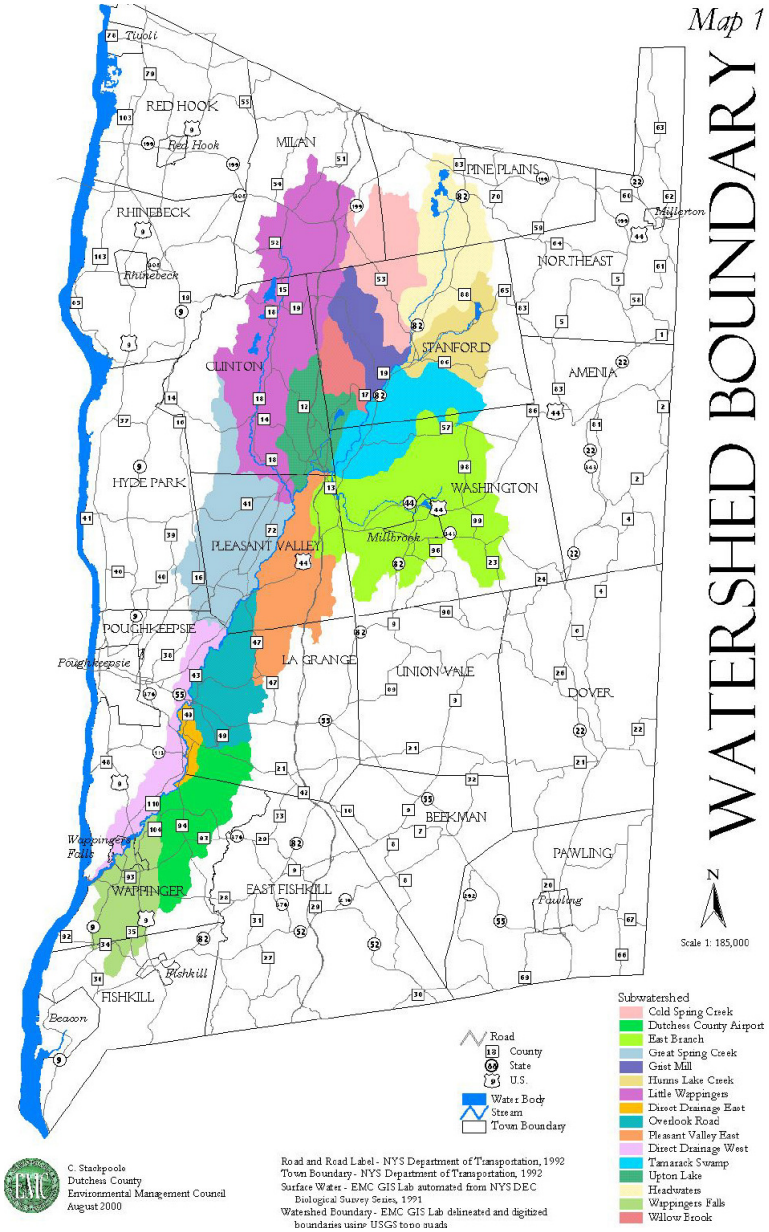
Name _____ Date _____

Why is it so salty?

Have you ever wondered what happens to all the salt that is spread on our streets and sidewalks during the winter? Where does it go? Did you know that there are also other sources of salt pollution, from sewers and water softeners? Eventually, all of this ends up in our groundwater, streams, and rivers. During this activity, you will try and determine which source of salt pollution has caused the increase in salt levels in a stream in Dutchess County, NY.

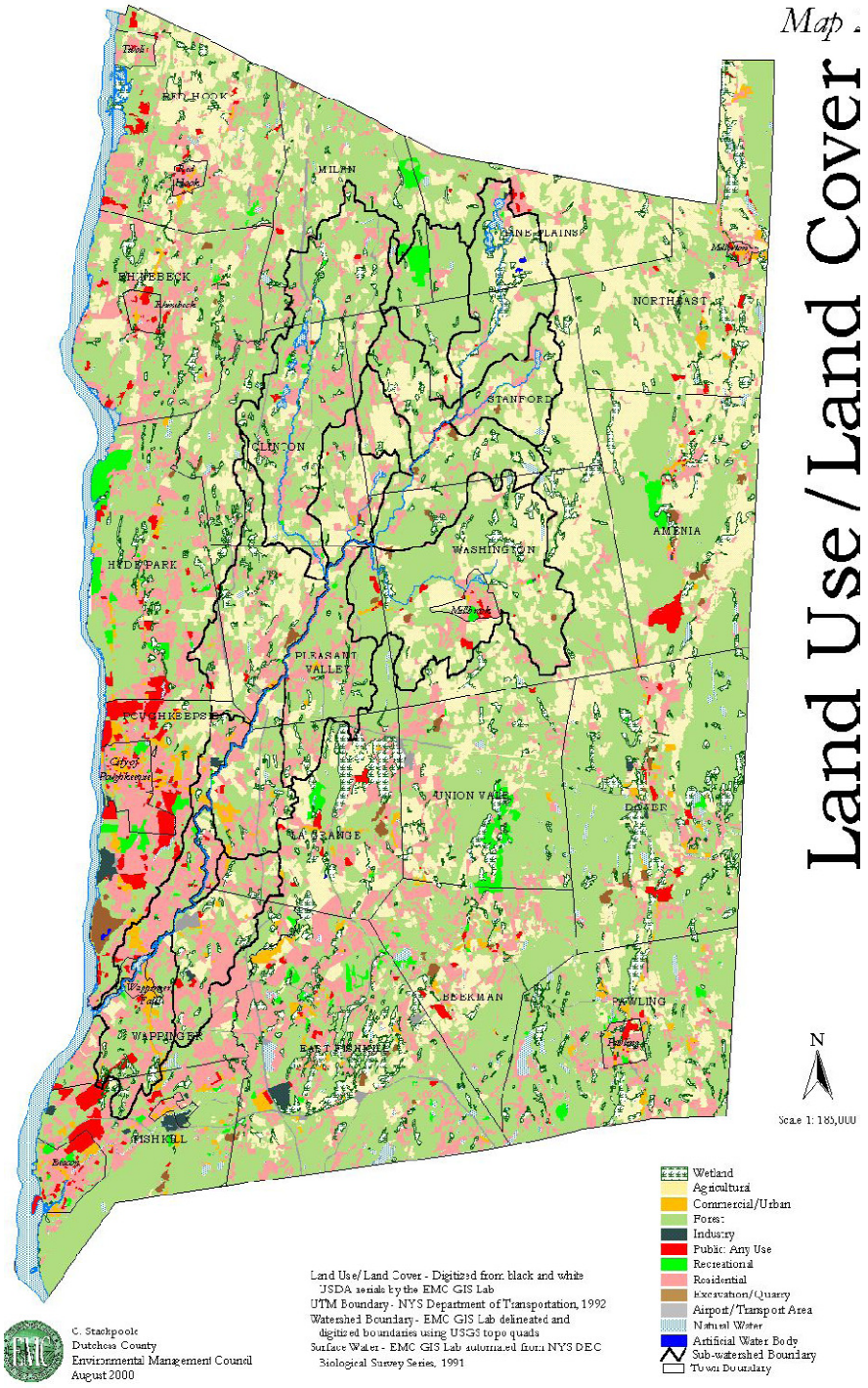
Background: The Wappinger Creek begins in northern Dutchess County, in an area full of wetlands and small lakes. It drains an area of 135,000 acres and winds through rural areas before moving into populated areas in Dutchess County. Ultimately, it forms a large pond in Wappingers Falls and then empties into the Hudson. Below is a map of the towns that are a part of the watershed.

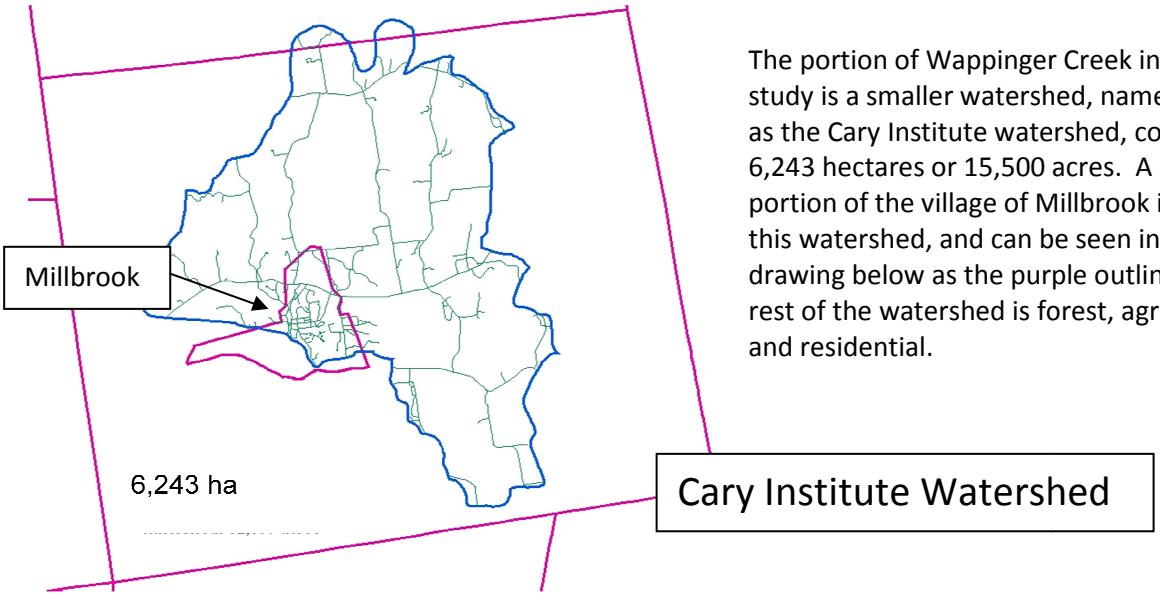


Land use in the watershed ranges from agriculture and forest to commercial and residential development. Use the map below to estimate which land use type is the most prevalent in the watershed. List the land use types in order from greatest to least:

_____

_____





The portion of Wappinger Creek in this study is a smaller watershed, named here as the Cary Institute watershed, comprises 6,243 hectares or 15,500 acres. A major portion of the village of Millbrook is within this watershed, and can be seen in the drawing below as the purple outline. The rest of the watershed is forest, agriculture, and residential.

Part 1: Amount of salt in the creek

Open the data set titled "Total salt" and create two graphs, one that shows the increase in Na and Cl concentrations, and one that shows the total amount of NaCl that is exported from the stream each year.

1. What has happened to the concentrations of Na and Cl in this part of the Wappinger Creek?
2. What has happened to the total amount of NaCl that is exported from the stream?
3. Which of the following sources of salt do you think is the main contributor to the increase in the amount of salt?

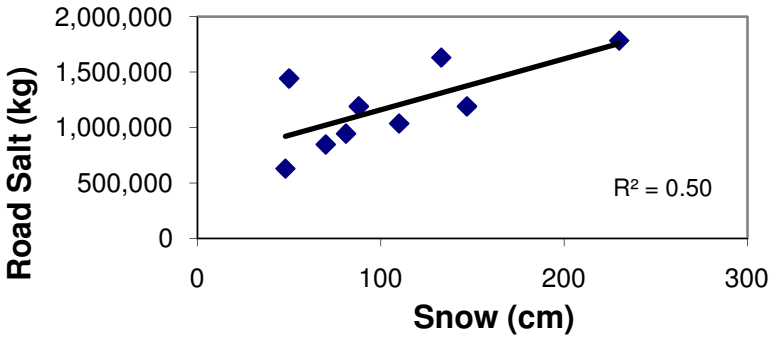
___ Road salt
___ Salt on parking lots
___ Deposition
___ Sewage
___ Water softeners
___ Rock weathering

Explain your decision: _____
_____
_____

Part 2: Snowfall and Road Salt

Using the information in the table as well as the graph, answer the questions that follow.

winter	snowfall (cm)	DOT used road salt (kg)
1996-1997	88	1,190,675
1997-1998	50	1,442,423
1998-1999	70	846,722
1999-2000	81	944,190
2000-2001	133	1,630,825
2001-2002	48	628,916
2002-2003	230	1,783,652
2003-2004	110	1,036,214
2004-2005	147	1,190,383



1. In what year was there the most snow? _____
   a. How much salt was used during that year? _____
2. In what year was there the least snow? _____
   a. How much salt was used during that year? _____
3. Is there a connection between the amount of snowfall and the amount of road salt used? If so, what? Explain.

   _____
   _____
4. Has there been more, less, or about the same amount of snow in the last ten years?

   _____
5. Has there been more, less, or about the same amount of road salt used?

   _____

Part 3: Groupwork

In order to find out what has caused the increase in the salt concentration in this portion of Wappinger Creek, you will investigate data from various sources. Each group will use a different data set.

Group 1: Road Salt

In the "Total salt" data set, there is a tab at the bottom called "Road Salt". Click on that tab and create a graph of the amount of road salt used in the watershed. Make sure you can explain what has happened to the amount of road salt applied in the watershed to the other groups.

Group 2: Parking lots

In the "Total Salt" data set, there is a tab at the bottom called "Parking". Click on that tab and make a graph showing the amount of salt used on parking lots in the village of Millbrook since 1986. Make sure you can explain your graph to your classmates.

Group 3: Sewage

In the "Total Salt" data set, there is a tab at the bottom called "Sewage". Make a graph showing the amount of salt that has come from sewage treatment plants since 1986. Make sure you can explain your graph to your classmates.

Group 4: Water Softeners

In the "Total Salt" data set, there is a tab at the bottom called "Softeners". Make a graph showing the amount of salt that has come from people's water softeners. Make sure you can explain your graph to your classmates.

Group 5: Deposition

In the "Total Salt" data set, there is a tab at the bottom called "Deposition". Make a graph showing the amount of salt that comes from wet deposition. Make sure you can explain your graph to your classmates.

Group 6: Weathering

In the "Total Salt" data set, there is a tab at the bottom called "Weathering". Make a graph that shows the amount of salt from rock weathering in the area. Make sure you can explain your graph to your classmates.

Part 4: Share Results

Now that you have examined one of the sources of salt pollution in more depth, you will learn from your classmates about the rest of the sources. Fill out this chart while your classmates present.

	Increase, decrease, or no change since 1986?	Comments
Road salt		
Parking lots		
Sewage		
Water softeners		
Deposition		
Weathering		

1. Based on this chart only, which source(s) do you believe caused the increase in the salt concentration in the stream? _____
2. Do you think these changes in the sources explain all of the increases in the stream?
   _____
   _____

3. Create a pie chart showing the salt budget of this part of the Wappinger Creek. To do this, you first have to calculate the percentage of each use by dividing the amount of salt used in each category by the total amount that was exported in the stream in 2005, which is 2,283,053 kg. Use "other" to express the amount of salt for which we don't have a specified source. You can create the pie chart in Excel or draw one on your own.

Source	Kg of salt	% of total
Road salt	1,191,689	
Parking areas	127,367	
Sewage	57,881	
Softeners	47,125	
Deposition	18,246	
Weathering	13,790	
Total of these sources		
Other (total amount exported minus the total from known sources)		
Total from known sources in 2005		

4. What is the largest source of salt to the creek? _____

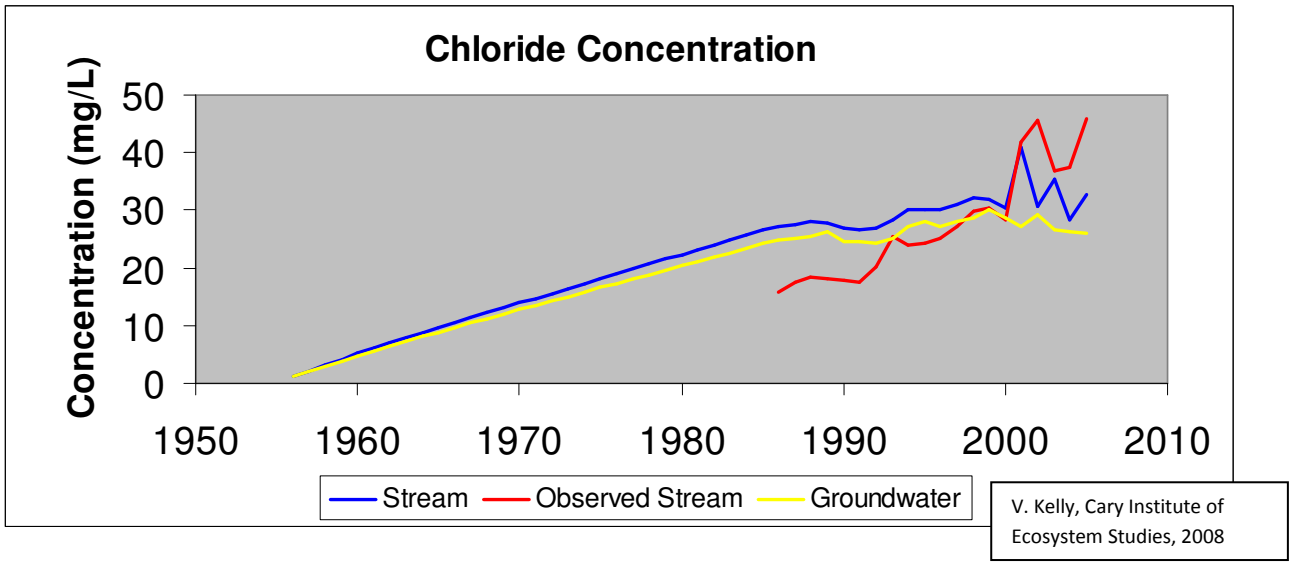
Now, compare the salt budget between 1986 and 2005.

Source	Kg of salt 1986	Kg salt 2005
Road salt	1,096,590	1,191,689
Parking areas	98,369	127,367
Sewage	48,452	57,881
Softeners	38,500	47,125
Deposition	15,417	18,246
Weathering	16,619	13,790
Total from known sources		
Total NaCl exported from stream	878,781	2,283,053
Subtract the total inputs from the total exports		

5. In 1986, the amount of salt that was an input to the stream was _____ (greater than/less than) the amount of salt that was exported.
6. In 1986, how much salt was 'missing'? (ie, didn't get exported) _____
7. In 2005, the amount of salt that was an input to the stream was _____ (greater than/less than) the amount of salt that was exported.
8. In 2005, how much salt was 'missing'? (ie, was not an input but was exported) _____
9. How do you think land cover affects the salt concentration in the watershed? What areas of land cover do you think would release the largest amounts of salt pollution?

   _____
   _____
   _____

Use this graph to complete the following questions.



10. What does this graph tell you about the behavior of chloride in the stream? How does this relate to the amount of salt that was released into the watershed? Based on this graph, why do you think there is so much 'extra' salt in the stream now?

_____
_____
_____
_____

11. What can we expect to happen to salt levels in the stream in the future? Why?

_____
_____

12. Based on what you know about the affects of salt on aquatic organisms, as well as the sources of salt in aquatic ecosystems, write a brief letter to your town's department of transportation authority explaining your concerns.

_____
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References: Kelly, V., 2007. Cary Institute of Ecosystem Studies.
Natural Resource Management Plan for the Wappinger Creek Watershed, Cornell Cooperative Extension of Dutchess County.