Teacher Notes

Learning Standards addressed:
Science and Technology
Science as Inquiry
Life science

Learning objectives for students:

The primary objective of this exercise is to expose students to the variety of ways in which scientists use **remote sensing** and how these uses relate to everyday life. Additionally students will learn about zooplankton and fish, two important groups of organisms in both aquatic and marine environments. Lastly, students will be conducting original research that is relatively open-ended. They will be giving a few starting principles, but there are no truly right or wrong answers to the questions posed.

Freely available remote sensing data will be used as a means to teach students about the seasonal variability of water temperature and its potential influence on the distribution and abundance of organisms. The remote sensing data used will consist of maps of Lake Ontario and portions of the Atlantic Ocean that show the temperature of the water surface. The National Oceanic and Atmospheric Agency created these maps from photographs taken by their satellites called NOAA 14 and 15 Polar Operational Environmental Satellites (POES). These satellites orbit the earth at a height of about 833 km. The original source data consisted of a photograph taken by an Advanced Very High Resolution Radiometer (AVHRR), which is a 5-channel instrument that uses each channel to photograph reflected energy in different wavelengths. NOAA scientists combine values from several channels to produce maps of **S**ea **S**urface **T**emperature (SST, see Figures 1-3).

These data provide means to observe vegetation, clouds, lakes, shorelines, snow, aerosols and ice. In the case of this exercise, we will use only data analyzed for the purpose of determining temperature. Temperature has an important influence on all living things, and can be used to predict zooplankton density (David Warner, Cornell University Biological Field Station unpublished data) and even fish abundance. The first principal we must consider for this exercise is that most animals have a preferred temperature range. This is certainly true for fish and also for zooplankton. Students will use temperature ranges for lake trout and alewives to predict where they are likely to be found on different dates in Lake Ontario. Similarly, they will use their knowledge of temperature-zooplankton relations (Figure 4) to estimate areas of high and low zooplankton density, and how this may influence the abundance of alewives.

The same approach will be applied to bluefin tuna, a very important (and probably familiar) species. Students will use the known preferred temperature range for this fish in conjunction with global SST maps (Figure 5) from the Space Science and Engineering Center at the University of Wisconsin (web site below).

Materials and Equipment:

This exercise requires access to an internet-connected computer with basic image viewing software and a color printer. If the teacher is interested in having students use the maps/images in this exercise to examine the concept of map scale, rulers will be required as well. Students will also need access to information about temperature preferences of fish and zooplankton (provided).

Sites of interest:
http://www.scifish.com/~george/esipsst.html

http://www.ssec.wisc.edu/data/sst.html

Interactive research ideas:
Once familiar with the concepts, students could use these techniques to help look for patterns in temperature distribution in Lake Ontario or other Great Lakes.

Remote Sensing, Fish and Zooplankton

Student Background

        As you know from studying Whitney Point Reservoir and from your lab experiment with fish, temperature can affect most living things. Most living things have a preferred temperature range because of their individual **physiology**. This is because the chemical reactions that happen during every second of life work best at certain temperatures. These temperatures vary from creature to creature because of the different **enzymes** used in the reactions (like digestion of food).

        You have all ready seen some different types of remote sensing in class, and now you are probably wondering what temperatures have to do with remote sensing. Well, because of physiology it is possible to use temperature to predict where you will find different organisms like fish and zooplankton. For some zooplankton (**copepods**, remember them?), you can even use temperature to tell how many of them are present. To examine this idea, go to the first web site listed below and check the remote sensing section. Click on the link for Figure 1 and for Figure 2. Print both Figures on the color printer.

Mr. Warner's website about remote sensing
http://www.people.cornell.edu/pages/dmw33/remsens.htm

Now you should go to the following web pages and print each one on the color printer (one copy for each group).

Lake Ontario Sea Surface Temperature Maps
May 9th 2001
http://superior.ceegs.ohio-state.edu/NOWCAST/ontario/01/s0112912.gif

August 31st 2001
http://superior.ceegs.ohio-state.edu/NOWCAST/ontario/01/s0124312.gif

October 26th 2001
http://superior.ceegs.ohio-state.edu/NOWCAST/ontario/01/s0129912.gif

Worldwide Sea Surface Temperature Map
http://www.ssec.wisc.edu/data/sst/latest_sst.gif

Using the maps you have, the handout about alewives, and the information provided in the tables below come up with 1 or more hypotheses related to fish or zooplankton distribution that YOU THINK would help you as a scientist locate a species or creature in Lake Ontario or the world's oceans.

Example hypothesis: Sea surface temperature in Lake Ontario varies with the seasons.

Hypothesis 1

Hypothesis 2

Hypothesis 3

If you come up with 3 hypotheses, then try to answer the questions below.

1. Locate the spots on each map of Lake Ontario where you would expect to find lake trout (use a square as a mark), King salmon (circle), and alewives (use an X).
2. Does the amount of suitable surface water temperature for each species change over the summer?
3. Do the different species have much overlap?
4. Locate the spots within the Atlantic Ocean where you would expect to find albacore tuna (use a triangle as a marker). You will need to use the World Sea Surface temperature map and the temperature converter web site below.
5. What is the primary food of the alewife?

6. Does the preferred temperature of the alewife overlap with the best temperature for its food?

Calculator to convert degrees Fahrenheit to Celsius
http://students.washington.edu/kyle/temp.html

Sites about albacore tuna
http://www.wfoa-tuna.org/
http://www.worldwaters.com/retail/common/currents/species/albacore.asp
Preferred temperatures for locally and internationally important fish.

Species	Temperature range (degrees Celsius)	
Lake trout	4-10	
Alewife	11-19 (adult)	17-19 (young)
King salmon	11-12	
Albacore tuna	14-20 (adults)	16-18 (young)

Lake trout and King salmon are economically important because a great deal of money is spent each year by fisherman trying to catch them. In some cases whole towns near Lake Ontario depend on the money spent by fisherman. Alewives are economically important because they are the main food for lake trout and King salmon. Albacore tuna are only found in the oceans, but they are important because they are the tuna you find in the little round cans at the grocery store.

Copepod densities at different temperatures in Lake Ontario

Temperature	Density (number per liter)
2	0.6
4	2.1
6	4.4
8	7.5
10	11.2
12	15.5
14	20.6
16	26.2
18	32.4
20	39.3