

Lesson 5: Data Detectives– Student Version

Lesson Objectives: At the end of the lesson, students will be able to

- 🌐 Use GeoMapApp mapping software and scientific data sets to explore real world scenarios.
- 🌐 Use the scientific method to analyze data and propose a solution to an environmental issue.
- 🌐 Understand how scientists and policy makers use data and map layouts to understand environmental issues.
- 🌐 Communicate results of data analysis with a map layout and design a report or advertisement designed to educate the reader about an environmental issue and persuade a course of action.

Background:



In this Lesson, you will use geospatial technology as a key method in finding answers to environmental problems. GeoMapApp is an excellent tool for developing an intuitive feel for geospatial relationships in data, and is considered a type of Geographic Information System. In its simplest form, the term "Geographic Information System," or GIS, is an acronym for a technology that offers a radically different way in which we produce and use the maps required to manage our communities and industries. A map of data points can convey more visual information than a 20 page detailed report. The human brain is highly efficient at processing spatial information and interpreting patterns, and a map layout can convey a complicated message in a highly efficient manner.



Using computer programs, the technology links items displayed on a map with records in a database with the answers displayed on a map. The resulting combination, and the ability to manipulate the data in response to any number of "what if" scenarios, provides government agencies, utilities and a long list of private industries with a powerful and dynamic new tool that has opened doors in management effectiveness and organizational efficiency. A GIS creates

intelligent super maps through which sophisticated planning and analysis can be performed at the touch of a button.



Geographic data is a rich source of information that will offer a myriad of opportunities for approaching social and environmental issues, if you know how to mine the data and search for the treasures it contains!

In this lesson, you will use GeoMapApp and geospatial data sets to evaluate current threats to whale populations. You will also use reasoning and writing skills to deliver a message that will attempt to persuade people to act for the environment and/or the whales.

Threats to Whales

Oil and Gas Exploration - The increasing demand for gas and oil creates pressure to find new sources as current fields are depleted. The ocean floors hold great promise for new areas of oil



sources. Seismic exploration uses loud explosions to send sound waves to the ocean floor's rock and sediment layers. Different rock stratum produce unique sound signatures and help scientists identify areas that are likely to hold oil reserves. The explosions, as well as the drilling and oilrig platform construction have been proven to disrupt and potentially harm whales.

Mining Extraction and Mining - The ocean sea floor is rich in chemicals that human use to produce fertilizer (phosphates), fuel their factories and automobiles (petroleum), flavor and preserve foods (salt) and even keep sandy beaches from eroding away (sand).



Coastal Water Pollution – Over 50 percent of the world’s people live within 50 miles of a coastline. By 2015, it is projected that the number will increase to 60%. Urban development removes forests and wild habitats and replaces them with houses, roads, industries and shopping centers. The business of human living produces toxic chemicals that are often washed away by rains into the rivers that flow into our oceans. Pollution affects coastal

areas in many ways, including polluting the water column and impacting the food web with disease and an imbalance of nutrients that disrupts the natural cycles.

Fishing Gear/ Nets, Traps - The rapidly increasing human population relies on fish as a source of protein, and we harvest millions of tons of fish from the oceans each year. Over half of the people in the world use fish as their primary source of protein, and fishmeal is also used as food for livestock. Fishermen use various types of gear, including large nets dragged through the water, to small traps set on the bottom and marked at the water’s surface with ropes and floats. Nets can be lost at sea and traps can be torn away from the bottom by storms, and sea life swimming in the ocean can become entangled in the nets or ropes. Scientists have estimated that 85% of the Atlantic Right Whales have scars that resulted from interaction with floating marine debris such as these nets, floats and ropes.



Shipping Collisions – The products that we use as consumers every day, including automobiles, electronics, clothing, food and petroleum are often transported across the ocean in ships. These products are transferred from ships to land in major city ports around the world. Near the large ports, shipping lanes can become busy and quite congested. The large propellers on the ships can kill or seriously injure slow-moving whales, and ship strikes from the front of the ship often result in the death of the whale.

There are many other threats that impact whale populations. Human activities that occur on a daily basis can affect whale populations, and increased tourism and increased sound in the oceans are currently threatening whales. Long term changes in our climate are also believed to be impacting the oceans and the animals that live in them. For this lesson, we will focus on a subset of the long list of threats facing whales. We will be considering impacts caused by exploration of the seas for resource extraction (oil and gas exploration, mineral extraction and mining) and anthropogenic causes (coastal water pollution, fishing gear and shipping collisions).

Scenario 1: Prepare an Environmental Impact Report Focusing on Whales for Oil Companies Interested in Drilling For Oil

1. Examine Figure 1, 'Oil Consumption per Capita'.

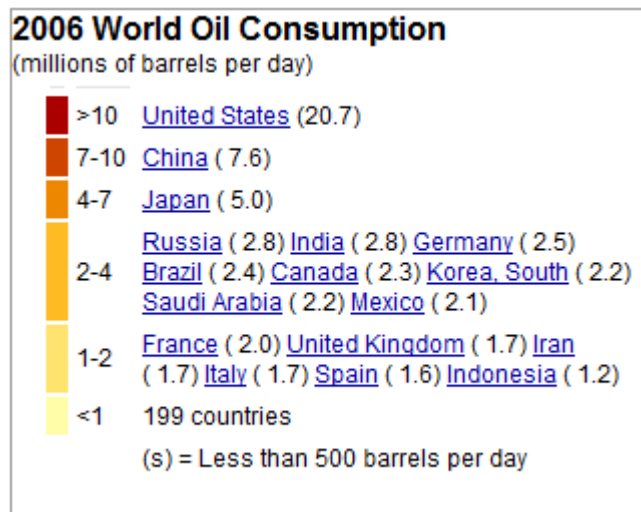
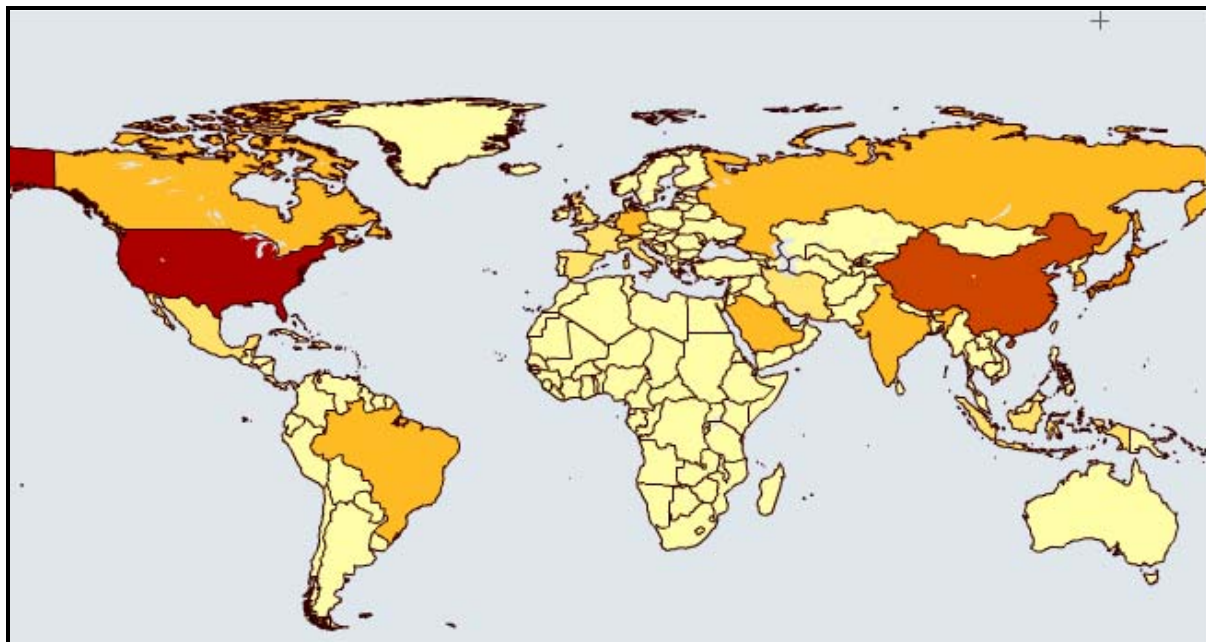


Figure 1. Map showing 2006 world oil consumption.

Question 1. List the 3 top oil consuming countries (darker colors represent more consumption) and millions of barrels consumed per day.

2. Examine Figure 2 showing oil production in the United States.

Question 1. List the 3 top oil producing countries or regions of the world and the number of millions of barrels of oil produced per day.

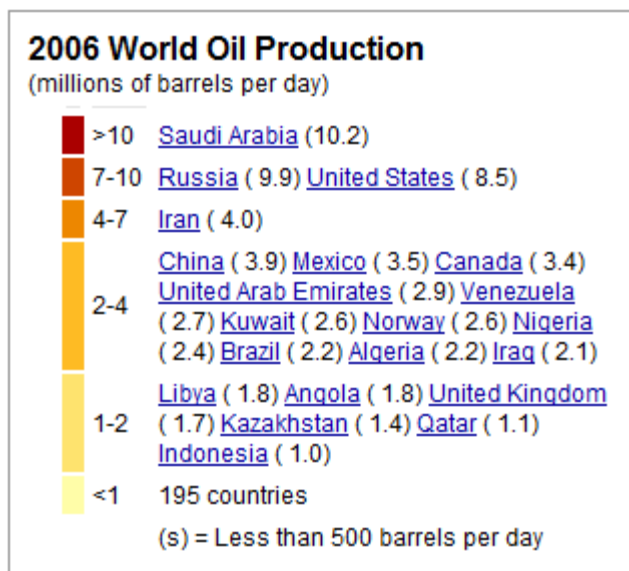
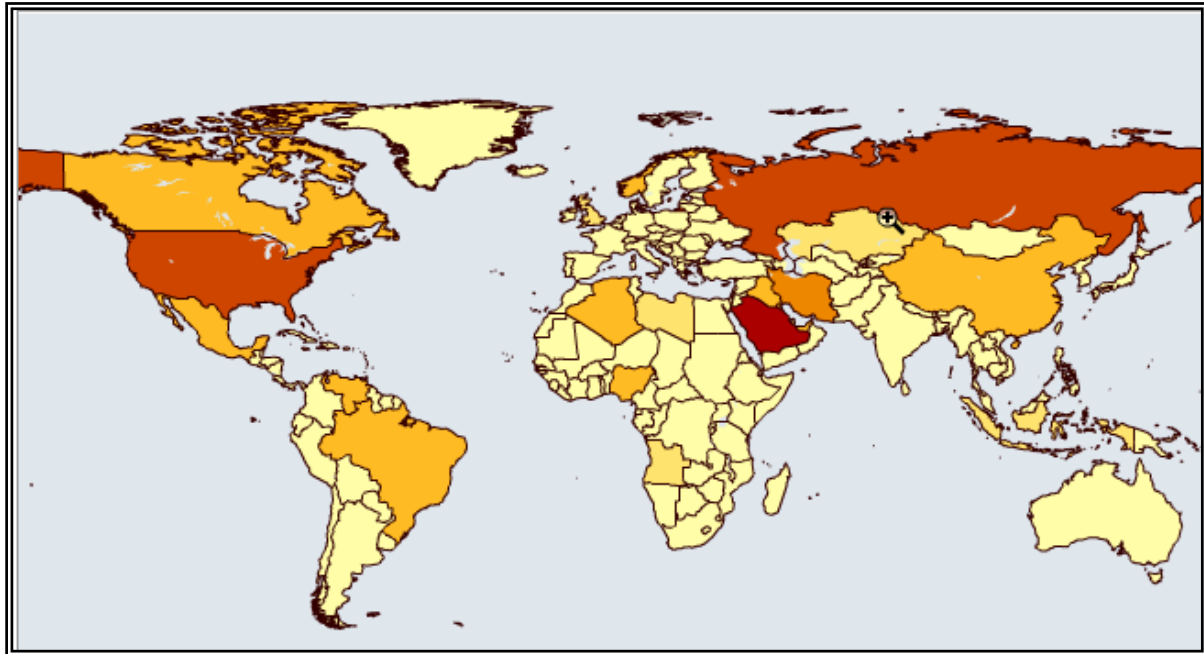


Figure 2. Map showing 2006 world oil production.

3. Examine Figure 3 showing reserves of oil and gas in the United States.

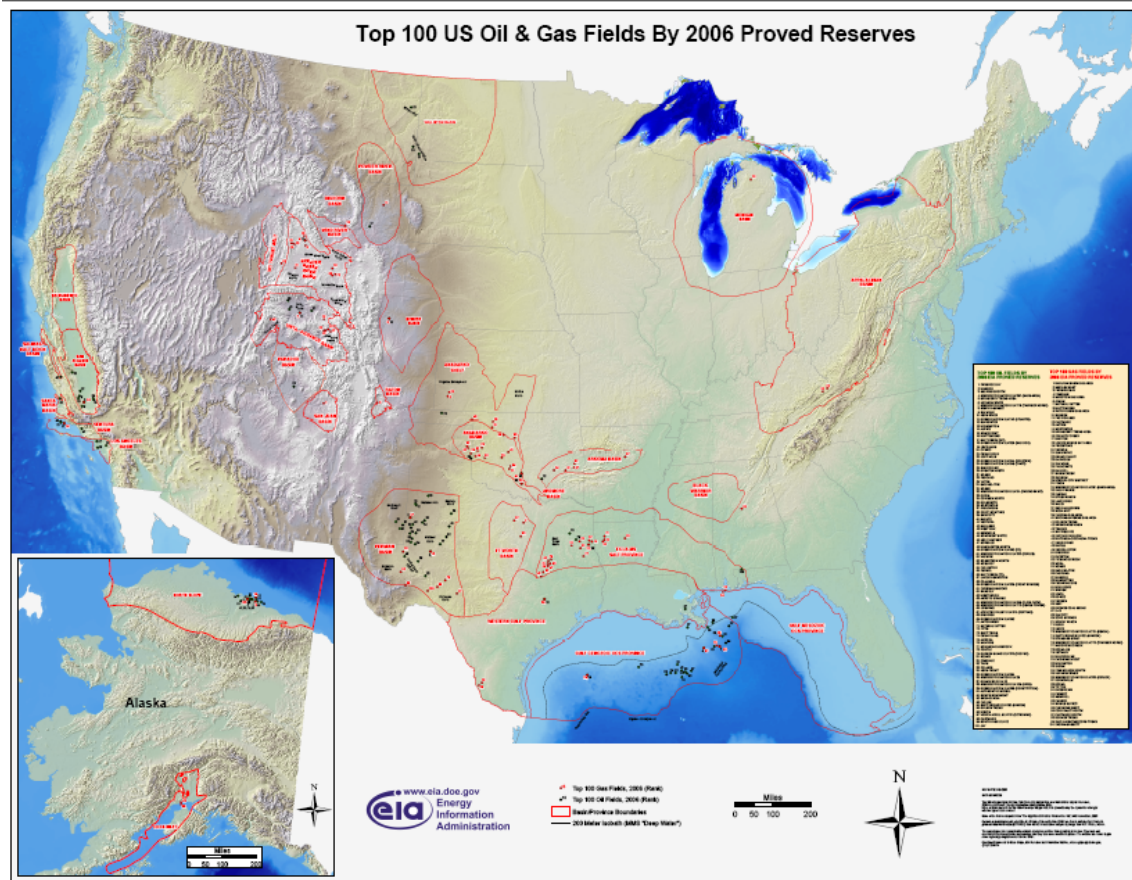


Figure 3. Map Layout showing potential areas of oil and gas mining in the United States.

As you can see from Figure 1,2 and 3, oil consumption is high in the United States, and current rates of oil production are low. Some economists and political leaders are advocating for increased oil drilling and mineral exploration in the coastal waters of the United States, as this would reduce our dependence on other nations for oil needs and reduce the cost associated with transport and import of petroleum. This could impact all of the life forms in our coastal oceans, and some whales would likely be affected.

Question 3. List 4 areas of the United States where whales could be found that are identified as Proved Reserves in 2006.

4. Examine the whale data in the Lesson 3 folder.

- A. Launch GeoMapApp.
- B. Select the Mercator Projection
- C. Add the shapefiles for the Blue 94, Blue 95, Bowhead and Right Whales.

Question 4. Which of the coastal areas on the Proven Reserves map are located near the whales locations?

5. Determine which coastal areas are within the United States Exclusive Economic Zone (EEZ).
The EEZ is defined as the area of coastal waters where nations have exclusive economic rights to the resources located in the water column or substrate.

- A. Add the Exclusive Economic Zone layer.** Select Overalys → Maritime Boundaries → World Maritime Boundaries → Inner (coast) and Outer (200 n. mi) Limits of Exclusive Economic Zone).

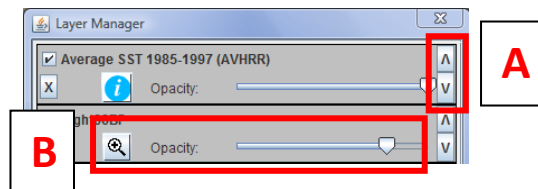
Question 5. Do any of the whale species travel outside the United States' Exclusive Economic Zone?

6. Add GeoMapApp data sets on characteristics of the ocean seafloor.

- A. Add the GeoMapApp Seafloor Sediment Texture data layer.** Basemaps → Global Maps → Seafloor Sediment Texture.

7. Compare the whale data in relation to the Seafloor Sediment Texture and Seafloor Sediment Thickness layers.

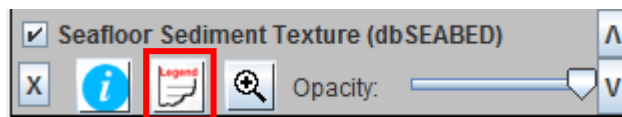
- A. Make sure the whale data is located on top of the other layers. If necessary, move the whale data to the top of the data layers list with the up arrow in the Layer Manager box.



- B. Change the opacity of the whale data layers by sliding the arrow in the Opacity slider bar.

8. Examine the Sediment Texture Legend

A. Click on the Legend button in the Seafloor Sediment Texture file box in the Layer Manager.



B. Examine the Seabed Grain and Class Sized



Question 6. List the 6 different types of seabed grains.

Question 7. Choose a subsample of the data set representing the bowhead and blue whales. Try to choose random points from throughout the range, varying near shore and close to shore. For each point you select, mark down the Seafloor Sediment characteristics in the chart below.

	Sediment Texture		Sediment Texture
<i>Blue Whale</i>		<i>Bowhead Whale</i>	
<i>Blue Whale</i>		<i>Bowhead Whale</i>	
<i>Blue Whale</i>		<i>Bowhead Whale</i>	
<i>Blue Whale</i>		<i>Bowhead Whale</i>	
<i>Blue Whale</i>		<i>Bowhead Whale</i>	
<i>Blue Whale</i>		<i>Bowhead Whale</i>	
<i>Blue Whale</i>		<i>Bowhead Whale</i>	
<i>Blue Whale</i>		<i>Bowhead Whale</i>	
<i>Blue Whale</i>		<i>Bowhead Whale</i>	
<i>Blue Whale</i>		<i>Bowhead Whale</i>	

Question 8. Was there a predominant sediment texture type correlated with the blue whale locations? Hint: Count the number of times an answer appeared, were there any that appeared more than 2 or 3 times?

Question 9. Was there a predominant sediment texture type correlated with the bowhead whale locations?



9. Add Earthquake location data. Select Datasets → Earthquake and Plate Boundaries → Earthquake Locations - USGIS - NEIC → Earthquake Magnitude > 5.5 (quick).

10. Examine the map and data layers you have added to determine potential sites for oil and mineral exploration. The oil and mining companies need the following criterion for ideal exploration sites.

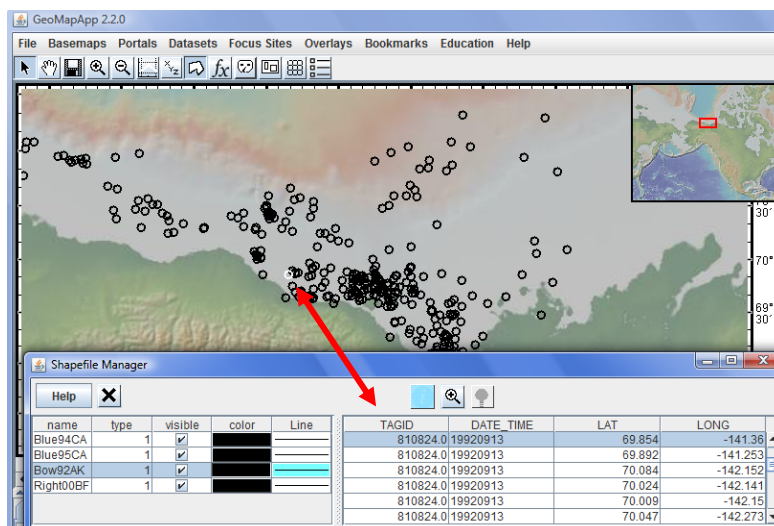
Substrate type = Sand-mud

No Earthquake Activity

Within Exclusive Economic Zone (EEZ)

Question 10. If the US adds new oil drilling or mineral mining operations, what geographic location are they most likely to choose, considering substrate type, earthquake activity and the EEZ? Which species is most likely to be directly affected?

Question 11. Research the time of year the whales (as identified in Question 10) were found in the areas identified as potential areas for oil mining or mineral extraction. What time of year would the whales most likely be found in these areas (Hint: You will find the dates for each location in the Shapefile Manager box. Click on the species of interest, Blue, Bowhead, etc. and the table will appear. Then click on the data point in the map to highlight the corresponding record in the table).

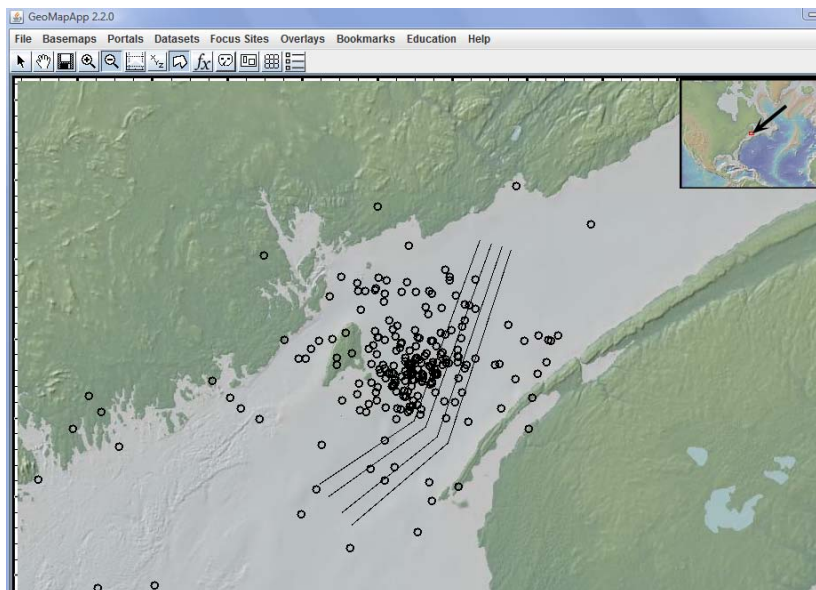


Scenario 1 Activity: Prepare a one page Environmental Impact Report and summarize your findings in this section of the lesson. Include a map layout showing the whale locations, describe which species could be impacted by offshore drilling or mining exploration and propose a time of year that the operations should be restricted or suspended.

Scenario 2: Prepare a map and set of guidelines for shipping industry to protect the Northern Atlantic Right Whale

The Northern Atlantic Right Whale is listed as endangered. One of the main causes of death for these whales is ship strikes, or collisions with large seagoing vessels. One potential approach to protecting these whales is to slow ship traveling speed and post lookouts on the deck of the ships in areas that are likely to have whales in them. For this part of the lesson, you will evaluate the whale data and compare it to high traffic areas, or shipping lanes in the Bay of Fundy, off the east coast of North America.

- 1. If necessary, launch GeoMapApp and choose the Mercator projection.**
- 2. Add the Northern Atlantic Right Whale shapefile data to your map.** Select File → Import Shapefile → From Local File System... Navigate to the Lesson 3 data folder and select the Right00BF.shp shapefile.
- 3. Add the shipping lanes shapefile data to your map.** Select File → Import Shapefile → From Local File System... Navigate to the Lesson 5 data folder and select the BOF_OldLines.



4. Compare the 2 data sets, Right Whales and Shipping Lanes.

A. Examine the map and look for clustered patterns or correlations in the data.

Question 12. Are there areas where the whales were found that overlap with areas of high ship traffic?

B. Estimate the geographic range of these overlapping area.

Question 13. What are the approximate ranges of whale locations and shipping lane overlap?

Question 14. Count the number of whale locations that are located directly in the shipping lanes. How many satellite locations were in these areas of high ship traffic?

Scenario 2 Activity: The local fishing fleet captains have agreed to attend a planning meeting to work together on an environmental task force to help reduce the chances of ship strikes. Prepare a powerpoint slide show for shipping captains, include a map and provide recommendations for key areas to post lookouts and reduce ship speed.

Scenario 3: Decide on 3 major cities for an advertising campaign about storm water pollution

1. If necessary, launch GeoMapApp and choose the Mercator projection.

2. Add the Whale shapefile data for all 3 species of whales (Blue, Right and Bowhead) to your map. Select File → Import Shapefile → From Local File System... Navigate to the Lesson 3 data folder and select the Right00BF.shp. Hold the Ctrl button and select the other whale data files in the Lesson 3 folder, Blue94.shp, Blue95.shp, and Bow92AK.shp shapefile.

3. Add the major cities layer. Select File → Import Shapefile → From Local File System... Navigate to the Lesson 5 data folder and select the Cities.shp. This data layers displays all US cities with a population greater than 10,000

4. Evaluate the patterns of whale locations in relation to proximity to coastal cities. Whales located in close proximity to major cities are more likely to be impacted by coastal water pollution.

Question 15. Which whales (based on your 3 data sets, blue, bowhead or right, are most likely affected by coastal water pollution?

Summary Activity: Based on what you have learned in this lesson, fill in the chart below on the potential threat for each species of whales. Rate the threat by number of check marks as noted in the legend below to indicate more serious threats.

✓ = Potential Threat

✓✓ = Moderate to Severe Threat (Impact has been documented)

✓✓✓ = Major Threat (Impact is currently threatening the population)

Consider the geographic location of the whales based on the satellite telemetry data you have explored in Lessons 3,4 and 5 in your assessment. For instance, if the whale telemetry data indicates that the whale inhabits an area with oil reserves, then oil and gas exploration will be a major threat. Another clue: if the whales are found close to shore, then coastal water pollution will be a threat.

Use these figures, data sets or resources to make an assessment of your rating:

Oil and Gas – results of Scenario 1 (this lesson)

Mineral and Mining – results of Scenario 1 (this lesson)

Coastal Water Pollution – results of Scenario 3 (this lesson)

Fishing Gear, Nets and Traps – Internet Search

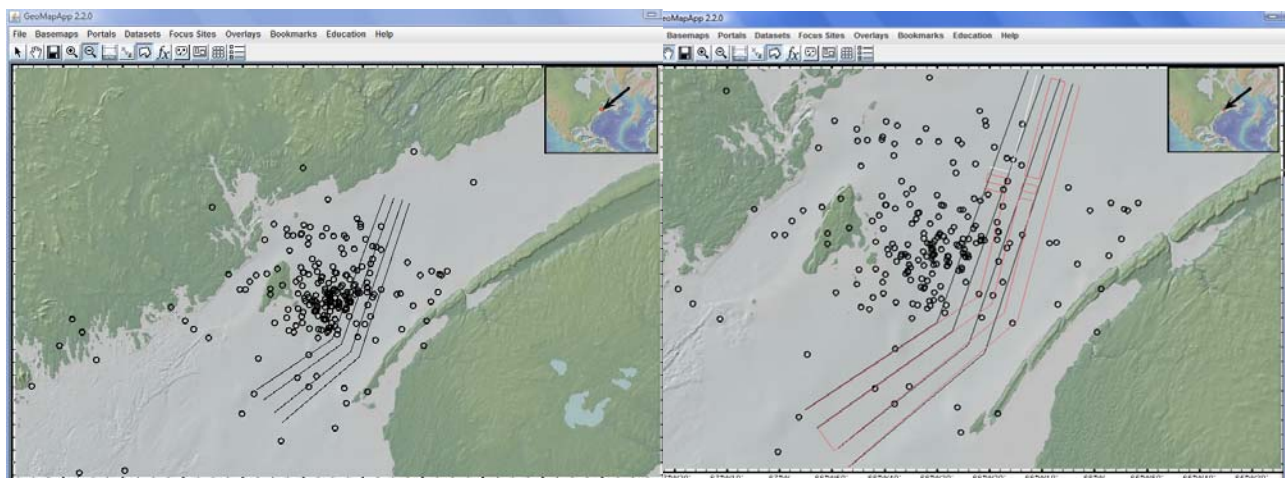
Shipping Lanes – results of Scenario 3 (this lesson)

Threat	Blue Whale	Bowhead Whale	North Atlantic Right Whale
Oil and Gas Exploration			
Mineral Extraction and Mining			
Coastal Water Pollution			
Fishing Gear/Nets,Traps			
Shipping Traffic			



Diving in Deeper - Extending the Lesson

1. Oil Spills can be devastating to ocean wildlife for many miles around the spill. Research oil spills on the internet, and determine where the major ports are in the United States that transport oil. Create a map layout and show the areas and the whale species that could be impacted by an oil spill. Discuss how computer mapping is useful in responding to an oil spill or preparing for such an event.
2. In the Atlantic, there is an environmental movement involving hydrophones and Right Whales. The hydrophones are listening for whales and a communication network contacts shipping captains in the area. This project is a great example of applying a GIS to solve an environmental issue. Investigate this project more at <http://www.listenforwhales.org/>.
3. Consider the Bay of Fundy shipping lanes and the location of the Right Whale data. Can you propose new shipping lanes that would avoid the largest clusters of whales, while still allowing ships to remain relatively close to their old shipping lanes? Use the shapefile layer in the Lesson 5 folder called BOF_Newlines to add actual proposed shipping changes.



Old shipping Lanes

New Shipping Lanes (in pink)

Evaluate these new shipping lanes. Does this eliminate, reduce or aggravate the problem of ship strikes? What would you do or recommend if you were involved in the planning process?

4. Search the American Cetacean Society for fact sheets on whales and to learn more about endangered species and the current threats impacting whale populations. www.acsonline.org.

References and Web Searches for Students and Teachers Websites

1. Energy Information Administration <http://www.eia.doe.gov/>
2. Compare energy production and consumption patterns in the US for the last 27 years
http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=US
3. The Bay of Fundy GIS data (shipping lanes in the Bay of Fundy) was generously provided by Kerry Lagueux, Associate Scientist and GIS Specialist at the New England Aquarium.
<http://www.marinegis.org>
4. The marine mammal data was generously provided by The Marine Mammal Institute of Oregon State University <http://mmi.oregonstate.edu/>. The MMI Telemetry group is led by Dr. Bruce Mate. <http://mmi.oregonstate.edu/wtg>.