Hold the Anchovies

A Classroom Activity for Ocean Gazing Episode #45: *MBARI: A seaside sequel*

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Grade Level: 9-12
Lesson Time: 1.5-2 hrs

Materials Required

MBARI PDO data (Excel), Bridge graphs (Excel)

Summary

Using Microsoft Excel, graph atmospheric and fisheries data from the Monterey Bay Aquarium Research Institute to look for evidence of the Pacific Decadal Oscillation (PDO) and its connection to fish abundance.

Objectives

- ✓ Explain the processes involved in the Pacific Decadal Oscillation (PDO).
- ✓ Graph and evaluate atmospheric and fisheries data over time to look for evidence of the PDO and its connection to fish abundance.
- ✓ Describe the relationship between warm and cold regimes of the PDO and the abundance of sardines and anchoveta.

Vocabulary

El Niño, Pacific decadal oscillation (PDO), Upwelling, Global-average Surface Air Temperature Anomalies (GSATA), Atmospheric Circulation Index (ACI), Mauna Loa CO_2

Introduction

Most everyone has at least heard of the El Niño climate phenomenon that happens once every 3 to 7 years. In "regular," non-El Niño years, warm seawater piles up in the western half of the Pacific Ocean. Scientists aren't sure exactly what causes this, though one theory is that tradewinds push the water toward the west. During El Niño years, the warm water piled up in the western Pacific flows toward the east bringing, heavy rains with it. But, recent findings indicate that El Niño may be just the tip of the iceberg of a much larger climate pattern in the Pacific.

Scientists have begun examining historical climate and oceanography data back 100 years and are finding indications of a much larger climate swing in the Pacific. This large scale cyclical climate change, called the Pacific decadal oscillation (PDO), is marked by warmer than average sea surface temperatures for 10-30 years, followed by colder than average sea surface temperatures for another 10-30 years. Because nutrient upwelling and atmospheric circulation are closely linked to

sea surface temperature, the PDO also causes changes in the Pacific's food web and affects the climate of North America.

Dr. Francisco Chavez at the Monterey Bay Aquarium Research Institute studied historic fisheries landings data and found that two fish species seem to be greatly influenced by the PDO. The South American sardine (*Sardinops sagax*) and the Peruvian anchoveta (*Engraulis ringens*) are both pelagic, plankton-feeding fish found in large schools off the coast of South America. Both have high commercial value, sardines for fish meal, bait, and human consumption, and anchoveta for fish meal and oil. The sardine, which can also be found along the coast of southern Africa, feeds on copepods and phytoplankton and lives an average of 15 years. The anchoveta, which is dependent on the Peruvian Current for its food, feeds mainly on diatoms and lives to be only 3 years old. It appears that depending on the current PDO temperature regime, anchoveta stocks are high when sardine stocks are low, and vice versa. In fact, the notorious collapse of anchoveta stocks in the 1950s that has been blamed on overfishing, could very well be due in part to a natural 50 year cycle in stock abundance. Read Dr. Chavez's full article in Science magazine.

In the following data exercise, we will use Microsoft Excel to graph Pacific atmospheric and fisheries data over time and look for evidence of the PDO and its connection to fish abundance.

Data Activity

Open the MBARI Pacific decadal oscillation and fisheries data using Excel. (Note: If you have an older browser, you need to **right click** on the link. In the drop-down menu select **Save Target As...** In the Save As window, the file name should be **mbarianchovy**. Save as type: **Microsoft Excel Worksheet**.) The data include:

1. **Year** - from 1900 to 2002
2. **Global-average Surface Air Temperature Anomalies (GSATA)** - difference between the annual air temperature and the mean air temperature over the past century (° celsius)
3. **Atmospheric Circulation Index (ACI)** - relative amount of wind blowing east-west versus north-south
4. **Mauna Loa CO_2** - atmospheric CO_2 measured at Mauna Loa, Hawaii (parts per million)
5. **Sardines** - annual landings from Peru (metric tons)
6. **Anchovy** - annual landings from Peru (metric tons)

In the first graph, we will plot the deviation from the mean for GSATA, ACI and CO_2 over time using the following step-by-step instructions:

1. Highlight cells B13 through D116. Open the Chart Wizard by going to **Insert** then **Chart**. Under the *Standard Types* tab, select **Area**. Choose the first **Chart sub-type** option. Click *Next*.
2. In Step 2 of the Chart Wizard, click on the *Series* tab. In the *Category (X) axis labels box*, click on the icon at the right end of the box and then highlight cells A14 through A116. Click on the icon at the right end of the box to get back to the Chart Wizard. Click *Next*.
3. In Step 3 of the Chart Wizard, enter titles for the chart (example: "Pacific Air Temperature, Atmospheric Circulation and CO_2 Levels"), X axis (example: "Year") and Y axis (example: "Deviation from Mean").

Under the *Legend* tab, select **Bottom** placement. Click *Next*.

4. In Step 4 of the Chart Wizard, select *As new sheet* and give it a name such as PDO graph. Click *Finish*.

Return to Sheet 1 in the spreadsheet and graph the sardine and anchovy landings.

1. Highlight cells E13 through F116. Click on the Chart Wizard icon. Under the *Standard Types* tab, select **Line** and choose the first chart sub-type. Click *Next*.
2. In Step 2 of the Chart Wizard, click on the *Series* tab. In the *Category (X) axis labels box*, click on the icon at the right end of the box and then highlight cells A14 through A116. Click on the icon at the right end of the box to get back to the Chart Wizard. Click *Next*.
3. In Step 3 of the Chart Wizard, enter titles for the chart (example: "Peruvian Sardine and Anchovy Landings"), X axis (example: "Year") and Y axis (example: "Sardine Landings (metric tons)"). Under the *Legend* tab, select **Bottom** placement. Click *Next*.
4. In Step 4 of the Chart Wizard, select *As new sheet* and give it a name such as Fisheries graph. Click *Finish*.
5. On the graph, right click on the Anchovy line and select **Format Data Series**. Under the *Axis* tab, select **Secondary** axis. Click *OK*.
6. Right click in the white background area of the page and select **Chart Options**. Under the *Titles* tab in the **Second value (Y) axis box** enter "Anchovy Landings (metric tons)". Click *OK*.

Print the graphs and compare them to the Bridge's graphs. Use your graphs to answer the following discussion questions.

Discussion Questions

- ✓ What trends if any do you see in the air temperature, atmospheric circulation, and CO_2 data?
- ✓ Can you identify the warm and cold regimes that make up the Pacific decadal oscillation? About how long do the regimes last?
- ✓ According to the graph, what regime do we seem to be in now?
- ✓ What trends do you see in the sardine and anchovy data?
- ✓ Do these trends seem to correlate with the warm and cold regimes of the PDO? Which species is more abundant during the warm regime? Which species is more abundant during the cold regime?
- ✓ How might fisheries data be used to predict climate regimes?

Related Resources

Climate, Physical oceanography, Fisheries, Fishes

References

"Tracking El Niño." NOVA Online. http://www.pbs.org/wgbh/nova/elnino/

"The Pacific Decadal Oscillation." Climate Impacts Group, Joint Institute for the Study of the Atmosphere and Ocean. http://cses.washington.edu/cig/pnwc/aboutpdo.shtml

Monterey Bay Aquarium Research Institute. http://cses.washington.edu/cig/pnwc/aboutpdo.shtml

"From sardines to anchovies and back in 50 years." Monterey Bay Aquarium Research Institute. www.mbari.org/news/news_releases/2003/nr01-chavez.html

"From Anchovies to Sardines and Back: Multidecadal Change in the Pacific Ocean." ScienceMag.org.

http://web.vims.edu/bridge/chavez.pdf?svr=www

Sources

The related podcast episode for this activity can be found by going to the podcast section of www.oceangazing.org