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Gray Whale Migration and Feeding
Introduction to Geographic Information System Use in Marine Biology

Before you begin using this module, you will need to know about using a Web-based GIS viewer. You can do this by watching the tutorial video and working through the hands-on tutorial. The tutorial video, student activity, and Web-based GIS Tutorial Viewer can be found at http://gis.lanecc.edu → "Modules" tab → "Tutorial" link. The activity works best with a high speed Internet connection.

Prior Skills: You will need to know how to turn layers on and off, use the ID tool and, zoom in and out of the map, toggle from layers to the legend, and perform a search (Boolean) query.

Objectives: You will be able to describe the spatial pattern of earthquakes in relationship to plate movement. Use Boolean logic to study the relationship between tectonic plates and landforms.

Remember**,** computer steps are indicated by a ▶ symbol and questions you need to answer are numbered.

Learning Objective: To gain an understanding of GIS and use it to answer questions about gray whale migration patterns and how they are correlated to various factors.

Please provide answers on answer sheet

Materials: Computers with an internet connection

Background Biology:

The gray whale is about 10 meters (35 feet) long and weighs up to 35,000 kilograms (40 tons). Some have been known to live more than 40 years.

Gray whales are baleen whales, and such whales don't have teeth, but plates of baleen that hang down from the upper jaw. The inside of these plates are frayed into a mass of hairs. Baleen whales take in mouthfuls of ocean, then push the water out through their baleen, and the hairs act as a sieve to remove small crustaceans or fish to be swallowed by the hundreds or thousands at a time.

The hairs on gray whale baleen is coarser than that of other baleen whales, and gray whales often feed by scooping up mouthfuls of sand and mud from the bottom. This benthic material is loaded with infaunal animals and gray whales feed especially on sediment rich in amphipods.

The Atlantic population of gray whales is extinct, but eastern Pacific numbers are likely to be close to the carrying capacity for this species in the eastern Pacific Ocean. Unlike most types of whales, gray whales are often seen from shore.

Gray whales spend their summers in feeding in cold northern waters. They migrate to Baja California (Mexico) in

the late fall. There, they mate and the pregnant females calve. In March, the whales migrate back to their northern feeding grounds. Although most of the population spends the summer in the Bearing and Chukchi Seas, about a hundred stop along the way and feed along the Oregon and Washington coasts. They spend very little time feeding during migration.

Part One: Distance from shore

The map we will be using is web-based GIS so you can also do some of the work at home if you do not finish by the end of the lab.

It is essential to complete the assigned tutorial first.

▶ Go to http://arcgis.lanecc.edu/website/whale

The components of the map are laid out in this basic format:

| Tools	Map Area	Layers/ Legend
	Selection/Table Display (blank at start-up)	

▶ Look at the layers available on our map.

▶ Uncheck "Whale Migration" then click the "Refresh Map" button.

1. What happens to the Whale Migration layer? (Use answer sheet)

You will use the legend tool and the identify tool .

▶ Make "Whale Migration" visible and active.

▶ Hint: to be active you click the radio button next to the layer.

▶ Refresh map.

▶ Use the identify tool to select one of the whale locations on the whale migration layer. You will get an information table at the bottom of the page.
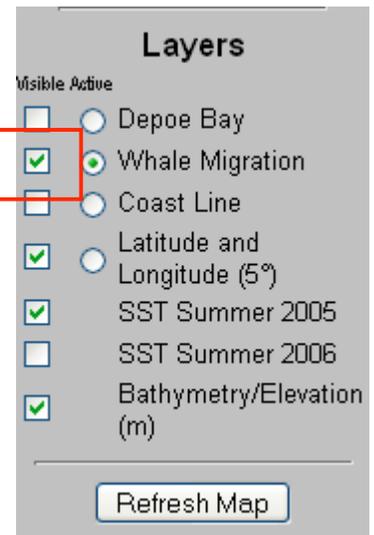
2. What kind of information is available in the table? Give three examples. (Use answer sheet)

▶ Next, click the legend tool . The layer menu changed to a legend. This legend shows the seasons during which whales were spotted in our study area. (To return to the view of all layers, just re-click the legend tool). The legend is also available on page 6 of this document.

3. *Draw and label the symbols for the whale migration layer. (Use answer sheet)*

CHECK IN POINT - Up to this point you should be comfortable turning on and off layers and using the identify tool to identify features in the active layer. If not work through the last section again.

Remember that GIS is much more powerful than a paper map because GIS has the ability to work with the data that is linked to a location. Thus far you have looked only at the map. Now let's look at the data.

Conduct a query:

A query asks the data a question. An example question written the way that we would speak is "Select whales of a certain pod size". However you will be asking the question to a database, so you will need to structure your query in a way that the database understands. The results of a query gives you the results both graphically and in a table. Queries are quite sensitive to typos, so you need to make sure and be specific. Use the query tool ▦ to answer the following question.

▶ Make the layer "Whale Migration" active and visible. Click refresh.

▶ Activate the query tool by clicking on the ▦ icon.

At the bottom of the screen you will now create the query.
  ▶ For *Field* select sp_count. This will designate which data field to use.
  ▶ For *Operator* use =. This will select all areas that are the same as the designated field.
  ▶ Use the *Add to Query String* button Add to Query String , and your field and operator selections should appear in the box next to the button.
  ▶ Now add a "3" at the end of the expression so that it reads sp_count = 3

The query builder should look like the figure below. If not, work through the steps again.
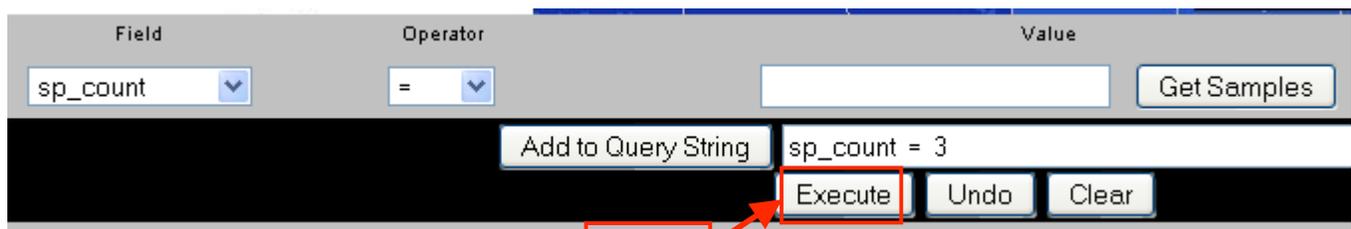
  ▶ If your query does look correct press *Execute.*

You should see a table appear at the bottom of the screen with a list of records that meet the conditions that "Have 3 whales in them?"

4. *How many records are displayed (make sure to scroll to the bottom).*

The previous example was an example of a simple query. We will now use a more complex query that focuses on our interest in a particular pod of whales that were observed in May.

  ▶ Create the same query as you did in the previous section, *but do not execute.* Now we will add a second component to the query.

► You now want to use the AND key.

You will now create the second portion of the query.
   ► For *Field* select "Month" for *Operator* use "="
   ► Press the "Get Samples" and then choose "MAY" and then add to the query string.

You should get a query that looks exactly like:

   sp_count = 3 AND Month = "MAY"

► Execute this query.

► At the table at the bottom of the screen you will have an option to "Zoom to these records". Choose this option.

► Use the table to determine how much time has passed between sightings. Write down these values on the answer sheet in a table.

► Use the measure tool to measure the distance between points.
► After activating the measure tool, the light blue highlights disappear, so keep track of where they were.
► Click once on the southernmost whale, and wait for a red dot to appear.
► Move the cursor to the next whale further north, click and wait for a red dot to appear.
► Move to the last whale and click again.
► The total distance will be shown in a box at the top of the screen. You can round up to the nearest whole number.

5. *Calculate the rate at which the pod is moving by dividing the distance by the time between sightings and add these values to your answer sheet.*

$$Rate\ of\ travel = \frac{dis\tan ce(km)}{time(day)}$$

You will now estimate how long it will take for this pod of whales to reach the Etolin Straight.

► Use the measure tool to determine the distance between the last sighting of your pod and the center of Etolin strait, between Nunivak Island and the Alaska mainland.

To do this you will need to pan up along the coast using the panning tool **.**
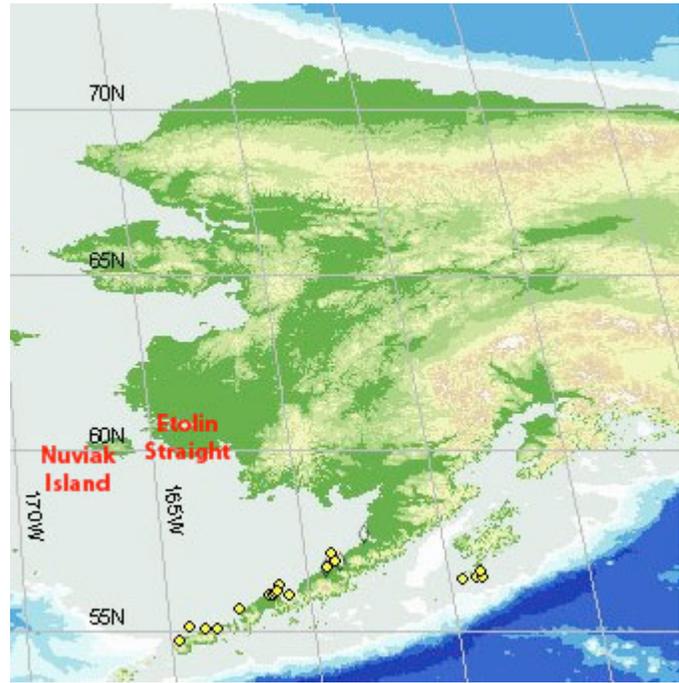
6. *Using the rate calculated earlier, estimate what date the whales would arrive in Etolin Strait.*

You will now measure the distance from shore for 5 spring whales and 5 fall whales. To look at each season,.

► Conduct a query that selects only spring whales. You will have to rely on what you have learned to complete this task.
► Choose five selected whales and use the measure tool to determine the whale's distance from the coastline. ***BE patient with this tool***. Wait for the first red point to appear before selecting the second feature. Use the eraser tool to clear each measurement.
► Repeat this process for fall whales.

Record these values in a table and average the spring distances and the fall distances.

7. *Which whales were closer to the shore?*

► Use the query tool to determine the sizes of whale pods in each season. You will have to rely on what you have learned to complete this task.

8. *In which season are pods bigger?*

9. *In which season are calves part of the migration? Considering this, can you think of a reason why the average distance from shore differs between the two seasons?*

Part Two: Depoe Bay

► Turn on the Depoe Bay 2005 layer, refresh map, and zoom in (Depoe Bay is symbolized by a small red triangle off of the coast of Oregon).

You should see two layers appear in the layer list.

► Turn on Depoe Bay 2005 (purple) and Depoe Bay 2006 (yellow-green).

▶   Make the Depoe Bay 2005 layer active.
▶   Continue to zoom in until the scale bar at the bottom represents about 2km.

▶ Use the identify tool ⬛🛈 to examine some of the collection points

10. *During what time of year was this data collected? Are these whales migrating?*

▶   Now activate the whales 2006 data points. Compare the data between the two years.

11. *In which year is there more kelp? In which are there more mysid shrimp? In which are there more whales?*

▶   Zoom out to the full extent ⬛ .
▶   Turn off the Bathymetry/Elevation layer.
▶   Turn on SST 2005 layer and hit refresh.

This represents average summer Sea Surface temperatures for 2005.

▶   Now switch the visibility of the 2005 and 2006 SST layers.

Compare the surface temperatures of the north Pacific for the two years.

12. *In which year was the surface temperature warmer?   Why do you think the surface temperature was different between the two years? Think about the depths at which water is relatively colder. What could account for the difference in surface temperature? What implications does this make for the richness of nutrients and oxygen in the surface water in the two years?*

Map of the Etolin Straight   **Map Legend**