Erratum to Activity: Impact of Climate Change on Chinook Salmon

Under “Materials”

First bullet, correct text and URL are: “22 Years of Sea Surface Temperatures” http://www.youtube.com/watch?v=vTig9gKegQk

Impact of Climate Change on Chinook Salmon

Region: Western Coastlines

Grade Level(s): 5-8

Time Required: 2-3 class periods

Focus Question(s):

- How will long term climate changes impact northwest Pacific salmon populations?
- What is the difference between cyclical increases and decreases and long term changes in salmon populations?

Learning Objectives:

- Students will define sea surface temperature and describe how it is measured.
- Students will understand there is a correlation between sea surface temperatures and the Pacific Decadal Oscillation.
- Students will be able to graph given data for the Pacific Decadal Oscillation from 1925 to present.
- Students will be able to graph given data for spring Chinook salmon runs.
- Students will be able to make observations about the relationship between sea surface temperature, the Pacific Decadal Oscillation and salmon populations

Materials:

- American Museum of Natural History Animation on Sea Surface Temperature (http://www.amnh.org/sciencebulletins/earth/v/sst.20040401/)
- New York Times Article "Chinook Salmon Vanish Without a Trace" (http://www.nytimes.com/2008/03/17/science/earth/17salmon.html?em&ex=1205985600&en=bad6b86418eaa53b&ei=5087%0A)
- NOAA Article "Fishery Failure Declared for West Coast Salmon Fishery" (http://www.noaanews.noaa.gov/stories2008/20080501_fisheryfailure.html)
- NOAA Fisheries Pacific Decadal Oscillation (http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/ca-pdo.cfm)
- Climate Impacts on Pacific Northwest Salmon
- http://www.cses.washington.edu/cig/pnwc/pnwsalmon.shtml
-

Prerequisite Knowledge:

- Students should understand the water cycle.
- They should have a general knowledge about salmon biology and the life cycle of the salmon, including what kind of river, stream, estuary and ocean conditions are required for survival.
- Students should have a general background of what climate change is and current climate change research.
- Students should have math skills necessary for graphing, including graphing two data

sets on one graph.

Procedures/Instructional Strategies:

Activity 1:

1. Set the stage by having students read the article “Chinook Salmon Vanish Without a Trace” (New York Times 3-17-08) and/or “Fishery Failure Declared for West Coast Salmon Fishery” (NOAA 5-1-08). See section “Internet Resources Needed for Activities”.

2. Use the Western Coastlines case study to hold a discussion with the class about what the potential or actual impacts of climate change are on Chinook salmon.

3. Share background information from NOAA Fisheries and show students the animation clip (2:40 minutes) on sea surface temperature (American Museum of Natural History website) and discuss the questions provided:

Sea surface temperatures are constantly changing. These changes affect—and are influenced by—weather and climate worldwide. By studying satellite measurements of sea surface temperatures, scientists are learning to detect and predict recurring weather patterns. Provided here are questions to help guide a discussion about sea surface temperature.

- What do the Advanced Very High Resolution Radiometer (AVHRR) and Moderate Resolution Imaging Spectroradiometer (MODIS) satellite instruments measure?
- What do long term observations of the sea surface temperature reveal?
- What happens every three to seven years along the equatorial Pacific?
- What impact do these higher than normal sea surface temperatures have?
- What are some of the weather related effects of El Niño?
- What might be some economic effects of El Niño?

4. Give students background information/definition of the Pacific Decadal Oscillation (PDO) from the NOAA Fisheries Service website.

The Pacific Decadal Oscillation is a climate index based upon patterns of variation in sea surface temperature of the North Pacific from 1900 to the present (Mantua et al. 1997). While derived from sea surface temperature data, the PDO index is well correlated with many records of North Pacific and Pacific Northwest climate and ecology, including sea level pressure, winter land–surface temperature and precipitation, and stream flow. The index is also correlated with salmon landings from Alaska, Washington, Oregon, and California.

The PDO is highly correlated with sea surface temperature in the northern California Current (CC) area; thus we often speak of the PDO as being in one of two phases, a “warm phase” and a “cool phase,” according to the sign of sea surface temperature anomalies along the Pacific Coast of North America.

5. Have students construct their own PDO graphs with the data provided in the Student Handout from 1955-2005.

Activity 2:

1. Have students read and discuss "Climate Impacts on Northwest Salmon" from the Climate Impacts Group at University of Washington. One strategy is to break students into groups, and after reading have each group present the 3-4 most important points of the article to the class.

2. Be sure to address the issue of salmon runs increasing in cold PDO years and decreasing in warm years versus looking at overall long term trends. Many people look at years with increasing populations as "evidence" that there is no climate change impact on salmon, and it is important for students to develop an understanding of cycles versus long term effect/changes.

3. Provide students with the raw data on percent survival of hatchery Coho found in the student handout section, and have them construct a line graph from this data for the years1960-2004.

   Next, have students take out the PDO graphs they have already constructed and compare the two graphs. They should be able to see the relationship between warm PDO cycles=decreased salmon population, cooler PDO cycles = increased salmon runs.

4. You may want to have groups prepare their graphs on overhead transparencies so they can be laid one atop the other for a great visual comparison. You may also want to have students construct their graphs using Excel.

5. It may be helpful to add trend lines into each graph, particularly the Coho graph, which will visually show students that even though there are some years with large increases, the overall "trend" is that salmon populations are declining.

6. Finally, provide students with the answer key which ines up the graphs for PDO, Chinook salmon returns and hatchery Coho returns, and discuss observations.
7.

Outcome/Assessment:

- Students should be able to make a short 2-5 minute presentation that explains sea surface temperature, the PDO and its impact on Chinook salmon populations. Students should be able to refer to their data and graphs in justifying their explanations.

Extensions/Adaptations:

- Discuss other measures/data that may be used to investigate the effect of climate on salmon, such as stream flow data, stream temperature data, and have students research this data and present it to class. Does it give a similar picture as that of the PDO data?
- Have students research other environmental factors that impact salmon survival, such as over-fishing, logging and erosion, recreation and human development. Ask students how the addition of climate changes may impact the effects of these other factors.

- As mentioned above, graphs may be constructed individually, in groups, using large chart graph paper, overheads, or with Excel on computers.
- Activity 2 may need to be broken up into 2 days.

National Science Education Standards Addressed:

Life Science:

- The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. Given adequate biotic and abiotic resources and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.

- An organism's behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger are based in the species' evolutionary history.

Earth Science:

- Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

Physical Science:

- The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation

Additional Resources:

NOAA Sea Surface Temperature
http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/da-sea-surface-temp.cfm

General Climate Change Background for teacher and/or students from CIG/UW
http://www.cses.washington.edu/cig/pnwc/cc.shtml

Pacific Decadal Oscillation, Nathan Mantua, PhD

http://www.atmos.washington.edu/~mantua/REPORTS/PDO/PDO_egec.htm

Forecast of Salmon Returns for 2008 & 2009 from NOAA Fisheries
http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/g-forecast.cfm

Student Handout

Pacific Decadal Oscillation Raw Data (for students to graph)

YEAR	PDO	YEAR	PDO
1955	-12	1981	6
1956	-8	1982	1
1957	5	1983	13
1958	6	1984	4
1959	-1.5	1985	3
1960	0	1986	6
1961	-5	1987	13
1962	-7	1988	4
1963	-3	1989	2
1964	-6	1990	3
1965	-.5	1991	-2
1966	-1	1992	8
1967	-6	1993	13.5
1968	-1.5	1994	1
1969	-.25	1995	7
1970	-4	1996	6
1971	-7	1997	14
1972	-5.5	1998	1.25
1973	-5	1999	-5
1974	-.5	2000	-3
1975	-5	2001	-2.75
1976	1	2002	-.5
1977	2	2003	3.5
1978	.2	2004	2
1979	5	2005	4
1980	4		

Percent Survival of Oregon Hatchery Coho Salmon (data for student constructed graphs)

Year	% Coho Survival	Year	% Coho Survival
1960	0.0457	1983	0.0209
1961	0.0282	1984	0.0191
1962	0.0568	1985	0.0726
1963	0.0453	1986	0.0207
1964	0.078	1987	0.0445
1965	0.0748	1988	0.045
1966	0.0936	1989	0.0165
1967	0.0667	1990	0.0485
1968	0.0592	1991	0.0112
1969	0.0773	1992	0.0056
1970	0.093	1993	0.0051
1971	0.0474	1994	0.0042
1972	0.0425	1995	0.0059
1973	0.0797	1996	0.0062
1974	0.0403	1997	0.010
1975	0.0926	1998	0.015
1976	0.0227	1999	0.0224
1977	0.0456	2000	0.049
1978	0.0313	2001	0.032
1979	0.0311	2002	0.040
1980	0.0291	2003	0.036
1981	0.0321	2004	0.020
1982	0.0154	2005	

Answer Key for Student Graphs

Summer average PDO (top) vs. adult spring Chinook passing Bonneville Dam (middle) and survival of hatchery coho salmon (bottom), 1955–2006. Vertical lines indicate climate shift points in 1977 and 1998