Finding the Salt Front

Students will use Hudson River salinity data to create a line graph that shows the location of the salt front, and use math skills to explore how this location varies over time.

Objectives: Students will use data from tables to:

- graph salinity data from sites along the Hudson River estuary;
- observe patterns of change in salinity along the estuary;
- use the graph to estimate the location of the salt front;
- compare the location of the salt front in different years.

Grade level: Elementary (Grades 4-7)

Subject Area: Math, Science

Standards: Mathematics, Science, & Technology Standards 3, 4

Skills:

- Use graphs to see patterns and relationships observed in the physical environment.
- Use whole numbers to identify locations and measure distances.
- Add and subtract whole numbers.

Duration:
Preparation time: 5 minutes
Activity time: 50 minutes for each of two sections

Materials: Each student should have:

- ☐ Worksheet: Finding the Salt Front – Section 1
- ☐ Worksheet: Finding the Salt Front – Section 2
- ☐ Regular pencil
- ☐ Two colored pencils of different hues
- ☐ Ruler
- ☐ Hudson River Miles map (helpful but not required)

Background:
Tidal from New York Harbor to Troy, the lower Hudson River is an estuary where fresh water and salty seawater meet. Fresh water dilutes the seawater entering the Hudson; its leading edge, called the salt front, is where the concentration of chlorides (sodium chloride—table salt—is an example) reaches 100 milligrams per liter (mg/L). Low concentrations of salt (20-50 mg/L) are found in fresh water north of the salt front, due to erosion and human activity.

Salinity greatly influences where the estuary's animals and plants are found. Some live only in fresh water, others only in salt. A few, like the blue crab, can survive in fresh or salt water.

The salt front's position depends on runoff from the watershed, which varies with seasonal climate patterns and weather events. Scientists give its location using Hudson River Miles. Hudson River Mile (HRM) 0 is at the Battery at the southern tip of Manhattan. The estuary part of the Hudson ends at the Federal Dam in Troy at HRM 153.

Activity:
1. Review the terms estuary, salinity, and salt front, and ask how salinity might influence where animals and plants live.
2. Explain Hudson River Miles and how upriver and downriver relate to north and south.
3. Do section 1 of worksheet in class; assign section 2 as homework.
4. Follow up with ***Which Fish Where?*** lesson on how salinity influences fish distribution.

Assessment:
- Have students share answers to questions from worksheets, or collect and grade sheets.
- Make up similar problems for quiz. Have students define the salt front in their own words.

Vocabulary:
chloride: a compound of chlorine with another element, especially a salt
concentration: the amount of an ingredient in a given volume of liquid or other substance
estuary: a body of water in which fresh and salt water meet
fresh water: water that is not salty
Hudson River Miles: distance north from the Battery at Manhattan's southern tip
salinity: saltiness of a solution
salt front: the leading edge of seawater entering an estuary
salt water: seawater or other water that contains salt
seawater: water from the ocean
sodium chloride: common table salt
upriver: towards a stream's source

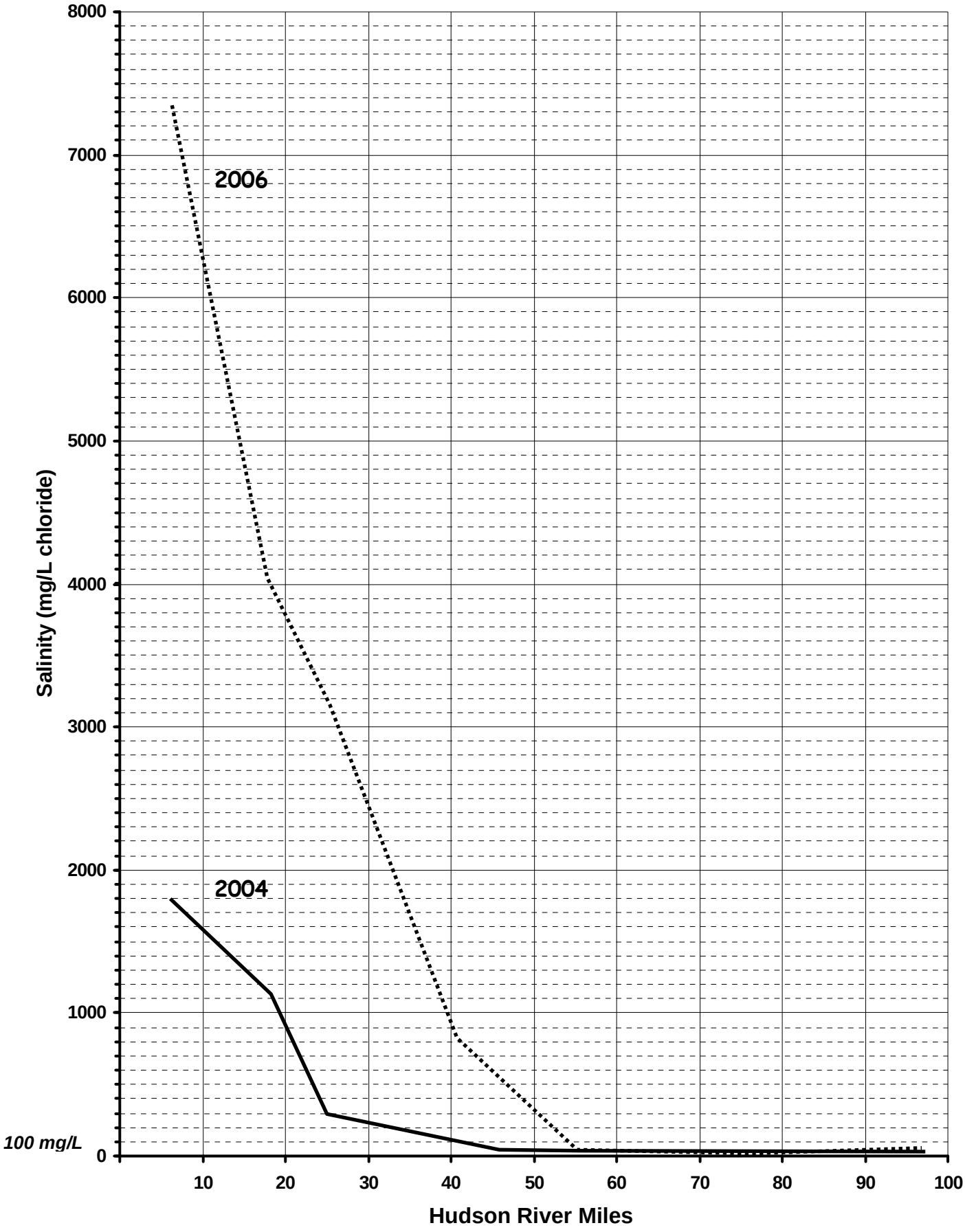
Resources:
http://ny.water.usgs.gov/projects/dialer_plots/saltfront.html The U.S. Geological Survey Hudson River Salt Front website has tables of historical data showing the salt front's location over time. The site also displays real-time data for Poughkeepsie and Albany.

The Hudson River Environmental Conditions Observing System [HRECOS] measures salinity and other water quality and weather parameters at sites from New York City to Albany and

uploads this data to the web at www.hrecos.org. On the HRECOS website, click on the Current Conditions page to access this information. Dropdown menus allow users to select a station and parameter, choose units of measurement, plot continous readings (usually generated every 15 minutes) or daily averages, and specify start and end dates. One can also compare parameters by plotting two on one graph.

On DEC's annual Day in the Life of the Hudson River (a.k.a. Snapshot Day), thousands of students and teachers collect data at field sites from New York Harbor north to Albany and beyond. Their results are posted on at www.ldeo.columbia.edu/edu/k12/snapshotday/. It supplied the salinity data used here, but note that salinity is measured in various ways, and some data had to be converted to equivalent mg/L of chloride.

Teachers's Key - Hudson River Salt Front Location



Finding the Salt Front – ANSWER KEY

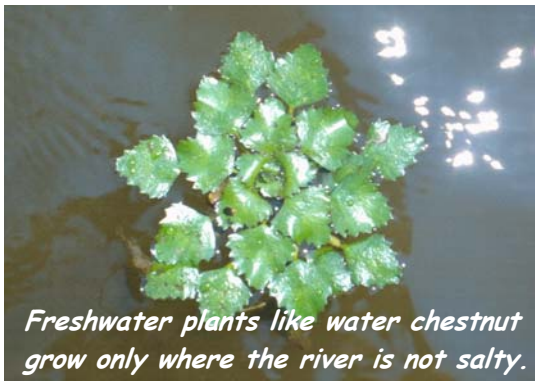
Finding the Salt Front - Section 1

The lower portion of the Hudson River is an **estuary**. Here **fresh water** flowing down the river meets **salt water** pushing in from the Atlantic Ocean. The leading edge of **seawater** entering the estuary is called the **salt front**. Its location influences where animals and plants live in the Hudson.

Saltiness in water is called **salinity**. Most of the salt in seawater is **sodium chloride**, the same compound as table salt. Measuring the amount of **chloride** in the water—its concentration—is one way to measure salinity. This concentration is given in units of milligrams per liter (mg/L), which is the weight of chloride in a set volume—one liter—of water.

In the Hudson, the salt front is where the chloride concentration reaches 100 mg/L. That's very weak compared to full-strength seawater, which has roughly 19,000 mg/L of chloride. But it is higher than the salinity of fresh water further **upriver**, which is 20-50 mg/L.

The salt front's location is given in **Hudson River Miles** (abbreviated HRM). Hudson River Miles start at Manhattan's southern tip. This spot, called the Battery, is HRM 0. Going north, Yonkers is at HRM 18, Poughkeepsie at HRM 75.



Freshwater plants like water chestnut grow only where the river is not salty.

The salt front moves with the tides, weather, and seasons. For example, heavy rain increases the flow of fresh water into the estuary, pushing the salt front towards the sea. Cities and towns that take drinking water from the river track the salt front carefully. Sodium chloride might make their water taste funny, and can be a problem for people on low-salt diets.

Salt can be a problem for communities that get drinking water from the river.

Saltwater fish like flounder move up and down the river with the salt front.

Hudson River Estuary

Directions: Use one of the colored pencils to plot salinity from Table 1 on the graph labeled "Hudson River Salt Front Location."
1. Carefully draw a point showing each salinity measurement directly above the river mile where the measurement was made.
2. Then use a ruler to draw a line from one point to the next. Start at the point for the lowest river mile, and work your way up to the highest.
3. Finally, use the table and graph to answer the questions below.

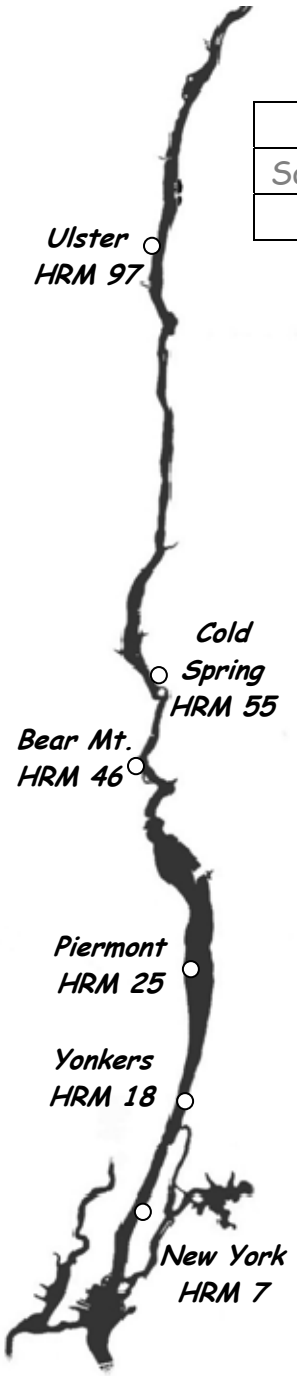


Table 1. Hudson River Salinity: October 6, 2004

Measured as mg/L of chloride; HRM = Hudson River Mile

City	New York	Yonkers	Piermont	Bear Mt.	Cold Spring	Ulster
Salinity (mg/L Cl^-)	1,805	1,162	300	50	47	34
HRM	7	18	25	46	55	97

1. Where (city & HRM) was salinity highest? _***New York***_ HRM_***7***_

2. Where was it lowest? __***Ulster***__ HRM_***97***_

3. Look at the graphed line between each pair of locations below.

   HRM 7 to HRM 46 HRM 25 to HRM 55 HRM 46 to HRM 97

   (a) Between which two locations is the graph steepest? ***HRM 7 to HRM 46***

   (b) What is the change in salinity between these two locations? (subtract the lower salinity from the higher) ***1,805 - 50 = 1,755***

   (c) Between which two places is the graph flattest? ***HRM 46 to HRM 97***

   (d) What is the change in salinity between these two places? (subtract the lower salinity from the higher) ***50 – 34 = 16***

4. Between which two towns did salinity fall below 100 mg/L?

   ___***Piermont***__ ____***Bear Mt.*** ___

5. The salt front is located where salinity equals 100 mg/L. Using your graph and the horizontal line at 100 mg/L, estimate (in river miles) the position of the salt front on October 6, 2004. ~ HRM_***42***_

6. Challenge: Why does salinity decrease between HRM 7 and HRM 46?

   Incoming salt water is diluted by fresh water.

Hudson River Estuary

Name _____ Date_____

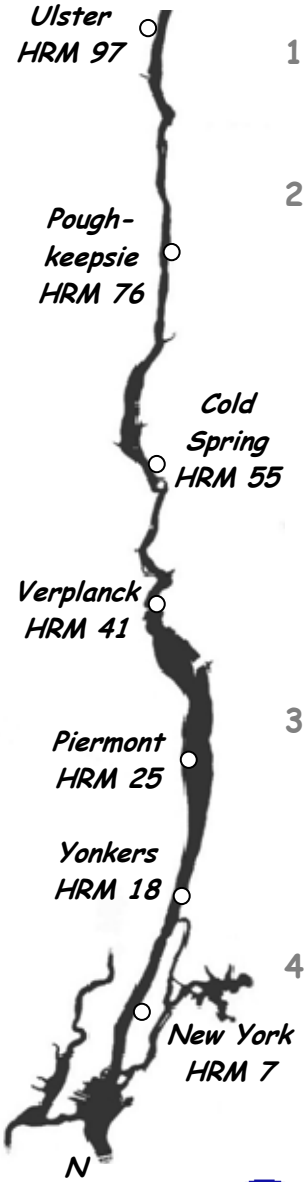
Finding the Salt Front - Section 2

Directions: On the same graph sheet used in section 1, use the other colored pencil to plot salinity from Table 2. Follow the same steps as in section 1. Then answer the questions below.

Table 2. Hudson River Salinity: October 12, 2006

Measured as mg/L of chloride; HRM = Hudson River Mile

City	New York	Yonkers	Piermont	Verplanck	Cold Spring	Poughkeepsie	Ulster
Salinity (mg/L Cl-)	7,362	4,041	3,177	830	50	30	64
HRM	7	18	25	41	55	76	97



1. Was salinity at Yonkers in 2006 higher or lower than salinity there in 2004? How much higher or lower? ***Higher in 2006 by 2,879***

2. Look at the graphed line between each set of locations listed below.

   HRM 7 to HRM 55 HRM 41 to HRM 76 HRM 55 to HRM 97

   (a) Between which two locations is the graph steepest? ***HRM 7 to HRM 55***

   (b) What is the difference in salinity between the two locations? (subtract the lower salinity from the higher) ***7,362 – 50 = 7,312***

   (c) Between which two places is the graph flattest? ***HRM 55 to HRM 97***

   (d) What is the difference in salinity between the two? (subtract the lower salinity from the higher) ***64 – 50 = 14***

3. (a) Where was the salt front on October 12, 2006? ~ HRM_***54***__

   (b) Was it north or south of its October 6, 2004 location? _***north***_

   (c) By how many miles? ____***12***____

4. What might have caused the salt front to be in a different location in 2006? ***Coming into October, 2006 was not as rainy as 2004, so the salt front was further upriver in 2006.***

Hudson River Estuary