On the Trail of the Hudson's Migratory Fish

Students will practice addition and subtraction skills by tracking the movements of migratory fish of the Hudson River estuary.

Objectives: Students will solve word problems that require them to:

- add and subtract using data from tagged fish to calculate distance traveled, elapsed time, and growth;
- understand the life cycle of anadromous fish.

Grade level: Elementary (Grades 3-5)

Subject Area: Math, Social Studies (Geography), Science

New York State Learning Standards:

Mathematics, Science, & Technology Standards 3, 4
Social Studies Standard 3

Skills:

- Use whole numbers to identify locations and measure distances.
- Add and subtract whole numbers.
- Apply mathematics in real world settings.
- Reason mathematically.

Duration:

Preparation time: 5 minutes
Activity time: 45 minutes

Materials: Each student should have:

- ☐ Worksheet: On the Trail of the Hudson's Migratory Fish
- ☐ Calendar (to determine number of days in each month)
- ☐ Hudson River Miles map
- ☐ Pencil
- ☐ If available, a wall map showing the Hudson and the eastern coast of North America is very helpful for in-class discussion.

Note: "Growing Up as a Striped Bass" from our collection of lessons for Kindergarten through Third Grade relates the size of fish at different ages to the size and age of young students. Find it at http://www.dec.ny.gov/education/77601.html.

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Background:
Scientists attach numbered tags to fish to track their travels and growth. Anglers who catch tagged fish contact the scientists using information on the tags. The data they provide can be used to determine how far and how fast fish travel and how quickly they grow.

Striped bass, Atlantic sturgeon, and American shad are born in the freshwater part of the Hudson but eventually swim out into the Atlantic Ocean. They spend most of their adult lives at sea, returning to the river only to spawn (lay eggs). We think of them as "our" fish, but their visit here is just one piece of their long-distance migrations. Fishes with this life cycle (living in the ocean but entering fresh water to spawn) are called anadromous fishes.

Distances on the Hudson are often measured in Hudson River Miles. Hudson River Miles start at the southern tip of Manhattan. This spot, called The Battery, is River Mile 0. The estuary part of the Hudson ends at the Federal Dam in Troy at River Mile 153.

Activity:
1. In preparation for this lesson, have students do the Readings in Hudson River Natural History lesson titled "Atlantic Sturgeon of the Hudson River."
2. Discuss the concept of migration and the anadromous life cycle of many Hudson River fish.
3. Introduce the Hudson River Miles system; show students the Hudson River Miles map.
4. Go over the worksheet with the class or hand out as an in-class or homework assignment.
5. Some questions require students to add distance between a point upriver and New York to distance between New York and another site along the coast. A U.S. map is helpful here.

Assessment:
- Have students share answers to questions from worksheets, or collect and grade sheets.
- Make up similar elapsed time/distance/growth problems for quiz.
- Extension: Have students cut out two small paper tags of different colors to represent fish – one for when it was tagged, the other for when it was recaptured. Paste each to the Hudson River Miles map or map of the Atlantic Coast in the appropriate spot.

Vocabulary:
anadromous: lives in salt water but migrates back to freshwater to spawn
angler: a person who fishes with hook and line
data: pieces of information
fresh water: water that is not salty (rainwater is freshwater)
Hudson River miles: distance measured north from the Battery at Manhattan's southern tip
migration: animals' movement from one place to another
recapture: to capture again
scientist: a person skilled in science
sonic tag: tags that, when attached to fish, send signals heard by underwater microphones
spawn: to lay eggs; usually refers to animals that live in water

Resources:
The Hudson River Foundation's striped bass tagging program posts results at http://www.hudsonriver.org/sb/ Illustrations and information about the fish described in this activity can be found on the New York State Department of Environmental Conservation website at http://www.dec.ny.gov/animals/269.html

On the Trail of the Hudson's Migratory Fish

Many Hudson River fish are **anadromous**. This means that they are born in **fresh water**, travel to the ocean to grow up, and then return to the Hudson to **spawn** (lay their eggs).

Scientists attach numbered tags to fish to study **migration** and growth. When a tagged fish is caught, the lucky **angler** uses an address or phone number on the tag to report where and when the fish was caught and how big it was.

You will use real scientific **data** from tagged fish to find out how far fish travel and how much they grow. Show your work as you answer the questions below.

The tag on this striped bass is a thin plastic strip. It is inserted through the skin, much like the way people get body piercings.

The tagged fish is then released back into the water.

1. Striped bass #388381 was 16 inches long when tagged near the Statue of Liberty in November 1996. When caught near Seaside Park, New Jersey, in November 2001 it was 26 inches long.

(a) How many years had gone by since this bass was tagged? ***_5 years_***

2001
- 1996
5 years

(b) How much had it grown from 1996 to 2001? ***_10 inches_***

26
- 16
10 inches

2. Striped bass #289667 was tagged on September 16, 1992, at Danskammer Point on the Hudson, 67 miles north of the Battery in Manhattan. This fish was **recaptured** near the Statue of Liberty, 2 miles south of the Battery, on September 27, 1992.

(a) How many miles had it traveled since September 16? ***_69 miles_***

67 − 0 = 67 miles

67 + 2 = 69 miles

(b) How many days did it take the bass to travel from Danskammer Point to the Statue of Liberty? ***_11 days_***

27 − 16 = 11 days

3. Striped bass #32057 was tagged on May 31, 1989 on the Hudson near Kingston, 90 miles north of New York City. It was caught on September 30, 1989 off Nova Scotia, Canada, 850 miles northeast of New York City.

(a) How many miles had the bass swum since being tagged? ***_940 miles_***

90 − 0 = 90 miles

90 + 850 = 940 miles

(b) How many months had gone by? ***_4 months_***

9 − 5 = 4 months

4. American shad #12640 was tagged on April 9, 2001, near Cape May, New Jersey, 161 miles south of New York City. It was caught on May 6, 2001, in the Hudson near Selkirk, at **Hudson River Mile** 136.

(a) How many miles had it traveled since April 9? ***_297 miles_***

136 − 0 = 136 miles

161 + 136 = 297 miles

(b) How many days had gone by? ***_27 days_***

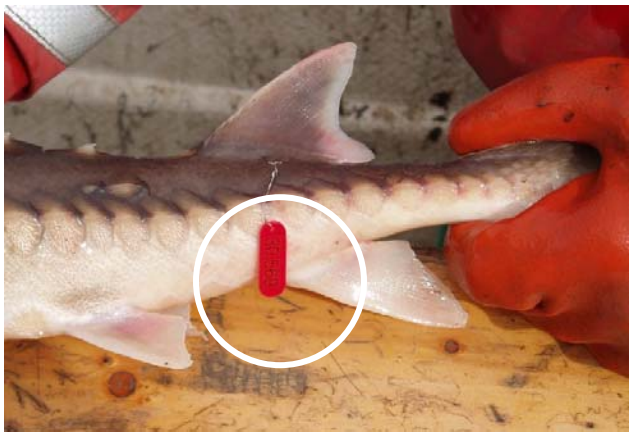
April has 30 days − 9 = 21 days

21 + 6 days in May = 27 days

5. In June 2004 at Kingston, an Atlantic sturgeon received tag #16709 plus a **sonic tag**. Sonic tags send a signal heard by underwater microphones. Scientists followed the signal as the fish swam south that summer. They last heard its signal in Haverstraw Bay, Hudson River Mile 40, in October.

In January 2005 this sturgeon was recaptured near Matapeake, Maryland, 180 miles up the Chesapeake Bay. The entrance to the Chesapeake is 310 miles south of New York City.

People pierce their ears to hang earrings. The same idea is used to attach tags on an Atlantic sturgeon.



(a) How many miles did this sturgeon travel from Haverstraw Bay to New York City?

40 miles

40
- 0
40 miles

(b) How many miles did this fish travel from New York City to the entrance of the Chesapeake Bay?

310 miles

(c) How many miles did the sturgeon travel from the entrance of Chesapeake Bay to Matapeake?

180 miles

(d) In total, how many miles did this fish swim from Haverstraw Bay to Matapeake?

530 miles

40
310
+ 180
530 miles

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Name _____ Date_____

On the Trail of the Hudson's Migratory Fish

Many Hudson River fish are **anadromous**. This means that they are born in fresh water, travel to the ocean to grow up, and then return to the Hudson to **spawn** (lay their eggs).

Scientists attach numbered tags to fish to study **migration** and growth. When a tagged fish is caught, the lucky **angler** uses an address or phone number on the tag to report where and when the fish was caught and how big it was.

You will use real scientific **data** from tagged fish to find out how far fish travel and how much they grow. Show your work as you answer the questions below.

The tag on this striped bass is a thin plastic strip. It is inserted through the skin, much like the way people get body piercings.

The tagged fish is then released back into the water.

1. Striped bass #388381 was 16 inches long when tagged near the Statue of Liberty in November 1996. When caught near Seaside Park, New Jersey, in November 2001 it was 26 inches long.

(a) How many years had gone by since this bass was tagged? _____ years

(b) How much had it grown from 1996 to 2001? _____ inches

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2. Striped bass #289667 was tagged on September 16, 1992, at Danskammer Point on the Hudson, 67 miles north of the Battery in Manhattan. This fish was **recaptured** near the Statue of Liberty, 2 miles south of the Battery, on September 27, 1992.

(a) How many miles had it traveled since September 16? _____ miles

(b) How many days did it take the bass to travel from Danskammer Point to the Statue of Liberty?

_____ days

3. Striped bass #32057 was tagged on May 31, 1989 on the Hudson near Kingston, 90 miles north of New York City. It was caught on September 30, 1989 off Nova Scotia, Canada, 850 miles northeast of New York City.

(a) How many miles had the bass swum since being tagged? _____ miles

(b) How many months had gone by? _____ months

4. American shad #12640 was tagged on April 9, 2001, near Cape May, New Jersey, 161 miles south of New York City. It was caught on May 6, 2001, in the Hudson near Selkirk, at **Hudson River Mile** 136.

(a) How many miles had it traveled since April 9? _____ miles

(b) How many days had gone by? _____ days

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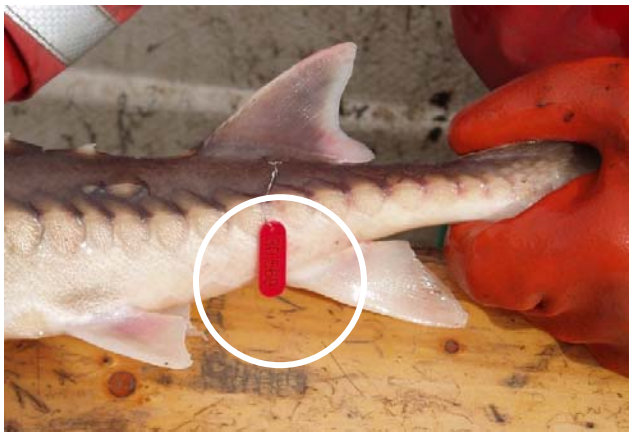
5. In June 2004 at Kingston, an Atlantic sturgeon received tag #16709 plus a **sonic tag**. Sonic tags send a signal heard by underwater microphones. Scientists followed the signal as the fish swam south that summer. They last heard its signal in Haverstraw Bay, Hudson River Mile 40, in October.

In January 2005 this sturgeon was recaptured near Matapeake, Maryland, 180 miles up the Chesapeake Bay. The entrance to the Chesapeake is 310 miles south of New York City.

People pierce their ears to hang earrings. The same idea is used to attach tags on an Atlantic sturgeon.



(a) How many miles did this sturgeon travel from Haverstraw Bay to New York City?

_____ miles

(b) How many miles did this fish travel from New York City to the entrance of the Chesapeake Bay?

_____ miles

(c) How many miles did the sturgeon travel from the entrance of Chesapeake Bay to Matapeake?

_____ miles

(d) In total, how many miles did this fish swim from Haverstraw Bay to Matapeake?

_____ miles

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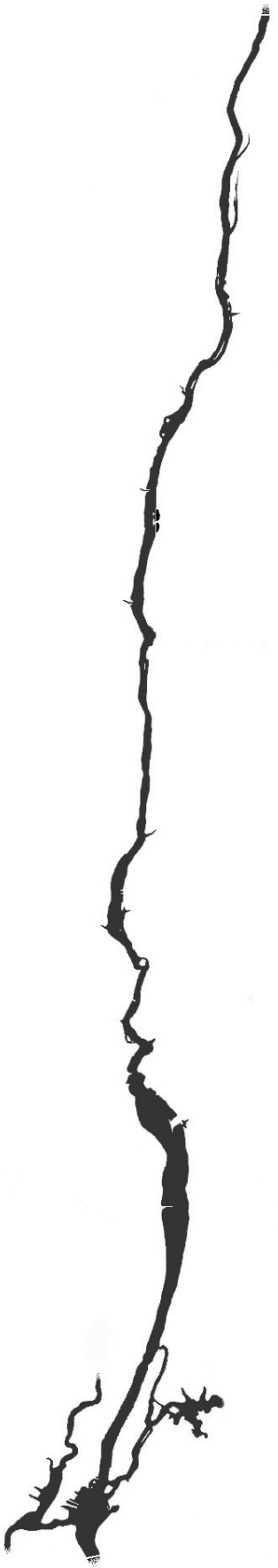

On the Trail of the Blue Crab

Students will practice subtraction skills by tracking the movements of blue crabs in the Hudson River estuary.

Objectives: Students will solve word problems that require them to:

- subtract using data from tagged crabs to calculate distance traveled and elapsed time;
- understand that blue crabs migrate.

Grade level: Elementary (Grades 3-5)

Subject Area: Math, Social Studies (Geography), Science

New York State Learning Standards:
Mathematics, Science, & Technology Standards 3, 4

Skills:

- Use whole numbers to identify locations and measure distances.
- Subtract two digit whole numbers.
- Apply mathematics in real world settings.
- Reason mathematically.

Duration:
Preparation time: 5 minutes
Activity time: 40 minutes

Materials: Each student should have:

- ☐ Worksheet: On the Trail of the Blue Claw Crab
- ☐ Hudson River Miles map
- ☐ Pencil

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Background:
The blue crab's life cycle involves migration between regions of high and low salinity in estuaries. This migration is aided by back legs, shaped like paddles, that enable the animal to swim rapidly. To track crab migration, scientists attach numbered tags to blue crabs. People who catch tagged crabs contact the scientists using a phone number on the tags. The data they provide adds to knowledge of how far and how fast the crabs migrate.

Also called blue claw crabs, these crustaceans are born in the saltiest parts of the estuary around New York Harbor. They then migrate upriver into less salty areas of the Hudson which serve as nurseries, providing plenty of food and shelter from predators. Male crabs tend to go further north than females, entering fresh water and sometimes reaching the Federal Dam at Troy. Females stay downriver, closer to the high salinities that their eggs will need to develop properly. As winter approaches, blue crabs move back downriver to New York Harbor.

Distances on the Hudson are often measured in Hudson River Miles. Hudson River Miles start at the southern tip of Manhattan. This spot, called The Battery, is River Mile 0. The estuary part of the Hudson ends at the dam in Troy at River Mile 153. Only two digit milepoints are used in this lesson, though blue crabs do travel more than 100 miles upstream.

Activity:
1. In preparation for this lesson, have students do the Readings in Hudson River Natural History lesson titled "Blue Claw!"
2. Discuss the concept of migration and how it fits into the blue crab's life cycle.
3. Introduce the Hudson River Miles system; show students the Hudson River Miles map.
4. Go over the worksheet with the class or hand out as an in-class or homework assignment.

Assessment:
- Have students share answers to questions from worksheets, or collect and grade sheets.
- Make up similar elapsed time/distance problems for quiz.

Vocabulary:
estuary: a body of water in which fresh and salt water meet
fresh water: water that is not salty like ocean water (rainwater is freshwater)
Hudson River miles: distance measured north from the Battery at Manhattan's southern tip
life cycle: the stages of form and activity through which a living thing passes as it develops from a beginning stage to an adult able to reproduce and restart the cycle
migrate: animals moving from one place to another
recapture: to capture again
scientist: a person skilled in science

Resources:
There are many websites about blue crabs, among them "Blue Crab Info" at http://www.bluecrab.info/ . While much of the research and information available on crabs focuses on the Chesapeake Bay, a brochure and technical reports about Hudson River crabs are available from DEC at http://www.dec.ny.gov/animals/6953.html .

On the Trail of the Blue Crab: ANSWER KEY

On the Trail of the Blue Crab


An adult blue crab

The blue crab lives in **estuaries** like the Hudson River. In its **life cycle**, this animal **migrates** between very salty water and less salty water. Sometimes blue crabs even swim into **fresh water**.


A tag on an adult blue crab

Scientists attach numbered tags to blue crabs to learn about crab migrations. A phone number is printed on each tag. A lucky person who catches a tagged crab can call to report where and when the crab was caught.

Use the Hudson River Miles map to answer the questions below. They use information about crabs tagged in 2005. Show your work.

1. A blue crab with tag #1328 was released on September 14 near Newburgh at **Hudson River Mile** (abbreviated HRM) 56. This crab was **recaptured** on September 23 at HRM 36 near Haverstraw.

(a) How many days did this crab take to swim from Newburgh to Haverstraw? ***_9 days_***

23
- 14
9 days

(b) How many miles did the crab travel?

20 miles

56
- 36
20 miles

(c) Using the Hudson River Miles map, tell which direction the crab traveled on its journey from Newburgh to Haverstraw. ***__south__***

2. On August 10, a crab with tag #1527 was released near the Beacon-Newburgh Bridge at HRM 63. It was recaptured on August 19 at HRM 74 near Poughkeepsie.

(a) How long did it take this crab to go from HRM 63 to HRM 74? ***19***

9 days ***- 10***

9 days

(b) How many miles did the crab travel?

11 miles ***74***

- 63

11 miles

(c) In what direction did this crab travel? ***__north__***

3. Blue crab #1872 was tagged and released on August 17 near Newburgh at HRM 56. It was recaptured on August 24 near Poughkeepsie at HRM 73.

(a) How much time went by from when the crab was tagged to when it was recaptured? ***24***

7 days ***- 17***

7 days

(b) How many miles did the crab travel?

17 miles ***73***

- 56

17 miles

(c) In what direction did this crab swim? ***__north__***

4. Blue crab #450 was tagged and released near the Beacon-Newburgh Bridge at HRM 63 on June 20. On June 26 it was recaptured near Croton at HRM 35.

(a) How long did it take this crab to travel from HRM 63 to HRM 35?

6 days ***26***

- 20

6 days

(b) How many miles did the crab travel?

28 miles ***63***

- 35

28 miles

(c) In what direction did it swim? ***__south__***

Name _____ Date_____

5. Challenge question: Imagine that you caught blue crab #450 again one year later. Do you think it would still have its tag? Why or why not? *Hint: How do crabs grow?*

The crab would probably not have its tag. It grows by shedding its shell and along with it the tag.

A blue crab with a tag

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Name _____ Date_____

On the Trail of the Blue Crab


An adult blue crab

The blue crab lives in **estuaries** like the Hudson River. In its **life cycle**, this animal **migrates** between very salty water and less salty water. Sometimes blue crabs even swim into **fresh water**.


A tag on an adult blue crab

Scientists attach numbered tags to blue crabs to learn about crab migrations. A phone number is printed on each tag. A lucky person who catches a tagged crab can call to report where and when the crab was caught.

Use the Hudson River Miles map to answer the questions below. They use information about crabs tagged in 2005. Show your work.

1. A blue crab with tag #1328 was released on September 14 near Newburgh at **Hudson River Mile** (abbreviated HRM) 56. This crab was **recaptured** on September 23 at HRM 36 near Haverstraw.

(a) How many days did this crab take to swim from Newburgh to Haverstraw? _____ days

(b) How many miles did the crab travel?
_____ miles

(c) Using the Hudson River Miles map, tell which direction the crab traveled on its journey from Newburgh to Haverstraw. _____

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2. On August 10, a crab with tag #1527 was released near the Beacon-Newburgh Bridge at HRM 63. It was recaptured on August 19 at HRM 74 near Poughkeepsie.

(a) How long did it take this crab to go from HRM 63 to HRM 74?
_____ days

(b) How many miles did the crab travel?
_____ miles

(c) In what direction did this crab travel? _____

3. Blue crab #1872 was tagged and released on August 17 near Newburgh at HRM 56. It was recaptured on August 24 near Poughkeepsie at HRM 73.

(a) How much time went by from when the crab was tagged to when it was recaptured?
_____ days

(b) How many miles did the crab travel?
_____ miles

(c) In what direction did this crab swim? _____

4. Blue crab #450 was tagged and released near the Beacon-Newburgh Bridge at HRM 63 on June 20. On June 26 it was recaptured near Croton at HRM 35.

(a) How long did it take this crab to travel from HRM 63 to HRM 35?
_____ days

(b) How many miles did the crab travel?
_____ miles

(c) In what direction did it swim? _____

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Name _____ Date_____

5. Challenge question: Imagine that you caught blue crab #450 again one year later. Do you think it would still have its tag? Why or why not? *Hint: How do crabs grow?*

A blue crab with a tag

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Tracking the Salt Front

Students will use Hudson River salinity data to practice math skills as they track movements of the salt front in response to storms and other weather events.

Objectives: Students will solve word problems that require them to:

- understand interactions between salt water entering the river from the sea and fresh water entering the river from its watershed;
- interpret data displayed in graphs and on maps;
- add and subtract river mile data to track salt front movements.

Grade level: Elementary (Grades 3-5)

Subject Area: Math, Science

New York State Learning Standards:
Mathematics, Science, & Technology Standards 3, 4

Skills:

- Use graphs and maps to see patterns and relationships observed in the physical environment.
- Use whole numbers to identify locations and measure distances.
- Add and subtract whole numbers.
- Apply mathematics in real world settings.
- Reason mathematically.

Duration:
Preparation time: 5 minutes
Activity time: 1 hour (about 30 minutes for each worksheet)

Materials: Each student should have:

- ☐ Worksheet: Tracking the Salt Front
- ☐ Worksheet: Salt Front Math
- ☐ Hudson River Miles map
- ☐ Pencil

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Background:
The lower Hudson is an estuary, where fresh water from the river's watershed and salt water from the Atlantic Ocean meet and mix. Seawater entering the Hudson is diluted by fresh water; its leading edge—the salt front—is where the concentration of chlorides (mostly sodium chloride, like table salt) reaches 100 milligrams per liter (mg/L).

Many people assume that tidal currents bring salt water into the river. However, they have only minor impacts, moving the salt front a few miles back and forth with each tide cycle. So how does seawater travel 50 miles or more up the Hudson?

Imagine an aquarium divided vertically by a panel separating salt water (colored green with food coloring) on one side from clear fresh water on the other. If the panel is removed slowly, the green salt water, being denser, will flow under the fresh water, which will in turn flow over the salt water remaining on the opposite side. Some mixing will occur, but two layers should be visible.

This phenomenon occurs in the Hudson, where it is called estuarine circulation. Tidal currents and wind tend to mix things up, blurring the layering, but denser seawater does push upriver under fresher water headed downriver at the surface.

How far upriver will the salt water go? That depends on the volume of freshwater runoff from the watershed. After heavy rains, runoff pushes the salt front seaward. During dry spells, seawater pushes further upriver. The salt front usually ranges between Newburgh and the Tappan Zee Bridge. Droughts may allow it to reach Poughkeepsie; major rainstorms may force the front downriver to Manhattan.

The front's location is given in Hudson River Miles (HRM), starting at the southern tip of Manhattan. This spot, called The Battery, is HRM 0. Ocean tides influence the Hudson north to the Federal Dam at Troy (HRM 153).

Activity:
1. In preparation for this lesson, have students do the ELA lesson titled "From the Mountains to the Sea."
2. Discuss the concepts of estuary and salt front.
3. Introduce the Hudson River Miles system; show students the Hudson River Miles map.
4. Do "Tracking the Salt Front" worksheet in class; assign "Salt Front Math" as homework.

Assessment:
- Have students share answers to questions from worksheets, or collect and grade sheets.
- Make up similar problems for quiz.

Vocabulary:

current: water moving continuously in a certain direction
dilute: to lessen the amount of a substance dissolved in a liquid by adding more liquid
downriver: towards a stream's mouth
estuary: a body of water in which fresh and salt water meet
flood: a large flow of water that rises above and spreads out past a stream's banks
fresh water: water that is not salty (rainwater is freshwater)
Hudson River miles: distance measured north from the Battery at Manhattan's southern tip
salt front: the leading edge of seawater entering an estuary
salt water: seawater or other water that contains salt
scientist: a person skilled in science
seawater: salty ocean water
upriver: towards a stream's source
watershed: the area of land from which water drains into a body of water
tides: the alternate rising and falling of the surface of the ocean

Resources:

http://ny.water.usgs.gov/projects/dialer_plots/saltfront.html The U.S. Geological Survey Hudson River Salt Front website has historical data on the salt front's location plus real-time data on water temperature, tide stage, and other parameters from Poughkeepsie and Albany.

http://www.hrecos.org/joomla/ 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. 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.

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Tracking the Salt Front

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 ocean water entering the estuary is called the **salt front**.

After heavy rains, lots of fresh water runs into the Hudson. It presses against the salty **seawater**, moving the salt front south down the river and closer to the ocean. In periods of dry weather, less fresh water enters the estuary. Ocean water pushes further north up the Hudson, moving the salt front inland.

Scientists track the salt front using **Hudson River Miles**, abbreviated HRM. Hudson River Miles start at the southern tip of Manhattan in New York City. This spot, called The Battery, is HRM 0. The George Washington Bridge is at HRM 12, the city of Kingston at HRM 91. Ocean tides reach the Federal Dam in Troy at HRM 153.

Using the graph "Hudson River Salt Front: Average Location by Month" and the map of Hudson River Miles, answer the questions below.

1. (a) In what month is the salt front closest to New York City? ***_April_***

   (b) In that month, where is the salt front located in Hudson River Miles?
   Hudson River Mile ***_37_***

   (c) On your Hudson River Miles map, mark this location with the numeral 1.

   What is the nearest town? ***_Haverstraw_***

2. (a) In what month is the salt front furthest north up the Hudson? ***_Sept_***

   (b) In that month, where is it located in Hudson River Miles?
   Hudson River Mile ***_66_***

   On your Hudson River Miles map, mark this location with the numeral 2.

   (c) What two towns are closest to it? ***_Newburgh_ _Beacon_***

3. On your Hudson River Miles map, what is the distance between the salt front's location at numeral 1 and its location at numeral 2? ***_29 miles_***

66
- 37
29 miles

The graph you just studied gives the <u>average</u> location of the salt front in each month. However, the salt front can move many miles over several weeks—even in a single day—depending on weather. Use the graph **Hudson River Salt Front Location: June 20 to July 10, 2006** to answer the questions below.

4. (a) Where was the salt front located (in Hudson River Miles) on June 26?
Hudson River Mile ***_48_***

Mark this spot on your Hudson River Miles map and label it June 26.

(b) Where was it on July 2? Hudson River Mile ***_9_***

Mark this spot on your Hudson River Miles map and label it July 2.

(c) How many miles apart are these two locations? ***_39 miles_***

48
- 9
39 miles

5. What do you think caused the salt front to move down the river between June 26 and July 2? Support your answer with evidence from the text above.
Heavy rains caused lots of fresh water to run into the Hudson where it pushed the salty seawater south, closer to the ocean.

6. (a) During the period shown by this graph, when did the salt front make its biggest move from one day to the next? ***_July 2 to July 3_***

(b) How far did it move? ***__18__*** miles

27
- 9
18 miles

(c) Did it move **upriver** (north) or **downriver** (south)? ***_upriver (north)_***

Salt Front Math: ANSWER KEY

Salt Front Math

*Heavy rains in the Hudson's **watershed** may cause **floods** along streams that flow into the estuary. How might these rains affect the salt front?*

In the Hudson River estuary, fresh water flowing from the Hudson's watershed meets seawater pushing in from the Atlantic Ocean. The fresh water **dilutes** the incoming salt water, but scientists can detect the leading edge of this ocean water—the salt front.

The salt front moves up and down the Hudson depending on how much fresh water is flowing off the watershed. This usually means that the salt front is closest to the ocean in spring, when there's lots of rain and snow is melting. The front moves upriver in the drier weather of summer and early fall. However, extreme weather events—major storms, for example—can upset this pattern.

This worksheet explores how weather and other factors control the salt front's location. Use the Hudson River Miles map to help answer the questions.

Example: On March 28, 2005, the salt front was at Hudson River Mile (HRM) 62. On your Hudson River Miles map, this is near Newburgh. A heavy rain began that day and lasted overnight. Three days later the salt front was at HRM 31. How many miles did the front move? Did it move downriver towards the ocean or upriver towards the dam at Troy?

HRM 62
- HRM 31
31 miles downriver towards the ocean

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1. Spring 2002 was rainy. In early June, the salt front was at HRM 32. Then the rain stopped, and the weather stayed dry into fall. By September 10, 2002, the salt front had pushed north 49 miles.

(a) What was the Hudson River Mile location of the front on September 10?

32
+ 49
81 miles

81 miles

(b) On September 10, the salt front was closest to which town on your Hudson River Miles map?

Poughkeepsie

2. On December 5, 2003, a foot of snow fell on the Hudson Valley. Five days later, a big rain storm hit the valley. As the rain began, the salt front was at HRM 62. The rain melted the snow, sending lots of fresh water into the Hudson. By December 13, the salt front was at HRM 40.

(a) How many miles did the salt front move because of the rain? ***_22 miles_***

62
- 40
22 miles

(b) Did the salt front move downriver (south) towards the ocean or upriver (north) towards the dam at Troy? ***_downriver (south)_***

3. Native Americans called the Hudson "The River That Flows Both Ways." About every six hours, **tides** make the river **current** reverse direction. This affects the salt front. On January 8, 2005, at 12:00 noon the salt front was near West Point at HRM 52. At 6:00 PM, the front was near the Bear Mountain Bridge at HRM 47. How many miles and in what direction did the salt front move between 12:00 noon and 6:00 pm? ***_5 miles downriver (south)_***

52
- 47
5 miles

Challenge questions:

At which time – 12:00 noon or 6:00 PM – was the tide high? At which time was it low? ***tide high at 12 noon, low at 6 PM***

Later on, at midnight, would the salt front be closer to West Point or the Bear Mountain Bridge? Why? ***at midnight, salt front near West Point because current reverses direction and flows upriver between 6 P.M. and midnight***

Name _____ Date_____

Tracking the Salt Front

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 ocean water entering the estuary is called the **salt front**.

After heavy rains, lots of fresh water runs into the Hudson. It presses against the salty **seawater**, moving the salt front south down the river and closer to the ocean. In periods of dry weather, less fresh water enters the estuary. Ocean water pushes further north up the Hudson, moving the salt front inland.

Scientists track the salt front using **Hudson River Miles**, abbreviated HRM. Hudson River Miles start at the southern tip of Manhattan in New York City. This spot, called The Battery, is HRM 0. The George Washington Bridge is at HRM 12, the city of Kingston at HRM 91. Ocean tides reach the Federal Dam in Troy at HRM 153.

Using the graph "Hudson River Salt Front: Average Location by Month" and the map of Hudson River Miles, answer the questions below.

1. (a) In what month is the salt front closest to New York City? _____

(b) In that month, where is the salt front located in Hudson River Miles?

Hudson River Mile _____

(c) On your Hudson River Miles map, mark this location with the numeral 1.

What is the nearest town? _____

2. (a) In what month is the salt front furthest north up the Hudson? _____

(b) In that month, where is it located in Hudson River Miles?

Hudson River Mile _____

On your Hudson River Miles map, mark this location with the numeral 2.

(c) What two towns are closest to it?_____ _____

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3. On your Hudson River Miles map, what is the distance between the salt front's location at numeral 1 and its location at numeral 2? _____ miles

The graph you just studied gives the <u>average</u> location of the salt front in each month. However, the salt front can move many miles over several weeks—even in a single day—depending on weather. Use the graph **Hudson River Salt Front Location: June 20 to July 10, 2006** to answer the questions below.

4. (a) Where was the salt front located (in Hudson River Miles) on June 26?

Hudson River Mile ____

Mark this spot on your Hudson River Miles map and label it June 26.

(b) Where was it on July 2? Hudson River Mile ____

Mark this spot on your Hudson River Miles map and label it July 2.

(c) How many miles apart are these two locations? _____miles

5. What do you think caused the salt front to move down the river between June 26 and July 2? Support your answer with evidence from the text above.

6. (a) During the period shown by this graph, when did the salt front make its biggest move from one day to the next? _____

(b) How far did it move? _____ miles

(c) Did it move **upriver** (north) or **downriver** (south)? _____

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Name _____ Date_____

Salt Front Math

*Heavy rains in the Hudson's **watershed** may cause **floods** along streams that flow into the estuary. How might these rains affect the salt front?*

In the Hudson River estuary, fresh water flowing from the Hudson's watershed meets seawater pushing in from the Atlantic Ocean. The fresh water **dilutes** the incoming salt water, but scientists can detect the leading edge of this ocean water—the salt front.

The salt front moves up and down the Hudson depending on how much fresh water is flowing off the watershed. This usually means that the salt front is closest to the ocean in spring, when there's lots of rain and snow is melting. The front moves upriver in the drier weather of summer and early fall. However, extreme weather events—major storms, for example—can upset this pattern.

This worksheet explores how weather and other factors control the salt front's location. Use the Hudson River Miles map to help answer the questions.

Example: On March 28, 2005, the salt front was at Hudson River Mile (HRM) 62. On your Hudson River Miles map, this is near Newburgh. A heavy rain began that day and lasted overnight. Three days later the salt front was at HRM 31. How many miles did the front move? Did it move downriver towards the ocean or upriver towards the dam at Troy?

HRM 62
- HRM 31
31 miles downriver towards the ocean

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1. Spring 2002 was rainy. In early June, the salt front was at HRM 32. Then the rain stopped, and the weather stayed dry into fall. By September 10, 2002, the salt front had pushed north 49 miles.

(a) What was the Hudson River Mile location of the front on September 10?

HRM _____

(b) On September 10, the salt front was closest to which town on your Hudson River Miles map?

_____

2. On December 5, 2003, a foot of snow fell on the Hudson Valley. Five days later, a big rain storm hit the valley. As the rain began, the salt front was at HRM 62. The rain melted the snow, sending lots of fresh water into the Hudson. By December 13, the salt front was at HRM 40.

(a) How many miles did the salt front move because of the rain? _____ miles

(b) Did the salt front move downriver (south) towards the ocean or upriver (north) towards the dam at Troy? _____

3. Native Americans called the Hudson "The River That Flows Both Ways." About every six hours, **tides** make the river **current** reverse direction. This affects the salt front. On January 8, 2005, at 12:00 noon the salt front was near West Point at HRM 52. At 6:00 PM, the front was near the Bear Mountain Bridge at HRM 47. How many miles did the salt front move between 12:00 noon and 6:00 pm? _____ miles

Challenge questions:

At which time – 12:00 noon or 6:00 PM – was the tide high? At which time was it low?

Later on, at midnight, would the salt front be closer to West Point or the Bear Mountain Bridge? Why?

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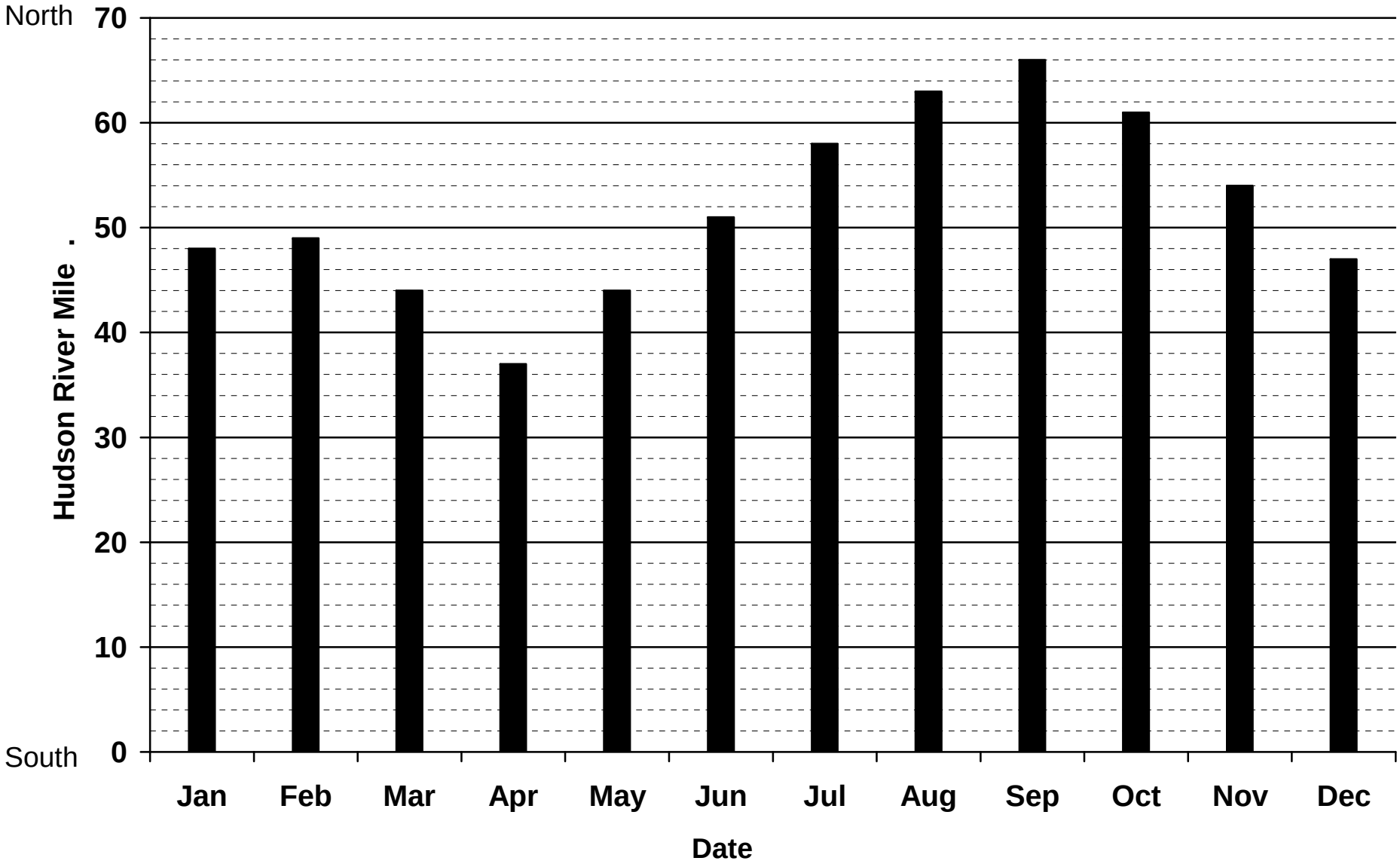
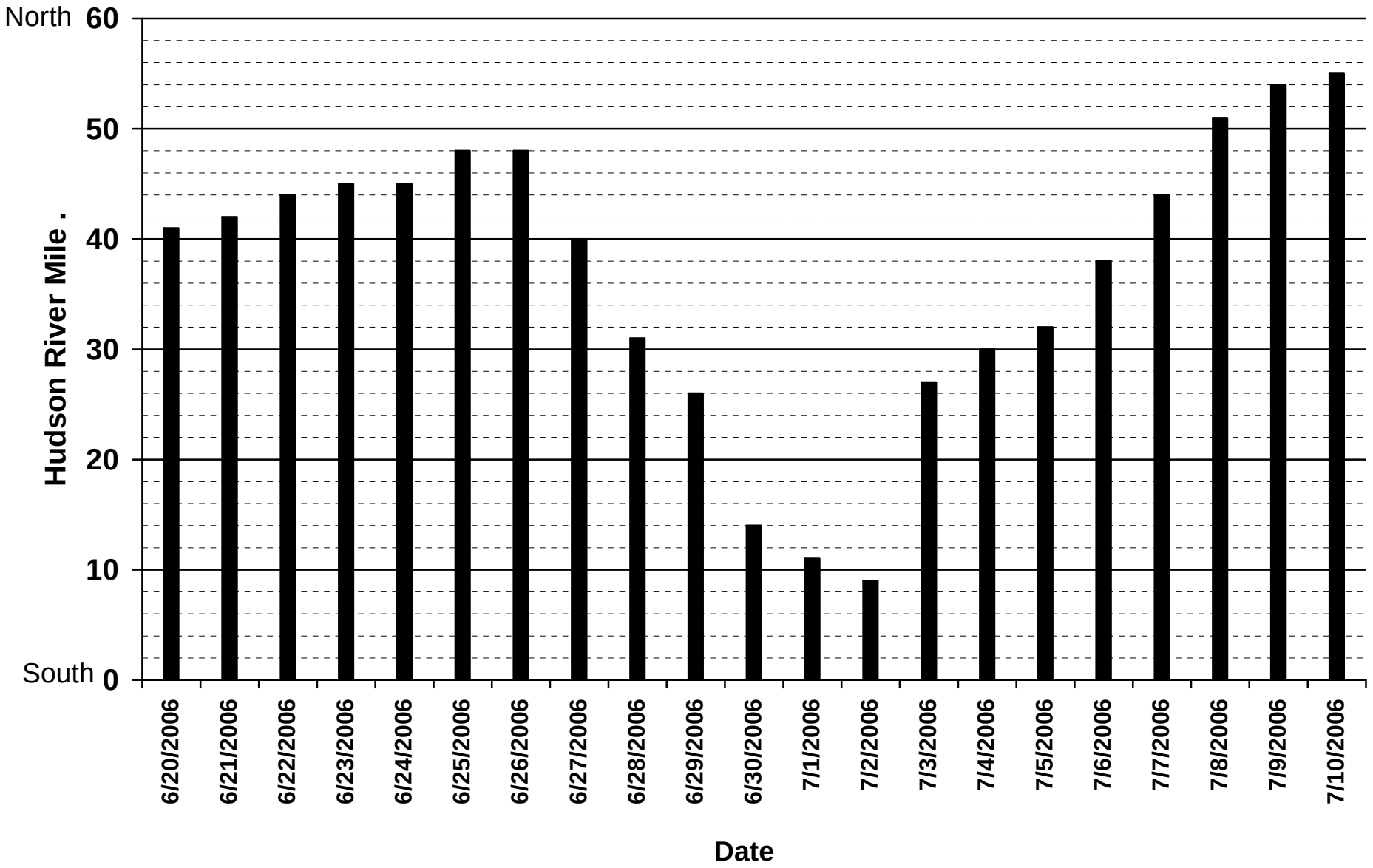
Hudson River Salt Front: Average Location by Month



Source: U.S. Geological Survey data for 1992-2001

Hudson River Salt Front Location: June 20 - July 10, 2006



Source: U.S. Geological Survey

Add & Subtract with Hudson River Shipping

Students will practice addition and subtraction skills by tracking the movements of ships, tugboats, and barges on the Hudson River estuary.

Objectives: Students will solve word problems that require them to:

- read and interpret data from a table;
- add and subtract to calculate distances traveled by vessels on the Hudson;
- add and subtract using hours and minutes to determine elapsed time required by vessels to move between river milepoints.

Grade level: Elementary (Grades 3-5)

Subject Area: Math, Social Studies (Geography)

New York State Learning Standards:

Mathematics, Science, & Technology Standards 1, 2, 3
Social Studies Standard 3

Skills:

- Interpret data from a table.
- Use whole numbers to identify locations and measure distances.
- Add and subtract whole numbers.
- Apply mathematics in real world settings.
- Reason mathematically.

Duration:

Preparation time: 5 minutes
Activity time: 30 minutes

Materials: Each student should have:

- ☐ Worksheet: Add & Subtract with Hudson River Shipping
- ☐ Hudson River Miles map
- ☐ Pencil

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Background:
The Hudson River is a major shipping route for oil, grain, cement, and road salt. A small unit of any of these products has little worth; transporting huge loads by water minimizes shipping costs. By volume and value, petroleum products are the most important cargos on the river; tanker barges are the most common commercial vessels. Ships carry gypsum to wallboard factories in Rensselaer, Verplanck, and Haverstraw. Road salt also arrives by ship. Powdered cement goes downriver in barges. Stone quarried in Ulster, Dutchess, and Rockland Counties is pushed downriver in scows (barges without a deck over their cargo area).

The Port of Albany is the destination of many vessels seen on the Hudson. Scrap metal is shipped in and out of Albany, as is wood pulp. Heavy equipment leaves the port on heavy lift vessels. Containers are barged between Albany and New York Harbor. Food products are also carried on ships. Grain goes in and out of Albany while cocoa beans and molasses come in from points south. Raw sugar is barged from Florida to a refinery in Yonkers.

Distances on the Hudson are often measured in Hudson River Miles. Hudson River Miles start at the southern tip of Manhattan. This spot, called The Battery, is River Mile 0. The estuary part of the Hudson ends at the Federal Dam in Troy at River Mile 153.

Activity:
1. Introduce the Hudson River Miles system; show students the Hudson River Miles map.
2. Discuss the kinds of ships and cargoes seen on the Hudson.
3. Go over the worksheet with the class, or assign as in-class work or homework.

Assessment:
- Have students share answers to questions from worksheet, or collect and grade sheets.
- Make up similar elapsed time/distance problems for quiz.

Vocabulary:
barge: a wide, flat-bottomed boat that is pushed or towed by other boats to transport goods
factory: a building or set of buildings with machinery for making products
gypsum: a colorless mineral that consists of calcium sulfate occurring in crystals or masses
Hudson River miles: distance measured north from the Battery at Manhattan's southern tip
tugboat: a strongly built, powerful boat used to tow or push other vessels
vessel: a boat, ship, or other craft used for travel on water
wallboard: a building material made in large stiff sheets to form interior walls and ceilings; often called sheetrock

Resources:
Photos and dimensions of the barges described in this activity, as well as many tugboats commonly seen on the Hudson, can be viewed at the websites of the Bouchard Transportation Company http://www.bouchardtransport.com/HomePage.htm and the Reinauer Transportation Company http://www.reinauer.com/RTCWeb/DesktopDefault.aspx?tabindex=4&tabid=3 .

Add & Subtract with Hudson River Shipping: ANSWER KEY

Add & Subtract with Hudson River Shipping

On October 6, 2004, students recorded information about **vessels** they saw on the river. Use this table of their observations to answer the questions below.

		Vessels: Time Seen/Direction of Travel			
		Gypsum Baron	*Bouchard B#35*	*Alice Oldendorff*	*RTC 120*
Hudson River Miles/Town	HRM 124/Stuyvesant		11:30 AM/south	1:02 PM/south	
	HRM 115/Athens			1:35 PM/south	9:00 AM/south
	HRM 97/Ulster				10:30 AM/south
	HRM 87/Esopus				11:17 AM/south
	HRM 61/Beacon		4:45 PM/south		
	HRM 18/Yonkers	9:45 AM/south			
	HRM 7/Manhattan	10:45 AM/anchored			

The Alice Oldendorff passes Stuyvesant (photo by Doug Reed)

1. The ship *Alice Oldendorff*, 633 feet long, carries road salt and **gypsum**.

(a) How long did the *Alice Oldendorff* take to go from Stuyvesant to Athens?

_33 minutes _

1:35
- 1:02

1 hour 35 minutes
- 1 hour 2 minutes
0 hours 33 minutes

(b) How many miles did the *Alice Oldendorff* travel between those two points?

_9 miles _

124
-115
9 miles

2. The *Gypsum Baron*, 495 feet long, carries gypsum to **wallboard factories** on the Hudson at Haverstraw, Buchanan, and Rensselaer.

(a) How many miles did *Gypsum Baron* travel from Yonkers south to Manhattan?

11 miles

18
- 7
11 miles

(b) How long did it take *Gypsum Baron* to make the trip?

1 hour

10:45
- 9:45
1 hour

10 hours 45 minutes
- 9 hours 45 minutes
0 minutes

(c) Using your answers from (a) and (b), how fast was the *Gypsum Baron* going in miles per hour? ***11 miles per hour***

*A **tugboat** pushes the RTC 120 past Poughkeepsie. The barge is empty, so it floats high in the water.*

3. The tanker **barge** *RTC 120*, 405 feet long, carries oil. Tugboats push or pull the barge through the water.

(a) How long (in hours and minutes) did it take *RTC 120* to go from Athens to Ulster? ***_1 hour, 30 minutes_***

10:30
- 9:00
1 hour

10 hours 30 minutes
- 9 hours 0 minutes
1 hour 30 minutes

(b) How long did it take *RTC 120* to go from Ulster to Esopus? ***_47 minutes_***

11:30
-10:30
1 hour

11 hours 17 minutes
-10 hours 30 minutes
47 minutes

10hrs+(60+17)min
10 hours 77 minutes
-10 hours 30 minutes
47 minutes

(c) How many miles did *RTC 120* travel between Athens and Esopus?

28 miles

115
- 87
28 miles

Name _____ Date_____

4. The tanker barge *Bouchard B#35*, 338 feet long, also carries oil.

(a) A football field is 300 feet long from one goal line to the other. Is the *Bouchard B#35* longer than a football field? ____no **_X_**yes

How much longer? **_38 feet_**

338
- 300
38 feet

(b) How long did it take *Bouchard B#35* to go from Stuyvesant to Beacon?

5 hours, 15 minutes

4:45 PM
-11:30 AM

16 hours 45 minutes
-11 hours 30 minutes
5 hours 15 minutes

(c) How many miles did *Bouchard B#35* travel between the two places?

_63 miles _

124
- 61
63 miles

A tugboat brings a tanker barge to an oil tank farm in Troy.
Since the barge is loaded with oil, it floats low in the water.

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Name _____ Date_____

Add & Subtract with Hudson River Shipping

On October 6, 2004, students recorded information about **vessels** they saw on the river. Use this table of their observations to answer the questions below.

		Vessels: Time Seen/Direction of Travel			
		Gypsum Baron	***Bouchard B#35***	***Alice Oldendorff***	***RTC 120***
Hudson River Miles/Town	**HRM 124/Stuyvesant**		11:30 AM/south	1:02 PM/south	
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	HRM 97/Ulster				10:30 AM/south
	HRM 87/Esopus				11:17 AM/south
	HRM 61/Beacon		4:45 PM/south		
	HRM 18/Yonkers	9:45 AM/south			
	HRM 7/Manhattan	10:45 AM/anchored			

The Alice Oldendorff passes Stuyvesant (photo by Doug Reed)

1. The ship *Alice Oldendorff*, 633 feet long, carries road salt and **gypsum**.

(a) How long did the *Alice Oldendorff* take to go from Stuyvesant to Athens?

_____

(b) How many miles did the *Alice Oldendorff* travel between those two points?

_____ miles

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2. The *Gypsum Baron*, 495 feet long, carries gypsum to **wallboard factories** on the Hudson at Haverstraw, Buchanan, and Rensselaer.

(a) How many miles did *Gypsum Baron* travel from Yonkers south to Manhattan?
_____ miles

(b) How long did it take *Gypsum Baron* to make the trip?
_____

(c) Using your answers from (a) and (b), how fast was the *Gypsum Baron* going in miles per hour? _____ miles per hour

*A **tugboat** pushes the RTC 120 past Poughkeepsie. The barge is empty, so it floats high in the water.*

3. The tanker **barge** *RTC 120*, 405 feet long, carries oil. Tugboats push or pull the barge through the water.

(a) How long (in hours and minutes) did it take *RTC 120* to go from Athens to Ulster? _____

(b) How long did it take *RTC 120* to go from Ulster to Esopus? _____

(c) How many miles did *RTC 120* travel between Athens and Esopus?
_____ miles

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Name _____ Date_____

4. The tanker barge *Bouchard B#35*, 338 feet long, also carries oil.

(a) A football field is 300 feet long from one goal line to the other. Is the *Bouchard B#35* longer than a football field? ____no ____yes
How much longer? _____ feet

(b) How long did it take *Bouchard B#35* to go from Stuyvesant to Beacon?
_____

(c) How many miles did *Bouchard B#35* travel between the two places?
_____ miles

A tugboat brings a tanker barge to an oil tank farm in Troy.
Since the barge is loaded with oil, it floats low in the water.

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Big Boats Up The River

Students will practice addition skills using information about ships visiting the Port of Albany on the Hudson River estuary.

Objectives: Students will solve problems that require them to:

- read and interpret data from a table;
- add strings of single digit numbers to compare use of the Port of Albany by different vessels;
- recognize that ships play a role in transportation and commerce in the Hudson Valley.

Grade level: Elementary (Grades 2-3)

Subject Area: Math, Social Studies (Geography)

New York State Learning Standards:

Mathematics, Science, & Technology Standards 1, 2, 3
Social Studies Standard 3

Skills:

- Interpret data from a table.
- Add using single digit whole numbers.
- Apply mathematics in real world settings.
- Reason mathematically.

Duration:

Preparation time: 5 minutes
Activity time: 20 minutes

Materials: Each student should have:

☐ Worksheet: Big Boats Up The River
☐ Pencil

NEW YORK STATE OF OPPORTUNITY | Hudson River Estuary Program
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Background:
The Port of Albany is the destination of many vessels seen on the Hudson. The largest grain export elevator east of the Mississippi loads ships with grain brought to Albany by rail. A few loads of molasses come in each year, to be mixed with grain to produce feed for livestock. Road salt also arrives by ship. Scrap metal is shipped out of Albany, as is wood pulp. Heavy equipment – windmill blades, generators, and turbines – enters and leaves the port on heavy lift vessels. Containers are barged between Albany and New York Harbor.

While oil is not included in data on cargoes handled at the Port of Albany (the tank farms located in the area are privately owned), gasoline, heating oil, jet fuel, and other petroleum products are – by volume and value – the most important cargos on the Hudson River. Tankers and tanker barges bring oil to Albany, and carry ethanol, brought in by rail, to refineries elsewhere in the Northeast, where it is blended into gasoline. Likewise not included in the port data are the frequent shipments of gypsum brought by ship to a wallboard (sheetrock) factory in Rensselaer, across from Albany.

Activity:
1. Discuss the kinds of ships and cargoes seen on the Hudson.
2. Go over the worksheet with the class, or assign as in-class work or homework.

Assessment:
- Have students share answers to questions from worksheet, or collect and grade sheets.
- Use other data from the table to make up similar problems for quiz.

Vocabulary:
cargo: the goods or materials carried on a ship
dock: (verb) to guide a ship onto a pier or wharf; (noun) a platform for unloading ships
estuary: a body of water in which fresh and salt water meet
grain: seeds from grass-like plants such as corn and wheat; used to make flour
grain elevator: buildings used to store grain and transfer it to and from boats, railroad cars, or trucks
machinery: sets of parts connected in ways that transmit force to do work
molasses: a thick, dark syrup made from raw sugar
port: a harbor area where ships load and unload cargo

Resources:
Information about the Port of Albany is available at the Albany Port District Commission's website http://www.portofalbany.com .
Line drawings and descriptions of types of ships seen on the Hudson and New York Harbor can be viewed at http://www.worldtraderef.com/WTR_site/cargo_vessels.asp

Big Boats Up The River: ANSWER KEY

This table shows the numbers of ships that docked at the Port of Albany from January to June, 2008. It also shows what cargoes they carried, including the grain, scrap iron, and heavy lift cargoes mentioned above. The molasses brought to Albany is mixed with grain to make food for farm animals. The salt is the kind spread on roads during snow and ice storms. Steel and pipe are used in construction projects. Wood pulp is the raw material from which most paper is made. Use the table to answer the questions below.

Ships Docking at the Port of Albany, January to June 2008

		Month					
		January	February	March	April	May	June
Cargo	grain	3		1		1	1
	heavy lift	2		1	7	2	4
	molasses			1			
	salt		1				
	scrap iron	1		1	1	1	1
	steel/pipe			3		2	2
	wood pulp	1	1	1		2	1

1. In what month did the greatest number of heavy lift ships dock at Albany? How many docked at Albany in that month? ***__April__*** ***__7__***

2. In what month did the greatest number of ships dock at Albany? ***_June_***
   How many docked in Albany in that month? ***__9__***
   1 + 4 + 1 + 2 + 1 = 9

3. In what month did the smallest number of ships dock at Albany? ***February***
   How many docked in Albany in that month? ***__2__***
   1 + 1 = 2

4. How many times did ships carrying steel or pipe dock at Albany during these six months? ***___7__***
   3 + 2 + 2 = 7

5. Which cargo was carried in and out of the Port of Albany most often?
   __heavy lift__ How many times? ***___16___***
   2 + 1 + 7 + 2 + 4 = 16

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Name _____ Date_____

Big Boats Up The River

If you spend a few days along the Hudson River **estuary**, then you are likely to see some very big ships pass by.

Ships up to 750 feet long travel to and from the **Port** of Albany. They carry many different kinds of **cargo**.

This ship is being loaded with **grain**. Behind the ship is a building called a **grain elevator**. The grain stored in this building is brought to Albany from western states by railroad trains.

These are stacks of huge blades for windmills. The windmills will make electricity. The ships that carry these blades and other large **machinery** are called heavy lift ships.

Scrap iron is shipped from Albany. The rusted iron from wrecked cars, broken washing machines, and other items can be recycled to make new metal.

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This table shows the numbers of ships that **docked** at the Port of Albany from January to June, 2008. It also shows what cargoes they carried, including the grain, scrap iron, and heavy lift cargoes mentioned above.

The **molasses** brought to Albany is mixed with grain to make food for farm animals. The salt is the kind spread on roads during snow and ice storms. Steel and pipe are used in construction projects. Wood pulp is the raw material from which most paper is made. Use the table to answer the questions below.

Ships Docking at the Port of Albany, January to June 2008

		Month					
		January	February	March	April	May	June
Cargo	grain	3		1		1	1
	heavy lift	2		1	7	2	4
	molasses			1			
	salt		1				
	scrap iron	1		1	1	1	1
	steel/pipe			3		2	2
	wood pulp	1	1	1		2	1

1. In what month did the greatest number of heavy lift ships dock at Albany? How many docked at Albany in that month? _____ _____

2. In what month did the greatest number of ships dock at Albany?_____ How many docked in Albany in that month? _____

3. In what month did the smallest number of ships dock at Albany?_____ How many docked in Albany in that month? _____

4. How many times did ships carrying steel or pipe dock at Albany during these six months?_____

5. Which cargo was carried in and out of the Port of Albany most often? _____ How many times? _____

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Tens! Hundreds!! Thousands!!! of Tons

Students will practice mathematics skills using information about ships visiting the Port of Albany on the Hudson River.

Objectives: Students will solve problems that require them to:

- read and interpret data from a table;
- use estimation in finding solutions involving large numbers;
- compute average loads of ships docking in Albany;
- recognize that ships play a role in transportation and commerce in the Hudson Valley.

Grade level: Elementary (Grade 5)

Subject Area: Math, Social Studies (Geography)

New York State Learning Standards:

Mathematics, Science, & Technology Standards 1, 2, 3
Social Studies Standard 3

Skills:

- Interpret data from tables.
- Use rounding and estimation to find reasonable answers.
- Calculate the mean for a given set of data.
- Apply mathematics in real world settings.
- Reason mathematically.

Duration:

Preparation time: 5 minutes
Activity time: 30 minutes

Materials: Each student should have:

- ☐ Worksheet: Tens! Hundreds!! Thousands!!! Of Tons
- ☐ Pencil
- ☐ Calculator

Background:
The Hudson River is a major shipping route for oil, grain, cement, and other commodities. A small unit of any of these products has little worth; transporting huge loads by water minimizes shipping costs.

The Port of Albany is the destination of many vessels seen on the Hudson. The largest grain export elevator east of the Mississippi loads ships with grain brought to Albany by rail. Molasses brought to the port is mixed with grain to produce feed for livestock. Road salt also arrives by ship, as does wood pulp. Scrap metal is shipped out of Albany. Heavy equipment – windmill blades, generators, and turbines – enters and leaves the port on heavy lift vessels.

While oil is not included in data on cargoes handled at the Port of Albany (the tank farms located in the area are privately owned), gasoline, heating oil, jet fuel, and other petroleum products are – by volume and value – the most important cargos on the Hudson River. Tankers and tanker barges bring oil to Albany, and carry ethanol, brought in by rail, to refineries elsewhere in the Northeast, where it is blended into gasoline. Also not included in the data are the frequent shiploads of gypsum brought to a wallboard (sheetrock) factory in Rensselaer, across from Albany.

Activity:
1. Discuss the kinds of ships and cargoes seen on the Hudson.
2. As needed, review skills (estimating; calculating means) required to answer the questions.
3. Point out that some questions require gleaning data from more than one table.
4. Go over the worksheet with the class, or assign as in-class work or homework.

Assessment:
- Have students share answers to questions from worksheet, or collect and grade sheets.
- Use other data from the table to make up similar problems for quiz.

Vocabulary:
bulk carrier: a ship that carries large amounts of raw or minimally processed materials
cargo: the goods or materials carried on a ship
generator: a machine that produces electricity from mechanical energy
machinery: sets of parts connected in ways that transmit force to do work
turbines: an engine in which water, air, or other liquids or gases rotate a shaft

Resources:
Information about the Port of Albany is available at the Albany Port District Commission's website http://www.portofalbany.com .
Line drawings and descriptions of types of ships seen on the Hudson and New York Harbor can be viewed at http://www.worldtraderef.com/WTR_site/cargo_vessels.asp

Tens! Hundreds!! Thousands!!! Of Tons: ANSWER KEY

1. For each of the cargoes listed below, write whether it is unloaded at Albany, loaded at Albany, or both.

   grain_____***loaded***_____ heavy lift___***loaded & unloaded***__

   molasses_____***unloaded***_____ salt_____***unloaded***_____

   scrap iron_____***loaded***_____ steel/pipe_____***unloaded***_____

   wood pulp_____***unloaded***_____

2. To fill in the blanks below, estimate using information in Tables 1 and 2.

   _steel/pipe__ More tons of this cargo were unloaded in Albany than of any other cargo unloaded there from January to June.

   ___grain____ More tons of this cargo were loaded at Albany than of any other cargo loaded from January to June.

   __January___ More tons of cargo were loaded at Albany in this month than in any other month in this time period.

3. Use data from the three tables to answer the following questions. Write each question out in numerical form, then answer it using a calculator.

   (a) How big was the average load of grain loaded at Albany in January?

   63,519 *(from Table 2)* ***÷ 3*** *(from Table 3)* ***= 21,173 tons***

   (b) How big was the average load of scrap iron loaded at Albany between January and June, 2008?

   (22,014 + 27,180 + 20,561 + 15,101 + 17,509) ÷ 5 = 20,473 tons

   (c) From January to June 2008, what was the average load per month of wood pulp unloaded at the Port of Albany?

   (2,930 + 3,400 + 2,187 + 7,283 + 3,280) ÷ 6 = 3,180 tons

   (d) Assuming that salt is worth $70 per ton, what was the value of the salt unloaded at Albany in February?

   34,532 x 70 = $2,417,240

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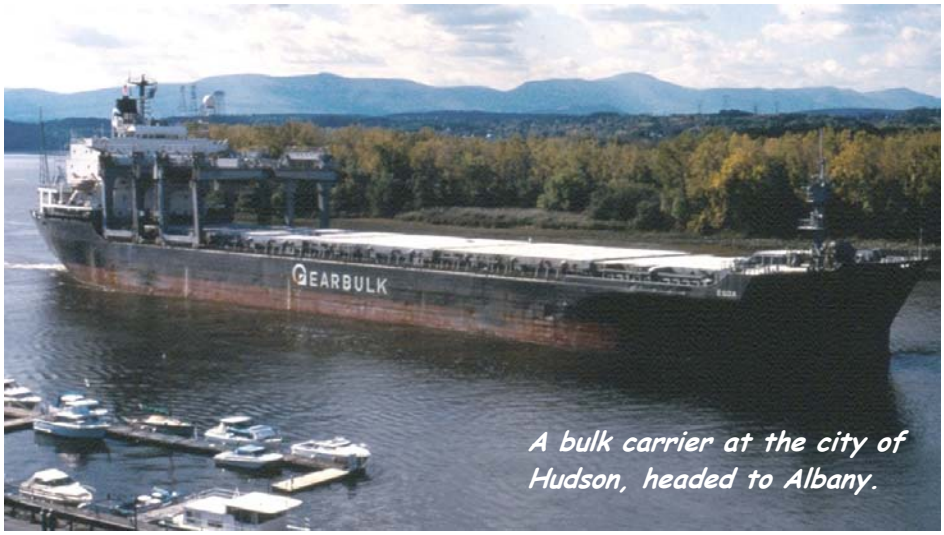
Name _____ Date_____

Tens! Hundreds!! Thousands!!! of Tons



A bulk carrier at the city of Hudson, headed to Albany.

Many of the big ships that travel to and from the Port of Albany are **bulk carriers**. They carry huge loads of loose material such as wheat. Such **cargo** is not valuable in small amounts. Only by transporting large amounts can the ships make money.

An example is the salt used to melt winter's ice and snow from sidewalks and roads. A shovelful of salt from your town's salt pile is worth only a few cents. Your highway department buys it by the ton (2,000 pounds), perhaps paying $70 for each ton. Ten tons would cost $700; one hundred tons would cost $7,000.

Now $7,000 may seem like a lot of money. But think about the costs of operating a large ship. The owners must pay for fuel, crew, repairs, and much more. They also must pay back loans for the millions of dollars that it costs to build a big ship. It helps to haul as much cargo as possible.

So how much salt could one bulk carrier bring to Albany? It would not be unusual for a ship to carry a cargo of 30,000 tons. At $70 a ton, that salt would be worth $2,100,000 – two million, one hundred thousand dollars!

On the other hand, the cargoes carried by heavy lift ships – **machinery** such as **turbines** and **generators** - are very valuable. As a result, these ships do not have to carry such large amounts of cargo to make money.

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Table 1 below shows the types and amounts of cargo that were brought to Albany and unloaded from January to June, 2008. Table 2 shows the types and amounts of cargo loaded and shipped out from Albany in the same months. Table 3 shows the number of ships that docked in Albany. Use these tables to answer the questions on the next page.

1. Tons of Cargo Unloaded at Albany, January to June 2008

		Month					
		January	February	March	April	May	June
Cargo in tons	grain						
	heavy lift			2,862	4,675	1,245	2,302
	molasses			13,202			
	salt		34,532				
	scrap iron						
	steel/pipe	574	512	17,862	1,264	22,058	11,480
	wood pulp	2,930	3,400	2,187		7,283	3,280

2. Tons of Cargo Loaded at Albany, January to June 2008

		Month					
		January	February	March	April	May	June
Cargo in tons	grain	63,519		25,022		27,477	19,694
	heavy lift	1,247			6,687		3,334
	molasses						
	salt						
	scrap iron	22,014		27,180	20,561	15,101	17,509
	steel/pipe						
	wood pulp						

3. Ships Docking at the Port of Albany, January to June 2008

		Month					
		January	February	March	April	May	June
Cargo	grain	3		1		1	1
	heavy lift	2		1	7	2	4
	molasses			1			
	salt		1				
	scrap iron	1		1	1	1	1
	steel/pipe			3		2	2
	wood pulp	1	1	1		2	1

Name _____ Date_____

1. For each of the cargoes listed below, write whether it is <u>unloaded</u> at Albany, <u>loaded</u> at Albany, or both.

   grain_____ heavy lift_____

   molasses_____ salt_____

   scrap iron_____ steel/pipe_____

   wood pulp_____

2. To fill in the blanks below, <u>estimate</u> using information in Tables 1 and 2.

   _____ More tons of this cargo were unloaded in Albany than of any other cargo unloaded there from January to June.

   _____ More tons of this cargo were loaded at Albany than of any other cargo loaded there from January to June.

   _____ More tons of cargo were loaded at Albany in this month than in any other month in this time period.

3. Use data from all the tables to answer the following questions. Write each question out in numerical form, then answer it using a calculator.

   (a) How big was the <u>average load</u> of grain loaded at Albany in January?

   (b) How big was the <u>average load</u> of scrap iron loaded at Albany between January and June, 2008?

   (c) From January to June 2008, what was the <u>average load per month</u> of wood pulp unloaded at the Port of Albany?

   (d) Assuming that salt is worth $70 per ton, what was the value of the salt unloaded in Albany in February?

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