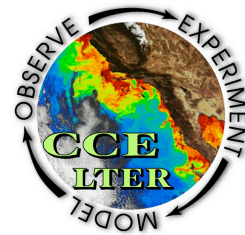


The Central North Pacific Gyre - Physics of Flotsam

By Beth Simmons (California Current Ecosystem LTER Education and Outreach) and
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Crab living on plastic debris

Plastic and glass bottles

Ghost Net

Photo credit: Scripps Institution of Oceanography
– SEAPLEX 2009

Plastic can be found in the Central North Pacific Ocean Gyre. In August of 2009, a group of marine biologists and volunteers from the Scripps Institution of Oceanography California set out to collect data related to the amount and type of plastic present and its effects on marine life. The Scripps Environmental Accumulation of Plastic Expedition (SEAPLEX) members had approximately 20 days at sea to gather data on the research vessel, New Horizon.

Plastic particles (approximately 1 cm in diameter or less) were found in over 100 consecutive surface water samples collected along a path of approximately 1200 miles within the gyre.

Flotsam, or marine debris, is the term used for human originated items that are unintentionally set adrift or abandoned. Plastic marine debris including tooth brushes, ghost nets, hard hats and the soles of shoes were observed during the SEAPLEX mission. However, the most concerning fact was the amount of the much smaller plastic pieces that were consistently found just beneath the surface of the water.

This area is now more commonly called the Great Pacific Garbage Patch. Media attention, including Rolling Stone magazine and Oprah's 2009 Earth Day program, have spotlighted the Garbage Patch and called for action to be taken.

Oceanography is interdisciplinary and requires the expertise of different types of scientists. Some scientists study the living organisms within the ocean, while physical oceanographers study the mechanics of the ocean. Understanding the density, temperature, and motion of the ocean is useful designing computer models of the ocean. These models can be used to predict where plastic will go, and possibly assist in determining where it has come from. Being able to predict where it is and how it got there are essential pieces of information in creating a plan to reduce the amount of plastic in the gyre.

Approximately 90 percent of the marine debris floating in the gyre is made of plastic (AMRF 2007). It is estimated that approximately 80% of the plastic accumulating in the gyre is from terrestrial sources (NOAA 2010). Plastic from shore gets caught in the currents close to shore and is then transported to the gyre. Plastic is buoyant and does not biodegrade. Plastic continues to collect without a means of exiting the gyre or the possibility of it decomposing. In addition, the plastic made brittle by the sun breaks apart into smaller and smaller pieces.

The currents that serve as the boundary for the gyre circulate in a way that continuously pulls flotsam into its center. However, minor currents and weather patterns create smaller convergence zones within the gyre that are constantly in flux. Although researchers from SEAPLEX consistently collected plastic during sampling, the amount of plastic in the tows varied.

The effects of the accumulated plastic on marine life are still being evaluated. Data linking plastics and negative effects to fish and other wildlife are still being analyzed. However, most people agree that finding a man-made material collecting in an area located approximately 1000 miles away from humans is alarming.

One of the concerns that the researchers are looking into is the bioaccumulation of toxins (associated with plastic) in marine life tissue and food webs. Another is the possibility that non-native animal species are being transported on the plastic and introduced into new areas as an invasive species.

The following sets of questions are similar to the ones physical oceanographers asked about the ocean currents and the journey the plastic went on to get to the gyre. Their work will assist the biologists with understanding their data better.

Vocabulary:

Marine debris: Any persistent (often synthetic) material that is intentionally or unintentionally left abandoned in oceans. Flotsam is the traditional term for marine debris.

Gyre: A major, slowly rotating mass of ocean water bounded by faster, circulating water currents; a vortex. There are five major gyres in our world ocean: two each in the Pacific and the Atlantic Oceans and one in the Indian Ocean. They flow clockwise in the northern hemisphere and counter clockwise in the southern hemisphere.

Current: The flow of water in a specific direction. It can be a portion of a larger body of water such as the California Current. The California Current is the eastern boundary of the Central North Pacific Gyre. It flows from north to south along North America and joins the Equatorial Current to flow west near the equator.

Physical oceanographer: Someone that studies the physical properties of the ocean like currents and waves, and how they affect the atmosphere and other aspects of the environment.

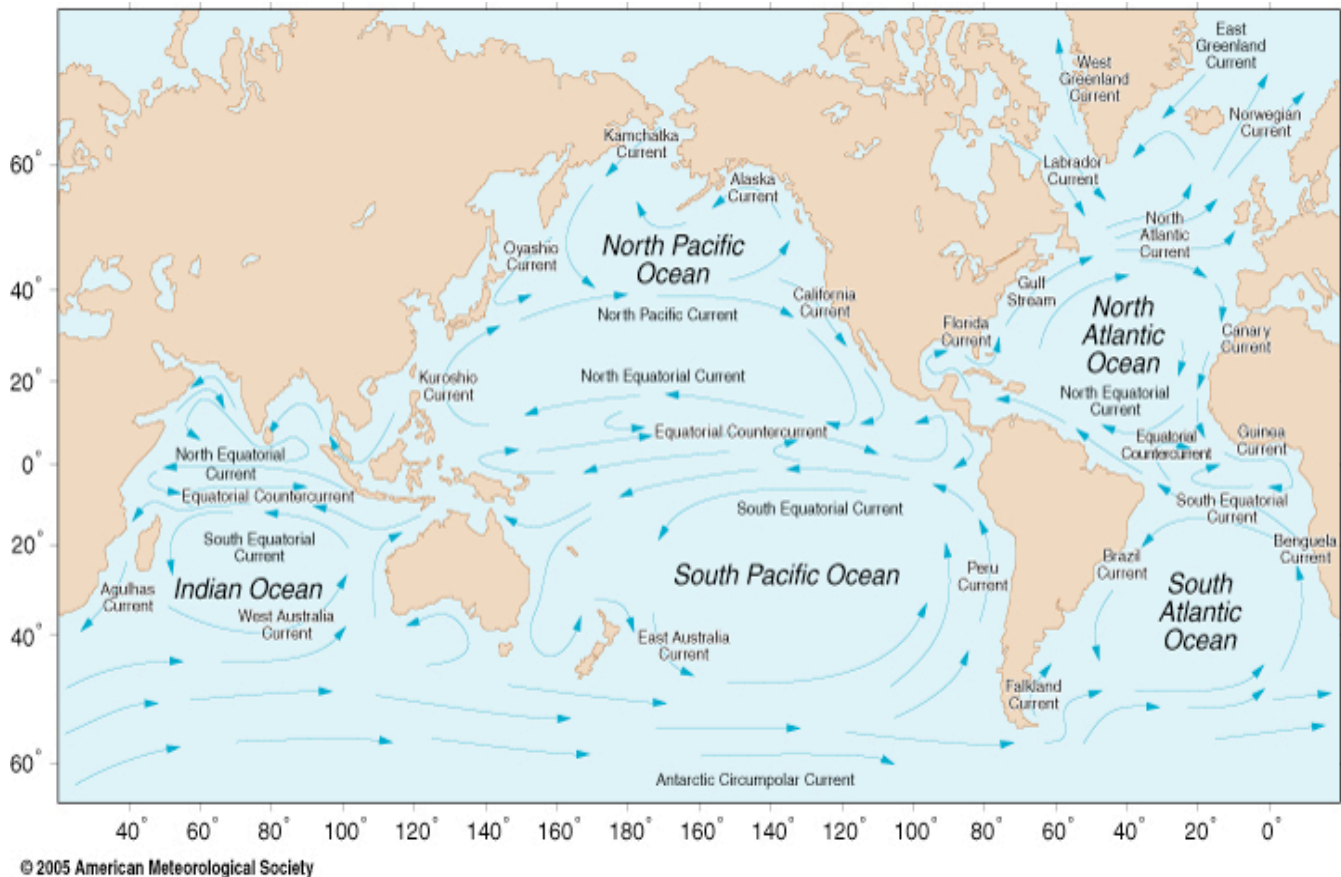
Marine biologist: Someone that studies the flora and fauna of the oceans.

Statute mile: A term used for a standard land-based mile, as opposed to a nautical ocean-based mile.

A Study of the Central North Pacific Gyre

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Objective: To familiarize students with the issue of plastic accumulation in the Central North Pacific Gyre



QUESTIONS:

- Using the map provided above and the definition of gyre, how many gyres does the Earth have? Use the ocean they are located in to list them.
- If one degree of latitude is equivalent to 69.047 statute miles, how many miles across is the Central North Pacific Gyre? Using the map, estimate the surface area of the gyre.
- If the surface of the California Current flows at approximately 1 km per hour, how far will a piece of marine debris move in 1 week?
- The North Pacific Current is warmer and faster than the California Current. It travels at speeds in the hundreds of kilometers per hour. SEAPLEX observers collected bottles written in Korean and Chinese (in addition to English). If the bottles floated across the Pacific Ocean from Asian shores, what is the least amount of time the bottles were in the water?

5. If the Pacific Ocean is approximately 17,000 km from east to west, how many days would it take the research vessel, New Horizon, traveling at a maximum speed of 10 knots to cross it? (1 knot = 1.852 kilometers per hour). Ignore water current influences on speed.

6. If the eastern edge of the Pacific Gyre is located approximately 1000 miles off the coast of California, how long would it take the New Horizon to reach it?

7. On average the New Horizon ship uses 1000 gallons of fuel per day. Do you believe that the amount of fuel it takes to reach the Patch is worth using in order to study the Garbage Patch?

8. Some activists note that plastic collected from the gyre can be recycled and converted into diesel fuel. In the October 2009 issue of Rolling Stone, Captain Charles Moore argues that there is no way the Garbage Patch can be cleaned up because the collection of the small pieces of plastic is impractical. Research these two opinions and list three supporting arguments and counter arguments for each one.

9. Debris that avoids being pulled into the gyre and continues to circulate around the Pacific Ocean ends up on to the shores of beaches. Investigate how much plastic is found on the various shores and how much is estimated to be in the ocean. Which of the two collections of plastic (in the gyre verses on the shore) do you feel should have a greater priority in terms of public policy and why?

10. Research information about the Central North Pacific Gyre over the past 10 years. What information and catch phrases seem to persist throughout your research? Why do you think the media continues to use these phrases and ideas? Has any new information surfaced over the last year?

Conclusions: In your opinion what should be done about the plastic accumulating in the Pacific Ocean, and other gyres. Use what you understand about the size of the Pacific Ocean and the ocean currents to support your arguments. Prepare a 3-minute presentation to explain what you understand about the size of the ocean and the current understanding of the situation to support your opinion.

Recommended Internet Sources:

Scripps Institution of Oceanography – Scripps Environmental Accumulation of Plastic Expedition

- SEAPLEX <http://sio.ucsd.edu/Expeditions/Seaplex/>

National Oceanic and Atmospheric Administration

- NOAA <http://marinedebris.noaa.gov/>

National Aeronautics and Space Administration

- Ocean Motion <http://oceanmotion.org/html/research/ebbesmeyer.htm>

FLOTSAMETRICS by Ebbesmeyer

- <http://flotsametrics.com/>

ALGALITA MARINE FOUNDATION

- <http://www.algalita.org/research.html>

References:

Doucette, Kitt. “An Ocean of Plastic.” Rolling Stone 29 October 2009: 54-57.

Harpo Productions. “The Oprah Winfrey Show.” 22 April 2009. Oprah.com. 23 October 2009
<http://www.oprah.com/article/oprahshow/20090422-tows-ocean-pollution>.

NOAA (2010) <http://marinedebris.noaa.gov/info/mvmt.html>