NEW YORK STATE OF OPPORTUNITY | Hudson River Estuary Program
A Program of the New York State Department of Environmental Conservation

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

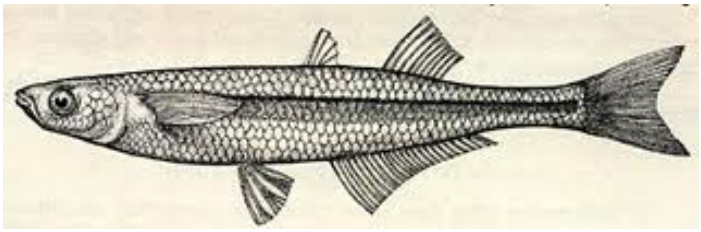
Teaching with data: Engaging students with 'Day in the Life' data can be an excellent way of using data to accomplish several goals such as: (1) Reinforce concepts the students might already be aware of, such as that different fish have different salinity tolerances; (2) Introduce a concept students might not be as familiar with, for example that the salinity can vary significantly spatially and temporally in the estuary; and (3) Generate a discussion on the role of models in science.

Testing the Salt Front Model

Background: The location of the **salt front** - the leading edge of seawater in the estuary - is defined as the area in the river where chloride concentration reaches 100 parts per million [ppm]. The U.S. Geological Survey [USGS] model for locating the salt front in the Hudson River is based on measurements from gages at Piermont, West Point, and Poughkeepsie. This activity explores two questions: *In the absence of technical models, what biological indicators of the salt front might we rely on? And How do 'Day in the Life' student-collected data compare to USGS model results?*

One potential biological indicator is the presence or absence of certain fish species. The **spottail shiner** is a small freshwater fish commonly found near or north of the Hudson's salt front. The **Atlantic silverside** prefers saltier water south of the salt front. In fact, the silverside's range seems to shift north and south, matching the salt front's movements. **Do the data confirm this?**


spottail shiner


Atlantic silverside

Activity: The Day in the Life salinity and fish catch data sheets for 2008, 2009, and 2010 show actual data that students collected each year. Real data can be tricky to work with and may require you to make decisions. At times a single data point may occur that is not representative of the full set of data. Not every group measures all the parameters, and not every parameter is measured with the same method, or recorded in the same units.

1. Use the data sheets to complete the charts for each year shown below. Indicate the northernmost site where silversides were caught, and the southernmost site where spottails were netted.
2. Next, use the site participant sheet, and enter the name and River Mile [RM] of the site where the salinity reading was **closest to 100 ppm chloride [Cl^-].** This might involve selecting a range or section in the river if the data does not clearly point to one location. *(Note that Hudson RMs are measured north from the Battery at the tip of Manhattan.)*
3. On the accompanying Hudson River map, label the locations entered in the charts below using the appropriate RM. The map is already marked every five RMs.

2008	Site	RM	Notes
Northernmost Silversides	Verplanck	41	
Southernmost Spottails	West Point	52.5	
Salinity reading closest to 100ppm	Cornwall	57	Salinity: 81 pm
Salt front location according to USGS	Just north of Newburgh	63.4	

2009	Site	RM	Notes
Northernmost Silversides	Verplanck	41	
Southernmost Spottails	Garrison	53	
Salinity reading closest to 100ppm	Students may select: Cornwall OR the range from Cornwall to south of Garrison	57-53	**Salinity: 68 ppm OR the Range 68-62 ppm**
Salt front location according to USGS	Newburgh	60.3	

2010	Site	RM	Notes
Northernmost Silversides	Nyack	31	Students may select RM 53 assuming RM 31 is an error – either answer is acceptable
Southernmost Spottails	Ossining	32	
Salinity reading closest to 100ppm	Verplanck	41-39.5	Salinity: 55 ppm OR somewhere between 55 and 248 ppm
Salt front location according to USGS	Haverstraw Bay	36	

4. Assuming that silversides and spottails have ranges that meet near the salt front, compare the student collected field data and the USGS model results with the biological indicators. How do the three sets of data match up? You may want to plot the data on the map.

The Student collected data and the modeled USGS salt front data aligns fairly closely. Recall that the student data does not actually capture the section of the river where the salt is 100 ppm Cl- since we had no sampling group where the actual salt front was, so the salt front RM would vary slightly from what you recorded on your chart, perhaps making the match up even more striking. If students look at the yearly fish catch data sheets the annual match up of the Silversides and Spottails with the salt front is striking in comparison with other fish caught in a distinctly saltwater or freshwater section of the river.

Discussion Questions:

5. What does the movement of the salt front mean for fish species like spottail shiners and silversides?

Fish that can tolerate being near to the salt front but not crossing over the 'salt barrier' must be mobile in their range, moving with both the tides and freshwater input to the system. In a dynamic system like the Hudson River where the salt front can move quickly and over quite a distance this can mean that less tolerant fish tend to stay further from the salt front. Students can look at the fish catch data sheets to see examples of fish that are marine or freshwater obligates.

6. What is the value of comparing field measurements with models?

Field measurements are an important way to validate and to calibrate models, checking that they are actually working as intended to measure the functioning of a real Earth system. Models are built from data and so adding new data to 'fine tune' and update models is key.

(Note to teachers: The value of this comparison for the students is to show them that the models do relate to the actual measurements made in the river, and to confirm that student collected data can be compared against more sophisticated technology.)

7. What suggestions would you have for improving the USGS model?

Adding additional gaging stations in the mid Hudson region, where the salt front is primarily located, would provide additional data to improve the model.

8. Consider what you know about the Earth System. What are some of the many factors that affect the salt front?

There are several answers that can be provided. The tidal currents, weather including extremely dry weather and rain and the associated runoff would be the main items to consider.

A FEW MORE TEACHER NOTES:

Weather has a strong affect on the salt front, and a confounding factor for modeling. You and your students may enjoy learning more about the phenomenon of "blowout tides" that happened with the 2009 Day in the Life event:
http://www.ldeo.columbia.edu/edu/k12/snapshotday/activities/2009/HRECOS_DAY_LIFE_2009.pdf