



## Rocky Mountain Mapping Center

### Spatial Analysis of North American Hurricanes Using a Geographic Information System (GIS)

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#### *Software Required:*

[Geographic Information Systems](#) software, such as ArcView (ESRI, Inc), Maptitude (Caliper Corp.), MapInfo (MapInfo Corp.), or GeoMedia (Intergraph Corp.). This lesson uses ArcView 8.x by [ESRI, Inc.](#)

#### *Summary:*

Students examine North Atlantic hurricanes from 1851 to 2001 over space and time using GIS tools and methods, analyzing hurricane direction, patterns, specific damaging hurricanes, the characteristics of hurricanes near world and specific cities, hurricanes in specific states in the USA and Mexico, and characteristics of hurricanes that passed near the students' hometown.

#### *Skills:*

1. Understanding the patterns and processes of hurricanes across North America for the past century.
2. Understanding the problems of hurricanes from a geographic perspective.
3. Symbolizing data to aid in understanding it.
4. Data and file management.
5. Selection, sorting, querying data in maps and in tables.
6. Changing and understanding map projections.
7. Creating summary tables to help understand the problem.
8. Creating and analyzing graphs.
9. Creating new information.
10. Analyzing point, line, and polygon data across space.

#### *Data:*

[ESRI Inc.](#), created all countries, cities, and the world30 map and data layers.

The US National Oceanic and Atmospheric Administration, Tropical Prediction Center/National Hurricane Center created the hurricane layer.

#### **Data Management**

Create a folder on your computer to hold the data with an appropriate name, such as tornados.

Click [here to download the data](#) that you will need for this lab exercise, and download into the folder you created.

This file is named hurricanelesson.zip and totals approximately 2.5 MB.


Next, unzip the file using the Winzip program.

You now should have the following files:

- World 30
- World Cities
- Countries
- Mexico Cities
- Mexico States
- USA Cities
- USA States
- Hurricane Tracks
- Large Hurricanes

### Displaying and Symbolizing Your Data

Open ArcMap GIS and start with "A New Empty Map."

Add the following map themes using the Add Data  button:

- World 30
- Countries
- Hurricane Tracks

The Add Data screen becomes visible. Look for the folder created in which the files were placed.

Place a check-mark in the box to the left of each theme to make them visible.

1) Does the world 30 layer represent the oceans? Why or why not?





Single click on the layers and slide them up and down in the table of contents so that world30 is at the bottom, the countries layer is in the middle, and the hurricanetracks layer is at the top.

2) What color are the tracks of the hurricanes?

Using File--> Save As, save your map document with the name "hurricanes" to the folder where your data is located or to the location provided by your instructor.

### Hurricane Analysis

3) In what ocean are these hurricane tracks concentrated in?

Using the zoom in  , zoom out  , pan  , and zoom to the full extent of all map layers  buttons to answer the following questions.

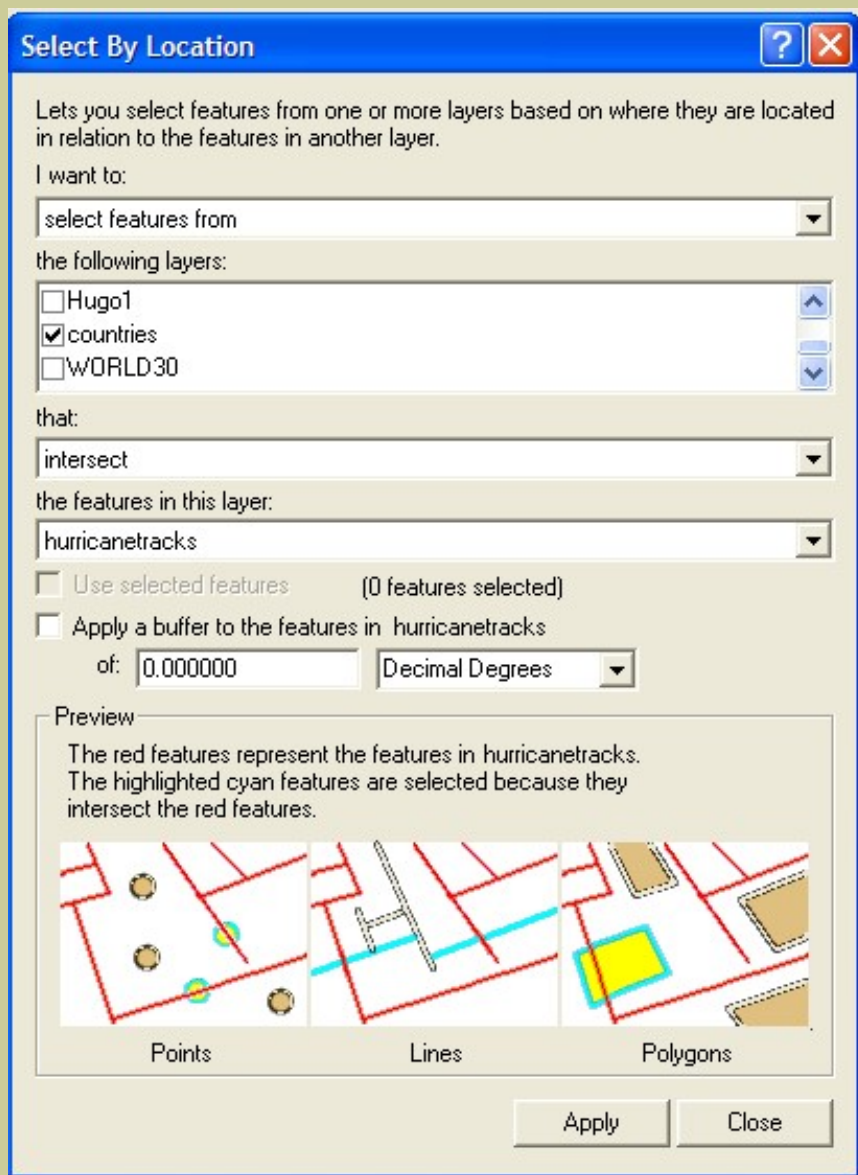
- 4) Write 3 observations about the distribution and pattern of hurricanes in the North Atlantic.
  
- 5) Is there anything about the distribution and pattern of hurricanes that surprises you? If so, what?
  
- 6) Write 3 observations about the direction that the hurricanes move.
  
- 7) Is there anything about the direction of hurricane movement that surprises you?


Notice the coordinates to the lower right of the data view screen as you move the mouse around the map.

- 8) What do these coordinates represent?

You work for the Red Cross, an organization that brings aid in natural and human-caused disasters. You need to find out what countries these hurricanes cross so that you can direct the future efforts of the Red Cross. Make the countries layer 'active' by single-clicking on it.

Access the selection menu: "Select By Location." Select the countries that hurricanes crossed, as follows:



When finished, click on "Apply." Note that those countries selected are outlined in another color. To access the countries table, right-click countries > open attribute table.  To see a list of countries selected, change "Show: All" to "Show: Selected."

9) Look to the lower center of the table to determine how many countries hurricanes crossed. Indicate the number below.

10) Examine your map. According to the distribution of countries selected, how many continents do the North Atlantic hurricanes affect?

11) Name these continents.

Next, you will further investigate the hurricanes data in the table that stores all of the characteristics, or attributes, of the hurricanes. First, make the hurricanetracks layer active by placing a check in the box to the left of the layer. This will activate the layer.

Access the table of hurricanetracks by right-clicking on the open attribute table button.



Scroll a bit through the table.

12) What field is this table sorted by?

13) What time period does this table span?

From \_\_\_\_\_ to \_\_\_\_\_

14) Look to the lower center of the table. How many rows are in this table?

15) During what season do you suppose most hurricanes strike?

Next, you will use your GIS to determine what months are the most common for hurricanes. Right-click on the **"Month"** field > Summarize. Save it in the folder where your other data resides. Take the defaults and select "OK" on the window that pops up.

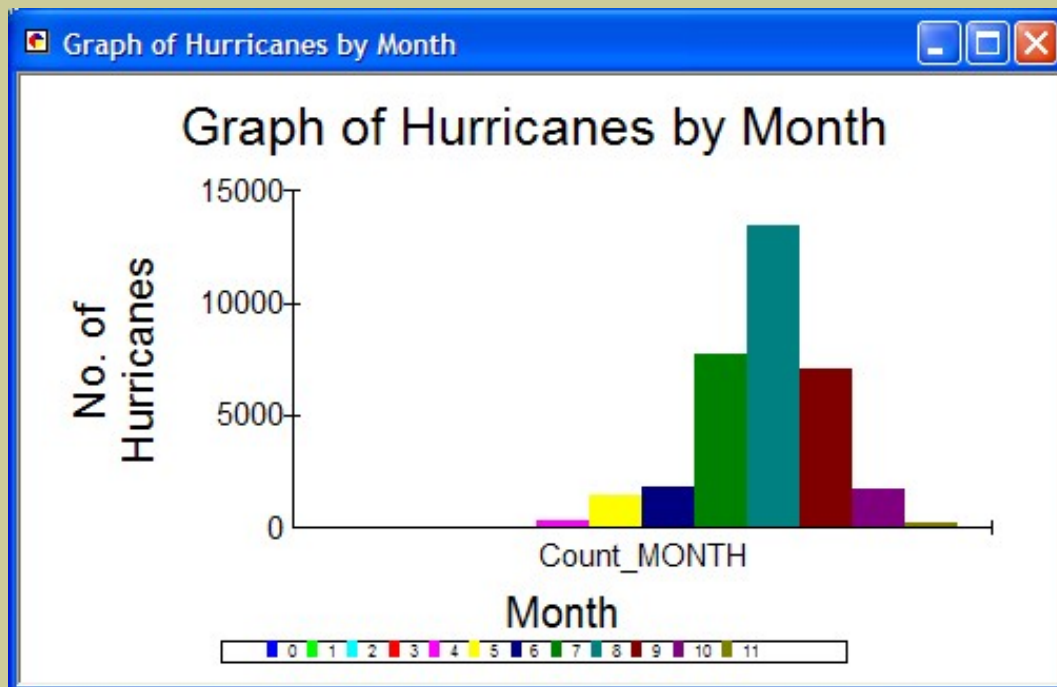
	OID	MONTH	Count_MONTH
▶	0	1	39
	1	2	12
	2	3	13
	3	4	13
	4	5	327
	5	6	1476
	6	7	1815
	7	8	7766
	8	9	13476
	9	10	7097
	10	11	1686
	11	12	197

Right-click the new table > open. The new table shows the frequency of hurricanes for each month.

16) Was any month free of hurricanes?

17) What month was by far the most common for hurricanes?

Select "Options" in the lower right corner of the attribute table > Create Graph. The Graph Wizard appears. Create a bar graph (chart) of your new table. Choose the layer or table containing the data. Choose one or more fields to graph. Add the field "**count**" and label series using "**month**". It should look similar to the following. Page 3 of the Graph Wizard includes a button for 'Advanced Options.' The options on page 3 along with the Advanced Options can produce different outcomes on the graph. You need to experiment with the options to produce the data you desire. Print the graph. You can also choose to print the graph on your map.



Close the graph and your monthly summary table.

Access your table for all the hurricanes.

Examine the "**cat**" field. This field represents the intensity of hurricanes, as follows:

### Tropical Cyclone Severity

Categories	Winds	Typical Effects
<b>E - Extratropical</b>		Extratropical is a term used in advisories and tropical summaries to indicate that a cyclone has lost its "tropical" characteristics
<b>SD - Subtropical Depression</b>	Less than 39 mph	A subtropical depression is a subtropical cyclone with maximum sustained surface (10 meter) winds of less than 34 knots/39 mph
<b>TD - Tropical Depression</b>	Less than 39 mph	A tropical depression is a tropical cyclone with maximum sustained surface (10 meter) winds of less than 34 knots/ 39 mph.

**SS - Subtropical Storm**

39 mph or greater

A subtropical storm is a subtropical cyclone with maximum sustained surface (10 meter) winds of 34 knots/39 mph or greater.

**W - Tropical Wave**

A tropical wave is a trough or cyclonic curvature maximum in the trade-wind easterlies. The wave may reach maximum amplitude in the lower middle troposphere.

**L - Tropical Low**

The storm was classified as a tropical low at the time of the advisory.

**D - Tropical Disturbance**

A tropical disturbance is a discrete tropical weather system of apparently organized convection--generally 100 to 300 mi in diameter---originating in the tropics or subtropics, having a nonfrontal migratory character, and maintaining its identity for 24 hours or more. It may or may not be associated with a detectable perturbation of the wind field.

**H1** Strongest gust less than 125 km/h

Category 1 Hurricane. Negligible house damage. Damage to some crops, trees and mobile homes. Draft may drag moorings.

**H2** Strongest gust 125 - 170 km/h

Category 2 Hurricane. Minor house damage. Significant damage to signs, trees and mobile homes. Heavy damage to some crops. Risk of power failure. Small craft may break moorings.

**H3**  
(eg. Winifred) Strongest gust 170 - 225 km/h

Category 3 Hurricane. Some roof and structural damage. Some mobile homes destroyed. Power failure likely.

**H 4**  
(eg. Tracy) Strongest gust 225 - 280 km/h

Category 4 Hurricane. Significant roofing loss and structural damage. Many mobile homes destroyed and blown away. Dangerous airborne debris. Widespread power failure.

**H5**  
(eg. Orson) Strongest gust More than 280 km/h

Category 5 Hurricane. Extremely dangerous with widespread destruction.

Look at the relationship between wind speed (wind\_mph) and the category (cat). Right-click the "**Cat**" field and use the Field--> Summarize to create a new table. Store it in an appropriate folder. Take the defaults and select "OK" on the window that pops up.

You now have a table of hurricane categories and their frequencies.


18) What are the categories of hurricanes in this list?


19) What are the category names of the two most destructive types of hurricanes in this list?

20) What is the most *common* category of hurricane in this list?

Close your new table and go back to the map.

### Save your map document.

You have probably noticed that because so many hurricanes exist, it is difficult to understand the pattern they make. Make the hurricanetracks layer invisible by clicking on the check mark next to the layer name and examine only the largest hurricanes. You will be able to examine the largest hurricanes, those that achieved Category 3, 4, or 5, as follows. These are stored in a layer named largehurricanes.shp. Add this layer using the same method that you added the other layers, earlier , and make it visible.

Right-click and open the attribute table. 

21) Which category of hurricanes is the least numerous?

22) Why?

### Analyzing the Last Hurricane

In this section, you will analyze the latest hurricane recorded in the table.

Uncheck the large hurricanes layer and check the hurricanetracks layer again. Access the table of all the hurricanes.

Go to the bottom of the table and examine the data for Hurricane Olga.

23) Does each row in the table represent one hurricane or one segment of the track of each hurricane?  
Circle your answer:

- A. Each row represents one hurricane.
- B. Each row represents one segment of the track of each hurricane.

24) Therefore, is the number of hurricanes more, less, or the same as the answer you wrote above for the number of rows in the table?

25) How many days did Hurricane Olga last?



Examine the "**cat**" field for Hurricane Olga.

26) Describe the categories classified for this hurricane and how they changed over the lifetime of Hurricane Olga.

27) Why do the categories change over the lifetime of this or any hurricane?

28) What was the highest wind speed for Hurricane Olga and on what day did it occur?

29) During what category of Hurricane Olga were the winds highest?

30) During what category of Hurricane Olga was the pressure lowest?

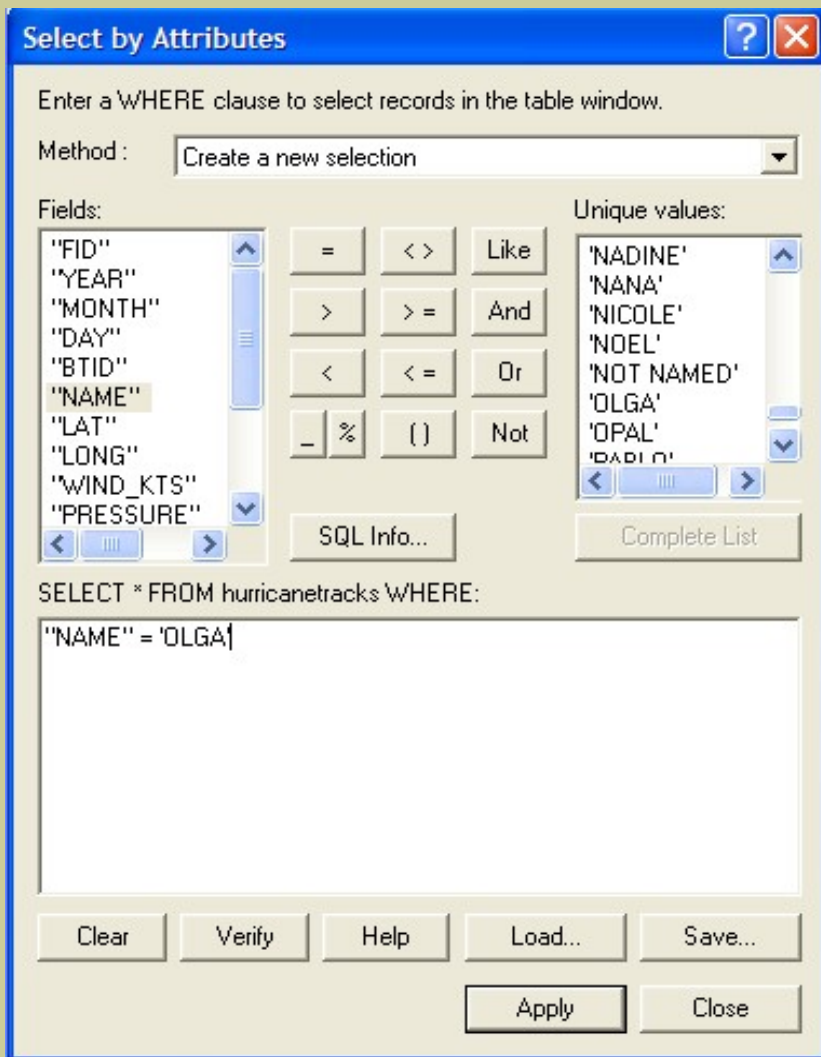
31) What is the relationship between wind speed and pressure? Why?

Close the table and return to your map.

Save your map document using File--> Save.

Next, you will examine the pattern that Hurricane Olga followed. To do this, you will need to set the definition of your hurricanes map theme to Hurricane Olga. It will then be easy to see Olga on the world map.

Right-click on hurricanes and left-click to open the attribute table. Click on the "Options" button > left-click on "Select by Attributes." Method: Create a new selection. Double click field "Name" = Double click values 'Olga'. (Click on complete list to bring up all entries.) The expression should look like the following:



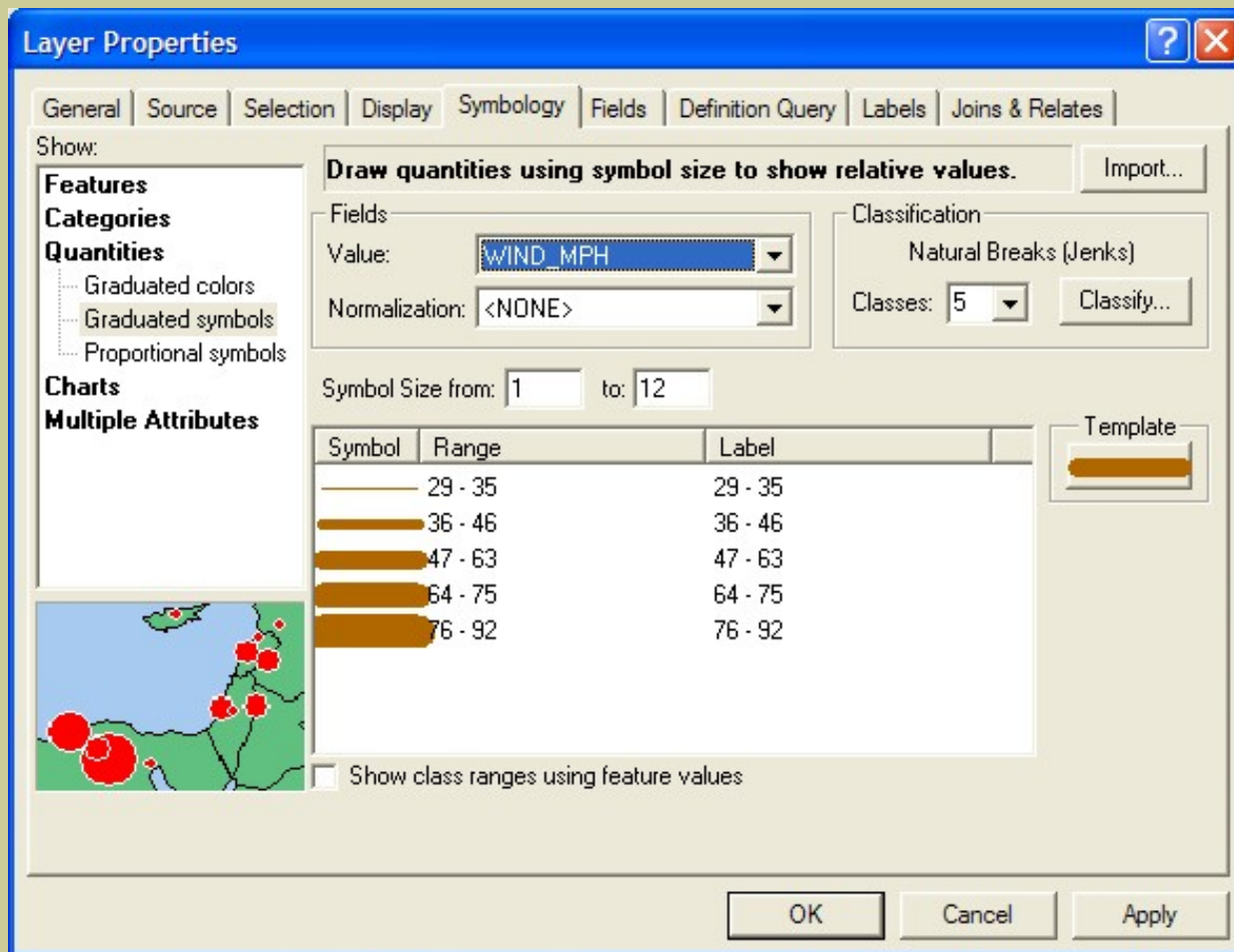
Change attribute table to 'Show Selected Records.' Export Olga data to a new shapefile. Right-click on hurricanetracks > Data > Export Data > Selected Features; rename file (same folder). Select "OK" and return to your map. Uncheck hurricanetracks; check Olga. You should see the path of Hurricane Olga, as follows:



Right-click countries to select "Label Features" to label country names.

32) Describe the path and direction that Olga followed, naming the closest countries that Olga approached.

Next, map the pattern of wind speed and pressure as you identified in your analysis of the attributes for Hurricane Olga. Right-click Olga shapefile; select Properties > Symbology > Show: Features > Quantities > Graduated Symbol and the Field Value to Wind Speed (wind\_mph). Make the size range from 1 to 12.



33) Describe the pattern of wind speed as Hurricane Olga moved.

Change the legend by double-clicking on the hurricanetracks layer. Return to Properties and follow above directions except change the Graduated Symbol and the Field Value **from** wind speed **to** pressure. Make the size range from 1 to 12.

34) Describe the pattern of pressure as Hurricane Olga moved.


## Hurricane Hugo Analysis

Next, you will analyze Hurricane Hugo. Hurricane Hugo, which caused approximately \$10 billion in damage, had been the costliest hurricane to strike the United States before Andrew three years later. Hugo was, in some ways, two hurricanes in one. First, it passed through the U.S. Virgin Islands and Puerto Rico, leaving \$3 billion in damage in its wake. After leaving the islands, Hugo remained over the waters of the Atlantic for over 3 days, gaining in strength and size until it made its assault on the South Carolina coast near Charleston. Even after making landfall, Hugo remained a threat and caused damage over 200 miles inland, and its effects were felt into North Carolina. (National Academy Press report, <http://www.nap.edu/execsumm/0309044758.html>)

Return to the hurricanetracks layer and the attributes table.



Show: ALL records, left-click the Options

button > Clear Selection  > then, Select by Attributes.

35) What expression should you use to select Hurricane Hugo?

Select Hurricane Hugo by entering your expression above and select OK. Create a .shp file as before for Hurricane Hugo. To make the track of Hugo stand out more, click on the line for Hugo and that brings up the "**Symbol Selection**": under Options change the color and/or width. Zoom to the extent of Hurricane Hugo.


36) At what approximate latitude and longitude did Hurricane Hugo begin?

37) What is the closest country to Hugo's point of origin? (Remember to label the layer)

38) At what approximate latitude and longitude did Hurricane Hugo end?

39) In what country did Hugo end?


40) What other country or countries did Hurricane Hugo cross?


Examine the attribute table for Hurricane Hugo  and use it in conjunction with your map to answer the following:

41) How many days did Hurricane Hugo last?

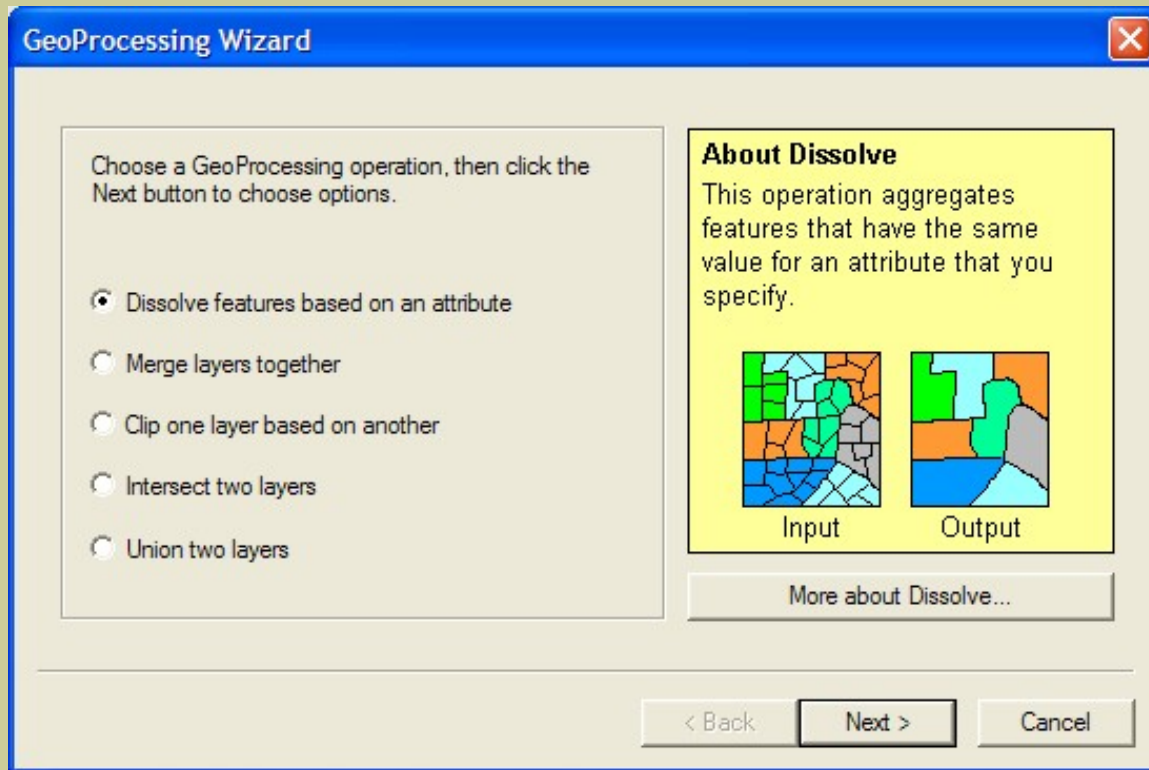
42) When was Hugo causing damage to Puerto Rico and the Virgin Islands?

43) How many days later was Hugo causing damage to South Carolina?

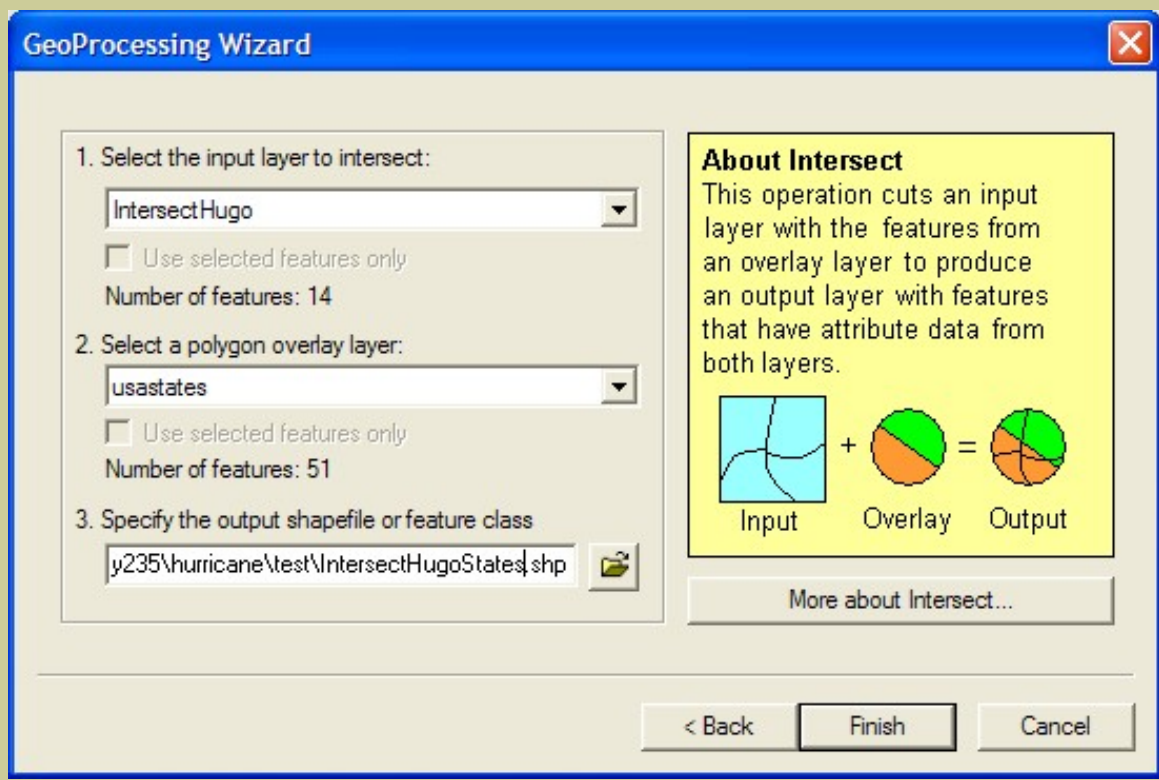
Create a map for printing by going to Layout View in the lower left corner of the View screen  . Add a title to your map and your name by clicking on the "A" text symbol button (the first 'A' symbol in the lower left corner; you can change font, size, and color). Print your layout.

You work for the Federal Emergency Management Agency (FEMA), an agency of the US Government that assists in helping mitigate the effects of natural and human-caused disasters. You need to find out what states Hurricane Hugo crossed. First, add the usastates.shp.  Second, make this layer 'active' by single-clicking on it.

Access the menu: Tools > Geoprocessing Wizard. Select the states that Hugo crossed, as follows: Inspect the description of the options.



44) Which option should be used for the operation?




Access the Hurricane Hugo table. Look to the lower center of the table to determine how many states Hugo crossed.

45) Indicate the number of states that Hugo crossed, below.

FEMA needs to assess how many people would potentially be affected by Hurricane Hugo. Click on Pop1999 to highlight the field. Go to Options-->Statistics. Examine the result.

46) What was the sum of the population of these states in 1999?

47) Label the states layer. Zoom in to Pennsylvania. What part of the state of Pennsylvania did Hugo cross?


Go to attributes table for hurricanetracks > Options: Clear Selection.  Now you should be able to see all the hurricanes again.

48) What is the primary direction that hurricanes travel across Pennsylvania?

From \_\_\_\_\_ to \_\_\_\_\_

**Save your map document.**

Create a layout view and print your Pennsylvania layout.

Pan  down to Texas.

49) What is the primary direction that hurricanes travel across Texas?

From \_\_\_\_\_ to \_\_\_\_\_

### Analyzing The Worst Hurricane

The worst natural disaster ever to strike the United States in terms of loss of life was a hurricane. This is the hurricane identified in the table as having a btid of 352. As you have done above, open attribute table > Options > Select by Attributes {this time make the expression ("btid"= '352')}; create shapefile; use Geoprocessing Wizard > Intersect: all from the hurricanetracks layer.

50) What countries did this hurricane cross?

51) What is unusual about the length of this hurricane track compared to some of the others you have examined?

52) What is unusual about the western and northern extent of this hurricane track compared to some of the others you have examined?

53) Examine your table. How long did this hurricane last?


Read the accounts of this hurricane after it left Texas on:

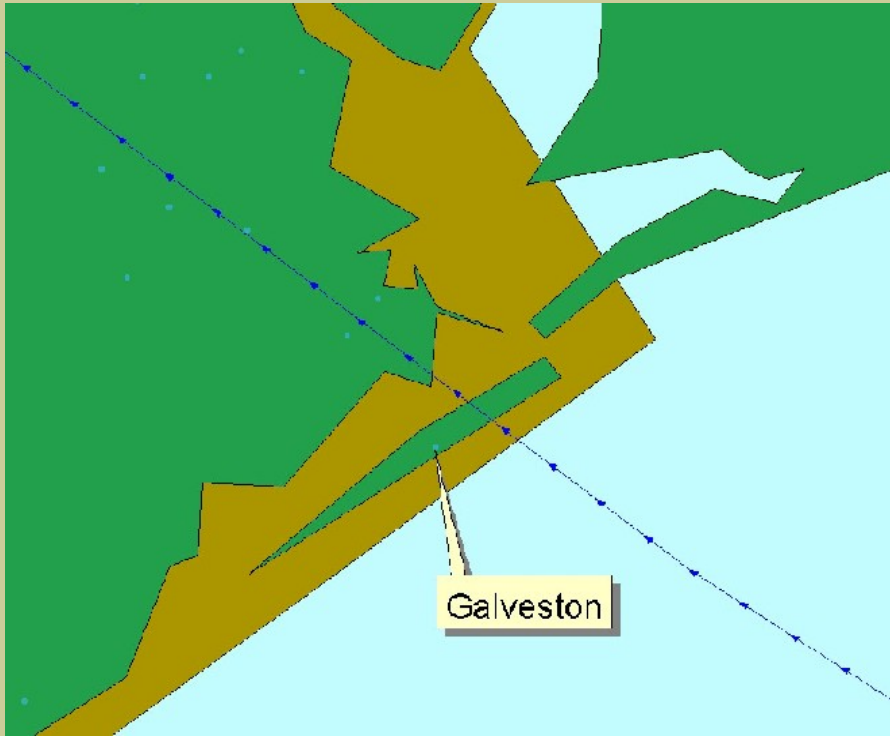
<http://www.islandnet.com/~see/weather/events/1900hurr.htm>

54) How many people were killed **after** the storm left Texas, according to this account?


55) Based on your GIS-based analysis on the storm's track, answer how this could have happened.



Zoom in  to where the hurricane hit land, or "made landfall." Add the layer usacities and label the city closest to where the hurricane made landfall (see below for example).



56) What city was closest to the hurricane's landfall?

Use the identify button  to identify the hurricane track that was closest to this city.

57) What year, month, and day did the hurricane make landfall?

During the evening before (Friday) the landfall, many of the 37,000 residents of this community were settling down to dinner, few if any of them concerned about the steady 15 mph northerly wind rattling their windows. Within 48 hours, at least 8,000 of the townspeople would be dead, victims of the single worst natural disaster in U.S. history. (<http://www.disasterrelief.org/Disasters/980813Galveston/>)

For more information, read the excellent book: *Isaac's Storm: A Man, A Time and The Deadliest Hurricane in History* by Eric Larson, The Crown Publishing Group, 1999, ISBN 0-609-60233-0.


### How Many Hurricanes Have Passed Near My Hometown?

The hurricane you just analyzed was not the only hurricane to pass near this city. With a GIS, you can determine how many hurricanes passed near this or any other city. Begin with finding out how many hurricanes passed within 50 miles of Galveston.


First, select the city of Galveston from the usacities layer by clicking on the Options button > Select by Attribute.

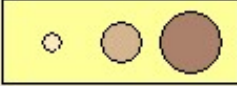
58) What expression should you use to select the city of Galveston?


Second, create a shapefile for the city of Galveston as you did before. Create a buffer around features of the layer **usacities**, using only the selected city of Galveston. Your page should look like this:

**Buffer Wizard** 


How do you want to create buffers?

At a specified distance  Miles 

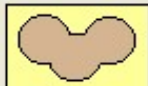
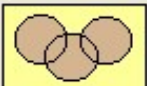
Based on a distance from an attribute  in Miles 

As multiple buffer rings  
 Number of rings:   
 Distance between rings:  Miles 


Buffer distance  
 Distance units are:

**Buffer Wizard** 


Buffer output type

Dissolve barriers between  Yes   No 

Create buffers so they are—

inside and outside the polygon(s)  
 only outside the polygon(s)  
 only inside the polygon(s)   
 outside polygon(s) and include inside

Where do you want the buffers to be saved?

As graphics layer in data frame  
 In an existing editable layer   
 In a new layer. Specify output shapefile or feature class:  
 

Save the results in a layer with a name of your choice, such as galv50buff. This is the area within 50 miles of Galveston.

59) What shape is your Galveston buffer?

60) Why?

Third, before you clear your selection, stack your table of contents items in the following order to examine the paths of the hurricanes passing within 50 miles of Galveston: 1) hurricanetracks; 2) btid352; 3) Galveston; 4) Buffer of Galveston, and zoom into that area. Clear your selection from the hurricanetracks layer so you are looking at all of the hurricanes.

Fourth, make your hurricanetracks layer your 'active' layer and use the Geoprocessing Wizard to intersect your buffer and the number of hurricanes. This will again create a shapefile. Name it appropriately. Examine the table of your hurricane layer when done.


61) How many hurricane tracks passed within 50 miles of Galveston?

Your new shapefile has the number of entries you stated above, but there are multiples of each hurricane.

62) How many actual hurricanes passed in Galveston's buffer? How many are not named? Why? HINT: Label all hurricanes in hurricanetracks.

63) When was the earliest of these hurricanes?

64) When was the latest of these hurricanes?

Clear the selection  from the hurricanetracks layer. Repeat the above four steps to find out how many hurricanes passed within 50 miles of YOUR home town.

65) What town did you investigate, what were your results, and why? [Answers will vary depending on your location.]

Again, select all layers (hold down SHIFT and single click each one) and clear any selections for all layers.



Save your map document.

### Which States in the USA are the Most Vulnerable to Hurricanes?

Zoom to where you can see the United States and all hurricane tracks.

66) Based on your observations, which state is probably the most vulnerable to hurricanes?

FEMA wants you to make an assessment of exactly how many hurricane tracks crossed each state so that you can quantitatively assess the risk in each state. To do this, you will have to create new information, but you will also use some of the functions you used before.

You will be using the Geoprocessing Wizard again. Examine the option descriptions as you did before.

67) Which option should be used?

Next: Assign data **to** hurricanetracks.shp **from** usastates.shp. Be patient. The GIS has to assign a state name to all hurricane tracks in the USA. If this is too much for your computer, then assign data **to** largehurricanes.shp **from** usastates.shp. {Note: Developer of answer key needed to use largehurricanes.shp.}

When complete, examine the hurricanetracks (or largehurricanes) table.



68) What is the name of the first of the new field(s) that has been added?

Click on the "**state\_name**" field to highlight it, and access Options > Summarize. Take the defaults and save to a table in your folder. Give it an appropriate name.

Sort the table on "**count**".



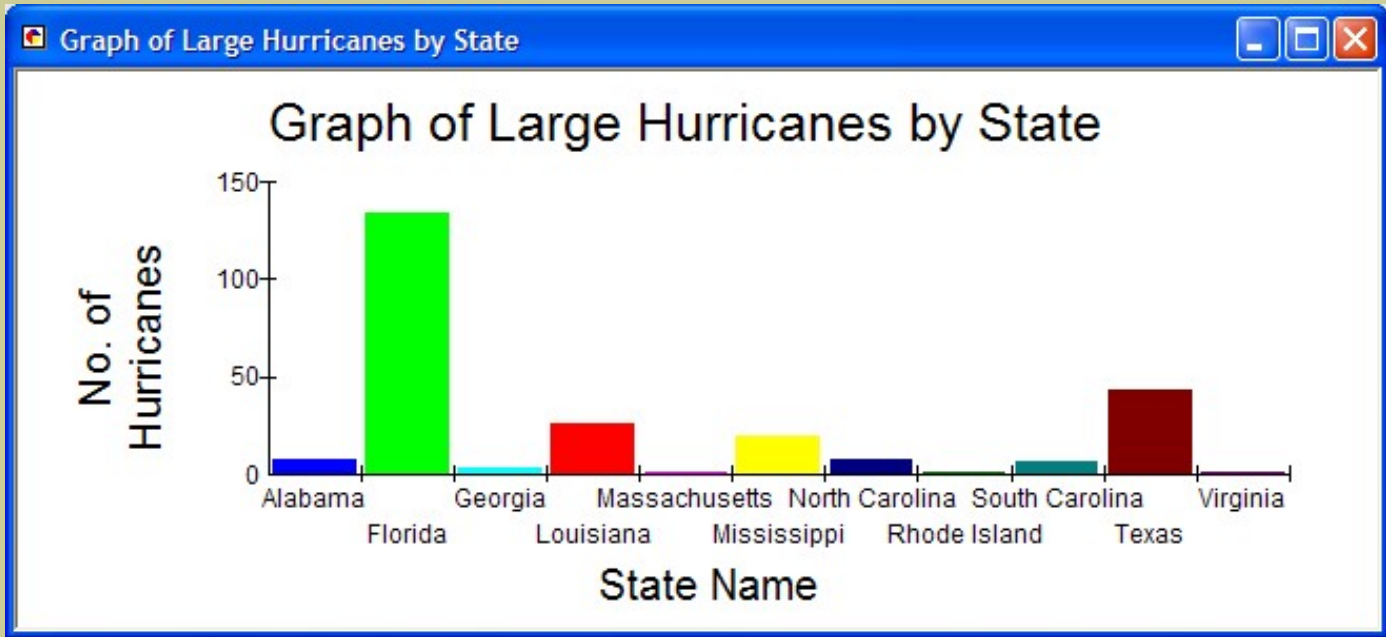
69) How many states or state equivalents were crossed by hurricanes between 1851 and 2001? {Answer will be different if hurricanetracks.shp was used.}



70) Did hurricanes cross over half of the states in the USA? {Answer will be different if hurricanetracks.shp was used.}

71) Which state experienced the most hurricanes? Does this correspond with your the visual observation you made earlier? Why or why not?

72) Name two reasons why this state is most vulnerable to hurricanes.

73) Bring up the Summary Table that you just created of the Large Hurricanes by State. Select Options button > Create Graph based on the "count\_State\_Name" column. Give it an appropriate name in the "name" column. Use "count" as the field and 'add' it to the chart. Print the chart.



Go to the hurricanetracks attribute table.  and clear any selections for all layers.  Save your map document.

**Which countries south of the United States are the Most Vulnerable to Hurricanes?**


The UN Disaster Relief Organization has contracted with you to make an assessment of how many hurricanes crossed each country, with a focus on Central America so that you can assess the risk in each country. To do this, you will have to create new information, but then you will use some of the functions you used before.

Zoom to where you can see the Caribbean Sea, Mexico, Central America, and northern South America, and the hurricane tracks that crossed these regions.

74) Based on your observations, which country in this region is probably the most vulnerable to hurricanes?


75) What hurricane moved furthest to the west in this area? In what ocean did it end?

Determine which countries are the most vulnerable to hurricanes. Again, access the Geoprocessing Wizard, as you did before. Assign data **to** hurricanetracks.shp **from** countries.shp. Be patient. The GIS has to assign a country name to all hurricane tracks in the world. If this is too much for your computer, then assign data **to** largehurricanes.shp **from** countries.shp. {Note: Developer of answer key needed to use largehurricanes.shp.}

When complete, examine the hurricane tracks table. 

76) What is the first of the new field(s) to have been added?

Click on the "**name**" field (there should be two name fields--you want the one on the right side of the table [**name\_1** field]). After highlighting the name field, access the Options button-->Summarize. Take the defaults and save to a table in your folder. Give it an appropriate name.

Sort the table on "**count**". 

77) How many countries were crossed by hurricanes between 1851 and 2001? {Answer may be different if hurricanetracks.shp was used.}

78) Which country experienced the most hurricanes? Why? {Answer may be different if hurricanetracks.shp was used.}



79) Which country south of the United States experienced the most hurricanes? Why? {Answer may be different if hurricanetracks.shp was used.}

80) Is this the same country as the one you indicated was the country most vulnerable in your earlier visual assessment?

81) What does the first row in the table represent--the one with no country name given?

82) Click on shapefile for intersection of largehurricanes and countries > Properties > Symbology > Show: Categories > unique value map using the field "**cat**." Based on this map, what were the most severe


hurricanes to cross the region south of the United States?


Go to the largehurricane and countries attributes tables  and clear any selections for all layers.  Save your map document.

### Which States in Mexico are the Most Vulnerable to Hurricanes?

The UN Disaster Relief Organization has contracted with you to make an assessment of how many hurricanes crossed each state in Mexico. To do this, you will have to create new information just as you did for countries in the world.

Zoom to where you can see Mexico and the hurricane tracks that crossed Mexico.


Use the Add Layer  tool to add Mexico states. Use the Add Layer  tool to add Mexico cities. Label the states.

83) Examine the Mexico states attributes table.  How many states are in Mexico?

84) Based on your observation of the map, which state in Mexico is probably the most vulnerable to hurricanes? Why?


85) Based on your observations, which cities in Mexico are probably the most vulnerable to hurricanes? Why?

Determine which states are the most vulnerable to hurricanes. Access to the Geoprocessing Wizard one more time; Next: Assign data **to** hurricanetracks.shp **from** mexicostates.shp. Be patient. The GIS has to assign a state name to all hurricane tracks in Mexico. If this is too much for your computer, then assign data **to** largehurricanes.shp **from** mexicostates.shp. {Note: Developer of answer key needed to use largehurricanes.shp.}

When complete, examine the hurricanetracks attribute table. 

86) What is the first of the new field(s) to have been added?

Click on the '**name**' field (there should be two name fields--you want the one on the right side of the table). After highlighting the name field, access the options button-->Summarize. Take the defaults and save to a table in your folder. Give it an appropriate name.

Sort the table on "**count**". 

87) How many states in Mexico were crossed by hurricanes between 1851 and 2001? {Answer may be different if hurricanetracks.shp was used.}

88) Which state in Mexico experienced the most hurricanes? Why? {Answer may be different if hurricanetracks.shp was used.}

89) Is this the same state in Mexico as the one you indicated was the country most vulnerable in your earlier visual assessment?

90) Click on shapefile for intersection of largehurricanes and mexicostates > Properties > Symbology > Show: Categories > unique value map using the field "cat." Based on this map, what were the most severe hurricanes to cross Mexican states?

Go to the hurricanetracks attributes table,  and clear any selections for all layers. 

### Analyzing Hurricane Mitch

The worst hurricane to strike Central America was Hurricane Mitch. Hurricane Mitch struck Central America with such viciousness that it was nearly a week before the magnitude of the disaster began to reach the outside world. Hurricane Mitch will be remembered as the most deadly hurricane to strike the Western Hemisphere in the last two centuries. Not since the Great Hurricane of 1780, which killed approximately 22,000 people in the eastern Caribbean, was there a more deadly hurricane.

Hurricane Mitch is responsible for over 9,000 deaths predominately from rain-induced flooding in portions of Central America. This makes Hurricane Mitch one of the deadliest Atlantic tropical cyclones in history, ranking only below the 1780 "Great Hurricane" in the Lesser Antilles, and comparable to the Galveston hurricane you analyzed earlier, and Hurricane Fifi of 1974,

As you have done above, open attribute table for largehurricanes > Options button > Select by Attributes. This time make the expression ("Name" = 'MITCH').

91) What countries do you think Hurricane Mitch affected most?

Read the USGS Hurricane Mitch overview on: <http://mitchnts1.cr.usgs.gov/overview.html>



92) How did your GIS assessment of which countries were most affected match the statements in the USGS overview that you just read?



93) Describe the hurricane track of Mitch, indicating how the hurricane moved over the course of its lifetime.


94) Examine your attributes table.  How long did this hurricane last?

95) What were the dates of Hurricane Mitch?

Go to the largehurricane attributes table,  and clear any selections for all layers.  Save your map document.

### Which World Cities are the Most Vulnerable to Hurricanes?

Next, the UN Disaster Relief Organization wants you to make an assessment of how many hurricanes passed close to world cities. The distance criteria is 50 miles.

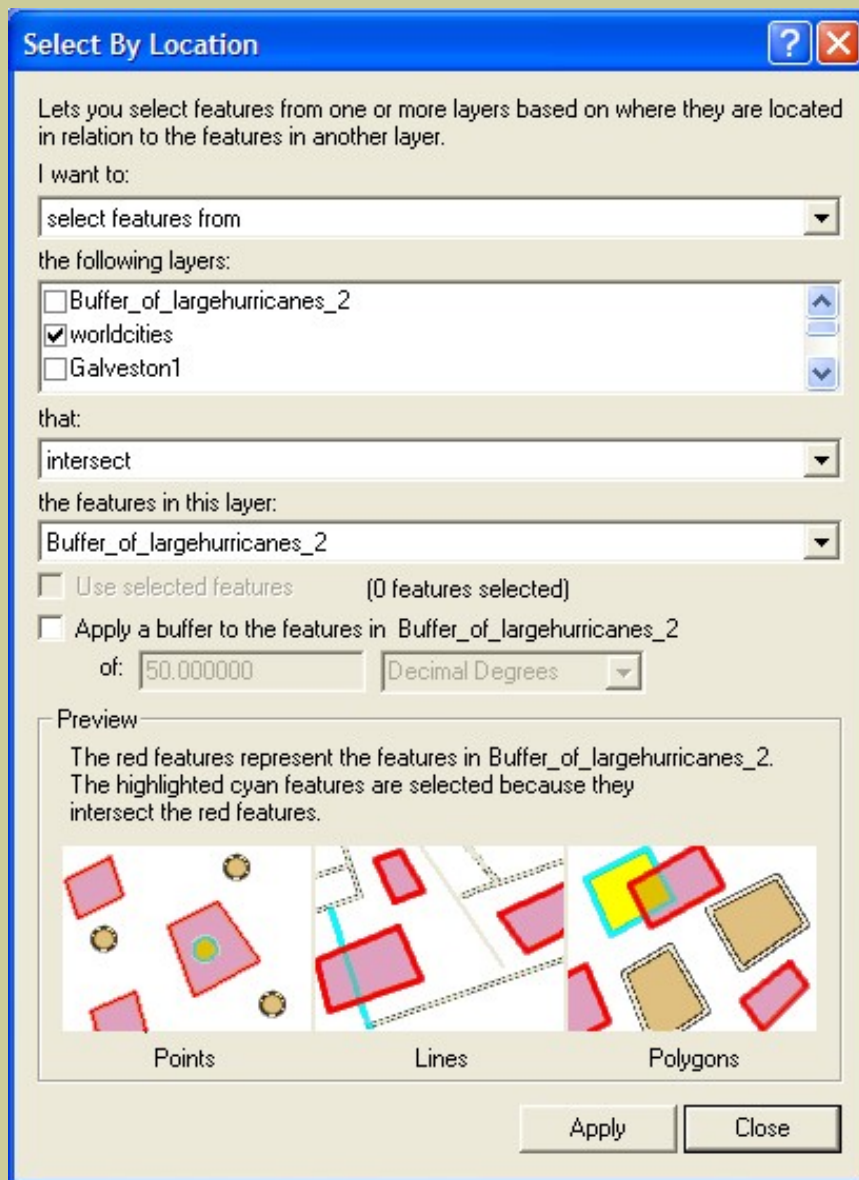
Use the Add Layer  tool to add world cities; make it 'active'.

Access its attributes table. 

96) How many cities are in the data set?

97) How many of these cities do you estimate are within 50 miles of a hurricane track?

Click on largehurricanes > Tools > Buffer Wizard to select cities that are within 50 miles of a hurricane track (name the buffer), then from the menu Selection > Select by Location as follows: {Note: Developer of answer key needed to use largehurricanes.shp.}



98) Examine the map when done. What is the pattern of the selected (yellow) cities?

99) Examine the attributes table for cities.  How many cities are selected?

100) How does this compare to your earlier estimate?

Determine the population that resides in these cities. In the table, select (click on) the field: **Population**. Next, access the Options button-->Statistics and examine your new data summary.

101) How many people live in these cities?

102) Name three things you might do to make these cities safer from hurricanes.

Save your map document, close your map document, and exit ArcView GIS.

103) Summarize in a few sentences what you have learned about hurricanes in this lesson.

104) Summarize in a few sentences what you have learned about GIS in this lesson.

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