

Duck, Duck, DATA!



A Classroom Activity for *Ducks In The Flow - Where Did They Go?*

Summary:

The Earth has one ocean with connected basins and currents circulate water and objects in the water throughout these basins. Students will plot information on maps, regarding the path of motion of trash (toys) spilled into the ocean in a 1992 shipping accident. Students analyze data about the spill site and beach sites where toys washed up onto shore. Using the data, students will construct hypotheses explaining the path of motion of the toys. Students apply their understanding of the movement of currents and maps to a scenario in the Great Lakes.

Student Learning Outcomes:

Students will be able to

- Explain the movement of ocean/Great Lakes trash using knowledge of surface currents
- Predict the path of ocean/Great Lakes trash by reading a currents diagram and a chronology of events
- Apply knowledge of latitude and longitude within the context of an investigation

Standards:

Ocean Literacy Essential Principles and Fundamental Concepts

- The Earth has one big ocean with many features.
- The ocean and humans are inextricably interconnected
- The ocean is largely unexplored

National Science Education Standards

- (K-4) Abilities necessary to do scientific inquiry
- (K-4) Position and motion of objects
- (K-4) Changes in environments
- (5-8) Structure of the earth system
- (5-8) Motions and forces

Grade Level: 3-5

Materials:

For Activity 1:

- Projection of *Ocean Map* and *Student Sheet 1* (Transparency or Smartboard)
- Colored pencils (2 colors per team of 2-3 students)
- Copies of the *Duck, Duck, DATA! Student Sheets 1 & 2* (1 copy per student)

For Activity 2:

- Globe or map showing the individual states of the United States and the Great Lakes
- Projection of *Great Lakes Map* and *Dye Plume Map*
- Colored pencils (3 colors per team of 2-3 students)
- Copies of *Great Lakes Map* (1 per student)
- Copies of the *Duck, Duck, DATA! Student Sheet 3* (1 per student)
- Copies of *Duck, Duck, DATA! Email Sheets 1 & 2* (1 per student)

Time: 1-2 class periods (45 minutes each)

*For more information, please visit:
www.windows.ucar.edu/ocean_education.html*

Activity 1 – Directions and Procedure

1. Children label important landmarks on the *Ocean Map*: for example, the United States, Alaska, the Pacific Ocean, Asia, and Hawaii.

2. Review Map Reading Skills

- **Explain the goal:** The goal is to review how to plot latitude and longitude information on a map. This exercise will help students understand the story of the traveling toys, like the plastic duck in the *Ducks in the Flow – Where Did They Go?* story.
- **Model the skill:** Using a projector, model transferring latitude and longitude information from *Student Sheet 1* to the *Ocean Map* by plotting a location on the **Ocean Map**. Place the number “1” at Hong Kong, the location where the toys began their journey. Students copy the location of the number “1” onto their copy of the *Ocean Map*, using the first colored pencil.
- **Guided Practice:** Help students transfer latitude and longitude from *Student Sheet 1* to the *Ocean Map* for the second event, the shipwreck. Use a number “2” to indicate this second event on the projected *Ocean Map*. Students use the first colored pencil to place a “2” in the correct place on their copies of the *Ocean Map*.
- **Independent Practice:** Students transfer the latitude and longitude information from the *Student Sheet 1* to their copies of the *Ocean Map*, using the first colored pencil. Students determine the place to write “3” through “7”– the Alaskan beaches where the toys were discovered in 1992-1993. After students independently complete this exercise, plot the locations on the projected *Ocean Map*.

3. Hypothesize Explanations for Traveling Toys Using Currents

- **Explain the goal:** Students will use a map of ocean surface currents (*Ocean Map*) to hypothesize 1) which currents carried the toys and 2) the path of the toys’ journey.
- **Model the skill:** Project the *Ocean Map* with markings for the place where the toys spilled into the ocean (“2”) and places where the toys washed onto Alaskan beaches. Hypothesize a route from the place of the spill to first Alaskan site (“3”). Follow the path of the major ocean currents. For example, the toys may have followed the North Pacific current, moved toward North America, and then followed the Alaska current north. Trace this hypothesized route on the projected *Ocean Map*.
- **Practice:** Students hypothesize routes from the place of the spill to the other Alaskan sites (5-7), using knowledge of the major ocean currents. Students draw their hypothesized routes on their *Ocean Maps*, using a second colored pencil. Students describe their hypothesis in words on *Student Sheet 1*.

Content Note: *There is no correct hypothesis, though some hypotheses may be more or less reasonable. Reasonable paths should roughly follow the currents and should be curved. The curve is due to the Coriolis Effect. Students may hypothesize how toys move from one major current to another (e.g., equatorial current and countercurrent). This can happen, especially during storms.*

4. Apply Knowledge

- Teams receive a copy of Email Sheets 1 & 2.
- Explain the scenario to the students: “NOAA needs our help. Their scientists have been receiving emails from all over the world. People have found plastic toys on beaches, just like Natalie in the *Ducks in the Flow, Where Did They Go?* story. We need to organize the information from these emails into a table. Then, we can use the information and what we know about ocean currents to hypothesize how the toys traveled around the world.”
- Students read the emails and transfer information out of the emails and into the table on *Student Sheet 2*.

- Students plot the locations of the toy finds on the *Ocean Map*, using the first colored pencil. As before, students label the places in chronological order (“8”, “9”, “10”, etc.).
- Students hypothesize 1) which currents carried the toys and 2) the path of the toys’ journey. Students draw the hypothesized paths onto the *Ocean Map*, using the second colored pencil. Students describe some of their hypotheses on *Student Sheet 2*. Other hypotheses should be discussed verbally.

Content note: *The toys likely traveled all the way around the North Pacific before returning to Alaska in 1995. The scenario and stories in the emails are fictional. The geography and timeline follows the true story of the plastic toys, as related in these sources:*

- de Bruxelles, Simon (June 28, 2007) Plastic duck armada is heading for Britain after 15-year voyage, www.timesonline.co.uk/tol/news/uk/article1996553.ece, viewed in Feb08.
- Guildford, Surrey. (July 14, 2007) First of the plastic duck invasion fleet makes landfall on the devon coast, www.timesonline.co.uk/tol/new/uk/article2072458.ece, viewed June08.
- Clark, Steve. (1997) NIKE Athletic Shoes, Rubber Duckies, and Ocean Currents. *Current* 14(3): 35-40.
- Ebbesmeyer, Curtis C., Beachcombing Science from Bath Toys, Beachcombers’ Alert, beachcombersalert.org/RubberDuckies.html, viewed in Feb08.

Activity 2 – Directions and Procedure

Great Lakes Current Predictions

Content note: As with the toys floating in the oceans there are many things that are floating or traveling with the surface currents in the Great Lakes. The direction of surface currents can be determined by using drifters that can send their location back to a research laboratory. See *Connection to the Great Lakes and Social Studies* at the end of this activity for this information. In 2006, scientists wanted to find out the direction of currents in Lake Michigan. Rather than use drifters, the scientists poured harmless red dye (like food coloring) into the Grand River. The Grand River flows into Lake Michigan at the city of Grand Haven.

1. **Access Prior Knowledge:**

- As a class, students make a list on the board of pollutants, organisms, and other things that can be carried by surface currents in the Great Lakes. (See *Connection to the Great Lakes and Social Studies* at the end of this activity for background information.)

2. **Understand the Maps:**

- For students less familiar with the Great Lakes, explain that the map on the *Great Lakes Map* is a portion of North America. Use a globe or website to orient the students.
- Students label each of the Great Lakes on the *Great Lakes Map* and add the directions, north, south, east and west on the map. Students should also sketch and label the boundaries of the Great Lakes States (Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, New York).
- On the *Great Lakes Map*, students locate the two stars on Lake Michigan and label these stars as Chicago, Illinois and Grand Haven, Michigan.
- Explain to students that the arrows on the *Great Lakes Map* represent currents, just like the ocean currents. These are normal currents for summer.

3. **Make a Prediction:**

- The teacher offers a scenario, “Let’s pretend someone dropped a lot of food coloring into Lake Michigan at the shore of Grand Haven. Look at the surface currents on the *Great Lakes Map*. What direction do you think the food coloring will travel, north, south, east, or west? Can you give a reason for your prediction?”
- The students use a colored pencil to draw their prediction on the *Great Lakes map* and describe their prediction and reasoning on the *Student Sheet 3*.

4. **Form a Conclusion:**

- Show the class the observed path of the dye plume on an overhead (*Dye Plume Map*).
- Explain that the *Dye Plume Map* is a “zoomed in” view of the section of Lake Michigan next to the city of Grand Haven.
- Ask the class: “Are your predictions for the direction that the food coloring will travel the same as or different from the path that the scientists observed? Do you have any ideas why your predictions are similar to (or different from) the observations?”

Scientifically Accepted Explanation

“The sea is One - unified, world-embracing. It is in fact one ocean - one ocean with five great names and a thousand little ones. There is no real boundary to any sea, save continental land. The waters mingle everywhere and the names are geographic, for convenience only.”

- (Alan Villiers, *Oceans of the World*, 1963)

The Earth has one ocean that has many basins. Familiar basins include the Pacific, Atlantic, and Southern (formerly known as Antarctic). Water flows among the basins, carried by currents (see the *World Map* at the end of this activity). Surface currents are one type of current. The North American Great Lakes are large inland seas. These are not considered part of the ocean, but the Great Lakes flow into the ocean. The Great Lakes are connected. Water flows around the Great Lakes, carried by currents.

Oceanographers study surface currents by analyzing the path of objects drifting in the current. Scientists used to dump objects, such as labeled bottles, into the current and wait for these objects to move to shore. They inferred the path of the moving water by looking at the beginning and ending placements of these objects. Unfortunately, these older methods produced a lot of polluting trash. These days, when accidents dump debris into the ocean or Great Lakes, oceanographers can follow the path of the currents by documenting where the trash washes up on beaches. Oceanographers hypothesize that the trash is carried by currents that they already know about and can predict the path of the moving objects and future beach landing spots. In these activities, children can tell the story of traveling trash (toys) by analyzing data about beach landings and information about currents.

In 1992, a ship carrying plastic ducks, turtles, and frogs dumped these toys into the Pacific Ocean during a storm. The toys became ocean trash. Oceanographers think that the trash was captured by the sub-polar gyre in the Northern Pacific. A gyre is a loop of currents, in this case the Alaska Current, North Pacific Drift, Oyashio current, and Kuroshio Current. Ten months after the spill, the toys floated past the Alaskan coast, and some washed onto shore. Other toys continued to travel with the current in a counter-clockwise path from Alaska to Asia and back. Computer models use the data from the toy landings and other floating objects to estimate that it takes 2-4 years to circle this gyre, traveling at 6.9 miles per day over 6,800 miles.

Some toys escaped the North Pacific currents, transferring to the South Pacific currents and washing up on Hawaiian beaches. Other toys moved into the Arctic Ocean currents. Scientists hypothesize that the ducks froze into the ice, and the ice floated eastward, slowly. Eventually, the ice thawed near Greenland, leaving toys free to be caught by the Atlantic currents. These currents brought the toys near beaches in North America and the United Kingdom.

Toys that landed on the Alaskan shoreline showed that animals had taken bites out of them. Toys found today are bleached of most of their color, probably due to a combination of salt and sun exposure. Eventually, the toys will likely disintegrate into plastic dust pollution.

The ocean currents that carried these toys are influenced by prevailing winds, making the speed and direction of these currents relatively stable. Events, such as strong storms, may temporarily change the direction of small sections of water, but these are usually very short-term. The long-term averages of major surface currents in the ocean are very predictable.

Connection to the Great Lakes and Social Studies

In contrast to ocean currents, currents in the Great Lakes are highly variable due to the effect of seasonal storms. These storms have a bigger effect on Great Lakes currents, because the Great Lakes are small, relative to the ocean.

Living things such as larval mussels and water fleas (*Daphnia*), vegetation and sand and other small particles (sediment) can move with the surface currents. Things that float on the Great Lakes also include pollution such as sewage including *E. coli* bacteria, harmful blue-green algae blooms, muck, farm fertilizers, trash like plastic bags, etc.

The section of the United States government that is in charge of research on ocean and Great Lakes currents is the National Oceanic and Atmospheric Administration (NOAA). People who work for NOAA are interested in weather, climate, the Great Lakes, and oceans.

NOAA has changed with history. Before NOAA, the “Weather Bureau” studied surface currents. President Ulysses S. Grant started the Weather Bureau. An early Weather Bureau chief was Prof. Mark W. Harrington. He thought that people navigating the Great Lakes needed to know about the surface currents. On August 23, 1894, the New York Times reported on the work of Prof. Harrington’s team to diagram the surface currents in the Great Lakes. Prof. Harrington’s team threw bottles with labels into the lakes and sailed along the shoreline, picking up bottles before they crashed onto the rocks.

Now, the Weather Bureau is the National Weather Service, a part of NOAA. Today, NOAA has a group of researchers at the Great Lakes Environmental Research Laboratory (GLERL), in Ann Arbor and Muskegon, Michigan. Scientists at GLERL study water currents in the Great Lakes in order to predict where nutrients and contaminants may move. Nutrients are chemicals that living organisms need to live. Contaminants are pollutants that disrupt life in the Great Lakes and sometimes make beaches unsafe for swimming. GLERL does not use floating bottles anymore, because these pollute the Great Lakes. Instead, GLERL scientists follow drifting buoys that report their positions via radio messages to satellites. GLERL scientists also use buoys that sit in one place and measure the current in those spots, constantly.

Activity Extensions

- In the storybook, Natalie found a plastic duck on the beach in Massachusetts. This duck was probably one of the toys that spilled into the sea in 1992. Can you hypothesize which currents floated the duck to Massachusetts? Which current do you think the duck rode first? Second? Third?
- The plastic toys in this activity floated through the Pacific Ocean, Arctic Ocean, and Atlantic Ocean. What divides the Pacific, Arctic, and Atlantic? Do you think there are three oceans with three names or one ocean with three names? Explain your reasoning.
- It is fun to find toys washed up on the beach, but other objects also wash up on the beach. Look at this list of objects that can be found on beaches:
 - barrel of dangerous chemicals;
 - an inflated volleyball;
 - a plastic coat hanger;
 - parts for a TV;
 - an inflated truck tire;
 - fishing line

How might these items get into the ocean? Where do you think these items might have washed up onto a beach? How far do you think these items traveled in the ocean?

- Can you imagine who and what might have traveled in the ships of the Great Lakes around 1894? Do you think these ships had plastic toys? When was plastic invented? Some of these ships traveled to Chicago, where the population of the city grew to almost 2 million people around this time and where the skyscraper was invented. Who and what may have come on ships to help build the population and skyscrapers?
- Your best friend invited you to go out on her family's boat in Lake Michigan during the Fourth of July! While you are on the Lake, your friend wants to throw a bag of trash from lunch out of the boat. Do you:
 - Look the other way – it's a big lake and nobody will ever see the trash again?
 - Explain to your friend that the trash could drift to many places on the lake, polluting beaches?
 - Go find your friend's parents and ask if they can explain why throwing trash overboard is not a good idea?
 - Offer to carry the trash to a dumpster when you get back to shore?
 - Do nothing?

Resources

Diagrams of Currents and Winds in the Ocean

- NASA's "Ocean Motion and Surface Currents" (currents) oceanmotion.org/html/background/wind-driven-surface.htm
- NASA's "Ocean Motion" (winds) oceanmotion.org/html/background/equatorial-currents.htm
- Cartographie du Monde. Surface Currents in the Arctic <http://carto.eu.org/article2411.html>

Diagrams of Currents and Winds in the Great Lakes

- GLERL's Mean Circulation in the Great Lakes www.glerl.noaa.gov/data/char/circ/mean/mean-circ.html

History of the "Weather Bureau" and National Weather Service

- Currents in the Great Lakes; Government Officials Continue Their Study Preparatory to Charting Them. (Aug. 23, 1894) New York Times. Page 5. Online at query.nytimes.com/gst/abstract.html?res=9907E0DB1730E033A25750C2A96E9C94659ED7CF
- Evolution of the National Weather Service. (Last modified May 10, 2007.) NOAA. Online at www.weather.gov/pa/history/timeline.php.

Great Lakes Field Experiments using Red Dye

- Grand River Field Experiments, Summer 2007 www.glerl.noaa.gov/res/Centers/HumanHealth/docs/grand_haven_factsheet.pdf
- Joseph, S. and Marcos, K. Tracking the Influence of Wind and Waves on Pollutants in the Great Lakes www.research.noaa.gov/spotlite/2007/spot_pollutants.html

Waterborne Contaminants in the Great Lakes

- www.glerl.noaa.gov/pubs/brochures/wcontflyer/wcont.pdf

Plastic Pollution in the Oceans

- Moore, C. (2003) Trashed: Across the Pacific Ocean Plastics, Plastics, Everywhere. Natural History Magazine. Online at www.naturalhistorymag.com/master.html?http://www.naturalhistorymag.com/1103/1103_feature.html

This activity was developed by Laura Eidielis, Sandra Rutherford, Margaret Coffman, and Marianne Curtis. Parts of the activity were modified from the following source:

- Clark, Steve. (1997) NIKE Athletic Shoes, Rubber Duckies, and Ocean Currents. Current 14(3): 35-40.
- Scientist in Residence Program for Elementary Schools (2007) Rubber Duckies and Ocean Currents, Vancouver School District, SRP_Marine Pollution_Lesson 5_Rubber Duckies and Ocean Currents_2007 R.doc

Illustrations by Lisa Gardiner

Graphic Design by Becca Hatheway

Duck, Duck, DATA!

Student Sheet 1

Name: _____

Event	Date	Location		
		Place Name	Latitude	Longitude
A ship left China with toy yellow ducks, green turtles, and green frogs aboard.	January 1992	Hong Kong, China	21N	110E
A storm at sea washed toys overboard and into the ocean.	January 10, 1992	North Pacific Ocean	45N	178E
People found toys on the beaches.	November 16, 1992	Sitka, Alaska	57N	136W
	November 28, 1992	Sitka, Alaska	58N	136W
	February 1993	Chicagof Island, Alaska	58N	137W
	April 1993	Yakutat, Alaska	60N	140W
	May 1993	Cordova, Alaska	62N	145W

What do you think?

How did the toys move from the middle of the North Pacific Ocean to the beaches in Alaska?

What do you think?

Describe a path that the toys might have taken. Use words like “north”, “south”, “east”, and “west”.

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Student Sheet 2

Name: _____

Location:			
Date	Place Name	Latitude	Longitude
Notes:			

What do you think?

How did the toys move from Alaska to Maine?

What do you think?

How did the toys move from Alaska to Hawaii?

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Student Sheet 3

Name: _____

Imagine that someone dropped a lot of food coloring into Lake Michigan on the shore of Grand Haven.

Where do you think the dye would travel?

I think this because...

Use a colored pencil to draw your idea on the Great Lakes Map.

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Email Sheet 1

TO: mbranner@noaa.gov
FROM: hmccal4@educ.uk
DATE: August 14, 2003
RE: Found a duck

Dr. Brannera:

I understand that American scientists are tracking toys floating in the ocean. I believe that I recovered one of these toys (Latitude: 57N, Longitude: 6W). The toy is a plastic frog. Please advise me.

Thank you,
Harrold

TO: nuuanu@noaa.gov
FROM: MsMaka@ha.k12.gov
DATE: July 30, 1996
RE: turtle

Dr. Nuuanu,

I remember reading something about plastic toys that fell into the ocean. I read about this 3 or 4 years ago. Do you remember the story that I am talking about? I think scientists were studying the toys. I found a toy turtle on the beach on Kure Island (28N, 178W). Could this be one of the toys that the scientists are interested in? I would like to know. I am a teacher, and I think my students would find this story very interesting.

Thank you,
Ms. Susan Maki, Sunset Elementary School

TO: Okioshi2@pifsc.noaa.gov
FROM: Mchavez@funmail.com
DATE: April 9, 1997
RE: Found a duck

Aloha, Mr. Okioshi,

On March 6, my family was on vacation in Hawaii. While on a surfing trip, I found a plastic beaver and frog on the beach. My son says he learned about these toys in school and we should report the find. Can you tell us where we should report these toys? We found the toys on the island of Lanai, which is at 21N, 157W in the Pacific Ocean.

Thank you,
Mario Chavez

TO: klee@nefsc.noaa.gov
FROM: jlobster@Maine.K12.gov
DATE: July 3, 2003
RE: Found a duck

Dear Dr. Lee,

I read about a group of scientists who study how plastic toys move around the ocean. I think these scientists are studying plastic ducks and frogs that spilled into the Pacific Ocean. I found a plastic duck on the beach in Maine! Is it possible that this is one of those ducks from the Pacific? I found my duck at latitude 44N and longitude 68W. Can you tell me who is studying these toys? I want to report my duck.

Thank you,
Jill Lobstera

Duck, Duck, DATA!

Email Sheet 2

TO: uweb@nwfsc.noaa.gov
FROM: shineygirl@funmail.com
DATE: June 16, 1995
RE: I found some turtle toys

Dear Dr. Web,
I found some toy turtles on the beach while my family was on vacation. We were on the Olympic Peninsula in Washington. I found the toys in May. You are a scientist. Can you explain something to me? How did these toys get to the beach in Washington? I looked up the latitude and longitude on the Internet. These are 48N and 124W.
Sincerely,
Elise

TO: muir@afsc.noaa.gov
FROM: smartman@sunmail.com
DATE: May 18, 1994
RE: Plastic Ducks

Dear Dr. Muir:
My family has found four plastic ducks on the shore near Shumagin, Alaska. We found the latitude and longitude for the fourth duck. This was 55N and 170W. Do you have any idea why these ducks are washing up on the shore? They look like they are the same type of duck. Was there a shipwreck nearby?
Thanks,
Jessie Kenner

TO: kanake@afsc.noaa.gov
FROM: kodiak@uaf.edu
DATE: June 15, 1994
RE: toys and currents

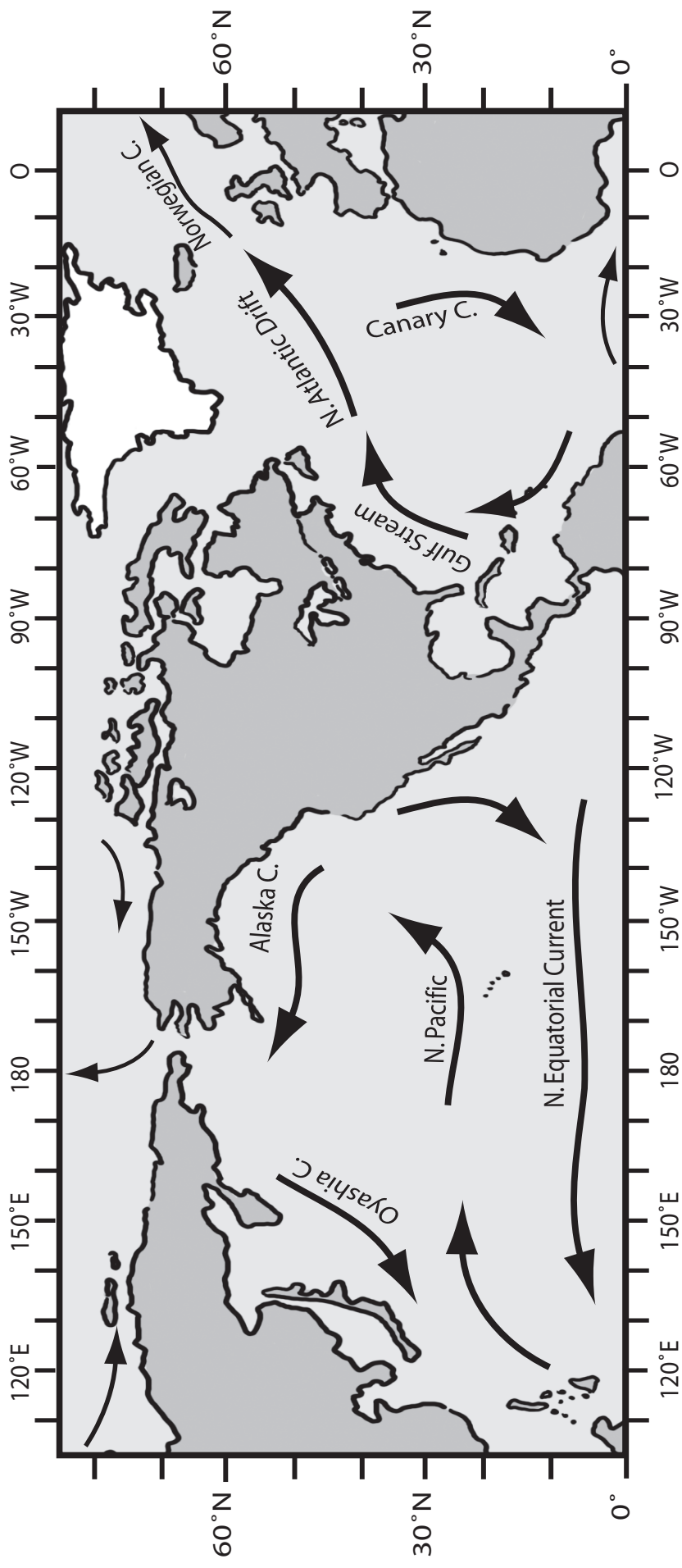
Dear Mr. Kanake:
While studying barnacles on the rocks, I found several plastic toys. Our study was on the St. Paul Islands. The locations were around 57N, 170W. A friend told me that a NOAA scientist was looking for these toys in order to study currents. Could you please provide me the name and email of this scientist?
Thanks,
Matt Evans

TO: editor@devontimes.com
FROM: cherie@mail.uk
DATE: July 1, 2007
RE: Plastic Duck Story

Dear Editor:
In *The Times* out of London, I read that a plastic duck “armada” was headed for England. This article was on the Internet on June 28, 2007, and the title was “Plastic duck armada is heading for Britain after 15-year global voyage”.
While on the beach in Devon county, I found a plastic duck. This duck looks very old. The duck has very little color and has holes in it. I think this might be one of the plastic ducks in the newspaper article. Would you like to report this in your newspaper? The duck was found at 51N and 4W.
Sincerely,
Cherie Jones

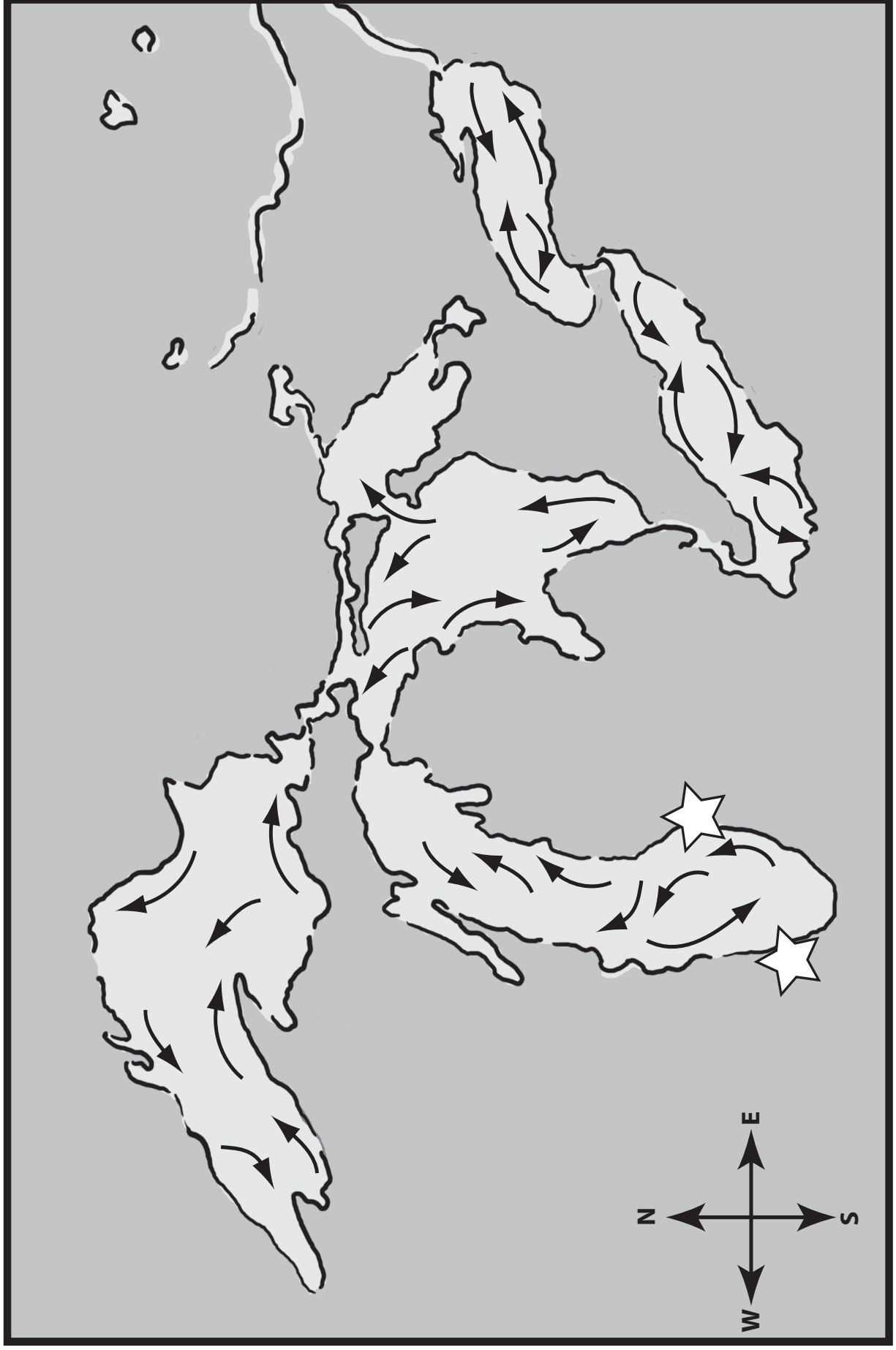
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Ocean Map



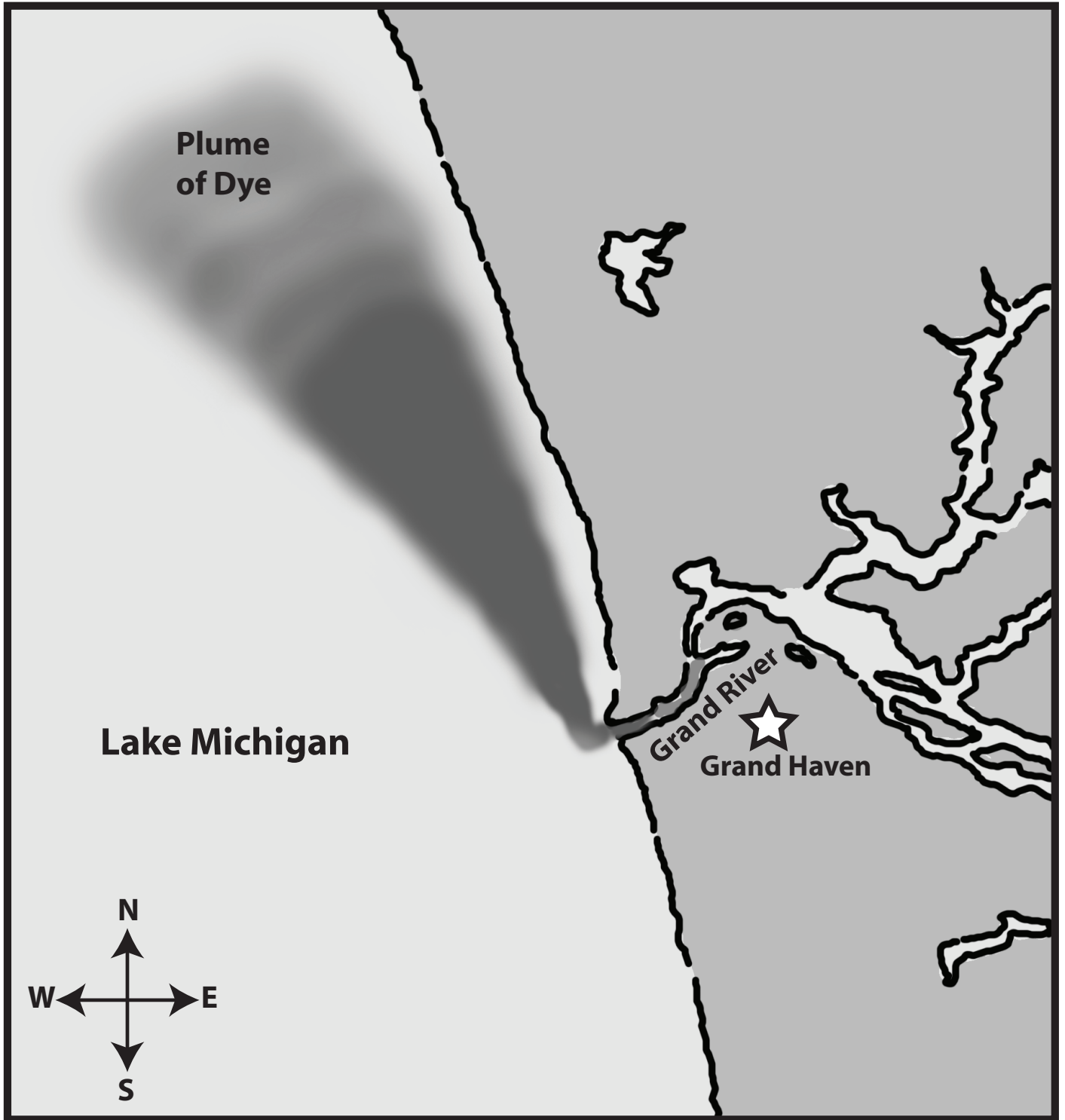
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Great Lakes Map



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Dye Plume Map



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World Map

