



## COASTAL MONITORING & OBSERVATIONS LESSON PLAN

# Bottom Watching

### NOS Topic

Coastal Monitoring and Observations

### Theme

Benthic Surveillance

### Links to Overview Essays and Resources Needed for Student Research

<http://oceanservice.noaa.gov/topics.coasts/monitoring>

<http://www.csc.noaa.gov/benthic/mapping/analyzing/gis.htm>

### Subject Area

Life Science/Earth Science

### Grade Level

9-12

### Focus Question

Why are marine benthic habitats important, and how can they be mapped and monitored?

### Learning Objectives

- Students will describe at least three ways in which marine benthic habitats are important.
- Students will describe at least three sources of stress that may adversely affect marine benthic habitats.
- Students will use a geographic information system to retrieve and analyze data about specific marine benthic habitats.

### Materials Needed

- Copies of “Introduction to Using a Geographic Information System to Monitor Marine Habitats Tutorial,” one copy for each student group
- Computers with ArcExplorer® Java® Edition for Education and GIS data for benthic habitats of St. Thomas and St.

John, USVI installed (this is easier than it may sound; see Learning Procedure)

- (optional) Computers with internet access; if students do not have access to the internet, download copies of materials cited under “Learning Procedure” and provide copies of these materials to each student or student group

### Audio/Visual Materials Needed

None

### Teaching Time

Two or three 45-minute class periods, and possibly additional time for student groups to work with GIS data

### Seating Arrangement

Groups of 3 - 4 students

### Maximum Number of Students

32

### Key Words

Benthic marine habitat  
Geographic information system

### Background Information

Coastal monitoring refers to periodic measurements of physical, chemical, biological, and meteorological factors that may affect the use and quality of coastal resources. For example, such factors may include temperature, salinity, the presence of chemical contaminants, biological species and their life stages (eggs, juveniles, adults, etc.), rainfall, and storm events. NOAA’s National Ocean Service (NOS) supports 28 different monitoring systems to provide key pieces of information needed to protect marine resources and control the ways in which they are used. Monitoring activities concerned with benthic habitats are the focus of this lesson.

Benthic habitats are bottom environments with distinct physical, geochemical, and biological characteristics. Marine benthic habitats are divided into zones based upon how deep they are in the water. From deep to shallow these include: the hadal zone (over 6,000 meters deep), the abyssal zone (2,000 to 6,000

meters), the bathyal zone (200 to 2,000 meters), and the near-shore and estuarine zones (less than 200 meters). Estuarine and nearshore benthic habitats can be highly diverse; and include submerged mudflats, sandflats, rocky hard-bottom habitats, seagrass beds, kelp forests, shellfish beds, and coral reefs. These habitats support a wide diversity of marine life by providing spawning, nursery, refuge, and feeding grounds for many species. Benthic organisms are often important members of the lower food web, consuming organic matter and phytoplankton and serving as food sources for higher level consumers (for example, bivalve molluscs are filter feeders that are a food source for octopus, stingrays and bony fishes; many deposit-feeding worms are food sources for fish species, etc.).

Benthic habitats can also be important in maintaining water quality. Many benthic organisms like clams, scallops, and mussels obtain food by filtering particles from sea water. As the water flows through their bodies, sediments, organic matter, and pollutants are filtered out and ingested. In addition, scavengers, deposit-feeders, and bacteria in benthic habitats play a critical role in nutrient cycling by breaking down organic matter.

The protection and wise use of benthic habitats requires detailed information that is provided by benthic habitat mapping. For example, the 1996 Reauthorization and Amendment of the Fishery Conservation and Management Act of 1976 requires the preservation of Essential Fish Habitat (EFH) which is defined as any habitat necessary for the complete life cycle of a commercially important fish. Benthic habitat mapping provides a way to identify the locations of EFH and the surrounding environments to determine the most effective means for preservation.

Benthic habitat mapping also provides a way to monitor the condition of other important habitats, such as coral reefs, eelgrass beds, and shellfish beds. Mapping and monitoring can be used to:

- Estimate the physical damage caused by trawl-fishing gear to seabed sediments and benthic animals;
- Locate marine reserves so they protect critical habitats;
- Determine the suitability of potential aquaculture sites based on detailed information about the natural habitats of

- the species to be cultivated;
- Determine the effects of habitat change due to natural or human impacts;
- Monitor the impact of dredging and dredged material disposal on benthic habitats; and
- Estimate recovery rates of damaged habitats.

Benthic habitats are mapped and monitored using a variety of tools and techniques. Satellite images and aerial photographs can be used to identify different habitats along the shore and in shallow water over large areas (hundreds to thousands of square meters). Video, still cameras, lasers, and physical sampling allow researchers to gather more detailed information about smaller areas, as well as to “ground-truth” information from broad-scale data collection techniques (that is, researchers can verify what they think a satellite image shows is true by actually going to the area shown in the satellite image and inspecting it in person).

Regardless of which methods are used, all data used for benthic habitat mapping and monitoring must be analyzed and interpreted. Geographic Information Systems (GIS) are powerful tools that can be used to study the relationships between map features and related information about those features. A GIS is a computer-based system that can be used to organize and analyze information about specific geographic locations. Data about these locations are stored in “layers,” with each layer containing a specific type of data. A GIS allows researchers to manipulate and analyze these layers one-by-one or in combination with other layers. One of the most powerful features of a GIS is the ability to display information graphically—especially on maps—which often makes it much easier to understand relationships between locations. The basic components of a GIS are the:

- Hardware, including the computer that runs the GIS software and other peripheral hardware, such as printers, scanners, input devices (such as digital video), and storage systems (hard drives, CDs, etc);
- Software, which is the GIS application package that includes tools for entering and manipulating information, a database management system, tools that create the digital maps, and a graphical user interface;

- Data, which may be spatial data (locations and shapes of map features, such as mountains, roads, countries, and cities), tabular data (data that describes map features, such as the height of mountains or population of cities), or image data (photographs, satellite images, or scanned documents); and
- Human resources; trained and knowledgeable people including cartographers, information analysts, programmers, and system administrators.

This lesson is an introduction to some of the ways that Geographic Information Systems are used to map and monitor benthic habitats. Because GIS techniques can be applied to many other kinds of study and research, this lesson can provide students with tools that will be useful in ways that are limited only by individual imagination.

### Learning Procedure

1.

There are separate installers for AEJEE for Windows and Macintosh platforms at <http://www.esri.com/software/arcexplorer/download.html>. Download ArcExplorer® Java® Edition for Education (AEJEE) and “Introduction to ArcExplorer® Java® Edition for Education” (the publication when downloaded is titled “Using ArcExplorer® Java® Edition for Education”). Download and decompress the files containing GIS data for benthic habitats of St. Thomas and St. John, USVI, from [http://biogeo.nos.noaa.gov/products/benthic/data/vi\\_shp/stsj\\_fin.zip](http://biogeo.nos.noaa.gov/products/benthic/data/vi_shp/stsj_fin.zip). If you plan to install the AEJEE software on computers outside your classroom, you may want to copy these files to a CD-ROM.

You should run through the “Introduction to Using a Geographic Information System to Monitor Marine Habitats” Tutorial and Worksheet to become familiar with the AEJEE software and the St. Thomas/St. John dataset. Because this lesson is only the beginning of what you may want to do with your GIS, you may also want to work through the lessons in “Using ArcExplorer® Java® Edition for Education” which will show you how to use AEJEE to

- analyze GIS data from sources on the internet;
- manipulate map projections;
- integrate image data with shapefiles;

- add point data with XY tables;
- work with georegistration; and
- share GIS projects between computers.

## 2.

Introduce the concept of benthic habitats and lead a brainstorming discussion on why these habitats are important, sources of potential stress to these habitats, and reasons why these habitats should be mapped and monitored. Introduce the basic concept of geographic information systems, and tell students that they will be using GIS software to explore data about some benthic habitats around St Thomas and St John, U.S. Virgin Islands. Point out that GIS can be used in hundreds of different applications, and that once students have mastered the basic concepts they may find many other ways to use these tools.

## 3.

Provide each student group with a copy of the “Introduction to Using a Geographic Information System to Monitor Marine Habitats Tutorial.” Allow at least one classroom session for students to work through the tutorial, ask questions, and/or troubleshoot problems they may be having. Once students are comfortable with the topics in the tutorial, provide each group with a copy of the “Introduction to Using a Geographic Information System to Monitor Marine Habitats Worksheet” for students to complete.

## 4.

Lead a discussion of students’ answers to worksheet questions. The correct answers are:

(1a) How many habitat types are classified as “Artificial”?

1

(1b) What is the size of the largest “Artificial” habitat?

64,720.66 acres

(1c) What are the coordinates of the largest “Artificial” habitat?

about -64.97, 18.33

(2a) How many polygons represent seagrass habitat types?

265

- (2b) What is the Polygonid and size of the largest?  
1212; 2,567,403.23 acres
- (2c) The largest seagrass habitat is near the coast of which island? St. Thomas
- (3a) What is the area of the largest linear reef habitat?  
1,935,046.11 acres
- (3b) What are the approximate coordinates of this polygon?  
-64.96, 18.28
- (3c) What habitats are adjacent to this reef?  
Macroalgae, Sand, and Unknown
- (3d) Suppose that the National Park Service decides to protect this reef by establishing a one-mile buffer zone around it that will be closed to boats anchoring. What will be the longest dimension of this buffer zone?  
about 7,811 m *[Students should first select the polygon containing the reef with the Select Features tool, then apply a one-mile buffer with the Buffer tool, then measure the longest dimension of the buffer zone with the Measure tool]*
- (4a) Where could you find a spur and groove reef?  
on the southeastern coast of St. Thomas; coordinates approximately -64.872, 18.303; polygonid = 712
- (4b) How far is this reef from the point of land at -64.876, 18.303? about 229 ft
- (5) Macroalgae are what percentage of total marine habitat area (excluding “Unknown”) in the vicinity of St. Thomas and St. John?  
The total acreage of macroalgae is 6,372,542.63; the total acreage of all habitats is 627,860,857.08; the total acreage of “Unknown” habitats is 330,823,273.69; the total acreage of “Land” habitats is 131,977,098.94; so the percentage of macroalgae in all marine habitats excluding “Unknown” is  $\frac{6,372,542.63}{627,860,857.08 - 330,823,273.69 - 131,977,098.94} = \frac{6,372,542.63}{165,060,484.45} = 0.0386 = 3.86\%$ ; note that land should



be excluded because it is not a marine habitat

- (6) A ship has run aground on the reef at -65.088, 18.334 and is leaking its cargo of weedkiller into the ocean. How far away is the nearest macroalgae habitat?

4.588 km

### The Bridge Connection

<http://www.vims.edu/bridge/> — In the “Site Navigation” menu on the left, click on “Ocean Science Topics,” then “Habitats,” then “Benthos.”

<http://www.vims.edu/bridge/data.html> — Links to real-time data

<http://www.vims.edu/bridge/archive0599.html> — May 1999 Data Tip about ReefBase, with a link to their Online GIS containing information about coral reefs

### The Me Connection

Have students write a short essay describing three ways in which benthic habitats are of personal importance, and how mapping and/or monitoring might be beneficial to these habitats. If students have difficulty with this, you may want to brainstorm some of the benefits associated with benthic habitats, e.g. shelter and food for commercial and recreational fish species.

### Extensions

Download the Education World Technology Article on geographic information systems from [http://www.educationworld.com/a\\_tech/tech/tech186.shtml](http://www.educationworld.com/a_tech/tech/tech186.shtml) for more ideas and links to resources for using GIS in the classroom.

### Resources

<http://www.csc.noaa.gov/benthic/mapping/analyzing/analyzing.html>  
— NOAA Coastal Services Center Web page introducing benthic monitoring projects and techniques for analyzing monitoring data

[http://www.educationworld.com/a\\_tech/tech/tech186.shtml](http://www.educationworld.com/a_tech/tech/tech186.shtml) —  
Education World Technology Article, “GIS Brings ‘Real Life’ to Learning”



[www.esri.com/arcexplorer](http://www.esri.com/arcexplorer) — ESRI, Inc. Web page providing information and access to ArcExplorer® software

[www.geographynetwork.com](http://www.geographynetwork.com) — Web site for the Geography Network, which is a global network of geographic information users and providers that supports sharing of geographic information and provides access to many types of geographic content including dynamic maps, downloadable data, and more advanced Web services.

[http://www.oceanservice.noaa.gov/education/kits/geodesy/geo10\\_cors.html](http://www.oceanservice.noaa.gov/education/kits/geodesy/geo10_cors.html) — Page in the NOS Geodesy Discovery Kit with information about GIS and the Continuously Operated Reference Stations network

<http://oceanexplorer.noaa.gov/technology/tools/mapping/mapping.html> — Introduction to GIS and mapping from NOAA's Ocean Explorer Web site

[biogeo.nos.noaa.gov/products/us\\_pac\\_terr](http://biogeo.nos.noaa.gov/products/us_pac_terr) — National Centers for Coastal Ocean Science Web page for a project to provide a benthic habitat classification manual, a benthic habitat map, and supplemental geospatial data for the nearshore waters of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands.

### National Science Education Standards

#### Content Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

#### Content Standard C: Life Science

- Interdependence of organisms

#### Content Standard E: Science and Technology

- Understandings about science and technology

#### Content Standard F: Science in Personal and Social Perspectives

- Natural resources
- Environmental quality
- Natural and human-induced hazards

- Science and technology in local, national, and global challenges

### Links to AAAS “Oceans Map” (aka benchmarks)

5D/H1 — Ecosystems can be reasonably stable over hundreds or thousands of years. As any population of organisms grows, it is held in check by one or more environmental factors: depletion of food or nesting sites, increased loss to increased numbers of predators, or parasites. If a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in stages that eventually result in a system similar to the original one.

5D/H3 — Human beings are part of the Earth’s ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.



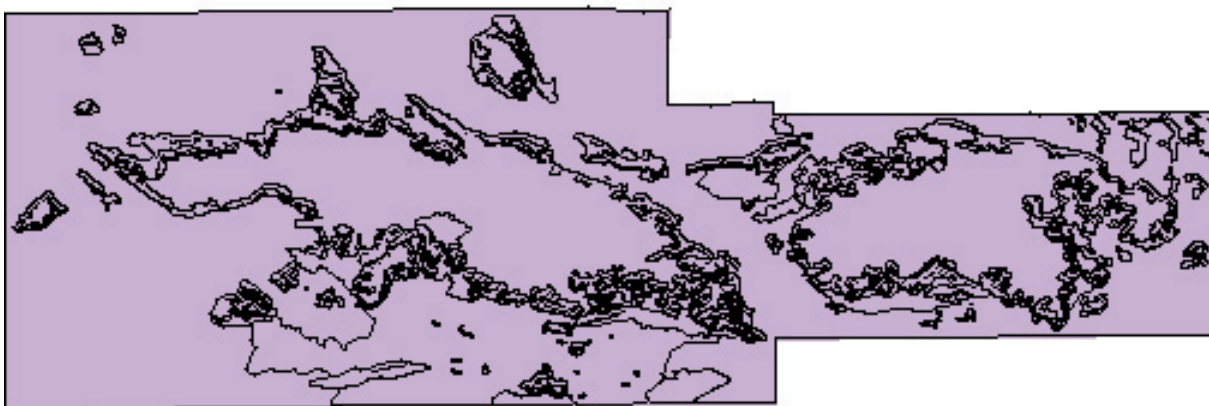
## COASTAL MONITORING & OBSERVATIONS TUTORIAL

# Introduction to Using a Geographic Information System to Monitor Marine Habitats

1.

Open ArcExplorer® Java® Edition for Education (AEJEE). Click on the “Add Data” tool (fifth tool from the left in the toolbar, with a yellow “+” sign.) Navigate to the “stsj\_fin” folder. Highlight the “stsj\_fin” folder, then click “OK”. You should see a file named “stsj\_fin.shp”. Click on this file, and “stsj\_fin.shp” should appear in the window beside “Name:”. Click “OK”. In a few seconds you should see a map of St. Thomas (to the left) and St. John (to the right), U.S. Virgin Islands, surrounded by a series of irregular lines that outline various marine habitats around the islands (Figure 1.)

Figure 1



2.

The column to the left of the map is called the “Table of Contents” (TOC), which shows the various layers that have been used to build the map. At this point the map consists of only one layer called “stsj\_fin”. The TOC also controls which layers are visible, and how the layers are stacked up. We won’t worry about stacking at this point, since the map only contains one layer. Layers can be made visible or invisible by clicking

in the checkbox to the left of the layer name. A black check mark means the layer is visible; an empty checkbox means the layer is not visible.

To the left of the checkbox is a smaller box containing either a “+” or a “-”. This box expands or collapses the legend for each data layer. Clicking on the box when it contains a “-” will collapse the legend, making more space available in the TOC. Clicking on the box when it contains a “+” will expand the legend.

A set of tools and menus is in the toolbar above the map. When you pause the cursor over one of the tools, a short description appears that tells what the tool does. The four tools on the left are for opening a new file, opening an existing file, saving the current file, and printing the current window. The next tool (with a yellow “+” sign) is for adding layers to the current file (more about this later). The “X” tool is for deleting layers, and is only active when one of the layers in the TOC is highlighted.

The six tools between the two “barber poles” are for navigating around the map display. From left to right, these tools include Zoom to the Active Layer, Zoom Full Extent (zoom out to show everything in the TOC), Zoom In (the magnifying glass with a + sign), Zoom Out (the magnifying glass with a - sign), Pan (the open hand), and Identify (the circle with an “i” in the center). Try zooming in on part of the map. You’ll notice that the scale indicator below the map changes as you zoom. You’ll also notice that as you move the Zoom In tool around, the coordinates in the box on the lower left change to show which part of the map is directly beneath the tool. These coordinates correspond to the latitude and longitude of the location on the map.

### 3.

Click on the “Zoom In” tool (the magnifying glass with a + sign). Move the Zoom In tool over the map image until the map coordinates in the box on the lower left are “X:-64.82 Y: 18.3”. Click the “Zoom In” tool, then re-position the tool so that it is over the same spot on the map. Repeat these steps a total of five times until the scale (bottom center) reads “1: 38,636”. Now you should see lines outlining individual habi-

tats more clearly (Figure 2). Notice that these lines outline irregular shapes called polygons.

Figure 2



4.

Click on the Identify tool, then click inside one of the polygons. Now you should see an “Identify Results” window that contains information about the polygon you clicked. In the left column you can see a number that is the identifying number of that particular polygon; each polygon has a specific number. In the right column you can see a list of “Fields”. Fields may be followed by a “Value”; if there is no value next to the Field name, it means that there is no data for that Field in this particular polygon. The Fields and their meaning for this map layer are:

<b>Polygonid:</b>	the specific identification number for this polygon
<b>Area:</b>	the area of this polygon in acres
<b>ID:</b>	an identification number assigned to each habitat type; see Table 1 for a list of habitat types and their corresponding identification numbers
<b>Descriptor:</b>	Type of habitat
<b>Zone:</b>	Name of the benthic zone in which the polygon is located
<b>Habitat:</b>	name of the most general benthic habitat that corresponds to this polygon
<b>Type:</b>	subset of Habitat
<b>Modifier1:</b>	subset of Type
<b>Modifier2:</b>	subset of Modifier1
<b>Modifier3:</b>	subset of Modifier2

Notice that this classification system allows each habitat to be divided into many smaller parts, but complete division of every habitat is optional.

## 5.

Each polygon is linked to a table of information about that polygon. You could use the Identify tool to explore each polygon, one at a time, but this would quickly become pretty confusing, unless you were only interested in a few specific locations. To get a better picture of how habitats are distributed around St. Thomas and St. John, we need to assign a specific color to each habitat type. To do this, right-click (or ctrl-click on a Macintosh platform) on “stsj\_fin” in the TOC, and scroll down to “Properties”. In the “Draw features using” box, select “Unique Symbols” from the pull-down menu. In the window next to “Field for values” select “TYPE”. You should now see a series of color bars underneath “Symbol” and a list of habitat types under “Value” and “Label”. Each habitat type corresponds to a different color bar. Click “OK” to apply these colors to the map and to close the “stsj\_fin Properties” window.

Now it’s much easier to see the relationship between various marine habitats around St. Thomas and St. John. You may want to change the colors assigned to a particular habitat (for example, if “Unknown” is brightly colored, you might want



to change its color to white or gray). To do this, re-open the “Properties” window as described above. Click on the color bar that you want to change, and a color palette will appear. Click on the color that you want to use, then click “OK”. When you have finished making changes to the color bars, click “OK” to apply the new colors to the map and to close the “Properties” window.

You can also add labels to the map. Click “Labels” at the top of the “Properties” window. In the “Label features using” box select “TYPE” from the pulldown menu. To change the color of the labels, select “Custom” from the pulldown menu next to “Color”, and a color palette will appear. Click on the color that you want to use, then click “OK”. You can change the font and font style, and add special effects to make the labels more visible. When you have selected the features for your labels, click “OK”. After a few seconds, ArcExplorer® should redraw the map with labels. Note that only one label will be applied for each habitat type in the map window (so there will only be one label for “Seagrass”, even though there may be several polygons in the map window representing seagrass habitats.)

## 6.

The eight tools on the right side of the tool bar are used to extract various types of information from the map and its associated database. Clicking on the Find tool (binoculars) will open a dialogue box that allows you to search the database for a particular word. This is useful when you want to locate a particular place name or feature on the map. When the search is completed, you can pan or zoom to the places or features that have been found.

The Query Builder tool (page with a “?” mark) is described below.

The Select Features tool (containing a white arrow) is used to select groups of polygons. For example, let’s look at two small islands near coordinates -65.055, 18.404. Zoom in to these coordinates until the scale is about 1:11,000. Click on the Select Features tool, and choose “Line” from the popup menu that appears. Put the cursor near the left side of the habitats surrounding the island on the left and click once. Now drag



the cursor to the opposite side of the habitats on this side of the island (but not in the “Unknown” area) and click twice. Now all of the habitats that were touched by the line are highlighted (Figure 4). Clicking on the Clear All Selections (eraser) tool will de-select all polygons. Clicking on the Attributes tool (page with a yellow star) will open an Attributes window displaying information for each of the selected polygons.

Another way to select features is to right-click (or ctrl-click on Macintosh platforms) on one of the colored symbols in the TOC. This will select and highlight all polygons corresponding to the habitat type selected in the TOC.

You can use the Measure tool (ruler with a “?” mark) to find the distance between points on the map. When you click on the tool, a popup menu appears in which you can specify the units of measurement. After you click on the desired units, the cursor changes to a “+” symbol. Position the cursor over the desired starting point, then click and drag to the desired ending point. A window in the upper left corner of the map will show the length of the segment you have just drawn. You can continue to add segments, and the window will show the length of the most recent segment as well as the total length of all segments. You can clear the totals by clicking on the Measure tool again and selecting “Clear Measure Totals”. If you use the Measure tool to find the distance between the two northern-most points on the two islands near coordinates -65.055, 18.404, you will find the distance to be about 3,434 feet.

The Buffer tool (two orange circles joined by black lines) will draw a line of a specified radius around a selected area. Try this tool using the polygons you highlighted in the previous step. If you specify a buffer with a 1 mile radius you will need to zoom out to see the buffer zone.

The MapTips tool (page with a light bulb) can be used to help identify features that are displayed on the map. In the TOC, click on “stsj\_fin” to make it active, then select the MapTips tool from the tool bar. In the MapTip Layer Selection window, select “stsj\_fin”. In the Field Selection window select “TYPE”, then click on the “Set MapTips” button. “TYPE” should appear

in the box below “MapTip Field”. Click “OK”. Now, as you place the cursor over features on the map, the name of the feature will appear.

#### 7.

Now let’s see how we can use the map and the data linked to each polygon to answer some specific questions. Suppose we are interested in mangrove habitats and want to know what the total area of mangrove habitat is around St. Thomas and St. John. Be sure the layer name “stsj\_fin” is highlighted, then click on the Query Builder tool (the tool with the “?” mark just to the right of the binoculars). Now you should see the “Query Builder” window, which you can use to build a set of criteria that AEJEE will apply to the map data. In the upper left column under “Select a Field:” double-click “TYPE”. Notice that “TYPE” has been transferred to the window just above the “Execute” and “Clear” buttons. In the function palette between the “Select a Field:” and “Values:” windows, click “=” and notice that it has been added to the query statement next to “TYPE”. In the “Values:” column, scroll down and click “Mangrove”. Now the query statement should read “(TYPE = ‘Mangrove’)”. Click “Execute”. In a few seconds, a list will appear of all the polygons whose “TYPE” field contains “Mangrove”. Notice that 36 polygons were found that match the query statement.

To find the total area of mangrove habitat, click on the “Statistics” button. The “Select a field to get statistics” window will open. Choose “AREA” from the list beneath “Select a field:”. Click inside the box next to “Use Query Results?”, then click “OK”. Now you should see a window titled “Statistics Results for field “AREA”. This window shows:

- Count:** the number of polygons (36);
- Max:** the size of the polygon having the greatest area of mangrove habitat (186,428.81 acres);
- Min:** the size of the polygon having the smallest area of mangrove habitat (646.88 acres);
- Mean:** the mean area of mangrove habitat in all 36 polygons (22,842.55 acres);
- Std Dev:** the standard deviation of this mean (43,262); and
- Total:** the total area of mangrove habitat in the data base (822,331.74 acres).

## 8.

Query Builder has several other useful features. If you select one or more of the polygons in the results window then click on “Highlight”. Each of the selected polygons will be outlined and tinted in yellow. If you select a polygon and then click on “Pan”, the map window will pan so that the selected polygon is near the center of the window. If you select a polygon and then click on “Zoom”, the map window will zoom in so that the selected polygon is magnified in the center of the window.

So if you wanted to locate the polygon with the largest mangrove habitat (186,428.81 acres), you could scroll through the list until you found the polygon with this area (Polygonid = 1206), click to highlight that line, click “Highlight”, then click “Zoom”. Now the map shows a highlighted mangrove area surrounding an area of mud and a smaller patch of mangroves. You can use the Identify tool to be sure it’s Polygonid 1206. If you position the tool over the center of the polygon, you can see that its coordinates are 18.314 latitude, -64.883 longitude.

## 9.

Finding the polygon with the largest area by scrolling through the Query Builder results list isn’t too difficult when there are only 36 polygons on the list; but what if there were several hundred? We can deal with this problem by using the Attribute Table for the “stsj\_fin” layer. Right-click (or ctrl-click on a Macintosh platform) on “stsj\_fin” in the TOC, and scroll down to “Attribute Table”. This table shows all of the data associated with every polygon in the database. To find the one we want, right-click (or ctrl-click on a Macintosh platform) on “AREA” and select “Sort Descending” from the popup menu that appears. Now the list is arranged according to polygon size, with the largest polygon (328,727,019.6 acres) at the top of the list. Right-click (or ctrl-click) on “TYPE”, and scroll down until “Mangrove” appears under “TYPE”. The first mangrove polygon is the largest (since we sorted according to descending area), Polygonid = 1206.

**Table 1****Habitat Identification Numbers for ID Field**

- 11 = Unconsolidated Sediments/Sand
- 12 = Unconsolidated Sediments/Mud
- 31 = Coral Reef and Hardbottom/Colonized Hardbottom/Linear Reef
- 32 = Coral Reef and Hardbottom/Colonized Hardbottom/Spur and Groove
- 33 = Coral Reef and Hardbottom/Colonized Hardbottom/Individual Patch Reef
- 34 = Coral Reef and Hardbottom/Colonized Hardbottom/Aggregated Patch Reef
- 35 = Coral Reef and Hardbottom/Colonized Hardbottom/Scattered Coral/Rock in Unconsolidated Sediment
- 36 = Coral Reef and Hardbottom/Colonized Hardbottom/Colonized Pavement
- 37 = Coral Reef and Hardbottom/Colonized Hardbottom/Colonized Bedrock
- 38 = Coral Reef and Hardbottom/Colonized Hardbottom/Colonized Pavement with Sand Channels
- 41 = Coral Reef and Hardbottom/Uncolonized Hardbottom/Reef Rubble
- 43 = Coral Reef and Hardbottom/Uncolonized Hardbottom/Uncolonized Pavement
- 44 = Coral Reef and Hardbottom/Uncolonized Hardbottom/Uncolonized Bedrock
- 45 = Coral Reef and Hardbottom/Uncolonized Hardbottom/Uncolonized Pavement with Channels
- 51 = Other Delineations/Land
- 52 = Other Delineations/Mangrove
- 53 = Other Delineations/Artificial
- 55 = Other Delineations/Unknown
- 211 = Submerged Vegetation/Seagrass/Continuous Seagrass/90- less than 100%
- 2121 = Submerged Vegetation/Seagrass/Patchy/70- less than 90%
- 2122 = Submerged Vegetation/Seagrass/Patchy/50- less than 70%
- 2123 = Submerged Vegetation/Seagrass/Patchy/30- less than 50%
- 2124 = Submerged Vegetation/Seagrass/Patchy/10- less than 30%
- 2221 = Submerged Vegetation/Macroalgae/Patchy/50- less than 90%
- 2222 = Submerged Vegetation/Macroalgae/Patchy/10- less than 50%



## COASTAL MONITORING & OBSERVATIONS REVIEW

# Introduction to Using a Geographic Information System to Monitor Marine Habitats

Use ArcExplorer® Java® Edition for Education and the data in the “stsj\_fin” file to answer the following questions:

1. a. How many habitat types are classified as “Artificial”?  
\_\_\_\_\_
- b. What is the size of the largest “Artificial” habitat?  
\_\_\_\_\_
- c. What are the coordinates of the largest “Artificial” habitat? \_\_\_\_\_
2. a. How many polygons represent seagrass habitat types?  
\_\_\_\_\_
- b. What is the Polygonid and size of the largest? \_\_\_\_\_
- c. The largest seagrass habitat is near the coast of which island? \_\_\_\_\_
3. a. What is the area of the largest Linear Reef habitat?  
\_\_\_\_\_
- b. What are the approximate coordinates of this polygon?  
\_\_\_\_\_
- c. What habitats are adjacent to this reef? \_\_\_\_\_
- d. Suppose that the National Park Service decides to protect this reef by establishing a one-mile buffer zone around it that will be closed to boats anchoring. What will be the longest dimension of this buffer zone? \_\_\_\_\_

4. a. Where could you find a spur and groove reef? \_\_\_\_\_  
b. How far is this reef from the point of land at -64.876, 18.303? \_\_\_\_\_
5. Macroalgae are what percentage of total marine habitat area in the vicinity of St. Thomas and St. John? \_\_\_\_\_
6. A ship has run aground on the reef at -65.088, 18.334 and is leaking its cargo of weedkiller into the ocean. How far away is the nearest macroalgae habitat? \_\_\_\_\_