CURRICULUM SUPPLEMENT

For use with the **INTRODUCTION** section of Meltdown

ACTIVITY ONE: HOW DOES THE OCEAN IMPACT YOU?

Materials:

-large political world map
-internet access to: http://stateofthecoast.noaa.gov/
-projection system to display website content

Teaching Time: 20 minutes

Preparation: 10 minutes

Teachers should review NOAA's State of the Coast website prior to using it in the classroom. This website provides a valuable resource to help students understand how the ocean and its resources impact their lives.

Background:

The NOAA State of the Coast website describes its intent as being to leave users with a "deeper appreciation of the connections among healthy coastal ecosystems, a robust U.S. economy, a safe population, and a sustainable quality of life for coastal residents".

The sea ice project detailed in this field trip aims to build our understanding of the Bering Sea ecosystem, with the same key objectives in mind.

As your class navigates the State of the Coast website they'll look at graphs, diagrams and statistics to help them quantify how and why the ocean impacts their lives (whether they live near the ocean or not)!

Directions:

1. After completing the introduction section of Meltdown, project the State of the Coast website at the front of the classroom.
2. Explain to your class that over the next several days they'll be studying the Bering Sea ecosystem in detail. The first step in this process will be gaining a better understanding of why it is important for scientists to study marine ecosystems like this one.
3. Under the Economy tab, pull up the commercial fishing page. Begin your exploration with discussion of the importance of commercial fisheries as part of our national economy. Connect this to students lives, and specific economic resources in your area.
4. Continue exploring through the site. Give students the opportunity to take choosing what to look at. Have students lead discussion interpreting the data they find on their selected page.
5. Help facilitate exploration and discussion with questions.

Conclusion:

With so much data to uncover, there is something on the State of the Coast website for everyone. Whether students find that they feel connected to the importance of the study of marine science because they are concerned for the sustainability of our commercial fisheries, the impacts of invasive species, the danger of coastal flooding, or the threat of changing climate; they are sure to learn and be inspired by this activity.

ACTIVITY TWO: PLOTTING SEA ICE DATA

Materials:

-sea ice extent data set from NSIDC (see below)
-graph paper (for each student)
-pens & pencils

Teaching Time: 45 minutes

Preparation: 10 minutes

Teachers will want to familiarize themselves with the data set and included National Snow & Ice Data Center (NSIDC) visuals.

If you're interested in exploring the subject further you may also want to look at nsidc.org

Background:

Arctic sea ice conditions change throughout the year. In winter, sea ice forms, extending south out of the Arctic into the shallow Bering Sea. The ice reaches its maximum extent in March. Summer brings warmer temperatures and nearly continuous daylight, causing sea ice to melt back into the Arctic. Arctic sea ice reaches its minimum coverage in September, which marks the start of the winter season.

Sea ice conditions also change year-to-year. Recently scientists have noticed summer sea ice coverage in the Arctic is shrinking. Researchers have been using POES (polar orbiting) satellites to monitor sea ice extent in the Arctic since 1979. Using this satellite record, the National Snow and Ice Data Center has calculated that the amount of sea ice each fall in the Arctic has decreased by more than 7% per decade over the last 30 years. Research conducted in the Arctic region points to changes in global climate as a major cause of sea ice loss.

In this activity your class will use NSIDC data to plot changes in sea ice extent since 1979. Each data point represents the mean extent of Arctic sea ice during the month of September in a particular year.

Directions:

1. Begin by introducing students to the science of studying of sea ice extent. Explain that the measure 'sea ice extent' describes how great an area of the Arctic is covered by sea ice during a particular time of the year. Since 1979 scientists have been using satellites to study Arctic ice extent, measuring and charting how it has changed over time.

2. Pass out graph paper to each student, explaining that the class will be learning how summer sea ice cover in the Arctic has been changing by plotting it's yearly minimums.

3. Display data set. Ask students to identify the two variables and what units they appear in: time (in years) and area (in 10^6 Km^2). Depending on students grade level either challenge them to describe or show them what 10^6 means- emphasize what a large area this is by comparing it to the total area of the United States 9,630,000 km^2.

4. Which variable will students put on the x-axis and which on the y-axis? What kind of change are we trying to observe with our graph?

5. Allow students time to complete their scatter-plots, adding a best fit line or connecting the dots if they prefer. Adapt this lesson for younger students by having them only use data points for years that end in 0 and 5. In addition, younger students can complete their scatter plot as a class rather than independently.

6. Ask students to write a few sentences explaining how they would describe their plot to someone who was unfamiliar with this dataset. They should include: what

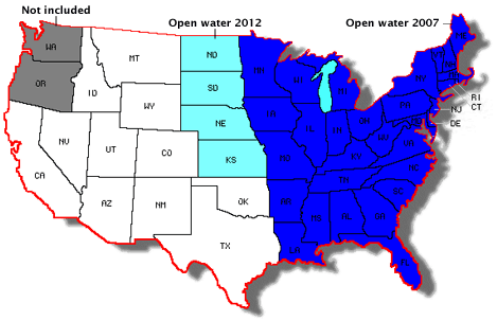
variables are being looked at, where the data came from, and what trends the display shows.

Discussion:

Have students talk in small groups about the possible consequences of changing sea ice conditions. Guide discussion with questions:

- Describe what trends appeared when you plotted your data set.
-How do you feel when you look at this data?
-What might be the consequences on the environment if the amount of Arctic sea ice continues to decline?
-What do you think would happen to the temperature of the Arctic Ocean if there were no sea ice during parts of the summer?
-What animals might be affected by less sea ice habitat?
-What positive outcomes might result from changes in sea ice extent?

Help students visualize the significance of this ice loss with the following graphic (see larger attachment at end of lesson):



Source: Walt Meier, NSIDC

The land area of the lower 48 (excluding Washington and Oregon) is about equal to the area of the Arctic Ocean covered by sea ice at the end of each melt season in the 1980's. The area in dark blue represents the unprecedented melt that took place during summer 2007, resulting in significantly less sea ice coverage in the Arctic. 2012 marked the lowest sea ice extent area on record. The amount of additional melt in 2012 is represented by both the light and dark blue state. In September 2012 when sea ice extent dropped to 3.36 million sq km it was equal in area to the white western states in the above image. For more details visit: [Earth Matters: NASA Blog]

Conclusions:

In this lesson we've explored two different ways of visualizing changes in Arctic sea ice cover. The satellite data clearly shows that summer sea ice extent is decreasing.

Less summer sea ice in the Arctic means later freeze-up in seasonally frozen areas like the Northern Bering Sea. In turn this means shorter winters and longer ice-free summers for areas like the Bering Sea

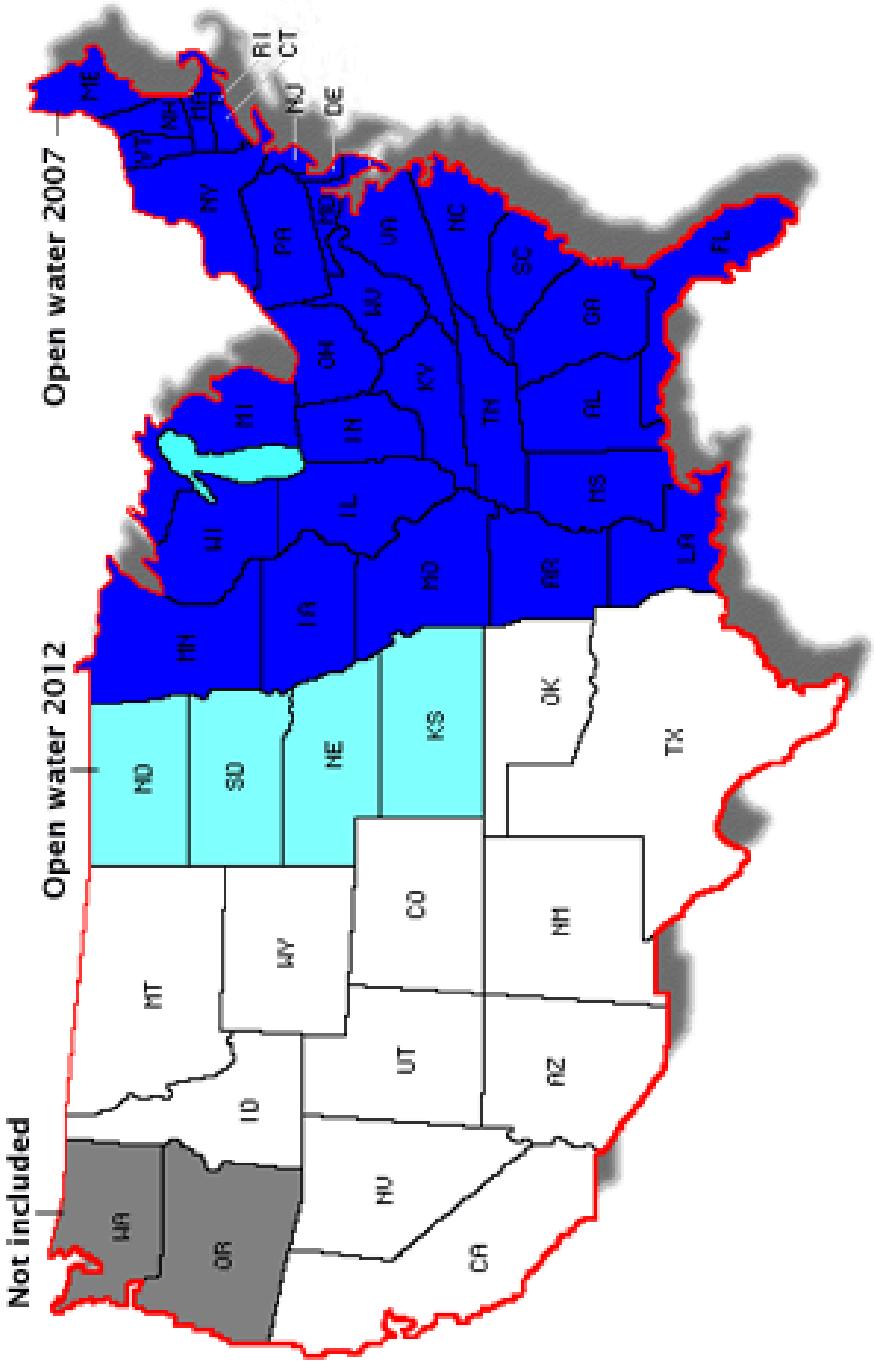
The observations students made during this activity will help them begin to understand the significance of changing sea ice conditions in the Arctic. The discussion questions are designed to help students connect sea ice with the Arctic ecosystem, recognizing that change in sea ice extent will impact species communities throughout the Arctic. Wrap-up by helping students recognize that their questions are much like the questions of researchers working on this project- *what will the changes be, and how will organisms react to these changes?*

Mean September Arctic Sea Ice Extent 1979-2014

Year	Sea Ice Extent, million km^2
1979	7.2
1980	7.85
1981	7.25
1982	7.45
1983	7.52
1984	7.11
1985	6.93
1986	7.54
1987	7.48
1988	7.49
1989	7.04
1990	6.24
1991	6.55
1992	7.55
1993	6.5
1994	7.18
1995	6.13
1996	7.88
1997	6.74
1998	6.56
1999	6.24
2000	6.32
2001	6.75
2002	5.96
2003	6.15
2004	6.05
2005	5.57
2006	5.92
2007	4.3
2008	4.73
2009	5.39
2010	4.93
2011	4.63
2012	3.63
2013	5.38
2014	5.28

Source:

Fetterer, F., K. Knowles, W. Meier, and M. Savoie. 2002, updated daily. *Sea Ice Index.* [ftp://sidads.colorado.edu/DATASETS/NOAA/G02135/Sep/N_09_area.txt]. Boulder, Colorado USA: National Snow and Ice Data Center. http://dx.doi.org/10.7265/N5QJ7F7W.



Source: Walt Meier, NSIDC
Earth Matters: NASA Blog