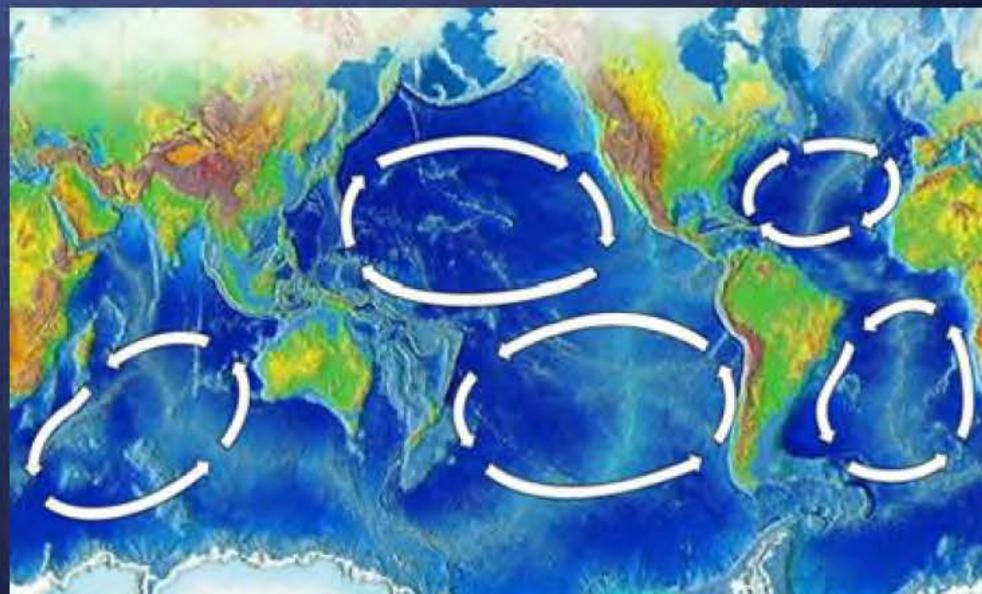
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Here's what you need to know...

Term “garbage patch” is a misnomer.

Marine debris concentrates in various areas of our oceans – not just the “garbage patches.”



Gyres (very large scale)
Eddies
Windrows

3 things to remember:

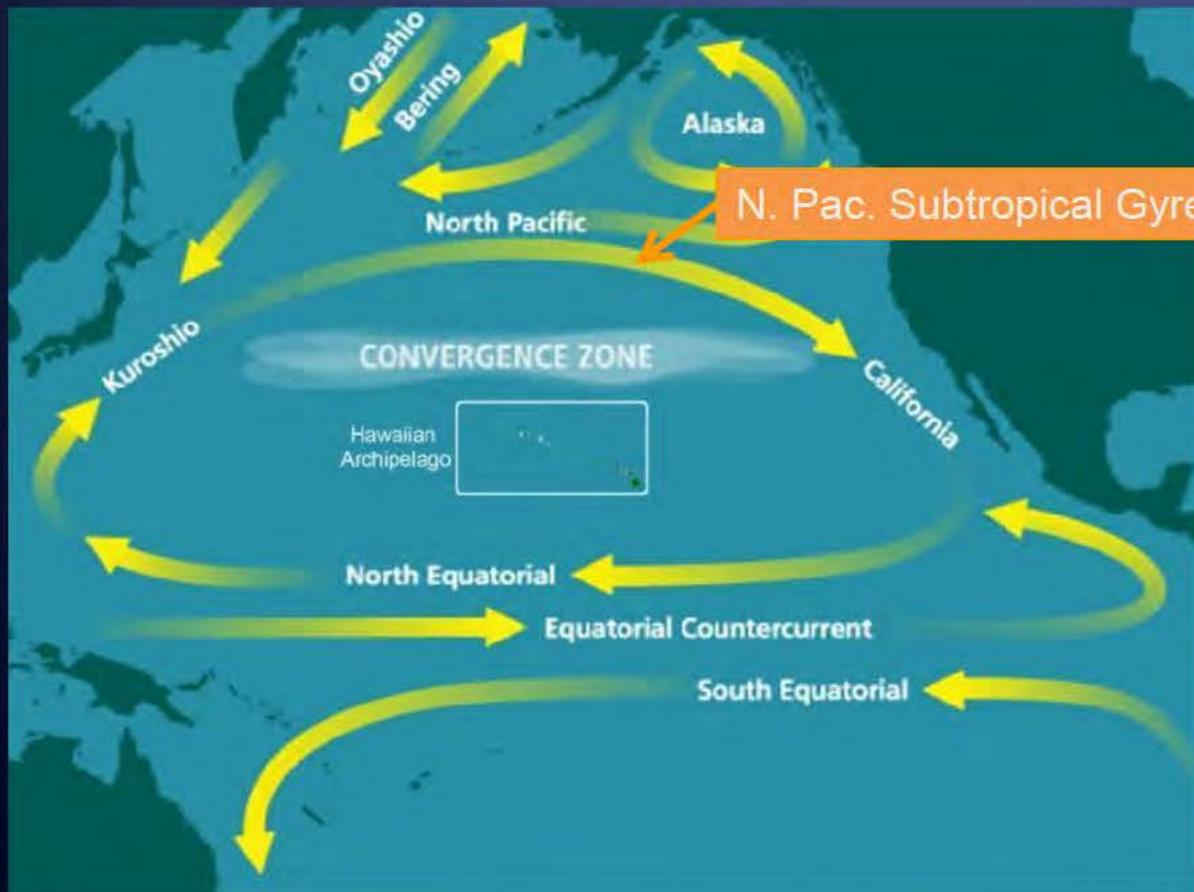
1. NOT a blanket of trash visible with satellite or aerial photography.
2. Exact size and mass are unknown.
3. Mainly small bits of floatable marine debris.

Marine Debris

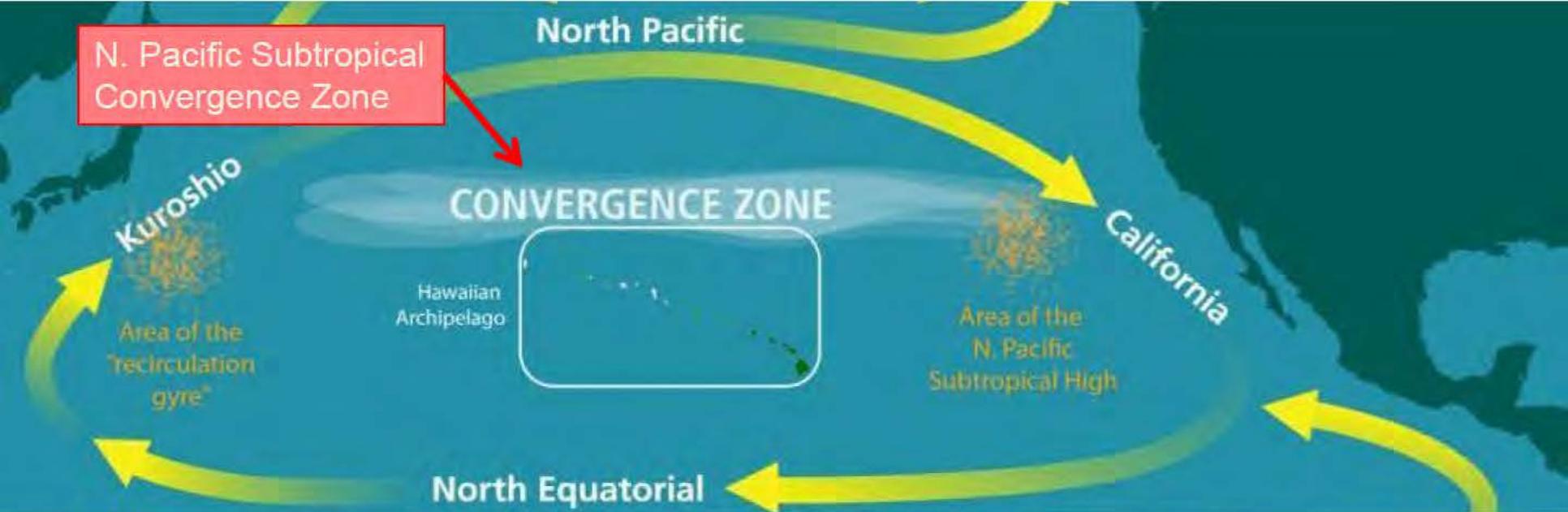
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Gyres



- The “gyre” is not necessarily the same as the “patch”
- 5 subtropical gyres worldwide (North Atlantic, South Atlantic, North Pacific, South Pacific, and Indian Ocean gyres)
- Likely increased concentration of debris near centers of all gyres



Known areas of concentration (Pacific)

.... All of which are spatially variable and change in strength

- **N. Pacific Subtropical Convergence Zone** (Pichel, et al., 2007)
 - Area of convergence between subarctic and subtropical frontal zones
 - Created by Ekman transport
- **Eastern Pacific “garbage patch”** (Howell, et al., in press) = North Pacific Subtropical High
- **Western Pacific “garbage patch”** = small “recirculation gyre” south of the Kuroshio current
- **S. Pacific Subtropical Gyre** (Martinez, et al., 2009)

Informative resource on N. Pacific STCZ: <http://marinedebris.noaa.gov/info/patch.html>

Image of the sea surface taken from aboard NOAA Ship Okeanos Explorer during a cruise from HI to CA, which transited through the garbage patch.

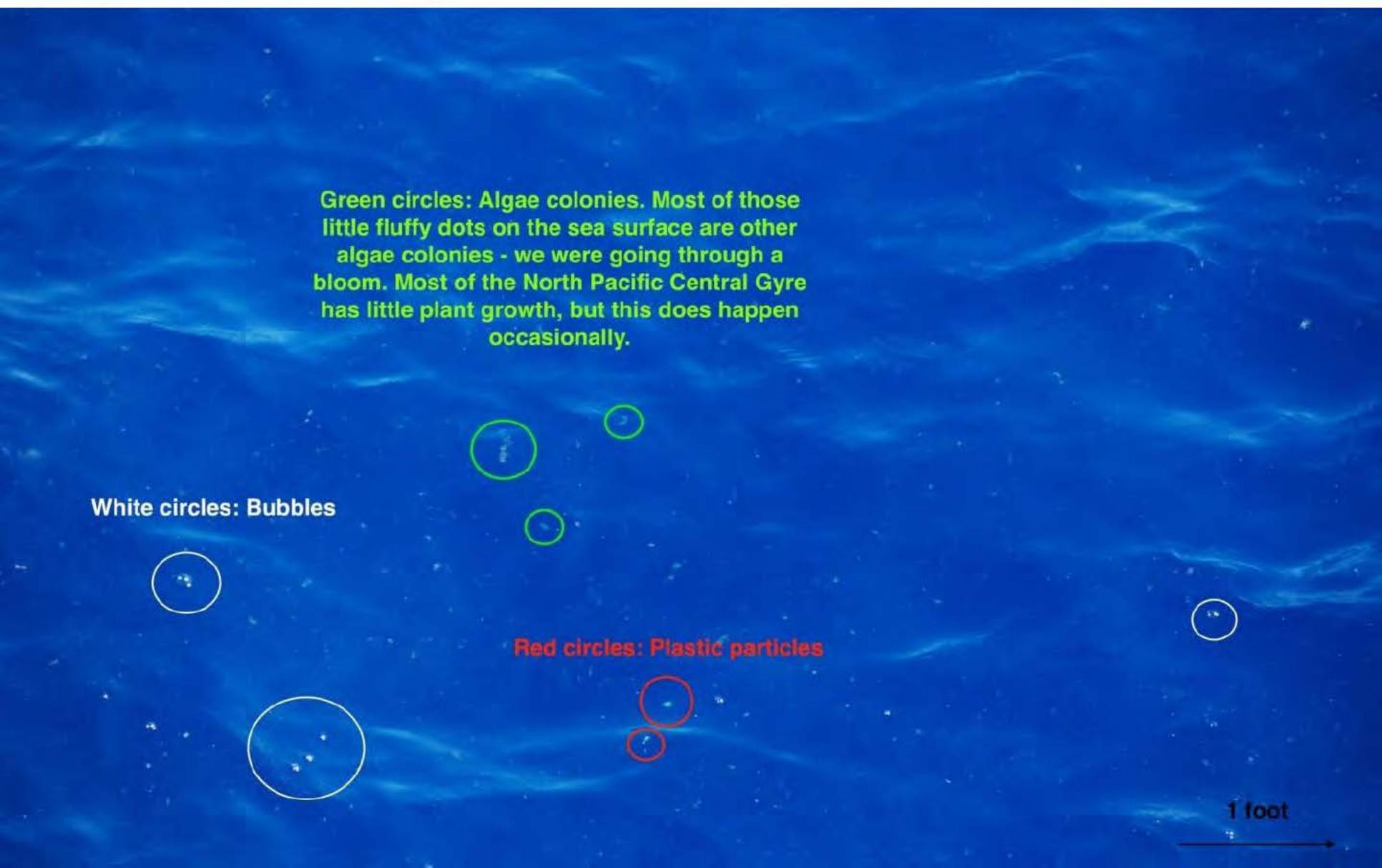
Explanation of photo contents (colored circles and labels) provided by Miriam Goldstein. Image courtesy of NOAA Okeanos Explorer Program.

Green circles: Algae colonies. Most of those little fluffy dots on the sea surface are other algae colonies - we were going through a bloom. Most of the North Pacific Central Gyre has little plant growth, but this does happen occasionally.

White circles: Bubbles

Red circles: Plastic particles

1 foot

A photograph of the sea surface showing various particles. The water is a deep blue color. There are several small, white, fluffy-looking particles scattered across the surface. Some of these are circled in white. There are also several small, green, fluffy-looking particles, some of which are circled in green. A few larger, red, irregularly shaped particles are circled in red. In the bottom right corner, there is a scale bar labeled "1 foot".



Science-based information sources on “garbage patches”

Just a few...

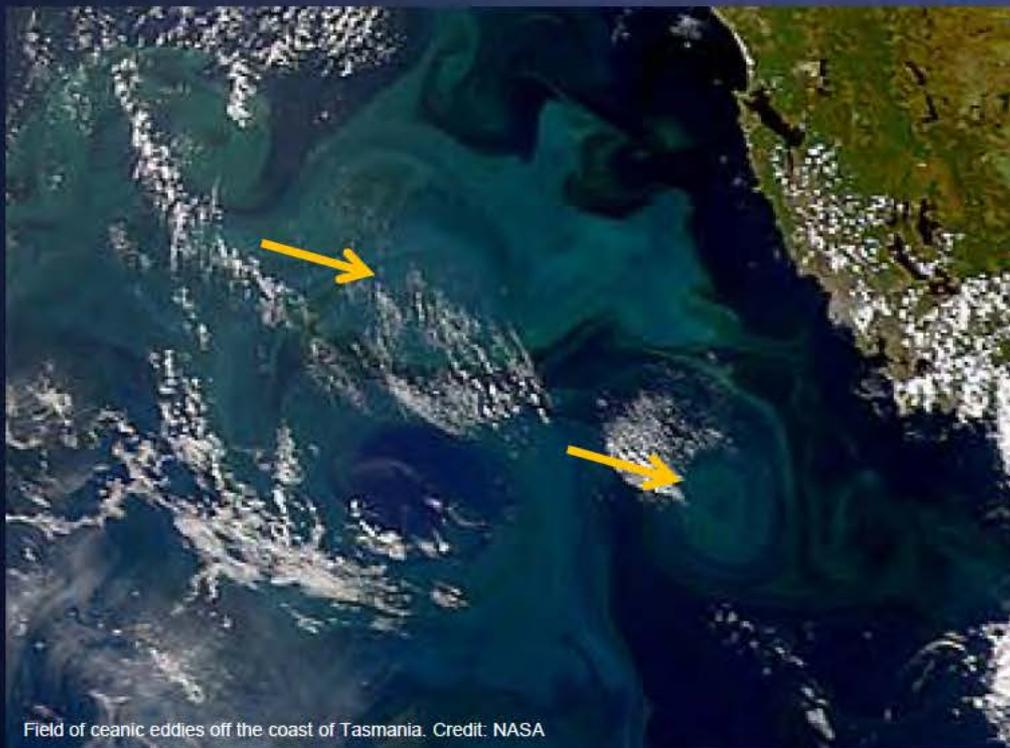
- Howell, E., S. Bograd, C. Morishige, M. Seki, and J. Polovina. In press. [North Pacific circulation and associated marine debris concentration](#). *Marine Pollution Bulletin*.
- Lavender Law, K., S. Moret-Ferguson, N. Maximenko, G. Proskurowski, E. Peacock, J. Hafner, and C. Reddy. 2010. [Plastic accumulation in the North Atlantic Subtropical Gyre](#). *Science*. 329: 1185-1188.
- Martinez, E., K. Maamaatuaiahutapu, and V. Taillandier. 2009. [Floating marine debris surface drift: Convergence and accumulation toward the South Pacific subtropical gyre](#). *Mar. Poll. Bull.* 58: 1347-1355.
- Pichel, W., J. Churnside, T. Veenstra, D. Foley, K. Friedman, R. Brainard, J. Nicoll, Q. Zheng, and P. Clemente-Colon. 2007. [Marine debris collects within the North Pacific Subtropical Convergence Zone](#). *Marine Pollution Bulletin* 54: 1207-1211

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Eddies



Field of oceanic eddies off the coast of Tasmania. Credit: NASA

- Mesoscale features (100's of km diameter)
- Circular, rotating
- Debris concentrates in center depending on direction of rotation
- Variable lifetimes, move, strengthen/weaken



www.livescience.com

Informative resource on ocean eddies: <http://oceanservice.noaa.gov/facts/eddy.html>

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Windrows



- Thin, visible stripes on the surface of the ocean parallel to the direction that the wind is blowing
- Created by Langmuir circulation
- Concentration of debris in lines along windrows
- Move, strengthen/weaken on timescale of winds



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Research Case Study: Survey and Assessment of Marine Debris

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Monitoring Marine Debris

- How much debris is in the environment?
- What impact is it having?
- Monitoring is important for determining a baseline from which changes in the abundance and types of debris can be compared.
 - Are there fewer plastic shopping bags in Anacostia River following DC bag fee?
 - Will Japanese tsunami debris wash up on shores of Hawaii, West Coast?

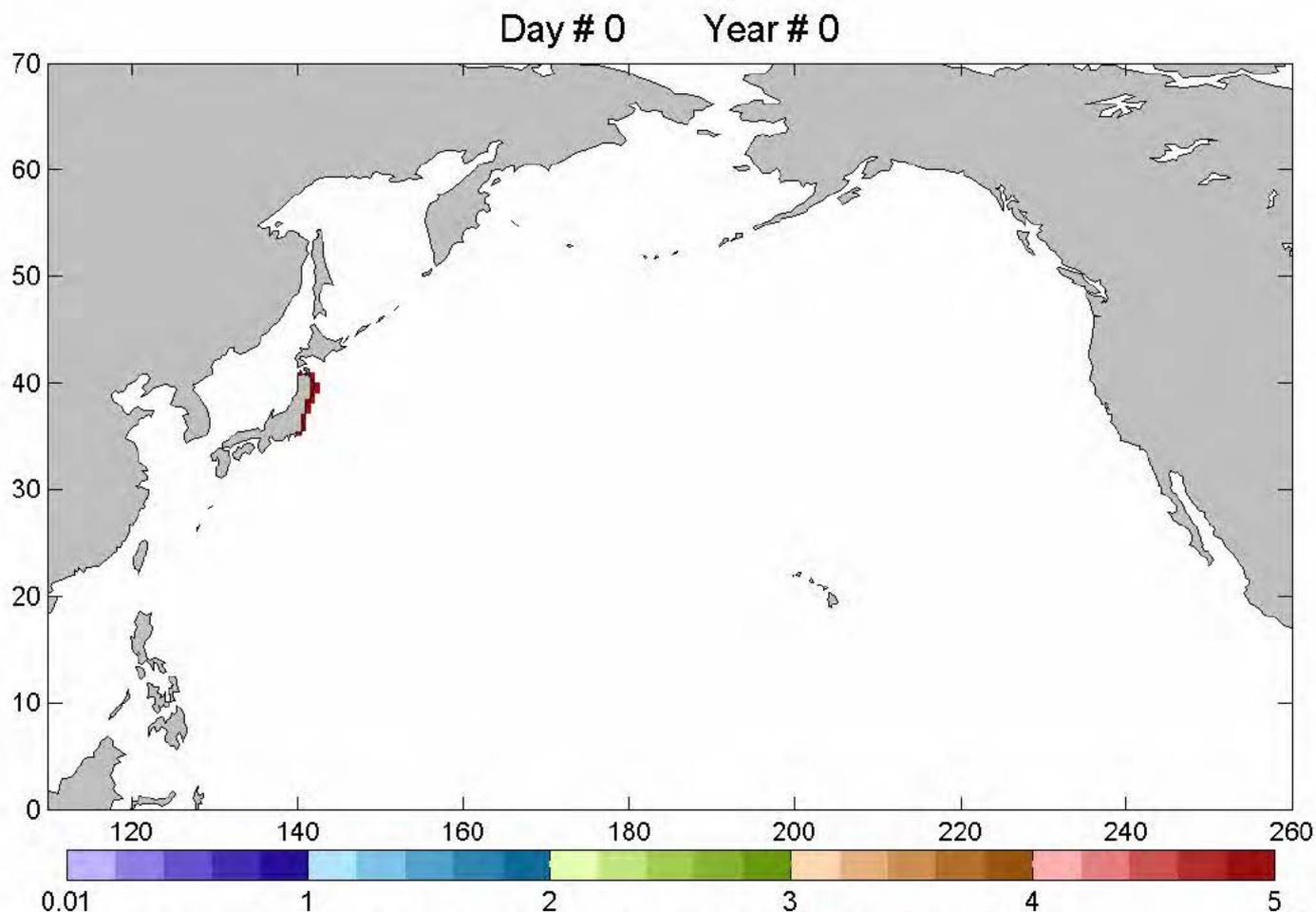


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Modeling Debris Movement



International Pacific Research Center / Nikolai Maximenko



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Want to track marine debris?

There's an APP for that!

www.marinedebris.noaa.gov/projects/seamdi.html

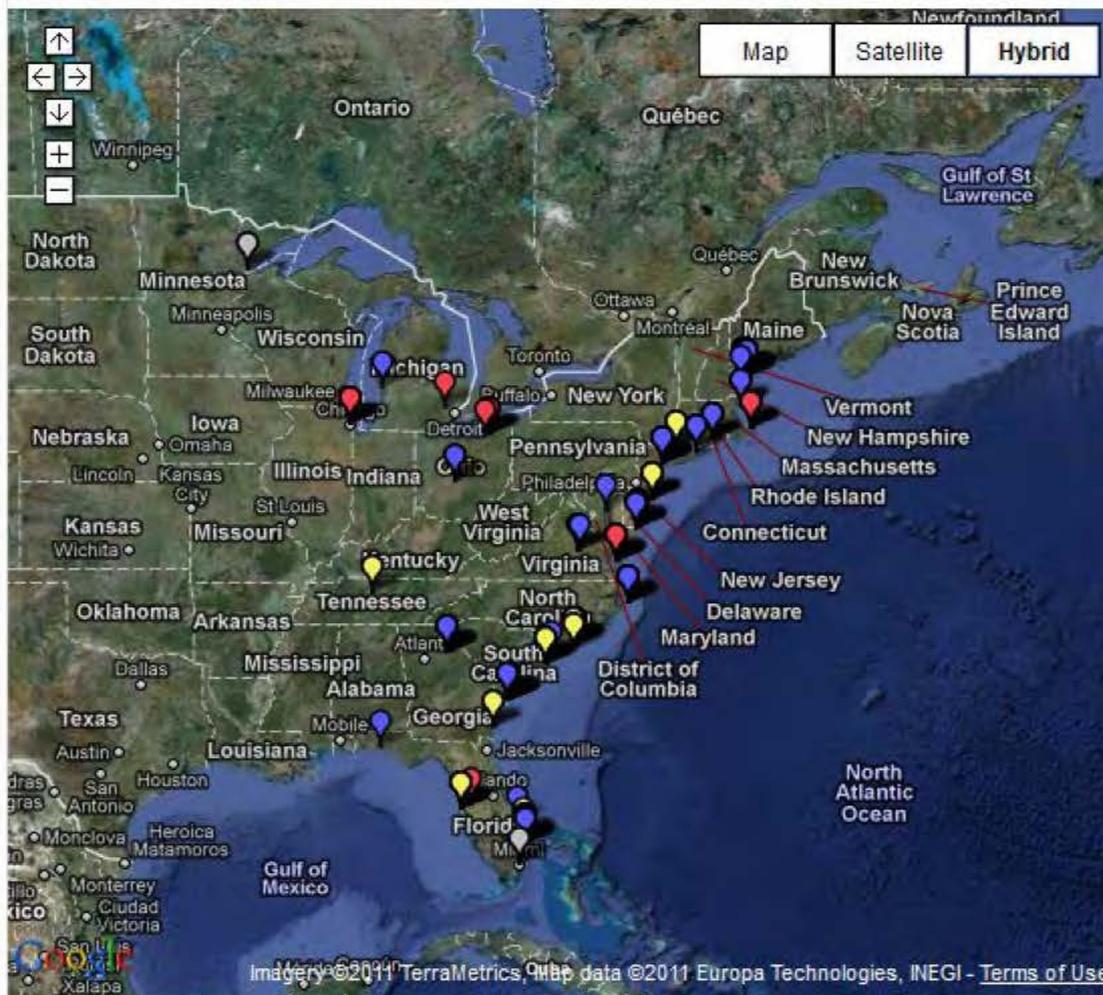
The screenshot shows the 'Marine Debris Tracker' website. At the top, there's a header with the title 'Marine Debris TRACKER' and navigation links: Home, View and Set Date, How do I Start Tracking?, List and Categories, FAQ, About. Below this is a section titled 'Recent Debris Activity' with the text: 'The Marine Debris Tracker mobile application allows you to help make a difference by checking in when you find trash on our coastlines and waterways.' It lists several entries, each with a location, item found, and time/date, accompanied by a status icon (yellow checkmark or red X). To the right, there's a 'Leave only waves and footprints' section with a 'What is Marine Debris?' link and a 'Developed in Cooperation With' section featuring logos for the Southeast Atlantic Marine Debris Initiative (SEAMDI) and NOAA. At the bottom, there's a 'Follow Debris Tracker on Twitter' section with a list of tweets and a 'Share this' button.

- Joint partnership
 - NOAA Marine Debris Program
 - Southeast Atlantic Marine Debris Initiative (SEA-MDI) – GA, SC, NC
- Track debris & input data
 - Android and iPhone
- View and download data
 - Class projects, data analysis



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Latest Items Tracked

- Beverage bottles (plastic)
- Beverage bottles (plastic)
- Cigarettes
- Cups (plastic or styrofoam)
- Other
- Rope or small net pieces (plastic)
- Plastic or styrofoam fragments
- Cigarettes
- Food wrappers (plastic)
- Cigarette or tobacco packaging
- Building materials (describe)
- Bottle or container caps (plastic)

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Marine Debris for Students: A Year-long Concept

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A Year-long Concept

September

- Survey student knowledge - Marine Debris Art Contest (K-8 open **Sept 16 – Oct 21**)
- Marine debris video / public service announcement
- Schoolyard clean up (Alice Ferguson Foundation: www.fergusonfoundation.org)
- International Coastal Cleanup sponsored by Ocean Conservancy, **Sept 17**

November/December – Reduce, Reuse, Recycle for Holidays

Field trip to Covanta Energy in Alexandria – waste to energy to power homes.
Innovations to prevent marine debris – packaging, reusable / degradable materials, etc.

April

- Potomac River Watershed Cleanup, a schoolyard cleanup at your school!
http://www.fergusonfoundation.org/trash_initiative/schoolyardcleanup_outline.pdf
- Recreate marine debris movement in the classroom
- Degradation study – timelines for items to degrade once in the marine environment

May/June and Summer

- Marine Debris Tracker iPhone/Droid App – survey and document marine debris during the summer beach season.

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Sample Curriculum

<http://marinedebris.noaa.gov/outreach/activity.html>

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Turning the Tide on Trash (Grades 1-12)

Unit One

The Definition, Characteristics, and Sources of Marine Debris

Lesson One: Coming to Terms with Marine Debris (Grades 1-6)

Lesson Two: Trash Traits (Grades 1-6)

Lesson Three: A Degrading Experience (Grades 5-8)

Lesson Four: Marine Debris – Data Mining (Grades 6-8)

Lesson Five: Waste Inventory (Grades 3-9)

Lesson Six: Sources of Marine Debris: From Street to Surf, From Hand to Sand (Grades 5-9)

Unit Two

The Effects of Marine Debris

Lesson One: Marine Animals and Harmful Debris (Grades 2-4)

Lesson Two: All Tangled Up (Grades 1-4)

Lesson Three: How Harmful Is Marine Debris? (Grades 3-7)

Unit Three

Working Towards Solutions

Lesson One: Nations and Neighbors (Grades 4-7)

Lesson Two: A Scientific Cleanup (Grades 9-12)

Lesson Three: Communicating for a Clean Future (Grades 8-12)

Lesson Four: Taking Action (Grades 5-12)

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Web Resources for Teachers



Alice Ferguson Foundation

Schoolyard clean up

A guide for conducting a litter cleanup on or near school grounds, that can be teacher/adult or student led. Contains activity, lesson plan and reading assignments.

Concepts: environmental issues, math and reading.

http://www.fergusonfoundation.org/trash_initiative/schoolyardcleanup_outline.pdf

Trash Free Schools

Addresses gap between environmental education and trash and litter problem in the Potomac River watershed. The information and resources are geared toward schools within the Potomac River watershed but can be applied to other regions of the country due to its universal nature.

<http://www.fergusonfoundation.org/trashfreeschools/TrashFreeSchoolsGuidebook1.pdf>

Litter Prevention Campaign Implementation Toolkit

Can be done through Trash Free Schools, or on its own.

http://www.fergusonfoundation.org/trash_initiative/antilitter_toolkit.shtml



Clean Virginia Waterways/Longwood University

Litter and Debris in our Waterways

This web resource provides teachers and students with a summary of sources, types, impacts of litter and debris in rivers, streams, bays, oceans and other bodies of water. Solutions also discussed. For teachers, there is a discussion on “Litter as a Teaching Tool” and a list of resources.

<http://www.longwood.edu/cleanva/litter.htm>

Water Resources – Lesson Plans

Interdisciplinary, problem-based plans about watersheds, water quality, stewardship, and management issues. **Concepts:** Classification skills, data analysis, and experiment design are presented to promote a meaningful outdoor experience for students.

Classification (Grade 3); Cleanup (Grade 6); Scientific Cleanup (Grade 10)

www.longwood.edu/cleanva/teachersvawatercurriculum.htm

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EPA

Marine Debris Abatement

Background on the sources and impacts of debris, relevant legislation addressing this issue, suggestions on what citizens can do, and what the EPA and its partners are doing to reduce the presence of marine debris are posted with access to additional resources of information. <http://www.epa.gov>

Factsheet: Marine Debris

Summary of the marine debris issue in the United States, information about the programs and other initiatives being conducted EPA and its partners on the abatement of marine debris.

http://www.epa.gov/owow/oceans/debris/factsheet_marinedebris.html

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U. S. Coast Guard

Inky the Whale (Middle School)

This is the story of Inky, a female pygmy sperm whale who was found stranded on a New Jersey coast on Thanksgiving Day in 1993. This activity book is to teach children about the problem of trash and marine debris through the true story of Inky. **Concepts:** conservation and reducing, reusing recycling in the community. http://www.uscg.mil/top/downloads/coloring_books/inky/

Officer Snook Hands On/Minds On Activity Book

Designed for teachers and educators, the Officer Snook Hands On/Minds On Activity Book provides many water pollution-related activities that can be used in classrooms, workshops, school presentations and community events. Several pollution demonstrations are also provided in the book. Activities and demonstrations can be adapted for any age group.

https://www.kattare.com/secure/7-dippity.com/store/st_list.jsp?catid=6

THANK YOU!

