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Lesson Plan

Map Skills, Ocean Currents, Pollution, and ... A Rubber Duck?

Jerry T. Mitchell
Department of Geography
University of South Carolina
Columbia, South Carolina, USA

Danielle Hance
Lake Murray Elementary School
Chapin, South Carolina, USA

The History Behind a Few Lost Ducks

Who doesn't like a rubber duck? *Sesame Street*'s Ernie let us know that "Rubber Duckie, you're the one. You make bath time lots of fun." It is perhaps our childhood fondness for this toy that makes the story of the "Friendly Floatees" so captivating.

The "floatees" in question are a number of bath toys—nearly 29,000—that fell off a container ship during a storm while crossing the north Pacific in 1992. This colorful flotsam included beavers, frogs, turtles, and, of course, yellow rubber ducks. Their story has been popularized for both adult and youth audiences, notably with the books *Moby-Duck* (Hohn 2011) [1] and *10 Little Rubber Ducks* (Carle 2005). The academic community also has taken note with ocean scientists using this event and other cargo ship losses to model ocean currents.

The lesson we present here uses the story of the "lost" ducks to integrate instruction in science, mathematics, and geography as students map the journey the ducks take across the Pacific Ocean. Students synthesize their knowledge of oceans currents and pollution, coordinate planes (latitude and longitude) and rate solving, and gain an overall understanding of how the world is interconnected. Importantly, students no longer use these skills in isolation and must pull knowledge from multiple disciplines to find the eventual locations of their favorite rubber friends.

Letting Ducks Teach Geography, Math, and Earth Care

Our lesson begins by reading *10 Little Rubber Ducks* by Eric Carle (2005) to the students. The book playfully and colorfully introduces the class to rubber ducks rolling off an assembly line, onto a truck, and finally aboard a ship. Sunny skies soon turn dark and the ducks are washed overboard. Here we explain that this story is actually true and that the students are charged with tracking the ducks' journey in the open sea.[2]

Learning Latitude and Longitude

"Before we did the lesson I was completely lost in latitude and longitude, but after I understood how important it is to know it."

Our experience teaching this lesson to fifth-grade students, like the one quoted above, highlighted a number of important considerations. First, all students will need a strong background in coordinate planes. Most students were able to identify the basic task when it was described as like playing the game *Battleship* (an alpha-numeric coordinate system), yet there was still a significant discrepancy between ability levels. Much of this we attribute to differing levels of exposure to coordinate planes in their mathematics instruction. We recommend that students undertake basic point-pair plotting activities to gain confidence in the days before this instruction.

A second issue regards latitude and longitude as a locational system. While it is a grid, two confounds exist: (1) the fact that it is draped over a sphere, and (2) the site of the mapped event straddles the International Date Line. Both have the potential to confuse without additional time viewing a globe or a digital representation such as Google Earth.

With time and care spent on coordinate systems generally and latitude/longitude more specifically, students will finally be prepared for plotting the "duck data." The coordinate pairs needed for mapping are provided in Table 1.[3] A blank copy of the map used is available for download at http://artsandsciences.sc.edu/cege/rubberduckmap.pdf. Students connect each coordinate pair with the next to depict the ducks' journey (Figure 1). Several students were surprised, and excited, to see that the final shape resembled a duck (the "head" would be in the Gulf of Alaska). Importantly, the students have done more than map the ducks' lap around the Pacific; they have mapped the major ocean currents propelling them. These include the North Pacific, Alaska, Kamchatka, and Oyashio currents.[4]

Seeing the World in a Different Way

Once the students completed their maps, we posed a new question: do you think that the ducks could make their way to Europe? When shown a traditional, flat map of the world, students were largely incredulous. The duck "accident" site had

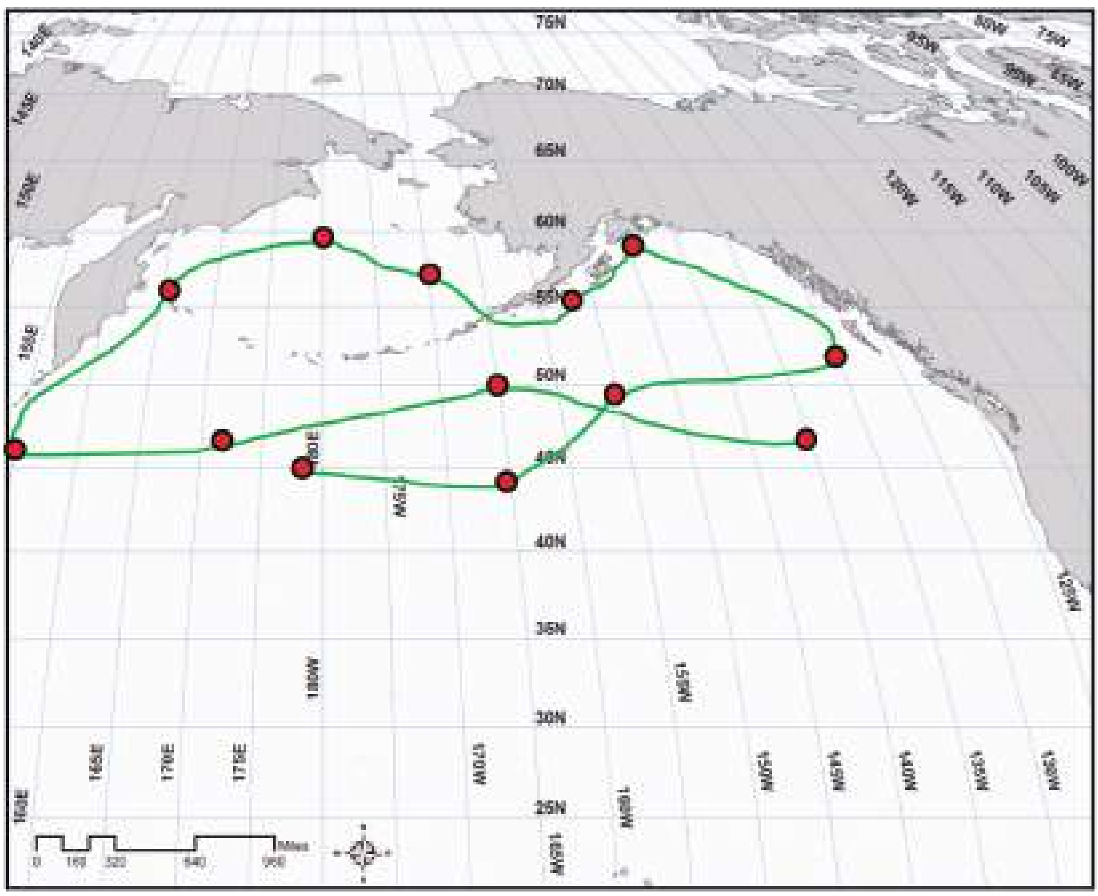

Figure 1. The lost ducks' journey. (Color figure available online.)

Table 1. Coordinate Pairs for the Lost Ducks

Point #	Date	Latitude	Longitude
1	January 1992	45°N	178°E
2	March 1992	44°N	165°W
3	July 1992	49°N	155°W
4	October 1992	52°N	135°W
5	January 1993	59°N	149°W
6	March 1993	56°N	157°W
7	July 1993	57°N	170°W
8	October 1993	59°N	180°E
9	January 1994	56°N	166°E
10	March 1994	45°N	155°E
11	July 1994	47°N	172°E
12	October 1994	50°N	165°W
13	January 1995	47°N	140°W

continents on either side that would make a duck landing in Europe seemingly impossible. Popular answers to the question included having the ducks wander through the Panama Canal or into a tourist's pocket who would then take the rubber friend with them. By revisiting the ocean currents map, students quickly realized that the flow of ocean currents made a Panama journey implausible and the less-serious answers unlikely as well.

Here we showed them that they needed to see the world differently. If one uses a globe or a paper map with a polar view, is becomes apparent that an Alaska-Europe duck route is possible. If some of the ducks were able to pass through the Bering Strait, they may be able to move with the ice over the North Pole and into the upper Atlantic. Figure 2 shows this possibility using Google Earth.

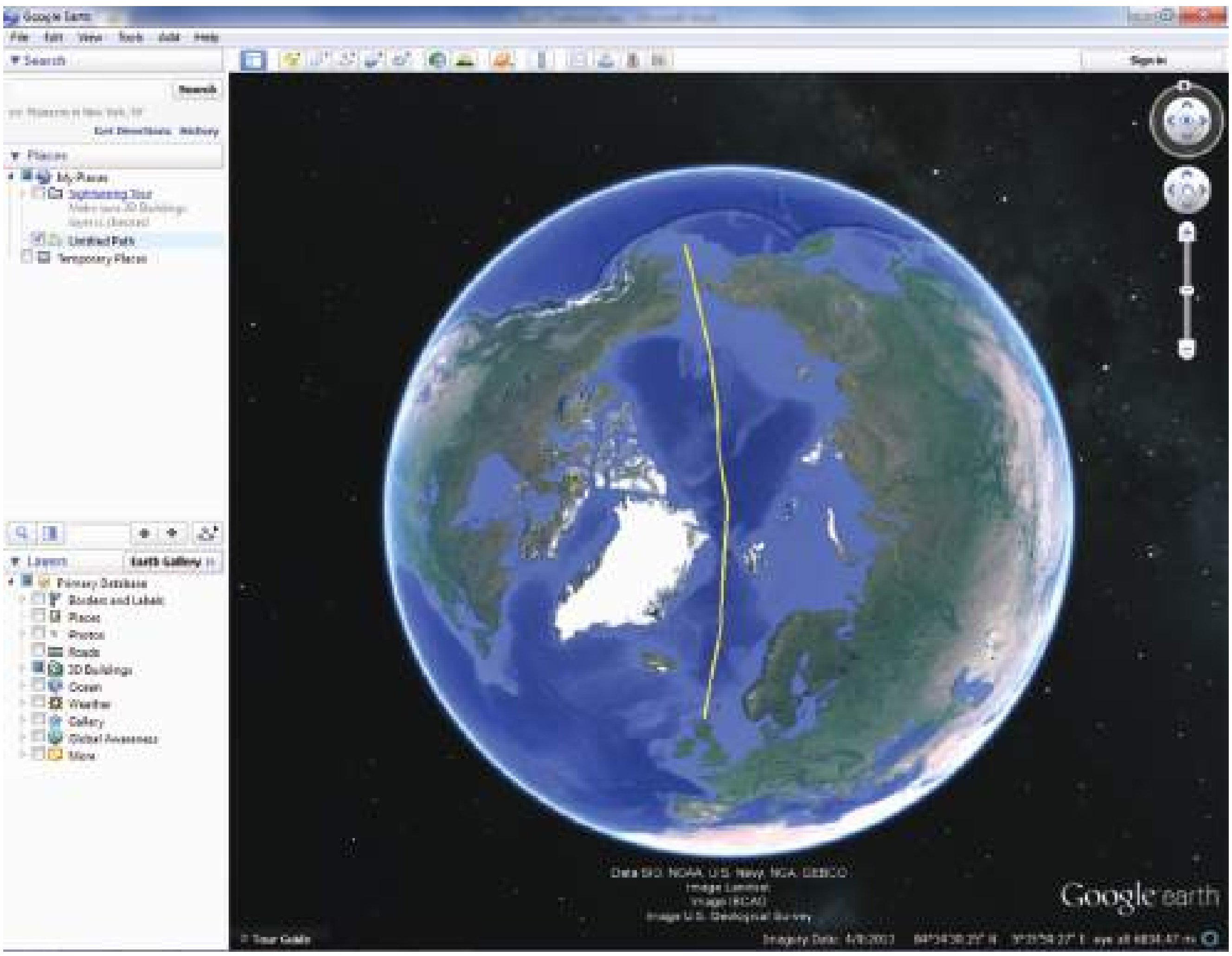

Figure 2. Example of possible polar journey visualized with Google Earth. (Color figure available online.)

Math Integration

The data presented in Table 1, along with the scale on the map, also allow students to engage in simple mathematic calculations. For example, ask the students "how fast did the ducks move?" They would need to gather the following information: (1) how far did the a duck travel from one point to another point?, (2) how many days did a duck need to travel that distance?, and (3) how many hours are there in one day? Using the example of Points 3 and 4, we can see that the distance (using the scale bar for measurement) is approximately 900 miles. The travel time is July to October. Assuming the full month was needed since we do not have precise days, then the travel time is 123 days. The ducks then moved about 0.3 miles per hour ((900 miles/123 days)/24 hours). Many children in this age range can run one mile in less than 10 minutes. Using that as a comparison, students realize that the ducks were moving rather leisurely (they may also note from the table that the ducks took three full years for the mapped journey).

The mathematic activity illustrated here also reflects a central part of the Common Core Standards Initiative where students must be able to "make sense of problems and persevere in solving them; reason abstractly and quantitatively; construct viable arguments and critique the reasoning of others; model with mathematics; [and] use appropriate tools strategically" among other practices (CCSSI 2014).

Environmental Concerns

"But why should we care about rubber ducks?"

This is a valid question raised by one of the boys while working on his map. To this point the students have been read a children's book and connected a few dots on a map; the latter action in particular is not an activity that they do regularly. But something they all encounter daily is trash. Cute as they might be, the rubber ducks are pollution. Here we took the opportunity to personalize the story by making connections to their own actions.

Given the location of the event, we chose to discuss the so-called "Great Pacific Garbage Patch." The same ocean currents (the North Pacific Gyre) that the ducks ride on their journey help to concentrate pieces of plastic and other marine debris in the north Pacific. Larger pieces of trash can be ingested by turtles, birds, and mammals, but importantly, smaller fragments can collectively block the sunlight needed by plankton and algae. This would result in a disruption of the food web, endangering larger sea life.[5] This one example highlights the interconnectedness of our environment and showcases how careless waste disposal can have impacts far from the original source. One student succinctly summed up this point: *"It made me realize how such little things can make such a big impact on our world."*

Conclusion

"It was interactive and thought-provoking."

Our initial goal with this lesson was to enliven and personalize a topic—ocean currents—that our students do not encounter daily. This meant creating an activity that engaged different media and challenged the students to think about the ocean as connecting other phenomena. This "interactive and thought-provoking" approach, as identified by one of our participating teachers, did so by integrating physical science, mathematics, and geography.

Students gained a better understanding of geography (in particular spatial connections) and ocean currents as a result of this lesson. Importantly, students reflected on the impact humans have on the environment. "Tracking the ducks" became a concrete example of how an action in one place can impact the environment half a world away. This new understanding made the study of ocean currents relevant. Further, students became more familiar with coordinate systems, learning to plot data not for its own sake but rather to better understand the world.

This particular lesson integrates the STEM disciplines with real-world problem solving. Adaptations to this lesson include working with the data in teams or framing the lesson with questions that create a more problem-based learning format (e.g., "What happened to the ducks? Why did they move that way? Why does it matter?"; Roberts 2013). Additional group projects could include tracking other marine pollutants or further research on the impact of the "Great Pacific Garbage Patch" on marine life.

We believe that the learning potential of this lesson can be summarized in this way: A cute story became an event that was *real*. Data points became a *pattern* worth investigating further. The "far away" became *near* and "should I care?" became a *yes*. Students leave this lesson seeing themselves in the world differently and collectively appreciating the need for math, science, and geography to make their way in it.

Acknowledgment

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Notes

[1]For an overview, see National Public Radio (2011).

[2]While we stopped reading Carle's book at the point of the accident, some teachers may want to continue with the story. The ducks soon

encounter a seal, a dolphin, and other friendly animals that share the sea.

[3]These coordinate pairs are modified from work by Harris, Archer, and Lundell (2006), from the original source material in Ingraham (1997). Harris *et al* originally modified the coordinate pairs "to reduce confusion over east and west longitude" as the study area crosses the International Date Line. We maintain that the proper coordinates should be used rather than having students "unlearn" an incorrect location system.

[4]Maps of ocean currents may be found in any number of atlases or online. One digital image is available at the SEOS (Science Education Through Earth Observation for High Schools) website: http://www.seos-project.eu/modules/oceancurrents/oceancurrents-c02-p04.html

[5]For additional content information, see National Geographic Education (2013).

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Jerry T. Mitchell is the director of the Center of Excellence for Geographic Education in the Department of Geography at the University of South Carolina and Coordinator of the South Carolina Geographic Alliance. His research interests are in environmental hazards and geography education. He has been editor of the *Journal of Geography* since 2010.

Danielle Hance teaches 5th-grade math, science, social studies, and language arts at Lake Murray Elementary in Chapin, South Carolina. She is Nationally Board Certified in Early and Middle Childhood Literacy and holds two Master's Degrees in Education. She has taught for twelve years and is passionate about project-based learning.

Lesson Overview

This lesson introduces students to a real-life event—the loss of ocean cargo that included rubber ducks—through a children's book, *10 Little Rubber Ducks*. Using latitude and longitude coordinates, the students plot the journey of the ducks as they ride ocean currents in the north Pacific. Students are further challenged to consider the environmental implications of the lost cargo and refine mathematic skills by determining their journey's rate. This lesson has been successfully taught for grade 5 and is adaptable for other grades.

Time Required

Two class periods (assumes one period for latitude/longitude practice, one period to complete this activity).

Preparation

Materials/Resources

- Carle, E. 2005. *10 Little Rubber Ducks*. New York: Harper Collins.
- Table 1. Coordinate Pairs for Lost Ducks.
- North Pacific Map with latitude and longitude grid. Available for download at: http://artsandsciences.sc.edu/cege/rubberduckmap.pdf
- Map of ocean gyres/currents
- Google Earth or a globe
- Pens or pencils

Standards

National Geography Standards

1. How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information.

7. The physical processes that shape the patterns of Earth's surface.

14. How human actions modify the physical environment.

South Carolina Science Academic Standards

5-3.5 Compare the movement of water by waves, currents, and tides.

5-3.6 Explain how human activity (including conservation efforts and pollution) has affected the land and the oceans of Earth).

Common Core Mathematics Standards

CCSS.MATH.CONTENT.5.G.A.1

Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., x-axis and x-coordinate, y-axis and y-coordinate).

CCSS.MATH.CONTENT.5.G.A.2

Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

Objectives

- The student will reconstruct the ducks' journey by using latitude/longitude coordinate plots.
- The student will identify ocean currents contributing to the ducks' movement.
- The student will use a globe or similar to identify other possible destinations for the ducks.
- The student will use the ducks' travel data to estimate their rate of speed.

Instruction

Opening Instruction

1. The teacher begins by referencing previous work with latitude and longitude. It may be appropriate for a review activity before beginning the reading activity.

Developing Instruction

2. The teacher reads aloud the picture book *10 Little Rubber Ducks*. Once the story is read, students are asked their thoughts about whether the story is actually true. The teacher then explains the real event and informs the stu-

dents that they will use a map and data coordinates to chart the ducks' journey in the north Pacific Ocean.

3. The teacher provides each student with the north Pacific map and Table 1, the coordinate pairs for the ducks. Each point should be plotted and a line drawn connecting each to create a path. The teacher will need to monitor progress as completion rates will vary.
4. Once the map is completed, the teacher shares a map of ocean gyres and currents. This may be done with a handout or via a Smart Board/projection system. The students then identify the currents responsible for the ducks' movement. Answers will include the North Pacific, Alaska, Kamchatka, and Oyashio currents.
5. Students are then asked if the ducks could make their way to Europe. After entertaining responses from the students, a globe or Google Earth can be used to show a possible route across the North Pole.
6. Using the travel data provided in Table 1, the students then calculate the ducks' rate of speed. For example, Points 3 and 4 are approximately 900 miles apart. With a travel time from July to October, the time expended is 123 days. In this calculation, the ducks moved about .3 miles per hour ((900 miles/123 days)/24 hours). Students may be asked to calculate the rate of speed between other points as well.

Concluding Instruction

7. The lesson is concluded by asking the students why this particular event is important to their environment. After fielding responses, the teacher discusses marine pollution (e.g.: the "Great Pacific Garbage Patch"). The teacher should make sure that the students realize how an event such as the cargo loss of rubber ducks can highlight the interconnected nature of Earth.

Assessment

- Students will have a completed "duck journey" map. This map may be used to assess their ability to plot latitude/longitude coordinate pairs.
- Since this is an introductory lesson the map is not graded, but students can be provided with an overlay (the teacher can print multiple copies of the map on clear overheads) to check their work. Students will then work in pairs to rework any missed coordinates.
- The teacher may ask the students to present their ideas about other potential travel routes or the impact of the ducks on the environment in writing.
- Students can write a reflection based on critical questions like: Why does what happens on one side of the world matter to the other side? How can we use geography to solve problems? What did you learn about ocean currents and how they impact us?
- The mathematic calculations for the ducks' rate of speed may be assessed for accuracy.

Extending the Lesson

- Use this lesson as a "jumping off" point for a study on the human impact on the environment. Students may work in pairs or individually to study one way humans have negatively impacted the environment. They can present their research along with what students can do to help.
- Provide students with another set of coordinates to plot and grade for accuracy.
- Use GPS units with the class. Have students create waypoints and plot their own coordinate data.
- Utilize Google Earth or a website like ArcGIS.com to extend their new appreciation of geography and mapping (Figure 3).
- A lab on currents can better help students understand the movement of warm and cold water: 1. Place one large rock in ice and one in boiling water. 2. Fill a clear tub with water. 3. Carefully place the rocks in opposite corners. 4. Drop a few drops of blue food dye on top of the cold rock and red on top of the hot rock. 5. Allow the students to watch the motion of the colored water and where purple water forms.
- Other published lessons on the "lost ducks" may be of interest. See ideas by a variety of authors in "Ducks Ahoy! Plastic Debris and Ocean Currents", *Middle Level Learning*, Number 46, January/February 2013 and Nagel, P. and D. Beauboeuf (2012).

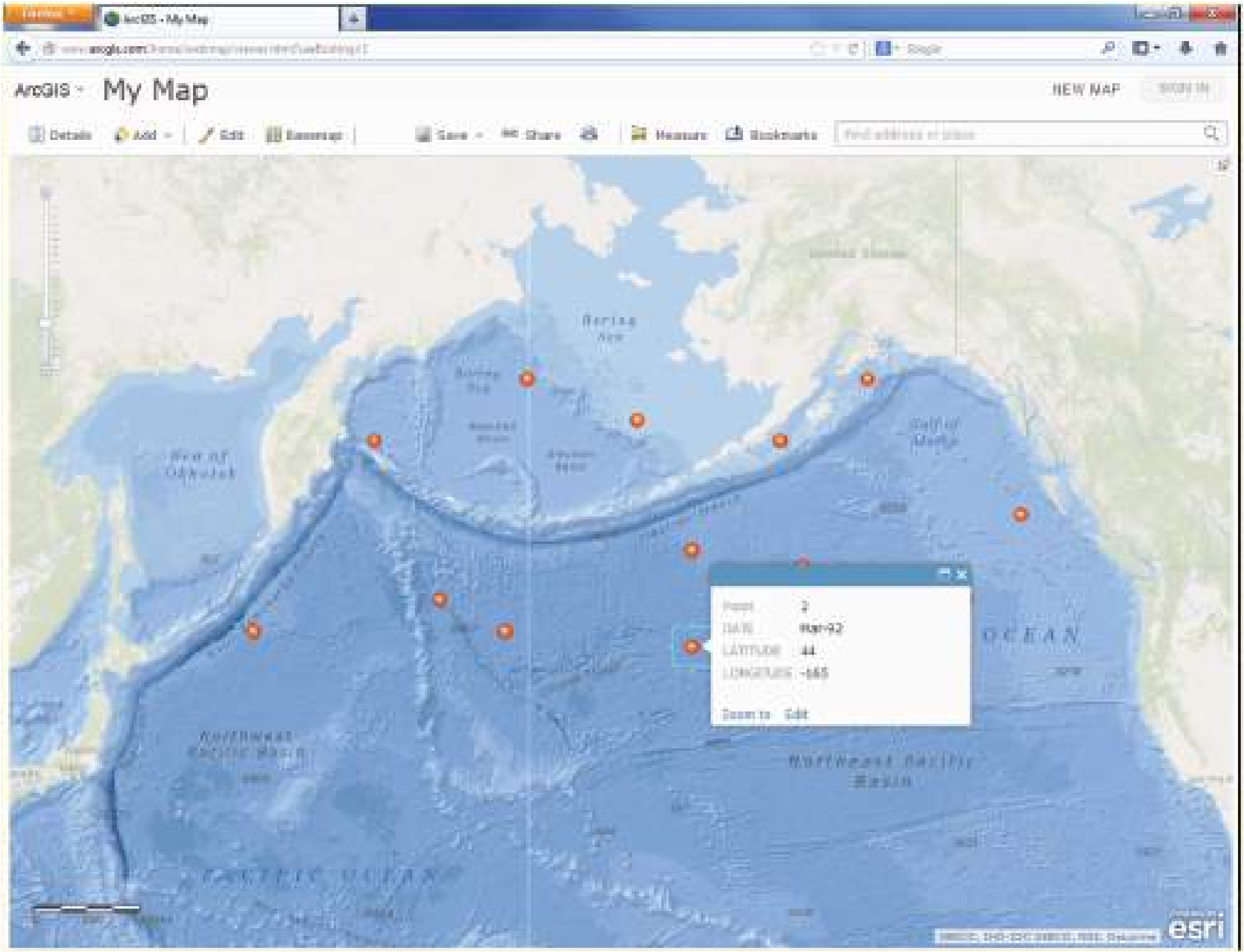

Figure 3. Using ArcGIS Online to plot the coordinates. (Color figure available online.)