



# El Niño Investigation

## *How are pinnipeds affected by changes in the ocean surface?*

### **Objectives**

- ✓ To synthesize understandings based on the Expert analysis of seal and sea lion movements and Earth imagery.
- ✓ To analyze sea surface data and how warming waters and increasing sea heights affect seals and sea lions.
- ✓ To analyze Earth imagery for evidence of unusual sea surface warming such as El Niño events.
- ✓ To generate recommendations for protecting sea lions and seals based on scientific understandings of the animals.

## Part 1

### *A Closer Look at Seals and Sea Lions*

In groups, answer the questions below to review what each student Expert has learned about pinnipeds. Choose a specific species of pinniped that students in your class have studied (i.e., California Sea Lion, Steller Sea Lion, Northern Elephant Seal, Harbor Seal, Fur Seal, etc.).

**Our pinniped species is:**

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1. Briefly describe the life cycle of your pinniped species.

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2. What are the needs of pinnipeds? How do they satisfy their needs? Discuss each need in the chart below.

Need	Description
Oxygen	
Food	
Water	
Shelter	
Need to Reproduce	



# Part 2

## *Ocean Anomalies*

Something that is unusual, unexpected or different from what is considered average in science is described as an **anomaly** (pronounced: uh-NOM-uh-lee). Therefore, an ocean *sea surface temperature anomaly* refers to unusual ocean temperatures. A *sea surface height anomaly* refers to unusual heights of the water. Instruments on-board remote sensing satellites orbiting Earth collect data. Scientists present this information in the form of colorful satellite imagery in order to perform analysis.

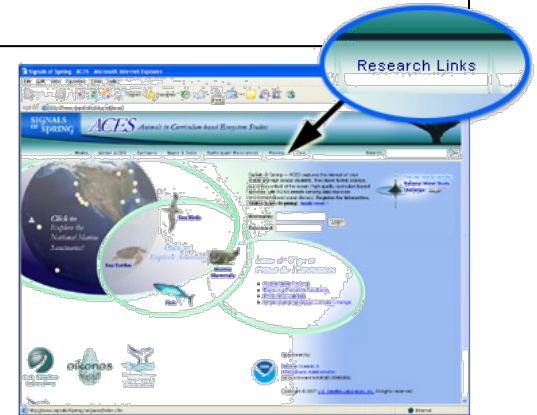
You are going to examine sea surface temperature (SST) images for specific times in the Pacific Ocean. You will look for an ‘SST anomaly’.

With your group, follow the instructions below.

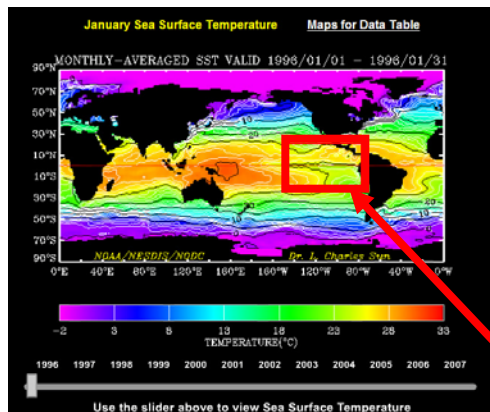
1. On the Signals of Spring – ACES website, go to Research Links. Select the category called ‘Sea Surface’.

Click on the ‘El Niño Interactive Map’ icon.

2. Look closely at the area in the Pacific Ocean near the equator (0° latitude line) shown in the box. Use the scroll bar to examine the different years of SST data. Based on the maps, which year shows an SST anomaly? (Hint: Which year looks very different from the others?)



Pick a category.



Look closely at the area in the box.

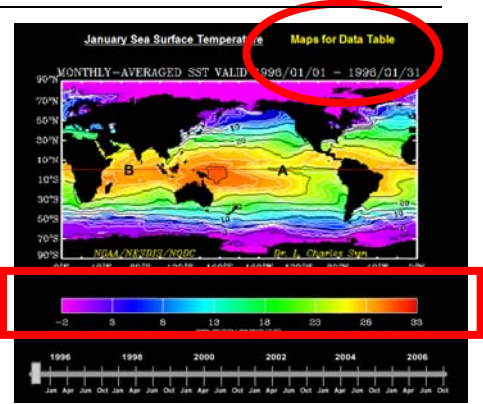
3. Describe the differences that you see in the map of the anomalous year.

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4. Now click on the 'Maps for Data Table' link at the top. Use the maps to complete the table below by scrolling from month to month. This table will help you to use numbers to compare the different years.



Use the color bar to help you determine the temperature.

Slide the bar across the screen to view the average January SSTs from 1996 through 2007.

Record the temperature for locations A and B along the equator during each year.

	Temperature (°C)							
	January		April		June		October	
	A	B	A	B	A	B	A	B
1996								
1998								
2000								
2002								
2004								
2006								

5. Describe the temperature differences that occurred during the anomalous year.

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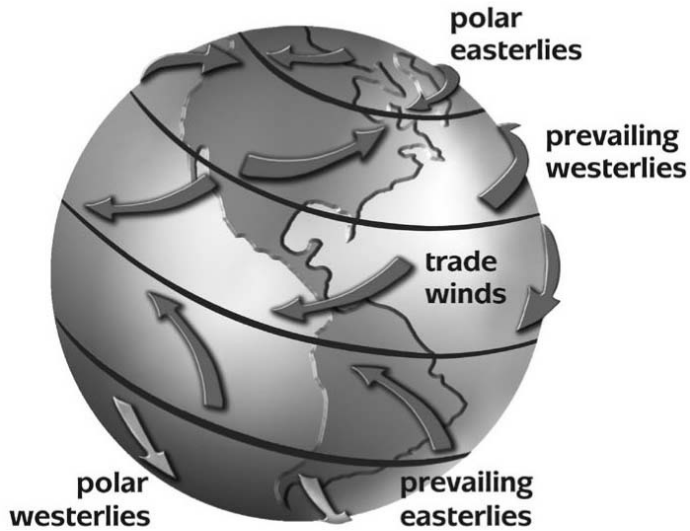


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# Part 3

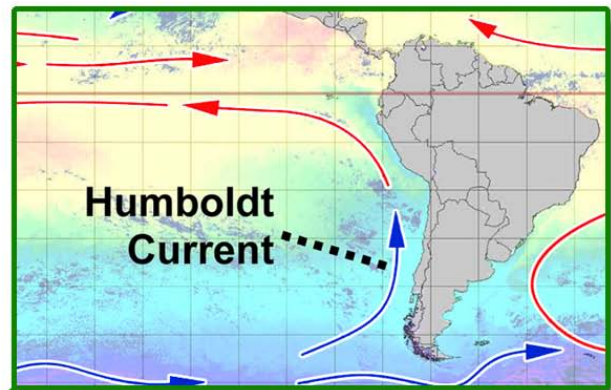
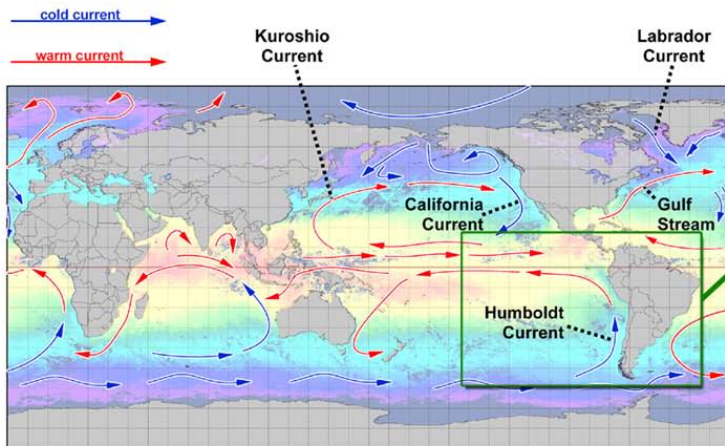
## Anomalies and Ocean Currents



The atmosphere and ocean are very tightly connected. In the area just south of the equator, the **trade winds** are the **prevailing easterlies**. They blow from east to west. Recall, it is the *wind* that drives the direction of ocean currents.

© U.S. Satellite Laboratory

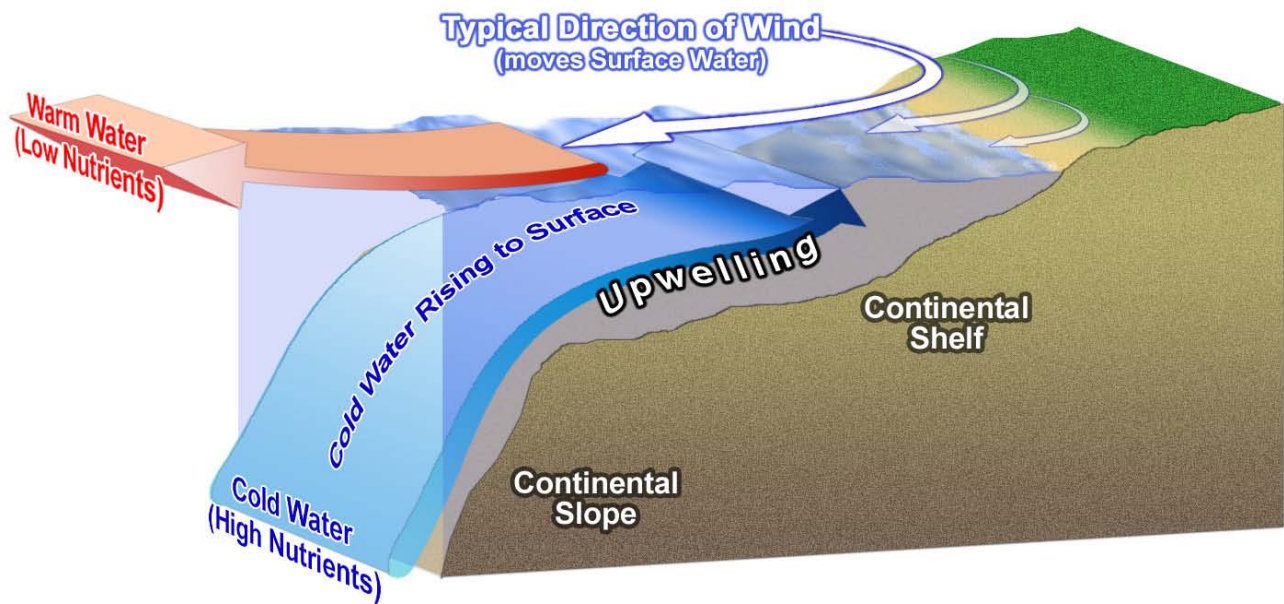
The major ocean current in this area is the Peru Current, also called the Humboldt Current.

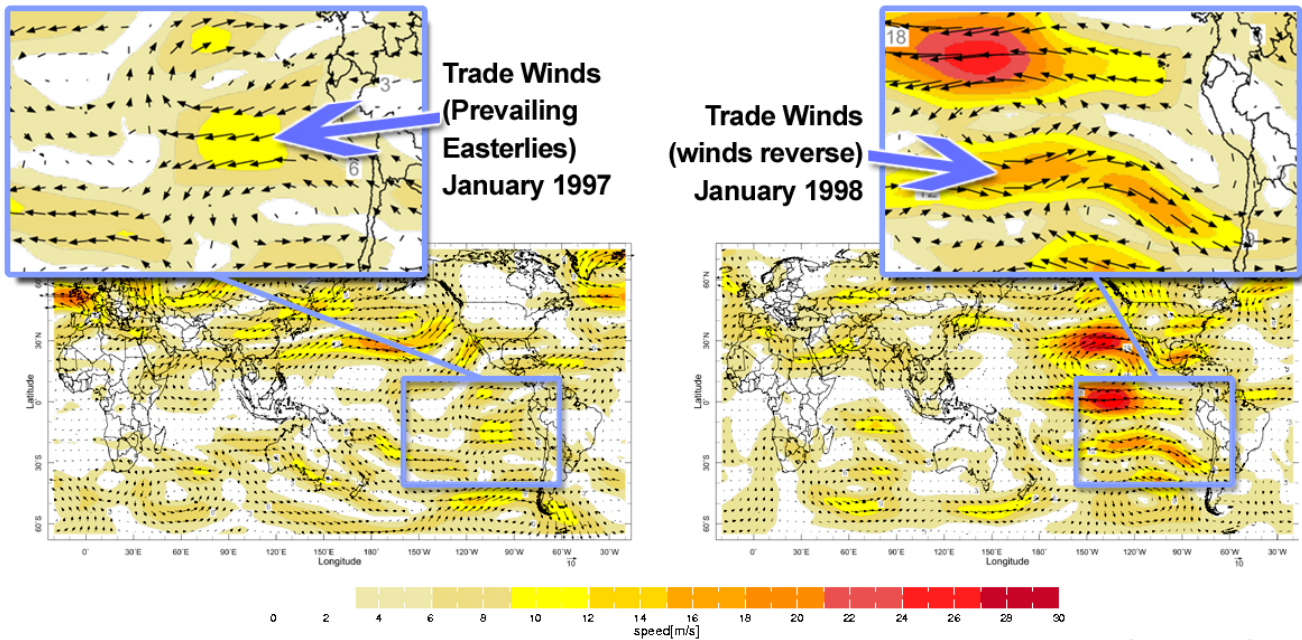


The conditions that you observed in the data from 1998 are part of a climatic phenomenon known as **El Niño**. El Niño refers to the both the anomaly in the ocean temperatures and sea heights in the tropical Pacific Ocean, the area you were just observing. In Spanish, El Niño means “The Christ Child.” People in South America noticed the anomalies occurring around Christmas time, when many celebrate the birth of Christ.

Because the El Niño anomaly is a result in changes in the atmosphere and the ocean, the event causes climatic changes throughout the world that can last anywhere from eight months to up to two years. After the El Niño event is over, normal weather patterns resume.

Under normal conditions, the trade winds push the Peru Current from east to west, off of the South American coast. Nutrient-rich, cold, deep water is pulled up to the surface, fueling a robust ocean food web. Recall that the process of nutrient-rich deep water coming to the surface is called **upwelling**.

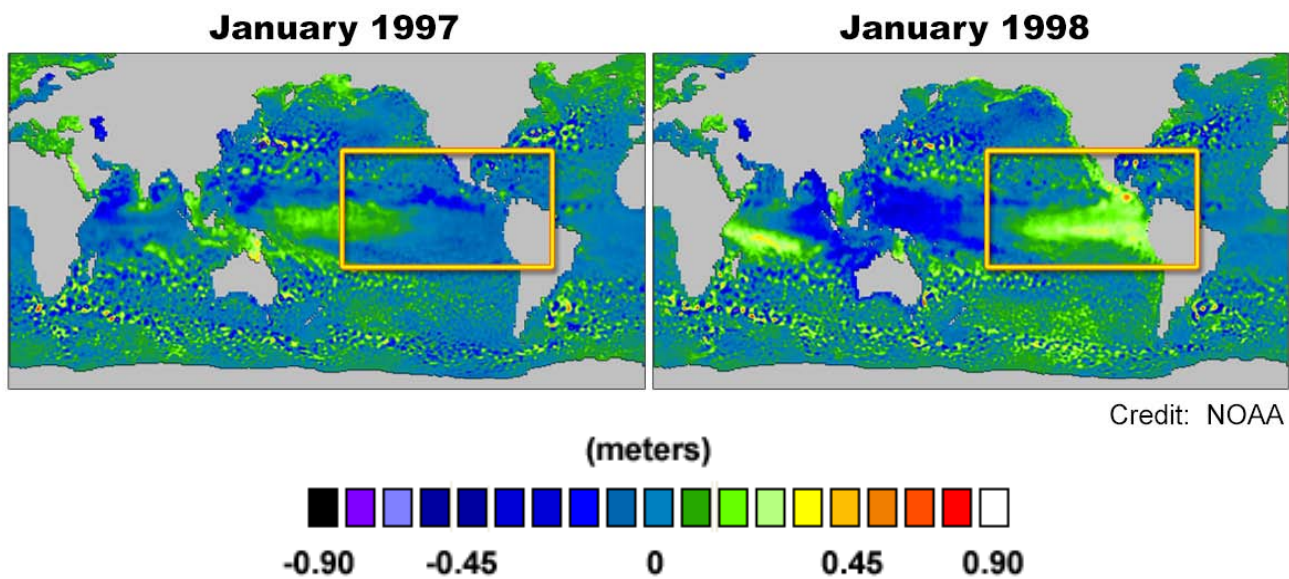




Credit: NOAA

During an El Niño event, the trade winds (from east to west) slow down and even reverse. This causes warm water to shift eastward. The warm water piles up. The image below shows the sea surface heights of the same area during a normal year and during an El Niño event.

Scientists are unsure of the reasons for this ocean anomaly.



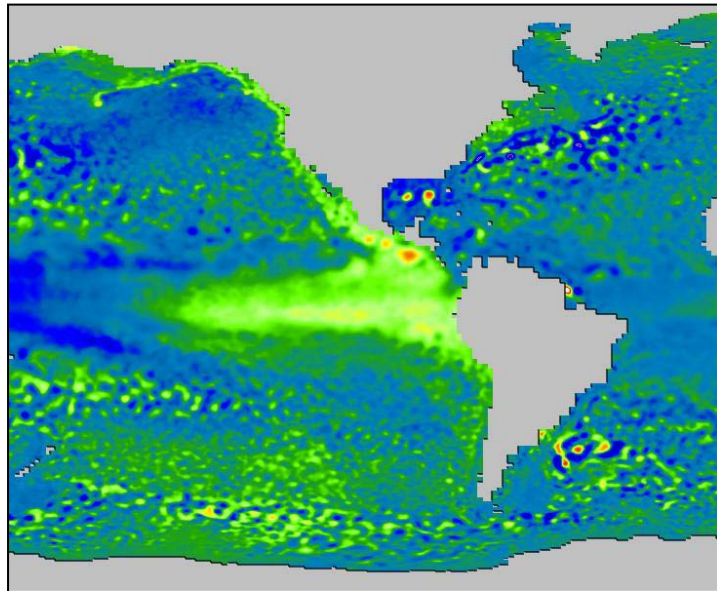
Credit: NOAA





El Niño and the Atmosphere. There are worldwide effects of the changing ocean SST on the atmosphere. The warmer, moister water from the tropical ocean in the Pacific means more evaporation of water vapor into the atmosphere. In many places, the result is increased precipitation; other areas experience drought. Changing patterns in the atmosphere result in changing weather; this means floods and storms in some areas of the world that do not normally experience these hazards.

What happens during an El Niño event? The Peru Current is changed from its normal motion. The wind from the East is no longer driving the ocean circulation. Upwelling slows and warmer water stretches toward South America. The lack of nutrients due to slow upwelling means that the entire food web is affected. This has affected fishers in South America for hundreds of years.



**Credit: NOAA**

Also, the warm water from the west piles up along the western coast of South America, affecting the heights of the seas; this results in the sea height anomalies.

Scientists are interested in examining the effects of El Niño. One main reason is that this phenomenon causes worldwide changes in the ocean and atmosphere and may give us clues about long-term climate change.

# Part 4

## Animals and Anomalies

2005 was not an El Niño year, but it was unusually warm in the north Pacific. Scientists were very interested in examining how animals such as pinnipeds behaved during that time, and whether their travel patterns were any different than in years of average sea surface temperatures.

### 1. How might warmer-than-usual temperatures affect pinnipeds?

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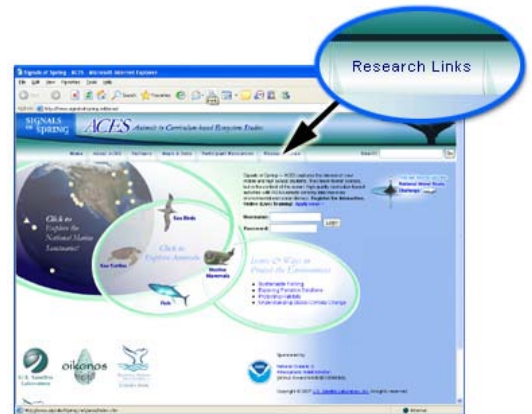
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With your group, follow the instructions below. Then answer the questions that follow.

On the Signals of Spring – ACES website, go to Research Links. Select the category called ‘Sea Surface’.

Click on the ‘California Sea Lion Map’ icon.

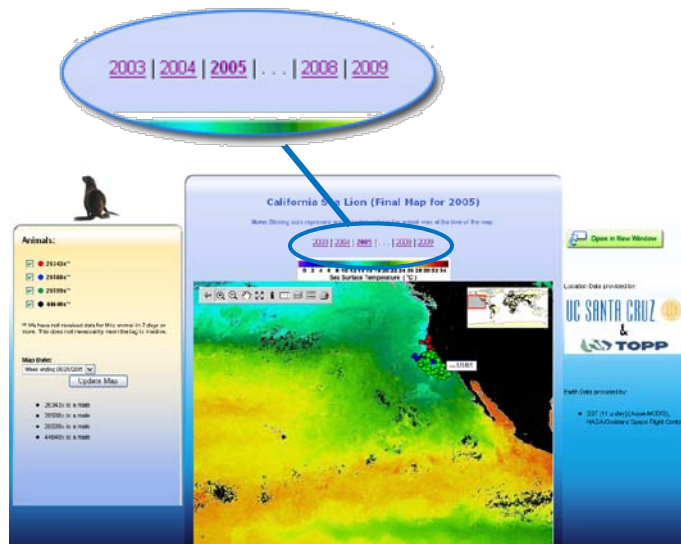
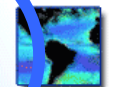
Click on the years to compare the California Sea Lion movement for 2003, 2004, 2008, and 2009 to 2005.



Pick a category.

Animal Links

Earth Links





2. Based on the maps, how do the sea lions' tracks differ in 2005 from their normal paths? (Hint: Be sure to zoom in to the area of sea lions' locations.)

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3. How is the SST in this area 2005 different than in other years?

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4. Why might the animals respond in this way to the anomalous conditions?

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5. Use your answer to make a prediction about the following question: How might California Sea Lions respond to an El Niño event?

Use evidence from your investigation of the animals' tracks to support your prediction.

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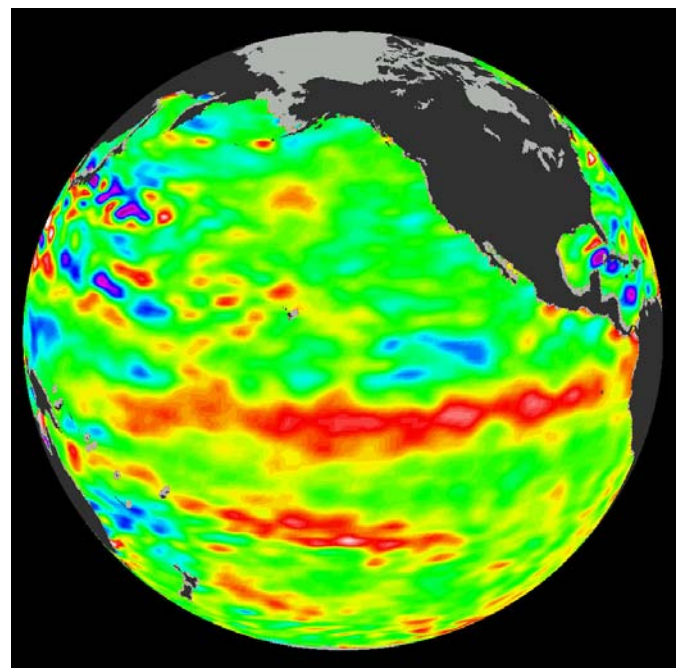
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Sea Surface Height Anomaly (mm)  
-180 -100 0 100 180

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6. Now it is time to present your findings to the scientific community. Choose one of the options below to share what you have learned about El Niño and your predictions about how pinnipeds might respond to changes in climate.

Select one of the following options:

- a. **White Paper (2-3 pages):** Write a ‘white paper’ to share with NOAA scientists. A white paper is a report that describes a new finding. Document your scientific observations and understandings about El Niño and the California Sea Lions’ response to SST anomalies. Include your recommendations for further studies that should be conducted about pinnipeds and changes in climate.
- b. **Poster:** Prepare a poster to share with NOAA officials about your scientific observations and understandings about El Niño and the California Sea Lions’ response to SST anomalies. Use images of the animal tracks and the sea surface data that you examined. Include your recommendations for further studies that should be conducted about pinnipeds and changes in climate.
- c. **Presentation:** Prepare a presentation to present to NOAA officials that outlines your scientific observations and understandings about El Niño and the California Sea Lions’ response to temperature anomalies. Include your recommendations for further studies that should be conducted about pinnipeds and changes in climate. Use visual aids including sea surface images (SST data, wind data, El Niño graphics, etc.) and animal tracking data as you share your presentation with the class or use a video camera to record it.