



Pollution Patrol Lesson Plan

Overview

Building on the previous lesson, [Just around the Bend](#), Pollution Patrol continues to concentrate on maps highlighting a section of the Missouri River in order to focus students' thinking on waterways and pollution. To introduce the lesson, students observe satellite imagery that illustrates how waterways can contain large amounts of pollution and sediment that eventually makes its way to larger bodies of water. Using that context as a springboard, students then participate in a dynamic, cooperative activity in which they hypothetically rescue two 50-gallon barrels of oil from the Missouri River. To do so, students will use and explore number lines, units of measurement, distances, scales, and directions. This lesson provides the mathematical framework for students to move on to [Search and Rescue](#) and other lessons involving graphing in the coordinate plane.

Suggested Lesson Sequence	Please see the Maps and More and Earth Systems and Humans module descriptions.
Lesson Level	Intermediate
Science Connections	<ul style="list-style-type: none"> - Students investigate the water cycle and possible sources of pollution in the water cycle. - Students investigate how land is cultivated for agriculture.
Math Connections	<ul style="list-style-type: none"> - Students will develop spatial sense using maps and imagery. - Students will use number lines to focus on both direction and distance. - Students will compare units of measurement. - Students will explore triangle (sides) relationships.
Technology Connections	<ul style="list-style-type: none"> - Students will examine and interpret satellite imagery of the Earth. - Students will use a computer to compare a satellite image with a map.
Human Connections	<ul style="list-style-type: none"> - Students will investigate the effect of pollution on the Earth's waterways, plants and animals.
Lesson Assessment	<ul style="list-style-type: none"> - Assessment and Standards Table (Word) - Assessment Activity Description

Materials

Powerpoint Reader ([Windows](#) / [Mac](#))

Volga River Pollution slideshow ([Powerpoint](#))

Pollution Patrol Activity Sheet ([Word](#))

Riverbend Map ([Powerpoint](#))

Water Pollution Photo Essay ([Powerpoint](#)), to be viewed and discussed as a class. This file is stored in the "Just Around the Bend" folder.

Vocabulary

Note: Students may be unfamiliar with vocabulary words that occur throughout the activity sheet of this lesson. This is done intentionally, to spur additional conversations and discussion about these words and their meanings. Encourage your students to ask about words that may be new to them.

Delta: The shoreline region where a large river empties into another body of water.

Peninsula: A body of land almost surrounded by water.

Sediment: Sand and dirt which enters waterways through a process called erosion.

Procedure

This lesson provides students with the opportunity to participate in a hypothetical adventure in which they try to stop the spread of river pollution. In addition to exercising their mathematical thinking and problem solving skills, students gain a sense of how simply pollution can occur, and how they can be active eyes and ears to help stop it.

I. Assessing Prior Knowledge

To begin this lesson, teachers may wish to begin with a review discussion about the major concepts explored in the *previous lesson, [Just Around the Bend](#). In that lesson, students began to think about the impact that water pollution can have on plants and animals -- even those living on land. Reviewing the [Water Pollution Photo Essay](#) will give students a good introduction to the topic of this lesson.

II. Contextual Preparation

To begin this lesson, students should view the [Pollution Patrol: The Volga River](#) photo essay on the computer (or projected on a TV or screen). As an alternative, the teacher may print this page out for students to observe. The photo essay contains imagery of the Volga River in Russia as it dumps tons and tons of sediment and pollution into the Caspian Sea. While there are no questions on this page, be sure to engage the students in a thoughtful discussion of the image. It is difficult to determine the difference between sediment (sand and soil) and pollution in the image. Students should be aware that all rivers carry sediment as they erode the riverbed. In this image, however, it is clearly the case that an unhealthy amount of sediment and pollutants have entered the river. The same kinds of sediment trails can also be seen in large rivers on other continents; for example, the Mississippi River in the United States. You may wish to show the Volga River on a map, indicating how it drains a very large portion of Europe.

III. Student Activities

1. After the students have had a chance to examine and discuss the images on the Water Pollution Photo Essay and of the Volga River, you may distribute the [Pollution Patrol Activity Sheet](#). To deepen students' investment, spend time informing them of their tasks -- they will help rescue a barrel of oil from the Missouri River before it leaks and pollutes the environment. After this discussion, distribute the [River Bend Map](#), and give students several minutes to examine its contents. This map should look familiar to students if they have already completed the [Just Around the Bend](#) lesson.
2. As students begin to work their way through the activity sheet, teachers should briefly introduce the idea of a number line if students have not had previous exposure to it. They will be using the number line to think about direction, distances, and units of measurement.
3. The following suggestions and answers to activity questions will help teachers guide students through the activity, and the task requirements in particular.
 - **Task #1:** This question requires students to use both the horizontal and vertical number line. Counting horizontally may not be as much of a problem as counting vertically (since they are not directly on the vertical axis). Students should come up with an answer of around 5 kilometers.
 - **Task #2:** Answers might vary, but the location on the map should be somewhere in the vicinity of the point that could be found 4 kilometers west of the campsite, and then 2 kilometers north. In the beginning of the story, there are hints that should allow the students to infer that the river is flowing (generally) from west to east, or from the left hand side of the page to the right hand side of the page.
 - **Task #3:** This question begins to hint at the Pythagorean theorem and triangle relationships. Specifically, the hypotenuse of a triangle is always shorter than the sum

of the two adjacent legs of the triangle. Although this concept may be beyond your students, they should be able to begin reasoning about the distances of the sides of a triangle. As an extension activity that pursues geometric relationships, students could use dry spaghetti pasta (or other straight manipulatives) to explore the relationships of the sides of a triangle in further detail. In any event, students should realize that it is shorter to follow the hypotenuse of that triangle -- i.e., the deer path -- on the way back to camp.

- **Task #4:** Answers will vary. Students should, however, consider various issues such as: How quickly is the water current flowing? Will we be able to catch up to the barrels? Can we row upstream effectively? If we get to the barrels, will we be able to attach them and paddle hard enough to tow them to shore? What options will be the safest?
- **Task #5:** In this task, students explicitly explore the number line. Several concepts in particular are involved. For example, students may use the number lines to measure distances on the number line itself. Students may have to infer distances by subtracting the starting and ending points as determined by the number line. Students may also use the number line as a scale, measuring distances that do not fall on the number line itself. Finally, students will have to combine two discrete sections of a number line as they determine a composite distance. Be sure to spend ample time on these questions as they provide students with foundational experiences and understandings of the number line. (You may want to hint toward the concept of negative numbers on the number line if you have students who are ready for such development. For example, the number line to the west of the campground could be illustrated with negative numbers. This concept will be pursued in later lessons.)

Answers for Task #5 (all answers are close approximations):

- 1) 5 km; 4 km
 - 2) 4-5 km; 1 km; Explanations vary.
 - 3) Speed of the current; ease in spotting the barrels; shorter distance to cross, etc.
 - 4) 11 km
 - 5) About 6.5 km; about 8 km
 - 6) About 25 km; (Strategies vary. Most common is to trace the road with string)
 - 7) About 1 km; about 9 km
- **Task #6:** This task is an important exercise, as it requires students to reason about optimal solution strategies for the context, using the information they explored in the previous set of questions. Task #5 was designed to help the students think critically about the three possible rescue sites. The following examples represent some of the comments students might make:

- 1) The wider the river, the more difficult to locate and rescue the barrels (although

the river runs more slowly). Hence, Site #1 would be least optimal of the three in that regard.

- 2) How quickly can we get the rafts to each of the rescue sites? The barrels might already have floated beyond Site #1 and Site #2.
- 3) Site #2 is most optimal in terms of the width of the river.
- 4) Site #3 is closest to camp, although it does require a hike across the peninsula.
- 5) The difficulty of carrying the rafts versus the time needed to load them in the car and drive to next point.

- **Task #7:** Answers will vary, although the location should be somewhere in the vicinity just south of Rescue Site #2. Depending on where students marked the location of barrel #1, they may have to extend the vertical axis below the campsite (again, a possible place to introduce the idea of negative numbers) as they draw in the location where barrel #2 was captured 10 kilometers directly south of barrel #1.

IV. Assessment

The series of questions found on the activity sheet in **Task #8: Reflection** can serve as an assessment of the lesson, and could provide an opportunity for extended discussion about the mathematical tools and concepts developed in the lesson.

In addition to the questions found in Task #8, the following questions might be used to assess students' understandings of this lesson's objectives.

- How are number lines used for determining distances on maps?
- What is the difference between distance and direction on a map?
- How does this activity relate to the satellite image of the Volga River?

Lesson Extensions for Authentic Assessment

- There are many ways to extend and develop the mathematics concepts introduced in this lesson. Students should spend time with number lines as they learn to use them to make measurements, think about distances and directions, or apply scales of different units to various lengths. One activity in particular that will help develop these concepts is to have students make their own rulers, and then measure common objects. Students should choose any length for their base unit, as long as they use that unit consistently as they measure with their "rulers." For example, students may measure a table in standard units like inches, as well as non-standard units on their own rulers such as: the length of my pinky, the length of a pencil, or the length of a piece of paper. Developing rich understanding of number lines will be easier for students if they see how these different units of measure can all be applied to the same objects.

- Meriwether Lewis and William Clark traveled this portion of the Missouri River during their western United States expedition in the early 1800s, right after the Louisiana Purchase. Discuss the differences between today and the early 1800s. How might this map be different now from during the time of Lewis & Clark? Would it be likely that Lewis & Clark would find a paint can floating in the Missouri during their trip? What people lived in this area during the time of Lewis & Clark? (It might be noted here that this portion of the Missouri is located within the Crow Creek Indian Reservation of South Dakota.) Have the students draw sketches of what they think the River Bend landscape would have looked like about 200 years ago.
- Students could "adopt" a portion of a local waterway for an extended period of time. In addition to observing the ecosystem informally, students could be the "pollution patrol" of the waterway, attempting to clear the area of possible sources of water pollution.