Science Unit: ***Marine Pollution***

Lesson 5: ***Rubber Duckies and Ocean Currents***

School year:	2006/2007
Developed for:	David Oppenheimer Elementary School, Vancouver School District
Developed by:	Sara Harris (scientist), Liza Archer and Scott Lundell (teachers)
Grade level:	Presented to grades 4-5; appropriate for grades 4-7 with age appropriate modifications.
Duration of lesson:	1 hour and 20 minutes
Notes:	Extension activities

Objectives

1. Plot latitude and longitude data on a map.
2. Learn the names of major ocean currents, where and in what directions they flow.
3. Analyze data from a rubber ducky spill to learn how the distribution of plastic pollution in the ocean relates to ocean currents.

Background Information

In January of 1992, during a winter storm, a container ship lost several containers overboard in the middle of the North Pacific Ocean. At least one of the containers broke apart, releasing 29,000 plastic bath toys into the ocean. Because the toys were made of plastic and floated, scientists could use their float tracks to study ocean currents, by recording when and where the toys washed ashore. It's likely that some of these toys are still out there, and have worked their way through the Arctic Ocean and into the Atlantic.

Similar spills of floating objects have also been used to study ocean currents (Nike shoes, hockey equipment, Legos, messages in bottles…)

The primary surface currents in the North Pacific Ocean form two gyres (circular patterns of currents), the North Pacific Gyre, which flows clockwise over the vast majority of the area of the ocean basin, and the smaller Alaska Gyre, which flows counterclockwise in the northeast part of the ocean basin. In this study, the rubber duckies mostly stay in the northern part of the North Pacific Ocean basin, including the Alaska gyre. The most important currents are the Kuroshio Current (the eastward extension of which is sometimes called the "Westwind Drift" or sometimes the "North Pacific Current"), the Alaska Current, and the Oyashio Current.

Vocabulary

Current:	Water in the surface ocean flowing consistently in a particular direction. Ocean currents are driven by the wind.
Latitude:	An angle north or south of the equator used to describe a location on Earth.
Longitude:	An angle east or west of the prime meridian (in Greenwich, England) used to describe a location on Earth.
Kuroshio Current:	A warm ocean current that flows northward, then eastward, on the west side of the North Pacific

Oyashio Current:	A cold ocean current that flows southward along the coast of Siberia and Kamchatka
Alaska Current:	A cold ocean current that flows northward, then westward near Alaska
California Current:	A cold ocean current that flows southward along the west coast of North America
North Pacific gyre:	A circular system of ocean currents that together flow in a clockwise pattern all around the North Pacific Ocean.
Alaska gyre:	A circular system of ocean currents that together flow in a counterclockwise pattern in the northeastern Pacific near Alaska.

Materials

- Map with ocean currents in the North Pacific (Fig 1) – one copy per student
- Blank maps of the North Pacific (Fig 2) – one copy per student
- Map of global ocean currents (Fig 3) – one copy per student.
- Copies of student data sheet - one per student
- Shallow pan with water, deep enough for a rubber ducky
- Flat piece of plastic (e.g. cut from the lid of a yogurt container)
- Rubber ducky(ies)
- Colored Postit notes
- Large world map

In the Classroom

Introductory Discussion

1. How does plastic get into the ocean?
2. Where are most of the plastic things that we use made? How do they get to us in Canada? (ships) what happens if ships carrying plastic encounter storms and stormy seas? (they can lose some of their cargo overboard).
3. Tell story of the rubber ducky spill.
4. What happens to plastic once it gets into the ocean? Does it float or sink? Demo. Does it stick out of the water very far? Which might get blown by the wind more, something that sticks up out of the water, or something the floats just at the surface?
    a. Put both a rubber ducky and a flat piece of hard plastic (cut out of a plastic yogurt container lid will do) into a shallow pan filled partly with water.
    b. Have students be the wind and blow on the water. Observe which piece (ducky or flat piece moves more under the influence of the wind).
5. How long does plastic last in the ocean? (decades)
6. Discuss vocabulary.
    a. Review latitude and longitude. Review how to plot positions on a map (using latitude and longitude)
    b. Describe ocean currents. Where are they coming from? Which ones are warm? (the ones that start near the equator and flow north or south). Which ones are cold? (the ones that flow from high latitude to low latitude. Is the ocean water near us warm or cold?
    c. Every ocean basin has a gyre, which is a circular pattern of currents flowing around and around. The main gyres in the northern hemisphere flow clockwise and the main ones in the southern hemisphere flow counterclockwise. We'll also be looking at the Alaskan Gyre, which flows counterclockwise at higher latitude than the North Pacific Gyre.

7. Briefly describe activity.
8. Review scientific method, particularly making observations, showing results graphically, and interpreting patterns in data.

Science Activity/Experiment

Activity Title: Ocean currents and the rubber ducky spill

Purpose of Activity: Plot and interpret data in two dimensions on maps. Make a connection between plastic distribution in the ocean and ocean currents.

Experimental Observations: This is not an experiment with controls and treatments. Students will analyze data from the rubber ducky spill.

Methods:

Students will work alone or in groups of 2. In their lab notebooks or on data sheets, they should record today's date and lesson title.

1. Explore the adventure of rubber ducks (plastic pollution) that were spilled in the ocean.
    a. Use Figure 2 to plot data (listed on handout, or write data on the board) of when and where the rubber ducks were at different times. Label each data point with the corresponding date.
    b. Have students connect the dots in order of time. One common student mistake is to make the track go over land in the Aleutian Peninsula. The duckies can't walk! Some may realize that the tracks between two points are probably not straight (and we don't know what they are, because we don't have the data). So putting in loops and curves is perfectly OK.
    c. After students plot the data on smaller maps (handouts), have volunteers plot the data on a large map with post-it notes labeled with the corresponding dates.
    d. Compare (either individually or as a group), the path the duckies took to the pattern of ocean currents in Figure 1. Which ocean currents did the duckies ride?
    e. Show and discuss a map of global ocean currents (Figure 3).
    f. Ask students to come up with a route (on Figure 3) by which the rubber ducks could have reached the Atlantic Ocean by now. Ask for volunteers to show the class their route. Many, many routes are possible, some very long, and one quite short (through the Arctic Ocean).

Closure Discussion

1. What will you do if you find a rubber duck at the beach?
2. What can we do to decrease plastic pollution in the oceans and on the beach?

References

1. W.J. Ingraham, Jr., 1997. Getting to Know OSCURS, REFM's Ocean Surface Current Simulator. Alaska Fisheries Science Center Quarterly Report, April-May-June, 1997. http://www.afsc.noaa.gov/REFM/docs/oscurs/get_to_know.htm
2. http://www.nationalgeographic.com/xpeditions/lessons/15/68/index/html for lesson plans about ocean currents, including floating cargo.
3. K. Krajick, 2001 Message in a Bottle, Mariner's Weather Log, v. 45, no. 3, p. 8-17 (originally printed in The Smithsonian, July, 2001).

4. http://www.theage.com.au/articles/2003/08/06/1060064238597.html for an article that includes information about debris traveling the Northwest Passage.

5. K.C. Heidorn, 1999. Of Shoes and Ships and Rubber Ducks and a Message in a Bottle. http://www.islandnet.com/~see/weather/elements/shoes.htm

6. http://www.mindfully.org/Plastic/Ocean/Moore-Trashed-PacificNov03.htm for map of North Pacific Currents

7. http://www.onr.navy.mil/Focus/ocean/motion/currents1.htm for map of global ocean currents

Extension of Lesson Plan

1. You could have students figure out how to estimate how fast the duckies traveled as an indicator of how fast ocean currents flow (how far did they go and how long did it take?). Compare to travel in a car or walking.

2. Listen to a radio report about the rubber ducks.
http://www.npr.org/templates/story/story.php?storyId=1323675

STUDENT DATA SHEET – Plastic Pollution

Name_____ **Date**_____

Rubber Ducky Spill!!!

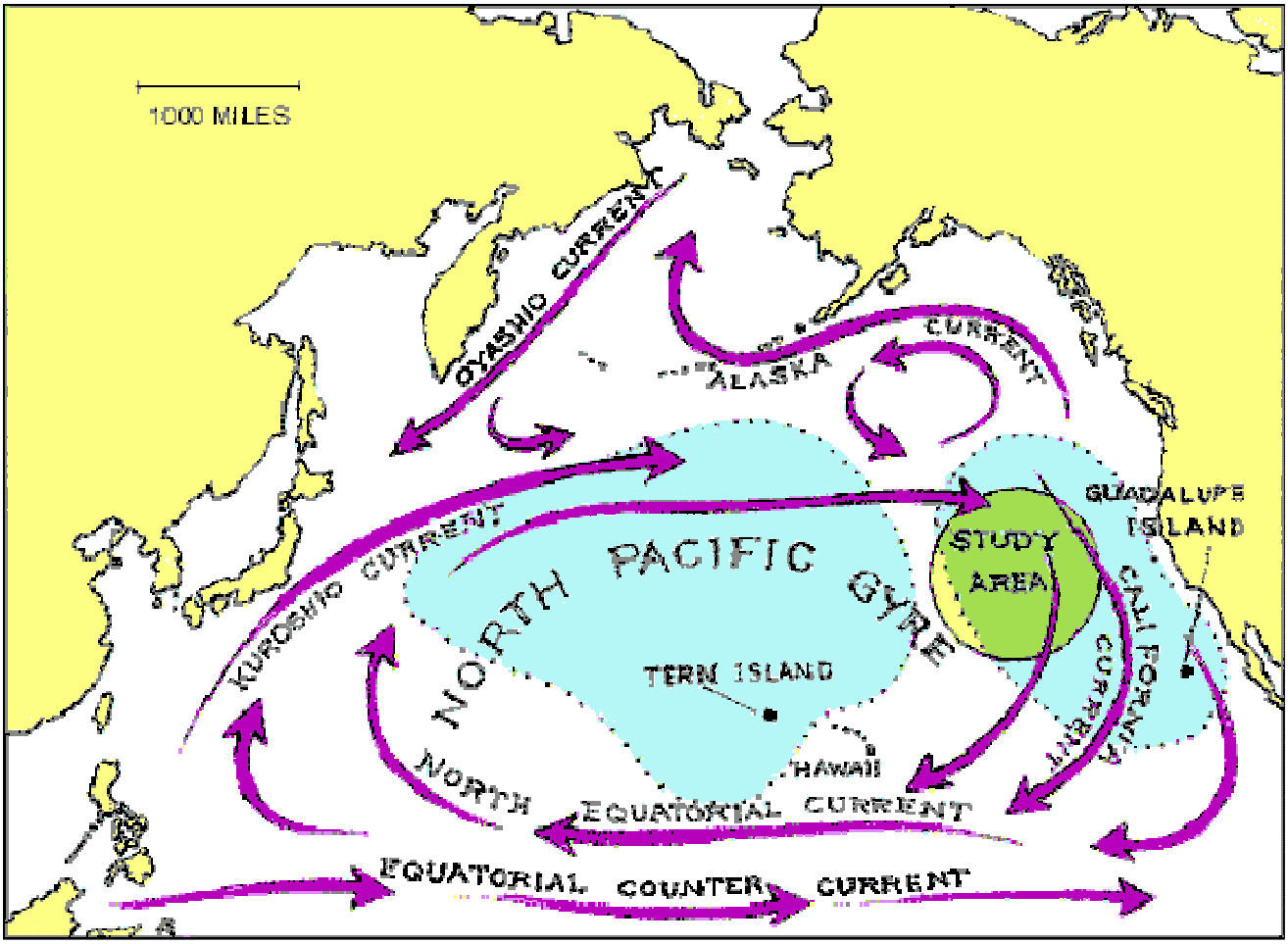
In January of 1992, a ship carrying 29,000 plastic bath toys lost the toys at sea! Using the data below, plot the path the bath toys followed on your map. Connect the dots in order.

DATE	LATITUDE	LONGITUDE
January 1992	45ºN	178ºE
March 1992	44ºN	195ºE
July 1992	49ºN	205ºE
October 1992	52ºN	225ºE
January 1993	59ºN	211ºE
March 1993	56ºN	203ºE
July 1993	57ºN	190ºE
October 1993	59ºN	180ºE
January 1994	56ºN	166ºE
March 1994	45ºN	155ºE
July 1994	47ºN	172ºE
October 1994	50ºN	195ºE
January 1995	47ºN	220ºE

1) **Which ocean currents did the rubber duckies ride during the three years of data you plotted ?**

2) **Some of these rubber duckies could have made it into the Atlantic by now. What path might they have taken to get there?**

Figure 1



Source: http://www.mindfully.org/Plastic/Ocean/Moore-Trashed-PacificNov03.htm

Figure 2:

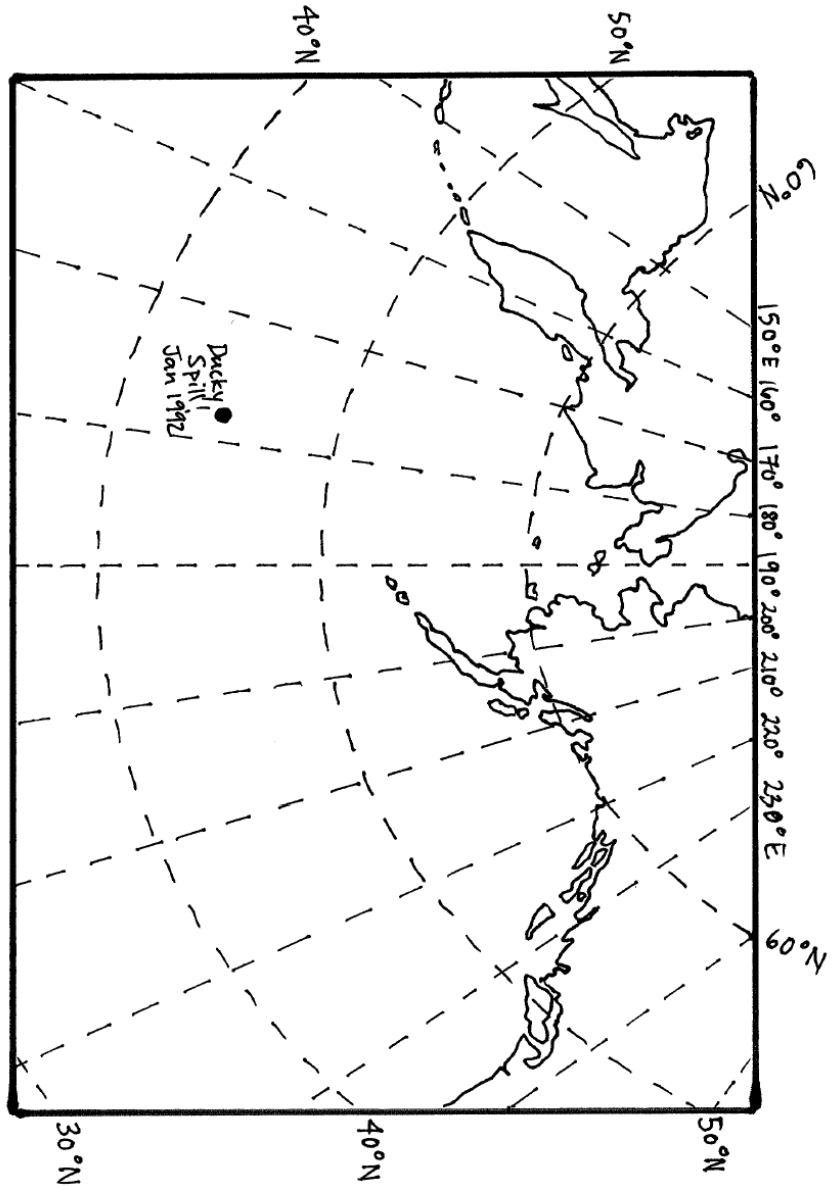


Figure 2 (above) was made by tracing the figure below (labeled Figure 7, from Ingraham, Alaska Fisheries Science Center Quarterly Report, April-May-June, 1997). Because this part of the world crosses the International Date Line, to reduce confusion over east and west longitude, all longitudes on Figure 2 and all longitudes in the student data table have been converted to east longitude. If you'd prefer to keep the original east and west longitudes, enlarge the image below ("Figure 7"), then trace just the continental shorelines, the latitude and longitude lines, and mark the location of the rubber bath toy spill. Also be sure to change the student data table accordingly. You can show this full figure, with the modeled toy trajectories, at the end of the lesson, if you'd like.

Figure 7. COUNTERCLOCKWISE DRIFT AROUND THE SUBARCTIC GYRE--RETURN OF THE BATHTUB TOYS? Location where 29,000 bathtub toys were spilled overboard on January 10, 1992, location of first reported recoveries by beachcombers at Sitka, Alaska, and 1 OSCURS trajectory tuned to the first recoveries. Track continues for 6 years, twice circumnavigating the Subarctic Gyre. January 1 locations are marked each year and measured currents are labeled.

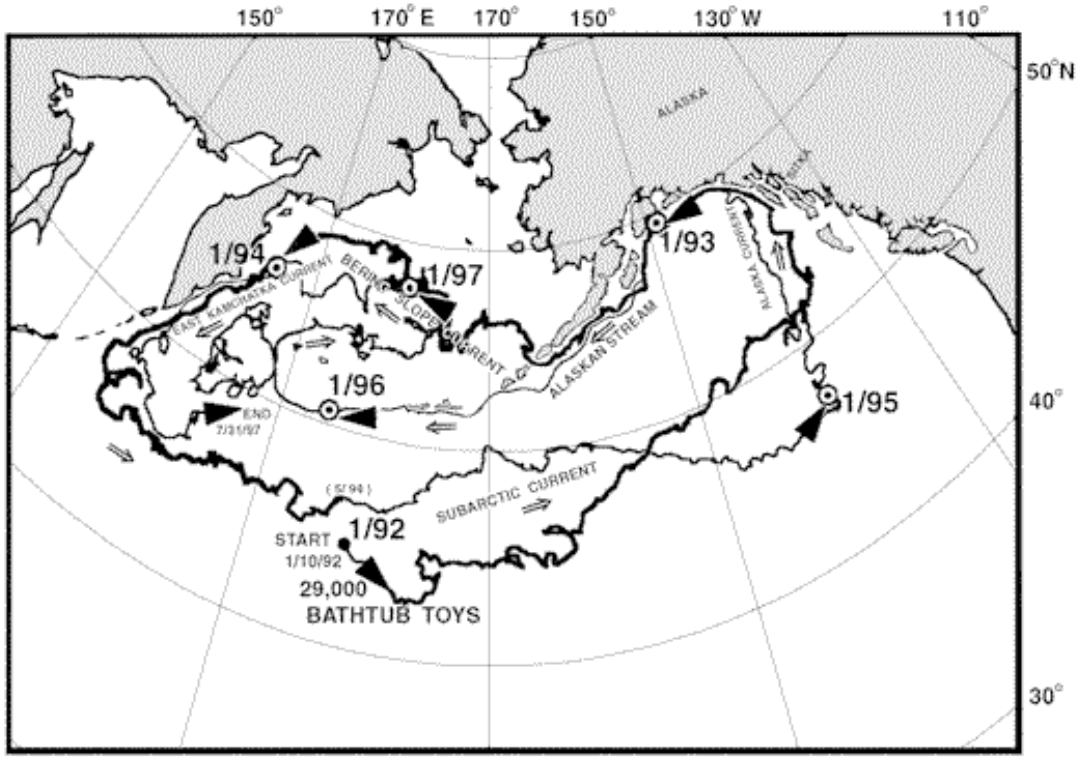
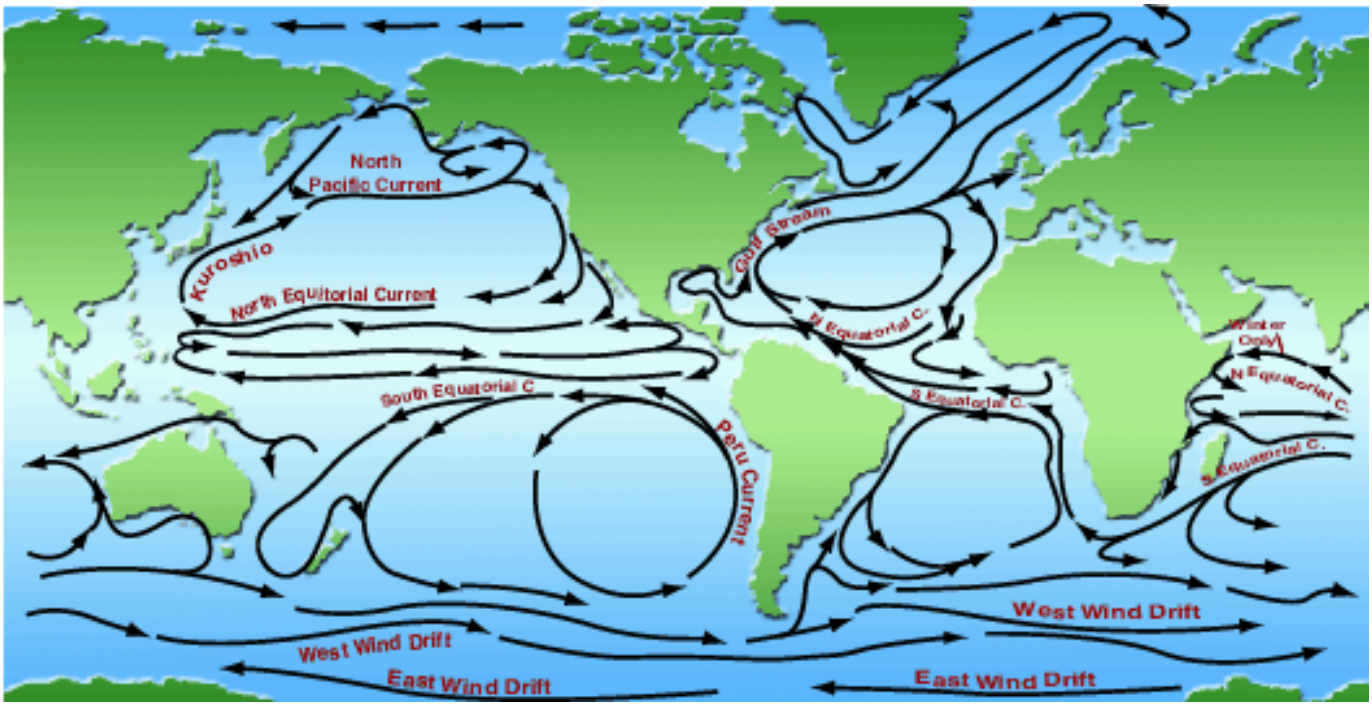


Figure 3:



Source: http://www.onr.navy.mil/Focus/ocean/motion/currents1.htm