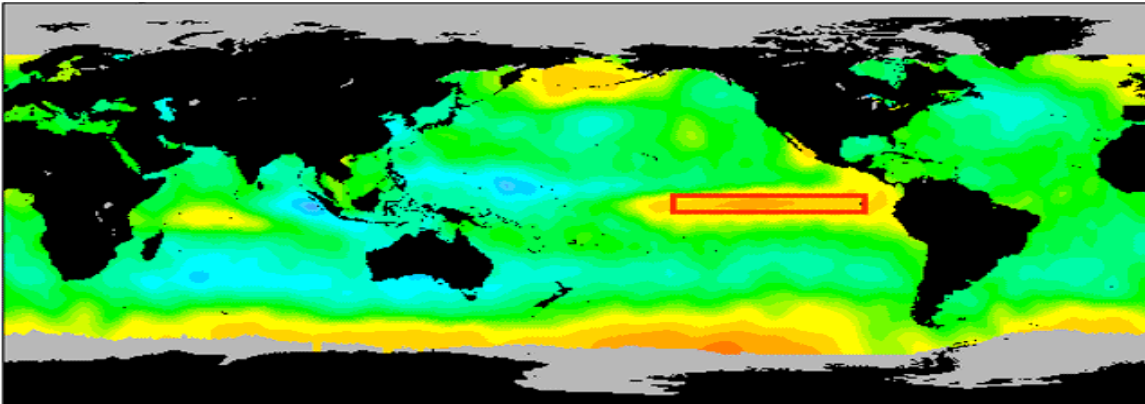


El Niño and the Channel Islands Kelp Forest



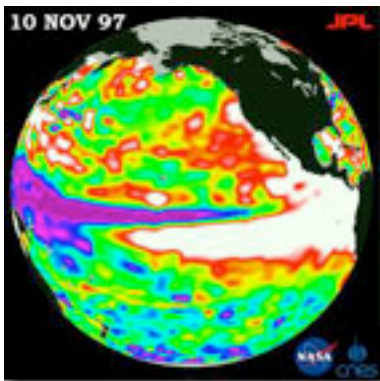
El Niño induced warm waters moving across the Pacific Ocean in the Fall of 1997.
Graphic source: NASA Topex Poseidon CD –Visit to an Ocean Planet

Introduction:

The Channel Islands are a set of rugged coastal islands in the Pacific Ocean off the coast of California. Their location and formation are due to the dynamics of the Earth’s shifting plates. Because of their proximity to the coast, these islands can be easily reached by boat. In fact, some of North America’s earliest inhabitants lived on these islands tens of thousands of years ago. The shallow waters of these spectacular islands, as well as the waters off the coast of California, are the natural location of kelp forests. These kelp forests provide food and shelter for a large variety of organisms. Many of the organisms are **endemic** to this area and are not found anywhere else of earth. So many so, that these islands have been called the “Galapagos of the Pacific”.

El Niño - When the Pacific Ocean Speaks, Earth Listens

From http://www.jpl.nasa.gov/earth/ocean_motion/el_nino_index.cfm




“The currents that power the ocean fluctuate from year to year, and these variations influence the atmosphere. One of the most famous and powerful of these ocean-atmosphere interactions is El Niño, the unusually warm current that invades South and Central American coastal waters at the end of some years. This unexpected warm water causes changes in fish populations, rainfall and weather across North and South America.

In a normal year, steady winds blow westward and push warm surface water toward the western Pacific Ocean. In contrast, during an El Niño year, weakened winds allow warm water to occupy the entire tropical Pacific. Rain follows the warm water eastward, causing drought in Indonesia and Australia and altering the path of the Jet Stream, which helps determine the weather in North America.

Although scientists don't fully understand how fluctuations such as El Niño work, they are learning more about them. Early prediction for such events will enable people to be better prepared to deal with the next El Niño and to save lives and property.”

While the causes of an El Niño are still a mystery, the impacts have been well documented. In this activity, we will use maps, pictures and graphics to explore the impacts of El Niño on the kelp forest habitat surrounding the Channel Islands including Catalina Island, the southern-most island in the Channel Island chain.

- To begin, launch My World  and then double click on the project “**El Niño and Kelp.m3vz**”.

The project loads with a brief “My World Tour” pop-up window. Begin the lesson by reading the tour pop-up window. Close the window when you are finished.

- Use the tabs at the top of the main window to switch to **Visualize** mode.
- Notice in the upper right hand corner of the main screen a pull down menu where you can select “**Map Views**”. These map views have been preset by the designer of this project to take you to specific views of the data.


Part A – World Sea Surface Temperatures and El Niño.

In this section of the activity we will explore the variation in Sea Surface Temperatures (SST) across the Earth, and across the seasons; from winter to summer.

Note: Put all answers on your student answer sheet.


- Use the pull down menu in the “**Map Views**” to switch to “**World View**”. You will see the **Sea Surface Temperature** for the month of *August*. Use the “**World View**” map view to answer the first 2 questions.

1. How does Sea Surface Temperature (SST) vary across the global ocean from the Equator North and South toward the Poles?

- Turn on the **Sea Surface Temperature** for the month of *February*.
- To see the two views side by side, use the “**Window**” menu and select “**New child window**”. You can now turn off the **February SST** layer in the main window.
- Use the pointer tool  in either window to click on the map. Notice the legends under the child window will give you the relative SST. (see illustration, below)



2. What is the mean temperature of the ocean in August? February?

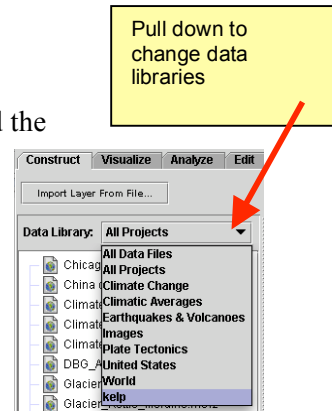
- To find the mean temperature of the sea surface temperature (SST) layer click on the statistics button  when the layer is active.
- Close any “child” windows that you had open.

Switch to **Construct** mode. From the **Channel Islands** data library add the **Generalized Kelp Forest**. (note: this may have already been done for you)


- Return to **Visualize** mode.

3. Give a generalization describing the regions of the Earth and water temperature that appear to be the most suitable to kelp.

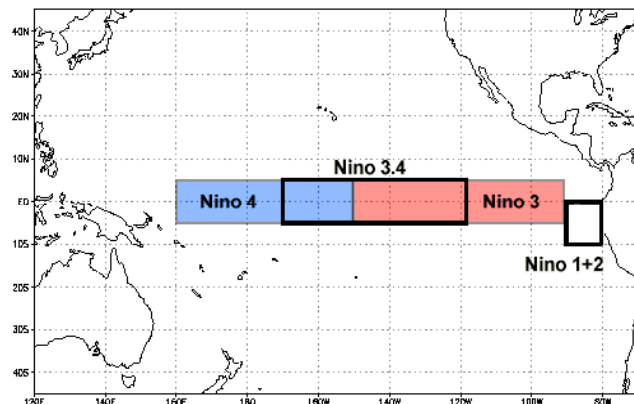
- Return to construct mode. From the **Channel Islands** data library add the **El Niño SST Anomaly** layer. Put it on top of the other SST layers.
- To better observe the El Niño anomaly, turn off the **August** and **February** SST layers. Your map will have only **Continents** and **El Niño SST Anomaly** checked (on). The legend is for the El Niño SST is in degrees above and below normal.



The mean temperature of this region of the Pacific Ocean is the average of the temperatures from 1950 to the present. An *anomaly* is the amount of deviation (change) from the mean for that time period and data set. In the case of El Niño, the change is measured in degrees above and below the 50-year mean temperature of the ocean. The number “0” would therefore represent normal. Once normal is established, any positive deviation from this mean would indicate *warmer* than normal and any negative number would be *cooler* than normal. The greater the deviation from normal the “stronger” the El Niño.

- Click on the Project Links Flag  to view the **El Niño movie**, **El Niño impacts graphic** and **El Niño SST graph**.

The linked graph in the project, shows the average anomaly for the region highlighted in the picture to the right. This region is known as the El Niño 3.4 region. There are 4 regions of the ocean in which El Niño is tracked. These regions span the Pacific Ocean from Indonesia to Peru. *Image source:* http://www.srh.noaa.gov/mlb/enso/15th_climate_hage_meyer.htm



Questions:



4. Using the data on the graph, determine what year had the strongest El Niño. Discuss how you made your choice.
5. List all the El Niño years that occurred between 1980 – 2003.
6. After watching the linked movie and reading the text above, explain anomaly in your own words.
7. After reviewing the linked El Niño impacts graphic, list 3 impacts of El Niño.


End of part A. Quit My World, do **not** save any changes.

Part B – Focusing on the Western United States Coastal SST variations and the Kelp Forest.

Now that we have a sense of the global ocean conditions and the El Niño phenomenon, we will focus in on one area of interest, the kelp forest of the Western United States.

Use the pull down menu to switch to “**Regional View Western United States**”. Our study area is located off the Coast of California.

- Select an area of interest. Zoom in to look more closely at this region. 
- Use the pan tool  to move around the map.
- Add the **Surface Currents** from the **Oceanography** data library.
- Turn on the **SST in February and August** and notice the difference in temperature for this region between the two seasons.
- Turn on the **Generalized Kelp Forest** layer, put it **above** the SST layer.

Zoom to Selected Layer Tip:
Using the **Zoom to Selected Layer**  is a fast way to zoom to all of the records of the activated layer. To use this button be sure to make the layer active and make the layer visible by checking on the Hide/Show Layer checkbox.


Use the “**Regional View Western United States**” map view with the new layers added to answer the following questions:

8. What type of **Surface Current** runs along the Western United States, warm or cold?
9. Generalize how the mean **sea surface** temperature in this area changes between February and August. (this number can be an estimate)
10. List the states of the lower 48 United States that have an adjacent kelp forest. (Note: Alaska also has a kelp forest, but it was not drawn for this project)

Use the pull down menu to switch to “**Channel Islands View**”

In this view, you will add the **Channel Islands Sea Surface Temperature (SST) October**. These are the average SST values during the month of October for this region. They are from 1997 - 2004. These temperature data layers were created from data collected by satellites and remote sensing.

To learn more about how SST data is collected check out the website for NOAA Oceanwatch.
http://oceanwatch.noaa.gov/ow_sst.html



- Activate the layer called **Island Names** to learn the names of the Channel Islands.
- From the **Channel Islands** data library, add the layer **Channel Islands SST October**. You will see that this layer has a pull down menu that will allow you to change the year that is being displayed by the program.
- With the **Channel Islands SST October** layer active, click on the statistics  button to see the statistics for this data.
 The values are coded in the following manner: 10_97 means October 1997.



- In the table to the right, record the **Mean** and **Maximum** temperature values for each year. The data should be from the **Channel Islands SST October** layer. Star the years with the highest and lowest mean values.
- Optional: use the math operation in My World to calculate the anomaly of this data for the year 1997. (as illustrated in the Detecting El Niño lesson)
- Turn off the Sea Surface Temperature layer. Leave on only the **kelp forest** and **Channel Island** layers.

Year	Mean SST <i>degrees C</i>	Maximum SST <i>degrees C</i>
1997		
1998		
1999		
2000		
2001		
2002		
2003		
2004		

The Kelp Forest of the Channel Islands

Appearing in this view are the areas of the Channel Islands where the kelp forest exists. The kelp forest of the Channel Islands is a lush forest. It is similar to the terrestrial tropical rainforest. The kelp forest provides important habitat for many species of animals. Scientists have been tracking the extent of the kelp forest since the 1930's. The data on the extent of the kelp forest is collected through the use of aerial photography. These photographs are then translated to shape (GIS) files that can be read by programs such as My World.

- If this is your first introduction to kelp forests you may want to switch to the Link tool  and click on the flag  at the lower right of the map. There you will see a link called "**Kelp Forest Movie**". Click the link to see the movie. This movie will give you an underwater tour of the kelp forest. (NOAA movie)

By clicking in the check boxes to the left of the layer names, turn on the various Channel Islands **Kelp Forest** and **Catalina Island Kelp Forest** layers from the years 1980 – 2004. Use the zoom  and pan  tools to move around the map.

Next, we will compare the Kelp Forest of the Northern Channel Islands and that of Catalina Island. We will compare the forests *spatially* (across an area) and *temporally* (over time).

11. Compare the 2004 Kelp forests of Catalina and Santa Cruz. Describe where you think the kelp forests seem to be the greatest.

12. Make other observations about the location and extents of the kelp forests and the Channel Islands. Do some islands have larger kelp forests than others? What other information would you like to know about these habitats?



Part C – Zooming into the Catalina Island Kelp Forest.



As the Southern-most of the Channel Islands, Catalina is even more exposed to the warm southern California Counter Current. Due to this warm current, Catalina has the highest mean water temperature of the islands. Therefore, the kelp forest around Catalina is even more vulnerable to El Niño impacts.

Use the pull down menu to switch to “**Catalina View**”. In this map view, we are zoomed in even closer into one project area. This map view will load with the Catalina place names marked by flags.

- To get a general sense of locations on Catalina, click on the legend to the right of the map to select the following **6 locations** and any other points of your choice. You will see that the selections are highlighted on the map when you do this. Fill in the chart below.

Points of Interest	Description
Arrow Point	
Bird Rock	
Emerald Bay	
Howland’s Landing	
Isthmus Cove	
Toyon Bay	

- Use the Link tool  and click on the flags  to see the pictures of the locations and tools that were used in data collection for the project.
- Turn on the **Kelp 2004 Catalina** layer.

- Use the zoom  and pan  tools to examine the kelp forest around Catalina.

Use the Catalina map view to answer the following questions.

13. Does the kelp forest ring the all of Catalina Island equally?

14. Where does kelp seem to be more or less prevalent, and how might you explain these variations? What other information would you like to add to your map?

End of Parts B and C: El Niño and the Kelp Forest.



Quit the program do not save any changes at this time.

Part D – Emerald Bay Kelp Forest Changes

The region, known as Emerald Bay, is at the Northeast end of Catalina Island. It is a well-known kelp forest, popular with scuba divers. This kelp forest is beautiful and nearly pristine. Due to its unique characteristics and accessible location, this kelp forest is the focus of several research projects by major US universities.

Switch to the “**Emerald Bay View**” map view.

In this section of the lesson we will compare the kelp forests of Emerald Bay from 1980 to 2004 in order to demonstrate how the kelp forests change over time.

- Use the Link tool  and click on the flags  to see the pictures of the locations, students and tools used in our project.
- Turn on both the **kelp 1980 Catalina** and **kelp 2004 Catalina** layers, which one appears to cover a greater area?
- Add the **kelp 1999 Catalina** layer. How does it compare to the 1980 and 2004 kelp forest?

Use the **Emerald Bay** map view and the **Catalina Island Kelp Forest** layers from 1980 until 2004 in order to answer the questions below.

*15. Compare the **kelp 1980 Catalina** and **kelp 2004 Catalina** layers, which one appears to cover a greater area?*

Summarize:

16. How does the 1999 Catalina Kelp Forest compare to the 1980 and 2004 kelp forest? Return to your Sea Surface temperature and El Niño anomaly information. How frequent and intense were the El Niño cycles during this time period?

Fill in the chart on your answer sheet like the one below, with information about how the kelp forest has changed over time and as a result of El Niño temperature patterns. Use the knowledge that you have gained while completing this project.

Year	Mean SST <i>Use the Channel Islands October SST from Part B</i>	Kelp Forest Extent <i>Use the Kelp Forest Layers from Part D</i>	Other Information <i>Description of general location of Kelp forest</i>
1980	<i>Not available</i>		
2004			
<i>choice</i>			

Extend: Choose one of the following.

1. Learn more about El Niño and its worldwide impacts. Use the websites provided in your handouts.
2. From the **Catalina** Data Library, add the **Elevation Catalina** layer. Use My World to find out what areas would be submerged if the sea level were to rise 20 meters. Predict how this could change the location of the kelp forest.
3. In an El Niño year, increased storms would bring increased rain and sediment from the land into the ocean. From the **Catalina** Data Library, use the **Elevation Catalina** layer to predict where the kelp forest would be damaged if there was a large amount of run-off and resultant erosion.
4. Add the **Sea Swell** data layer from the **Catalina** data library. What region has the largest waves? In El Niño years where would you predict the largest wave action occur? How could this effect the coastline?

Student Answer Sheet

1. How does Sea Surface Temperature (SST) vary across the global ocean from the Equator North and South toward the Poles?

2. What is the mean temperature of the ocean in August? February?

August _____

February _____

3. Give a generalization describing the regions of the Earth and water temperature that appear to be the most suitable to help.

4. Using the data on the graph, determine what year had the strongest El Niño. Discuss how you made your choice.

5. List all the El Niño years that occurred between 1980 – 2003.

6. After watching the linked movie and reading the text above, explain anomaly in your own words.

7. After reviewing the linked El Niño impacts graphic, list 3 impacts of El Niño.

a.

b.

c.

8. What type of **Surface Current** runs along the Western United States, warm or cold?

9. Generalize how the mean **sea surface** temperature in this area changes between February and August. (this number can be an estimate)

10. List the states of the lower 48 United States that have an adjacent kelp forest.
 (Note: Alaska also has a kelp forest, but it was not drawn for this project)
 Fill in this table:

Year	Mean SST °C	Maximum SST °C
1997		
1998		
1999		
2000		
2001		
2002		
2003		
2004		

11. Compare the 2004 Kelp forests of Catalina and Santa Cruz. Describe where you think the kelp forests seem to be the greatest.

12. Make other observations about the location and extents of the kelp forests and the Channel Islands. Do some islands have larger kelp forests than others? What other information would you like to know about these habitats?

Fill in this table:

Points of Interest	Description
Arrow Point	
Bird Rock	
Emerald Bay	
Howland's Landing	
Isthmus Cove	
Toyon Bay	

13. Does the kelp forest ring the all of Catalina Island equally?

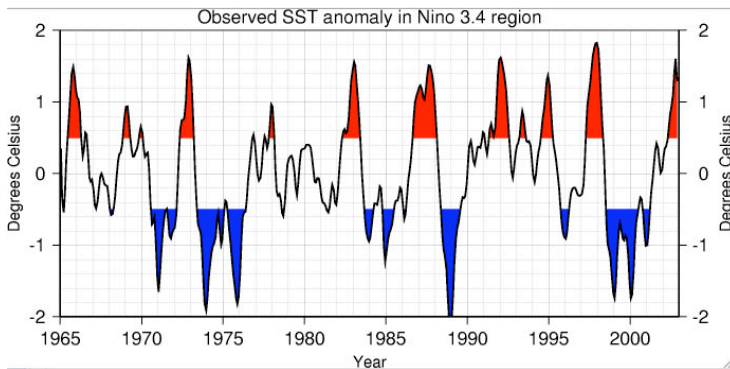
14. Where does kelp seem to be more or less prevalent, and how might you explain these variations? What other information would you like to add to your map?

15. Compare the **kelp 1980 Catalina** and **kelp 2004 Catalina** layers, which one appears to cover a greater area?

16. How does the 1999 Catalina Kelp Forest compare to the 1980 and 2004 kelp forests? Return to your Sea Surface temperature and El Niño anomaly information. How frequent and intense were the El Niño cycles during this time period?

Year	Mean SST <i>Use the Channel Islands October SST from Part B</i>	Kelp Forest Extent <i>Use the Kelp Forest Layers</i>	Other Information <i>Description of general location of Kelp forest</i>
1980	<i>Not available</i>		
2004			
<i>choice</i>			

Graphs and images linked to project:



Graphic source:
http://iri.columbia.edu/climate/ENSO/background_monitoring.html
<http://iri.columbia.edu/climate/ENSO/currentinfo/figure4.html>