Name _____ Date _____

Using Data: Climate Change and the Hudson River

Melting glaciers, sea level rise, global warming—we often think of climate change as a global problem, but what will be the impacts here in the Hudson Valley? In this activity, you will use long-term data from Poughkeepsie to think about possible impacts to the Hudson River ecosystem.

Part 1: Air Temperature

Create a graph of the annual air temperature using the dataset titled "Annual Temperature Poughkeepsie Student." Then answer the questions below. The temperature data were recorded from 1889 until 2012 at a Poughkeepsie monitoring station by the United States Historical Climatology Network.

1. How has the air temperature changed over the last one hundred years?
2. Explain some possible reasons for this change.
3. Research the potential ecosystem impacts of a 1-2° Celsius change in climate. You can begin by watching short videos online at http://on.natgeo.com/12EjhdL (see links at right). Give at least three examples.
4. Based on your research, why should we be concerned about temperature changes in Poughkeepsie?

Part 2: Hudson River Temperature

Next, create a graph showing the mean water temperature, as collected from the Hudson River at Poughkeepsie. Open the dataset titled "Student Hudson River Temperature" and create a graph. Answer the following questions.

1. What has happened to the average river temperature since 1946?
2. When have the highest temperatures occurred? Based on these data, what do you predict about the future?
3. What types of life might be affected by this change?
4. Based on this graph, what can you conclude about the Hudson River?
5. How does this graph compare with the air temperature? In what way(s) are they similar? In what way(s) are they different? Why?

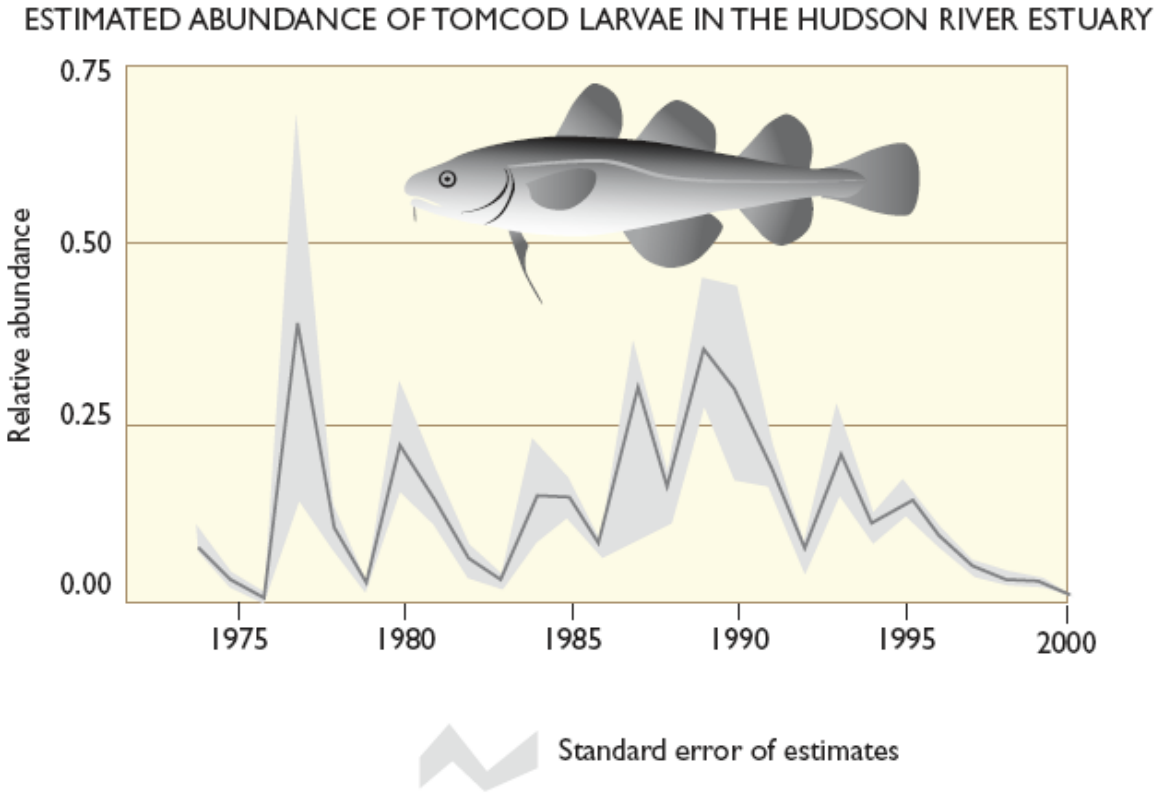
Part 3: Fish Response

ATLANTIC TOMCOD

Artwork by Jan Porinchak

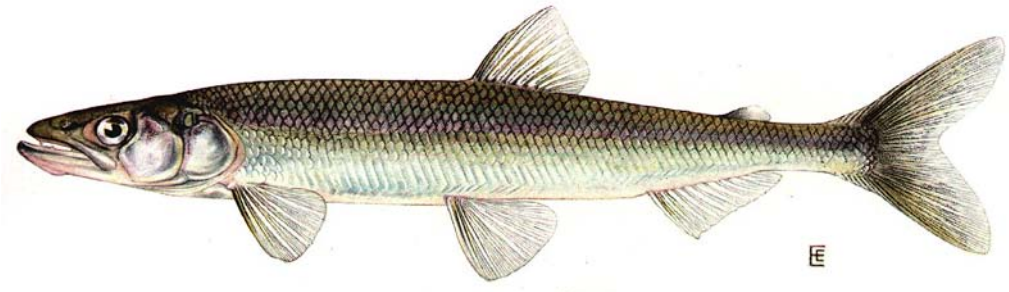
One way that scientists learn more about how climatic changes are affecting local ecosystems is by monitoring the species living at the edge of their geographic range. One such species is the Atlantic Tomcod, which, although it was once found as far south as Virginia, hasn't been seen anywhere south of the Hudson since the 1980s. It is an anadromous fish, which means that it lives in salt water, but also lives part of its life in fresh

water, in this case its breeding season. Below are some tomcod data collected from the Hudson over the last 25 years; for the full paper, see the reference at the end of the lesson. Abundance index refers to the number of tomcod in the sample. The sample was large enough to represent the fish population in the entire river.



Abundance index for juvenile Atlantic tomcod in the Hudson River from 1974 through 2000. Every year, the estuary was sampled weekly from the Battery to Albany between May and July. Recent collections in 2001-2002 showed a continuation of extremely low numbers.

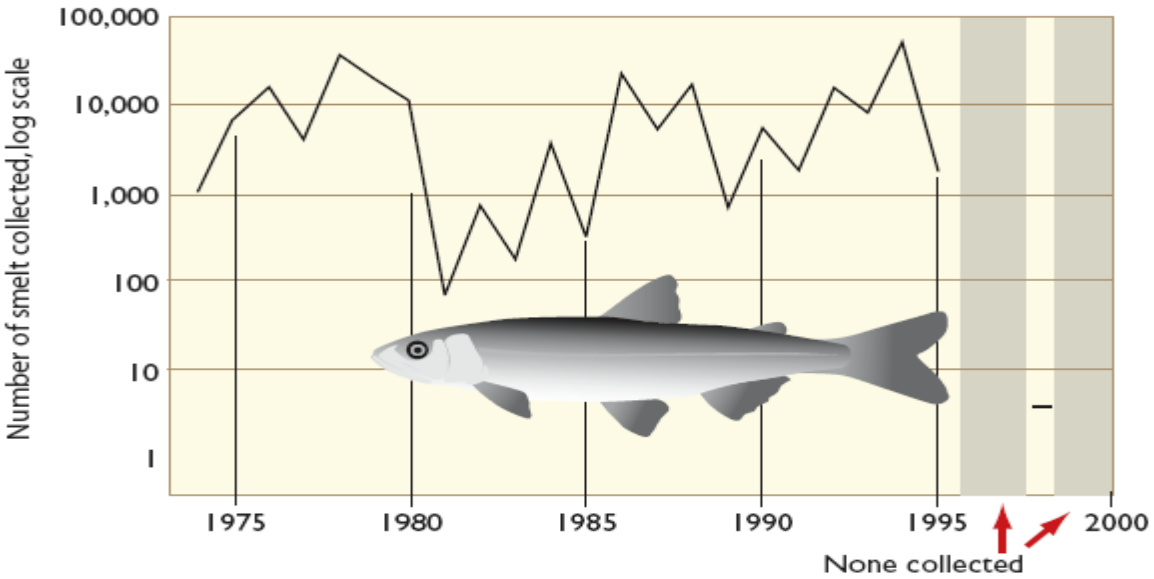
A second species, rainbow smelt, has basically disappeared from the Hudson. Rainbow smelt are also anadromous and used to be found spawning in numerous tributaries. The last time smelt were seen in a tributary of the Hudson was in 1988.



Rainbow smelt

Image courtesy of: New York State Department of Environmental Conservation

COLLECTIONS OF RAINBOW SMELT LARVAE IN THE HUDSON RIVER ESTUARY



Based on these two graphs, answer the questions below.

1. What changes have taken place in the tomcod and smelt populations in the Hudson River?
2. What types of things might impact these changes?
3. What else would you need to know before you can conclude that climate change is the main reason for the declines?
4. Based only on the data above, what can you say about the future of these two fish populations? What else would you need to know to make a better decision?

Read the following excerpts from a report by Riverkeeper, entitled "The Status of Fish Populations and the Ecology of the Hudson." This will give you a bit more information about the Atlantic tomcod and the Rainbow smelt.

> The Atlantic tomcod is an inshore species that ranges from Labrador to the Chesapeake Bay. It is anadromous, and reaches its southern spawning limit in the Hudson. Tomcod enter estuaries in mid winter to spawn in brackish water. The main spawning area in the Hudson is between West Point and Poughkeepsie. They are unusual in that their growth slows and stops as the water temperature rises.
>
> The fate of tomcod may be related to river water temperature. The tomcod is a small, short-lived member of the cod family. Because it is at the southern extremity of its geographical range within the Hudson estuary, sensitivity to climatic factors, particularly temperature would be anticipated.

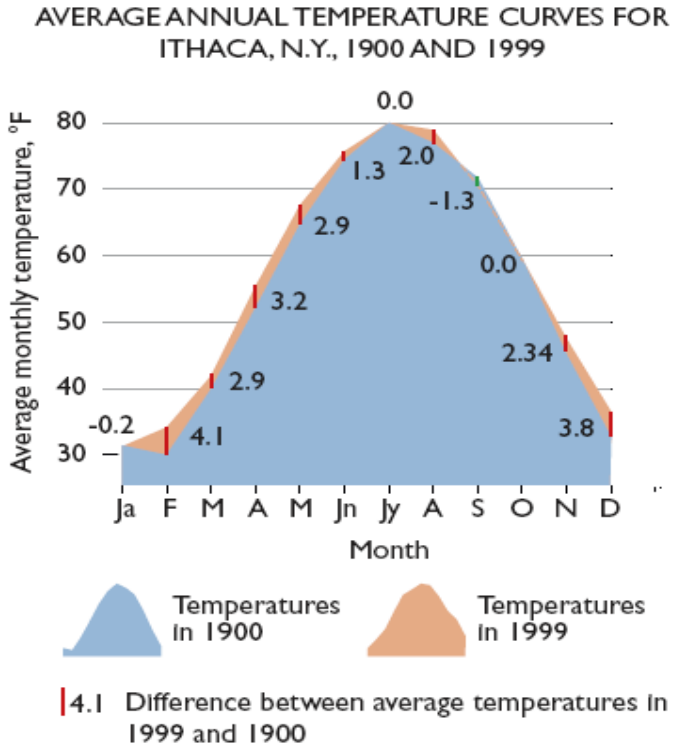
The rainbow smelt is a salmon-like fish which is found from the northern part of the western Atlantic and in many naturally land-locked populations. They can spend most of the year within estuaries. The rainbow smelt spawns in the lower reaches of tributaries at night. They mature at 1 to 5 years old. Historically, juvenile fish were found in mid-June to August in the middle and lower estuary.

Juvenile rainbow smelt have disappeared from the survey since the mid 1990s (Figure 30). This may to be due to a change in their distribution, possibly due to the invasion of zebra mussels, which occurred from 1992 onward (Strayer, 2004). However, as shown in Table 1, rainbow smelt has one of the lowest upper temperature tolerances of Hudson fish. It is therefore possible that the species has declined because of rising water temperatures.

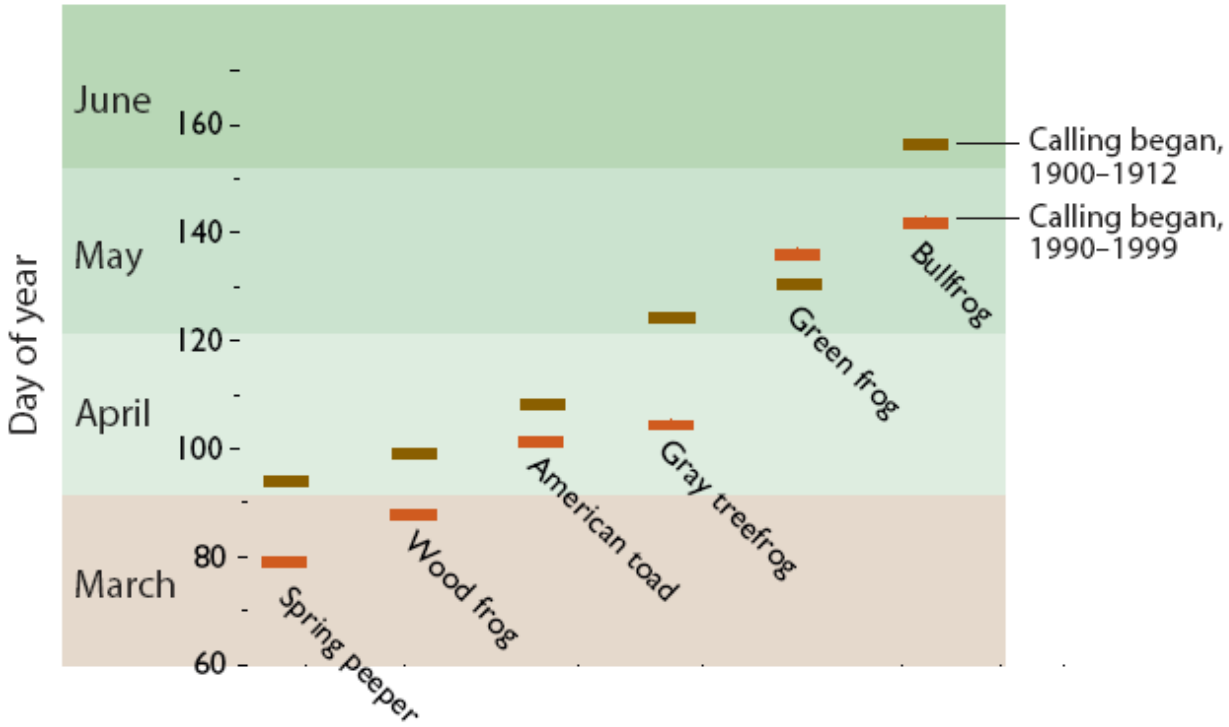
5. What do the two fish species have in common?
6. Based on this report, what do you think is the main cause of the decline of the two fish species? Where do you think the tomcod and smelt have gone?
7. Are you convinced that temperature is the main reason for these fish declines? What else would you like to know before making a conclusive decision?

Part 4: Amphibian Response

Finally, take a look at the following data collected near Ithaca, New York, compiled by James Gibbs and Alvin Breisch



CHANGES IN AVERAGE DATES WHEN FROGS BEGIN CALLING NEAR ITHACA, N.Y.



"Anurans" is the name of the taxonomic family that includes frogs and toads. Researchers James Gibbs and Alvin Breisch looked at six species, synthesizing information from three different studies to compare 'first-calling dates' from 1900-1912 and 1990-1999. First calling dates are often used to monitor amphibians, because it is easier to hear them than to see them; and, after they start calling, they start breeding. Therefore, calling tells us that reproduction is occurring.

1. Look at the information in the temperature graph. What are the main differences between the temperatures in 1900 and 1999? How much of a difference is there?
2. There are six different anurans shown on the graph. Which species started calling earlier in the 1990-1999 time frame when compared to 1900-1912, and which started calling later? Which species had the largest difference?
3. Based on this information, what is taking place in the wetlands near Ithaca, New York? Why do you think this is happening? How is this related to temperature change? Do you feel confident about your statement? What other information would you like to know?
4. How do you think earlier calling (and therefore breeding) may impact the anuran populations? Will it change what they eat? Where they live? etc
5. What other types of species could be affected by changing temperatures?
6. What do you think should be done to combat the rising temperatures?

References:

Daniels, R.A., K.E. Limburg, R.E. Schmidt, D.L. Strayer, and R.C. Chambers. 2005. Changes in Fish Assemblages in the Tidal Hudson River, New York. *American Fisheries Society Symposium*, 45:471-503.

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