Exploring a Sanctuary

Natural History of the Channel Islands National Marine Sanctuary

Overview of the Channel Islands

The Channel Islands National Marine Sanctuary (CINMS) is located 25 miles (22 nautical miles) off the coast of Santa Barbara, California. The islands and offshore waters provide an important transition zone between the cooler northern currents and the warmer southern currents. Here, marine life abounds. The cold nutrient rich waters are extremely productive. Large populations of small fish and crustaceans support larger, commercially valuable fish populations. Dense kelp forests provide safety and food for thousands of creatures. Many pinnipeds, marine birds and cetaceans either reside in or visit sanctuary waters. The secluded waters of the Sanctuary also provide temporary or permanent homes to many endangered species including blue, humpback and sei whales, southern sea otters, the California brown pelican and the California least tern.

Start ArcView and open the project Explore.apr found inside the ExploreCI folder on your hard drive.

The All Islands view window opens showing a grid depicting latitude and longitude, the boundaries of the Channel Islands National Marine Sanctuary, and all the major islands in it. Several themes are listed on the left side of the All Islands window, but are not yet visible. Before we begin exploring them, label each island.

Activate the Shoreline theme by clicking on it once. It should appear raised. If necessary, scroll down to find the theme.

Label the islands as they occur from Northwest to Southeast: San Miguel, Santa Rosa, Santa Cruz, Anacapa and Santa Barbara.

Select the text tool from the menu bar. Click on a spot below each island, outside of the sanctuary boundary. A text property box will appear. Type the name of the island and click OK. Move the mouse to the next location and continue.

If you need to move or resize the text, select the tool, then click on the text to activate it. Drag or resize the text as needed.

The themes listed contain biological and physical data about each island. Researchers and sanctuary personnel use these themes to show the biodiversity of the area and to determine which areas to protect in the event of an environmental disaster, such as an oil spill.

Click the box to display each of the themes in the All Islands view. Click the box again to turn off a theme. Each theme displays as a separate layer on the map.

Zoom in on areas of interest. Select the tool, then draw a box around the area you wish to zoom in.

In 1972 Congress passed the National Marine Research and Sanctuaries act, recognizing the intrinsic natural, cultural, historical and economical value of our oceans and coastal waters. The National Marine Sanctuary Division is administered by NOAA, the National Oceanic and Atmospheric Association, under the Department of Commerce.
Student Activity

1. Write the name(s) of the island which matches each description. Some islands will be used more than once. a) shellfish bioregions encircle island, b) highest seal density, c) fewest roads/trails, d) surrounded by kelp, e) kelp populations found mainly on south side, and f) shellfish found on north and west sides.

2. What factors might affect the distribution of the kelp, shellfish, seabird, and marine mammal populations on each island?

Exploring Santa Cruz Island

The bioregions themes from the All Island view provided introductory information about the diversity of life within the Channel Islands National Marine Sanctuary. They do not provide any specific information about the organisms found in each area. This information (environmental sensitivity data) was collected in the early 1990’s by NOAA and the California Department of Fish and Game. It can be accessed from the individual island views.

From the project window, select the Santa Cruz view. Click Open. Study the theme table of contents on the left side of the Santa Cruz view. Each of the bioregions have been subdivided into different areas, called rarenums, identified by different colors and numbers in the legend. Scientists use these numbers to identify each region and to link to tables containing information about the types of species found in each region, their abundance, reproductive habitats, and the months they are present.

To learn more about a specific bioregion, activate the theme by clicking on it (ex. Mammals Bioregions). Select the field tool. Click on the region in the northwest corner of Santa Cruz. A window will appear listing information about the area. Record the Rarenum. Close the Identify Results window.

3a. What is the rarenum of the mammal bioregion located on the northwest corner of Santa Cruz island?

From the Explore.apr project window, click the Tables icon, and open the scmamesi.dbf mammal table. Move and resize the table window so the Santa Cruz Island view is also visible.

Query the table for the Rarenum you identified. After the query, all the species found in this area will be highlighted yellow in the table and the region will be highlighted on the chart.

Student Activity

Kelp and seaweeds are algae. They belong to the kingdom Protista. While both plants and algae photosynthesize and have similar looking structures, algae lack true vascular systems and have very different reproductive processes.

Learn more about environmental sensitivity (ESI) data online at http://response.restoration.noaa.gov/esi/esiintro.html.

A rarenum is a variable name used in a database. Each area is assigned a unique value. In this instance, it contains information about which species use an area, their concentration, and the months they are present.
Notice the menu, button and tool bars have changed. Each ArcView project consists of views (maps), tables, charts (graphs), and layouts (presentation documents.) We will be working mostly with views and tables. Depending upon which type of window is active, the graphical user interface or GUI changes. Some of the menu items and icons remain the same, others are added or deleted.

Promote the results, so you can see which species are found in the area. Scroll through the table to learn more about each species.

3b. Which mammals are found in bioregion 249?

4. When are you most likely to see elephant seals at this location? Will you see a rookery (moms with their pups)?

If time permits, use the steps described above to query the other bioregions and determine which species are found around Santa Cruz. You can also query by species names to determine all of the bioregions the species uses.

Close the Santa Cruz view.

Exploring the bathymetry of the Channel Islands NMS

The distribution of plants and animals is dependent upon physical factors such as depth, elevation, temperature, substrate type, and temperature. Begin exploring the Channel Islands National Marine Sanctuary by looking at the topography (elevation) and bathymetry (depth) of the region.

Open the California coast view.

Turn on the Bathymetry and Topography themes. Both are measured in meters.

Zoom in on the area depicted by the bathymetry and topography themes.

5. Study the bathymetry legend. Which shades represent deeper water? What depth interval(s) correlates with progressively deeper shades?

The depth theme you just looked at provides a relative scale of the sanctuary depth. It is based upon actual depth readings although the values have been rounded to match the legend. The colors have been selected to give you an impression of depth. Around the islands, the water is relatively shallow then it drops off quickly at the shelf break.

Turn on the 120m Contours theme. Each subsequent line represent a 120 meter increase in water depth. The water depth reaches 120 meters at the line closest to the islands (or mainland), 240 meters at the next line, and so on. The depth changes very quickly when the lines are close together.

Explore the contour map using the zoom in, zoom out, and zoom to previous extent tools. Return to the larger sanctuary view when you are finished.

6. At what depth does the shelf surrounding San Miguel, Santa Rosa, Santa Cruz, and Anacapa islands appear to end?

At the height of the last Ice Age, 18,000 years ago, the sea level was 120
meters (400 feet) lower than it is today, dramatically changing the shape of
the coastline and providing easier passage for California’s early inhabitants.
What would the islands and coastline have looked like then?

- Activate the 120m Contours theme. Query the theme to select the
120 meter contour line. The 120-meter depth contour line, representing
the shoreline 18,000 years ago, will be highlighted yellow.

7. Which present day islands were connected to form the ancient Santa
Rosae Island?

- Measure the shortest distance from the edge of Santa Rosae island
to the mainland. Select the tool. While holding down the left
mouse button, drag and draw a line from the end of Santa Rosae to
the closest point on the ancient mainland shoreline.

- Double click when you have reached the mainland. The distance in
miles will appear in the bottom left hand corner of the ArcView
program window.

8. Recently a 10,000 year old skeleton of a women was found on present
day Santa Rosa Island. How far would she have had to travel by boat to
reach the edge of Santa Rosae?

- Turn off the 120m_Contours theme.

Impact of bathymetry on marine life

In the early 1990’s, residents and scientists in Southern California began
noticing large numbers of blue and humpback whales feeding in the Santa
Barbara Channel between July and September. Prior to this, few large whales
were seen, despite frequent use of the channel as a major shipping lane and by
commercial fishermen and recreational boaters. The blue whale population
had been decimated by whaling. In 1966, the International Whaling Com-
mmission listed the blue whales as a protected species and commercial hunting
ceased.

Two studies were initiated to learn why the blue whales were congregating
off the northern Channel Islands. The Whale Habitat and Prey Study
(WHAPS) was conducted during the summers of 1995 and 1996 by NOAA’s
Southwest Fisheries Science Center in collaboration with scientists from the
University of California at Santa Cruz and Oregon State University. The goals
of the project were to study the distribution of the whales, survey their prey
organisms (krill), and to measure physical and biological habitat variables
that influence the distribution of whales and their prey. A second study was
conducted between 1992-1999 by Cascadia Research, a non-profit corpora-

Learn more about these studies on-
line. Read a news article about the
WHAPS study at http://swfsc.ucsd.
edu/NewsRel/whalefeed.htm or follow
the link to the scientific paper at http:/
/www.hmsc.orst.edu/groups/marine
mammal/Blue.htm. Information about
the Cascadia study can be found at
http://www.cascadiaresearch.org/.
tion which conducts scientific research on marine mammals. They photographed and catalogued blue and humpback whales around the northern Channel Islands to learn more about their migratory routes and to determine if the same whales were returning each year.

Add the WHAPS95-96 and Cascadia whale data. The WHAPS 95-96 theme contains sighting information for thirteen species of whales and dolphins spotted around the sanctuary waters, while the Cascadia theme only contains data for blue and humpback whales.

Turn on and activate the WHAPS95-96 theme and query for the blue whales. Some of the blue whales may be hidden behind other sightings.

Convert the selected blue whales to a shapefile.

Adjust the California coast view window by zooming in or out as necessary to see individual whale sightings.

9. Where were most of the blue whales sighted? Do they congregate at specific depths or are they evenly distributed throughout the channel?

In 1995, the WHAPS survey was conducted using a large area grid. Researchers systematically surveyed a variety of potential whale habitats, both near shore and offshore, in warm and cold water temperatures, and productive and unproductive areas. Repeat coverage was given to areas with high numbers of blue whales. During 1996, WHAPS scientists surveyed the areas where the blue whales were the most abundant the previous summer. The Cascadia study, which focused on whale identification, only surveyed areas with high congregations of blue whales. How do the results of the two studies compare?

Turn on and activate the Cascadia theme. Open the Legend Editor and classify the whale data by species.

View/Add Theme... Navigate to the ExploreCI/data/Ca_coast folder. While holding down the shift key, select WHAPS95-96 and Cascadia. Click OK.

Theme/Query or Theme/Convert to Shapefile... Navigate to the YourName folder. Enter "WHAPS_blue" in the common name type: box. Click OK and then click Yes in the dialog box.

Open the Legend Editor, or double click on the symbol.  
• Change the Legend Type: to Unique Value and the Values Field: to Spp.  
• Change the label next to BM to "Blues"  
• Change the label next to MN to "Humpbacks".  
• If you want to, change the color of each symbol.  
• Click Apply.  
• Close the Legend Editor window.

10. How does the distribution of blue whales compare between the studies?
11. Which study method more accurately surveys the whale population (not just feeding behaviors) in the region? Why?
Student Activity

Using the 120m_contour theme from earlier, we can determine more precisely what depth the blue whales seem to prefer and begin to investigate reasons for their preference.

- Turn on the **120m_contours** theme and move it above the **WHAPS95-96** and **Cascadia** themes.
- Turn off the **Cascadia** theme.
- With the **120m_contours** theme active, use the \( \text{[ ]} \) tool to determine which contour line runs includes most of the blue whales.

12. At what depth do most of the blue whales congregate? Why might they be found here?

- Explore images of whales feeding and their prey. Open the three **Whale Feeding** views. In the project window, click on the **Views** icon. Select all three **Whale Feeding** views (Whale Feeding: Humpback, Whale Feeding: Krill Close Up, and Whale Feeding: Krill Slick), by holding down the shift key and clicking on each name. All three views should be highlighted. Click **Open**. Each views opens with an image and descriptive text in it.
- Study each image. When you finish, close all three of the **Whale Feeding** views. The **California coast** view should still be open. If not open it.

Blue whales are filter feeders; they feed primarily on krill. During the WHAPS whale study, scientists found several different krill species (**Tysanoessa spinifera**, **Euphausia pacifica** and **Nematoscelis difficilis**) congregated in slightly different areas in the study area. Dense layers of **Tysanoessa spinifera** were more common in shelf waters, less than 150 meters deep, while dense layers of **Euphausia pacifica** and **Nematoscelis difficilis** were more common near or off the shelf edge in waters 200 meters deep.

- Add the **150m_cont** and **200m_cont** themes. Turn on the themes and adjust the color so they are easily visible against the bathymetry theme.

13. Based upon the distribution of whales in the WHAPS theme, which krill species do the blue whales seem to prefer? Why? How could you determine for certain which krill species blue whales prefer?

- Turn on the **Cascadia** theme again and study the distribution of humpback whales.

14. Suggest reasons for the different distribution patterns between the blue whales and humpback whales.

The high concentration of krill species found off the north side of San Miguel, Santa Rosa and Santa Cruz islands is not a random event. All three krill species sampled are normally found in the colder waters of northern and central California. Between May - June, strong equatorial winds drive coastal upwelling off the coast of Point Conception. The upwelled waters enter the Santa Barbara Channel north of San Miguel moving eastward. The cold, nutrient-rich waters support large phytoplankton blooms which in turn support dense populations of zooplankton and small fish species. The large blue and humpback whales are attracted seasonally to the area to feed on the dense swarms.
15. Write a paragraph describing how the physical characteristics of an area can affect species distributions.

Save the project (File/Save As...) in the YourName folder.

Close the project window and exit ArcView.

Extension Activities

- Continue exploring the environmental sensitivity data provided. Which islands and species would be affected the most by an oil spill? During which months would a spill be the most disastrous, impacting the largest number of species and interfering with breeding efforts?

- Continue analyzing the WHAPS data. Analyze the distribution of each whale or dolphin species. How are dolphins and porpoises distributed around the Sanctuary? Do they aggregate in any one part of the sanctuary? Suggest reasons for the different distribution patterns. Hint: Compare the eating habits of blue and humpback whales with dolphins and porpoises.

- Take a field trip to the Channel Islands National Marine Sanctuary. On the boat ride out to one of the islands, collect data on marine mammal and vessel sightings. Record the date, time, location, species name, quantity and other comments in a data table. Use a GPS unit to determine the location of each sighting. Enter the data into ArcView and create new themes displaying your data (see Environmental Monitoring for instructions on getting your own data into ArcView.) Compare your data with the WHAPS95-96 data set.

- Create a profile chart showing the depth along a given transect line. You may choose to create a profile chart showing the shelf break, the canyon between Santa Rosa and Santa Cruz, across the submerged Santa Rosae island, or of some other area of interest. You must be working on a computer running a Microsoft Windows® operating system and have the Spatial Analyst and Grid Data Handler extensions.

Turn on the Spatial Analyst and Grid Data Handler extensions. Choose File/Extensions... Scroll down until you see Spatial Analyst. Click the box in front of its name, then click OK. Repeat for the Grid Data Handler extension. Surface, Analysis and Grid Data Handler menu items will be added to the top of your program window.

Add the Bathymetry grid data. View/Add Theme... then select Grid Data Source from the Feature Data Source menu. Navigate to the ExploreCI/data/Ca_coast folder and select Bathy. Click OK.

Turn on the Bathymetry theme and edit the legend. Open the Legend Editor, click Load. Navigate to the ExploreCI/data/Ca_coast folder and select Bathy.avl. Click OK, then OK again. Click Apply. The theme should look similar to the Depth theme. With the Bathymetry theme active, select the and click on the view. Notice that the depth is now an exact value (ex. -858.4711.)

Open the project, Esi_data.apr, from the ExploreCI folder. ESI data is provided for each of the major islands within the sanctuary. Access the data using the instructions provided in this lesson.
Create a transect line for your grid profile. From the Grid Data Handler menu, select Grid Profiler. While holding down the left mouse button, draw a line from the beginning of the canyon to where it leaves the sanctuary waters. When the Profile Information window appears, navigate to the YourName folder and change the file name to CanyonProfile.dbf. Click OK. A profile chart window will appear showing the depth profile along your transect line. If your graph looks strange, draw another profile line.

Edit your chart. As you study the chart, you'll notice the Y axis is incorrectly labeled “Temperature”. Relabel the Y axis “Depth”, by selecting the Chart Element Properties tool. Click on the Y axis label to open the Chart Axis Properties window. Change the Axis label: to Depth and click OK.

When you have finished examining the profile map, close its window. Remove the transect line by selecting the tool and clicking on the line. When its handles appear, hit Delete.

- Create your own contour chart showing the bathymetry of the CINMS. Experiment with changing the contour interval. Select contour intervals to show areas of safe SCUBA depths, shallow water productive areas, or other features. You must be working on a computer running a Microsoft Windows® operating system and have the Spatial Analyst and Grid Data Handler extensions.

Follow the instructions given above to turn on the Spatial Analyst extension, load the bathymetry grid data, and edit its legend.

Create a contour map from bathymetry data. Turn on the Bathymetry theme (entitled Bathy) and make it active. From the Surface menu, select Create Contours... Set the Contour Interval to 120 to create contour lines 120 meters apart (or enter in a desired number) and click OK. Wait while ArcView creates a new theme for you. It will add the Contours of Bathymetry theme to the top of the Table of Contents.

Rename the theme “120m Contours” (Theme/Properties...) If necessary, adjust the color or thickness of the contour lines using the Legend Editor.
Mapping a Sanctuary

Name(s) _________________________________________

1. Write the name(s) of the island which matches each description; islands may be used more than once:

<table>
<thead>
<tr>
<th>Description</th>
<th>Island name(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) shellfish bioregions encircle island</td>
<td></td>
</tr>
<tr>
<td>b) highest seal density</td>
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2. What factors might affect the distribution the kelp, shellfish, seabird and marine mammal populations on each island?

3. What is the rarenum of the mammal bioregion located on the northwest corner of Santa Cruz island? Which mammals are found there?

4. When are you most likely to see elephant seals at this location? Will you see a rookery (moms with their pups)?

5. Study the bathymetry legend. Which shades represent deeper waters? What depth interval(s) correlate with progressively deeper shades?

6. At what depth does the shelf surrounding San Miguel, Santa Rosa, Santa Cruz, and Anacapa islands appear to end?

7. Which of the present day islands were connected during the last Ice Age forming Santa Rosae Island?
8. Recently a 10,000 year old skeleton of a woman was found on Santa Rosa. How far would she have had to travel by boat to reach the edge of the ancient Santa Rosae island?

9. Where were most of the blue whale sighted? Do they congregate at specific depths or are they evenly distributed throughout the channel?

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