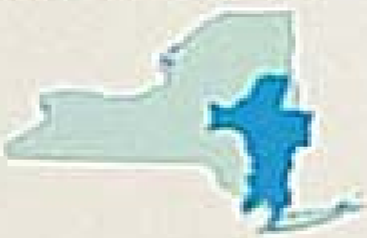
WATER QUALITY STUDY
OF THE UPPER HUSON RIVER,
TOWNS OF HADLEY AND LAKE LUZERNE, NY

Conducted: Spring and Fall 2002



Confluence of Hudson and Sacandaga Rivers,
Warren County, NY

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River Watch students: A.J. Brooks
Eric Rentz
Melissa Merkle
Tabitha Bennett
Advisor: Catherine LaBombard

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ABSTRACT/SUMMARY

In the spring and fall of 2002, Hadley Luzerne High School's River Watch consortium students took to the field for their seventh annual river analysis. This report will provide information on three Hudson River sites and one on the Sacandaga River.

Six years of collecting data and performing analytical tests show there exists a slight deterioration in water quality. Quantitative data shows that nitrate, phosphate, and chloride levels have increased. The pH and alkalinity has decreased. Testing is done in spring and fall and many of these negative trends are seasonal. Dissolved oxygen and percent saturation tests continue to remain comparatively high.

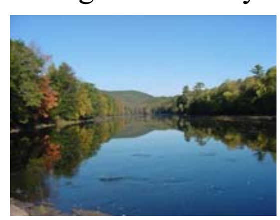
Because the Hudson River contributes greatly to the Hadley and Lake Luzerne community as a recreational, economic, and aesthetic resource, it is only fitting that it be monitored for any adverse environmental impacts. There are hundreds of camps and homes on the river. The stretch of river from Luzerne to Corinth is long and straight making boating, water-skiing, and swimming popular during the warm months. There is a new DEC boat launch on this section of the river and a public beach. The rafting companies use the "rapids" when the water is let out of the Sacandaga Reservoir. This event controls the salt wedge of the Hudson River, a necessity because cities as far south as Poughkeepsie use the river for their drinking water. There is a golf course that borders the river. East River Drive and Route 9N run parallel to both sides of the river and require much maintenance for ice and snow during the winter.

BACKGROUND

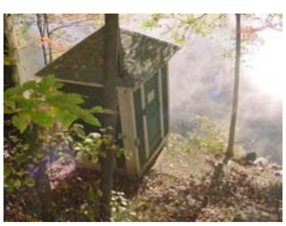
The upper Hudson River is a class A-S stream and flows between the towns of Hadley and Lake Luzerne. The shoreline contains a significant amount of limestone, which contributes to the adequate buffering capacity of the river. The three sites for taking water samples are described in the following paragraphs. Because the Sacandaga River plays such a viable role in the flow patterns of the Hudson, the water at the gauging station is sampled and is referred to as site 2. The Sacandaga River is a class A-S stream. It flows out of Sacandaga Lake and is controlled by the DEC at the dam. This flow helps to control the salt wedge on the lower Hudson River. In conditions of severe drought or when rainfall in the southern Hudson River basin is inadequate, the water released into the Sacandaga River will push the encroaching salt wedge back downstream. Poughkeepsie and many downstream communities rely on the Hudson for their water supply.

Site 1 is the GIS gauging station above Rockwell Falls in the town of Hadley.

The river is about 100 yards wide across from the large flat rock from which the samples are collected in about two feet of water. For the spring 2002 sampling the river was flowing very fast with smooth moving water. It rained hard two days prior to sampling. The day of sampling was rainy, cold, and cloudy with less than 25% shading. The appearance of the water was very clear with no algal growth. The river bottom shows about 10% small boulders. The river is straight at this point, narrowing about 200 yards downstream to form the Falls. There is a dam 17 miles upstream. There are no wastewater treatment plants upstream or any pipes emptying directly into or near the water.



For the fall 2002 sampling there were sediment deposits in the form of sand and there was a faint non-discernible odor coming from the tea colored water. Algal growth was 25% and the present flow was average. The weather has been dry, sunny, and very warm for this time of year. - 80^0 F.



Site 2 is about two miles upstream at the Sacandaga River gauging station. The river is about 50 yards wide here. The streambed was composed of boulders, rubble, gravel, sand, silt, and organic debris. Between five and twenty percent of the surface area which covered fine sediment was made of large particles such as boulders and rubble. In order to access the shoreline, one has to climb down fifty-five stairs. Hardwoods are abundant and both banks were covered with shrubs and grasses. The water samples were taken from the bank at a depth of one foot. There was no algal growth and the water was clear. The river was running fast due to the dam being open.

On this autumn day of sampling a mud-like odor emanated from the water.

Site 3 is the confluence of the Hudson and Sacandaga Rivers that can be seen in the photo from the Hadley Bridge looking south from Rockwell Falls. The Sacandaga enters on the upper right. There is a lot of rock by the bridge and heavy vegetation towards the confluence. The samples are collected south which is the upper left of this photo. The location is Johnson's front yard on the Hudson River. It is about 200 yards downstream from where the rivers meet. The water quality at the spring sampling was clear with no algal growth and sand deposits near the wading area. The current was moderate and gliding. The water is shallow and clear with healthy shrubs and grasses growing on the shoreline. There are boulders along the shoreline. In the autumn the water smelled of leaves and mud. The beach-like area was filled with sand and silt. Most of the area was open with very little shade.

Site 4 is downstream. The spring sampling was done at Nevin's boat dock on the East Side about four miles downstream from the confluence. There is a lot of sand deposited off the dock. The water was clear with no odor. It had rained for two days prior. The streambed consisted of gravel, sand, silt, and organic debris. There was no canopy due to the season, but the trees were a mix between soft and hardwoods. There is a culvert directly across the site running under route 9N into the river. This section of the river is long and straight and is heavily used for recreation. Samples from site 4 were taken to the Town of Queensbury Water Department to be professionally analyzed for coliform bacteria.

In the fall Site 4 was moved to Cartier's boat dock. The day of sampling was cloudy with some rain. The previous two days had been sunny and very warm. The summer was unusually hot and dry. This site, which is located on the west bank of the river, is adjacent to a golf course and directly across from a storm water pipe off East River Drive. The river is about 75 yards wide at this point. The shoreline next to the dock is partially eroded. There was a lot of sand deposits and algal growth covered up to 50 % of the bottom. The water was clear. The substrate composition was rubble, sand, and silt. About 75% of the sampling area was covered with overhanging grasses, shrubs, and deciduous trees. There are many year round homes in this vicinity.

RESULTS

In order to properly complete a stream analysis one must examine the patterns and trends that the data show. While interpreting the data it was noticed that the DO level for the fall is considerably lower in all sites tested. However, it was site four that showed the greatest decline in the spring. For site 1 the spring D.O. was 9.88 mg/L with 82% saturation. The fall DO was 7.7 mg/L with 90% saturation. The water temperature for the spring was 6.4°C and the fall temperature was 17.6°C. At site 2 the D.O. for the spring was 10.16 mg/L with 92% saturation. The fall DO was 7.6 mg/L with 84% saturation. The water temperature for the spring was 8.1°C and for the fall, the temperature was 19.9°. For site 3 the spring D.O. was 8.26 mg/L with 72% saturation. The fall D.O. was 7.6 mg/L with 83% saturation. The water temperature for the spring was 8.1°C while the fall temperature was 18.1°C. At site 4 the spring D.O. was 6.34 mg/L with 54% saturation and the fall DO was 8.9 mg/L with 100% saturation. The water temperature for the spring was 7.2°C and fall was 19.2°C for site 4.

There are a few reasons for these results. One explanation could of course be human error. Another reason is that the water was relatively low and the tests were preformed closer to shore than usual. The fall readings for D.O. could be more accurate because a Hach DO meter was used instead of the Winker method. Additionally, the water temperature in the fall was warmer. This means that there should have been lower DO readings in the fall. This was the case at each site except for site 4.

As far as pH, the spring readings may have been inaccurate due to the fact that the Hach meter was not calibrated correctly. This imperfection affected both the results for pH and the alkalinity. For site 1, the spring pH was 7.22 and the alkalinity was 23.0 mg $CO\ 3^{2--}$ mg/ L. At site 2, the spring pH was 7.79 and the alkalinity was 25.0 mg $CO\ 3^{2-}$ mg/ L. At site 3, the spring the pH was 7.19 and the alkalinity was 29.0 mg CO_3^{2-} mg/ L and, at site 4, the spring pH reading was 7.18 while the alkalinity was 25 mg $CO_3\ ^{2-}$ mg / L. However, the fall pH and alkalinity readings showed that the water was practically neutral. At site 1, the fall pH was 6.9 and the alkalinity was 35.9 mg/L. At site 2 however, the fall pH was 7.0. This shows that the water was neutral. Also, the fall alkalinity was 28.7 mg/L. At site 3, the fall pH was 7.0. The fall alkalinity was 24.5 mg/L. At site 4, the fall pH was 7.0 and the alkalinity reading was 22.3 mg/L. These results were more accurate and this was confirmed when the water was brought to the Queensbury Water department.

At site 1, the total coliform count for the spring was 129 / 100mL and the fall was 272 / 100mL. At site 2, the total coliform count for the spring was 83 / 100mL, while the fall reading was 53 / 100mL. At site 3 the total coliform count for the spring was 59 / 100mL and the fall was 168 / 100mL. Site 4 had a total coliform count of 44 / 100mL for the spring and 97 / 100mL for the fall. The coliform readings were also brought to the Queensbury testing plant and they should also be very accurate. This does not necessarily mean they are safe for swimming. The fall coliform for site 1 exceeded the maximum level (standard) that is safe for swimming, which is 200/ 110mL. The total coliform count is indicative of fecal coliform and E. coli bacteria which are pathogenic and usually attributed to animal wastes and septic systems which are not working up to code.

Finally, it is expected that that the nitrate and phosphate levels would be considerably higher downstream than up because of the near by summer camps. There is also a golf course nearby that would affect this. The affects of these things would be prominent in the fall readings. However, Site 1 has shown high levels of phosphate which could be attributed to the fact that Mill creek empties into the river above this site. For site 1 the spring nitrate was 1.2 mg/L and the fall reading was 1.6 mg/L. The spring phosphate was 0.17 mg/L and the fall phosphate was 0.25 mg/L. The spring chloride was 31.7 mg/L while the fall chloride was 18.15 mg/L. At site 2 the spring nitrate was 0.9 mg/L and the fall nitrate for site 2 was 0.55 mg/L. The spring phosphate was 0.48 mg/L and the fall reading was 0.14 mg/L. Also, the spring chloride was 31.0 mg/L while the fall chloride was 14.35 mg/L. At site 3 the spring nitrate was 0.7 mg/L and the fall nitrate reading was 0.45 mg/L. The spring phosphate was 0.33 mg/L while the fall reading was 0.32 mg/L. The spring chloride was 29.9 mg/L and in the fall the phosphate was 18.7 mg/L. At site 4 the spring nitrate was 0.5 mg/L and the fall nitrate was 1.45 mg/L. The spring phosphate was 0.14 mg/L while in the fall the reading for phosphates was 0.15 mg/L. The spring chloride was 30.4 mg/L and in the fall it was 19.3mg/L.

How these measurements compare to DEC standards will be discussed in the next section.

DISCUSSION

For all of our sites in spring and fall, the pH readings of 7.0 were indicative of the high alkalinity measurements. The bedrock contains a significant amount of limestone,

$CaCO_3$, which buffers the river against the potential lowering of pH from carbon, nitrogen, and sulfur oxides, which come from the factories of the Mid-West. It then returns to earth as acid rain over the Adirondack Mountains. The fall and spring alkalinity measurements were nearly the same. The spring pH readings for sites 1 and 2 tended to be slightly basic, but that may have been from an inaccurate calibration of the new pH meter. When tested with litmus paper, the water was neutral. Samples were later taken to the Queensbury Water Lab to make sure our readings were correct and to have our pH meter checked for accuracy.

There was considerable precipitation in spring 2002, although the snow melt was below average. The temperatures ranged in the mid-80's the week before testing in April. This was very unusual to be that warm, but not unheard of. Because it was short-lived, the temperature of the water at our four sites was not affected. It remained cold. The dissolved oxygen levels were high, acceptable for a large diverse fish population. The fact that we sampled so close to shore on sites 3 and 4 could account for the low reading for percent saturation. Also, the students and teacher were new at performing the Winkler test and human error may have been a factor. Since then, we have become more proficient performing the titration with the starch indicator. In the autumn we borrowed a DO meter from the Lake George Association's educational director to check on our technique. The autumn readings for DO were lower than the spring because of the high temperature of the water that ranged from 17^0 C to 20^0 C on our four sites. September was an unusually warm month and the water did not cool down.

The coliform readings on the four sites are higher in the fall than in the spring. This is because most of the camps are vacant over the winter and the river doesn't get the recreational use. The golf course is closed, there is no boat traffic, swimming or rafting. It was a concern that site 1 above Rockwell Falls had a fall coliform count of 272, well over the limit for swimming. However, the other sites were within the acceptable levels.

Phosphate measurements on all four sites are above the recommended values for rivers and streams. Although phosphates are necessary for aquatic plants to grow, a level greater than 0.1 mg/L will cause algae blooms and oxygen depletion. There was not much disparity in our spring and fall phosphate readings, which leads us to believe that there may be septic runoff from the year-round homes on the river. Fertilizers from the golf course could be entering the river all year long through ground water seepage. Also, Mill Creek flows from Lake Luzerne into the Hudson just above site 1. There are year round homes on Lake Luzerne. The "Q" values for the phosphate measurements categorized the quality of water from medium to excellent.

Too many nitrates can also encourage excessive plant growth and oxygen depletion. Nitrates in drinking water can contribute to a health issue in infants where the nitrates interfere with oxygen attaching to the hemoglobin molecule in their blood.

Nitrate levels higher that 20mg/L can trigger this condition. The nitrate concentrations from the four sites have no affect on fish viability. Converting our nitrate measurements to a "Q" value, the quality of water in all four sites is excellent.

The chloride ion concentration is well within the limits of the rivers to support trout, bass, pike, and perch. The chloride measurements in the spring are significantly higher than the fall data. Route 9N and East River Drive, which run adjacent to the stretch of the river under analyses, receive a great deal of salt maintenance due to many winter storms. The chloride concentration is mitigated downstream at the town of Queensbury water treatment plant as these levels are way over the recommended for drinking water. The silver nitrate titration can be difficult to detect the endpoint. The test relies on a color change from yellow to a burnt orange at the endpoint. The shade of orange at the equivalence point can be perceived differently by each student. To keep a control the same student performs all of the chloride titrations.

It must be noted that the flow of both rivers in the fall was considerably below normal. The dam at Sacandaga Lake had not been open so the water was very low in the river. This could account for the higher than normal readings for phosphates and nitrates. The 2002 concentrations were double the 2001 concentrations for both phosphates and nitrates on sites 1, 2, and 4 in spring and fall. The storm water pipes that discharge into the river across from both sites 4, Nevin's and Cartier's docks, also play a factor in the elevated chloride, nitrate, and phosphate levels.

CONCLUSIONS/RECOMMENDATIONS

After six years of testing the upper Hudson and Sacandaga Rivers at four different sites, we have learned that we cannot make a generalization whether or not the quality of the water is good or bad. What we have learned is that we can measure the degree to which our rivers are affected by pollution. We can compare our measurements to set standards or water quality references set by agencies such as the DEC. (Testing the Waters. 180)

Water seepage from septic tanks appears to be causing elevated levels of phosphates and E. coli (coliform) in all four sites. This doesn't necessarily happen during low flow that occurs when the water has not been let out of the dam on Sacandaga Lake or during times of drought. Even when the flow of water is high on the Sacandaga, the coliform readings have been high. There are many year round homes on the lake and heavy recreational use in the summer. These factors can overload the capacity of the lake and river and the impact phosphate and coliform pollution can be significant.

From physical site evaluations, the water appears to have algal growth during the fall sampling. We believe that fertilizers from the golf course may be the cause. Also, the heavy populated camps and homes overuse the septic systems during the summer months.

A storm water pipe empties directly into the river across from both of our sites #4. In the past we sampled from Nevins' boat dock, which is three miles downstream from the confluence. Jeremy and Jess Nevins have graduated, so we decided to change site 4 to Cartier's dock which is about one-half mile from the confluence and adjacent to the golf course. We plan to sample the storm water drain that runs off East River Drive to see if it contributes significantly to elevated chloride, phosphate, and nitrate levels. Although accessing the site may be difficult, we are thinking about testing during mid-winter. The prediction is that the chloride level would be significantly higher than in the spring or fall. This might be a result of salt used on roads in the winter and their proximity to the river. Therefore, a test during winter could prove or disprove our prediction.

Mill Brook flows from Lake Luzerne into the Hudson just above site 1. We plan to sample the brook to see if the homes on Lake Luzerne are contributing to increased phosphate and E. coli levels. The biology students will be testing Mill Brook this spring for Benthic macro-invertebrates.

In the past our River Watch students have made a presentation to parents, teachers, students, and members of the Board of Education. This has been an effective way to educate the community about the significance of the environmental impacts on the Hudson and Sacandaga Rivers. We will again give our Clean Water Congress 2002 presentation at a Board of Education meeting. Also, we plan to ask the Lions Club and Chamber of Commerce to present our program at one of their monthly meetings. This will give more community awareness of our efforts and hopefully, cooperation for future levels of study. For example, we would like to go to homes on the river and put a dye into their septic systems to monitor any pollution. Right now we feel that is a too sensitive and a very invasive topic.

Although we sample in spring and fall to conform with the other schools in the River Watch consortium, it would be beneficial to sample on a more regular basis throughout the year. The sampling along with biological and chemical testing could be incorporated directly into the curriculum for the new science standards. Using hands-on activities, collecting and analyzing data, and employing technology to measure and present data is all part of the standards in the living environment/physical setting science curricula. Mrs. LaBombard has written lesson plans for all of her chemistry classes and labs. She plans to introduce the unit during the spring 2003 sampling.

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Appendix 1

DATA COLLECTING METHODS

- **Nitrate Test**: Cadmium Reduction method using Hach DR 700 colorimeter

- **Phosphate Test**: Ascorbic Acid method using Hach DR colorimeter

- **Chloride Ion Test**: Silver Nitrate Method – titrate w/0.2256 N $AgNO_3$ & chloride 2 indicator

- **Alkalinity Test**: Titrate w/0.1600 N H_2SO_4 to a pH = 4.2. Use formula:
  Initial pH, # digits to get to pH = 4.5 x 2 - digits to get to pH = 4.2 x 0.1

- **Dissolved Oxygen Test**: Winkler Method: Use 300 mL bottle to collect sample. Add $MnSO_4$ + 1 alkaline iodide-azide reagent pillow. After floc has settled, add sulfamic acid pillow. Transfer 100 mL of sample to a flask. Add starch indicator and titrate w/sulfamic acid using digital titrator.

- **pH** – Hach Sension pH meter

- **Coliform Test**: Collect samples in sealed sterile bottles and return to the Queensbury Water Department Laboratory for professional analysis.

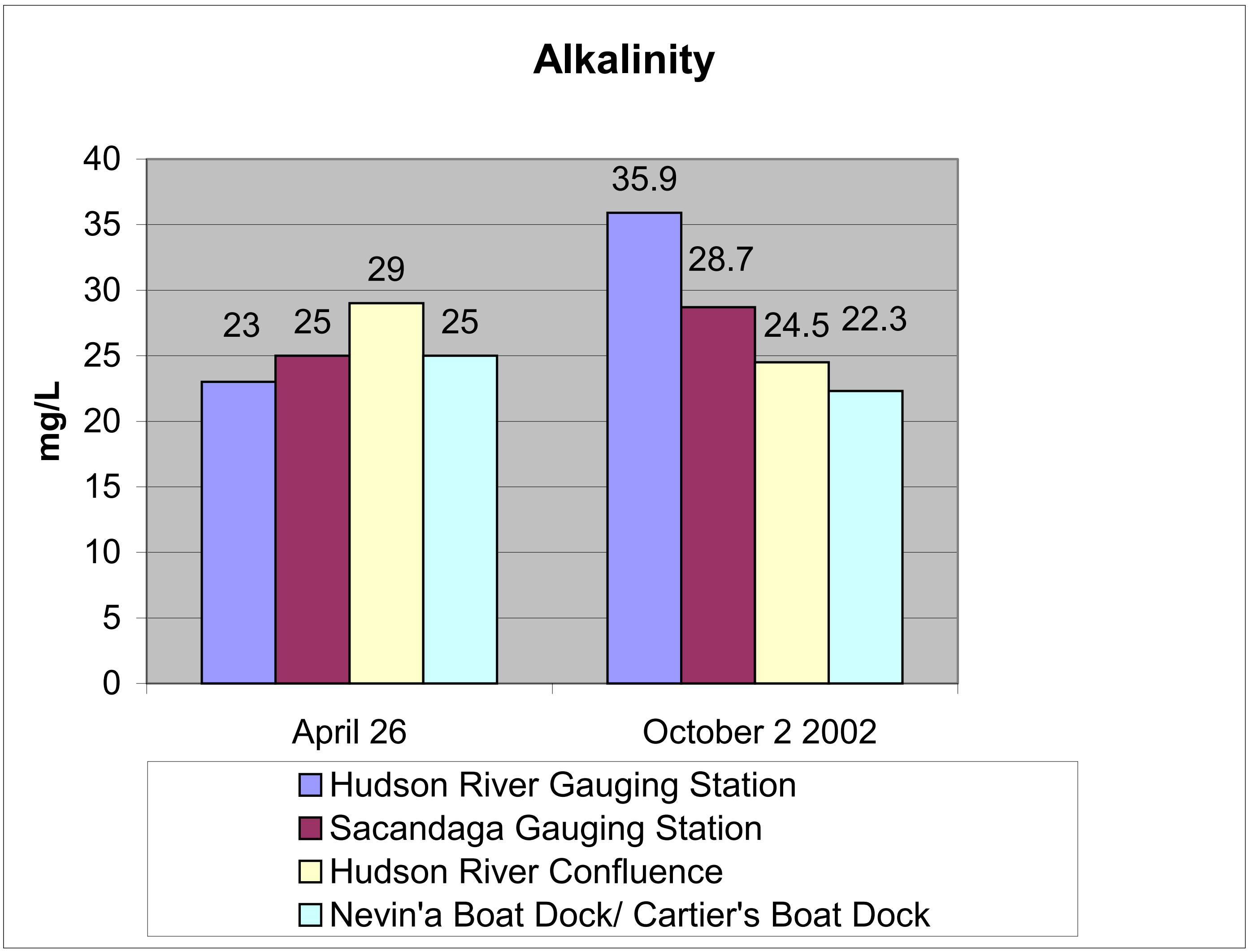
Appendix 2

Spring Data for 2002

Test Type	Chloride	Nitrates	DO	Coliform	pH	Water temp	Air temp	Alkalinity	Phosphates	CFS	Percent Saturation
Units	mg/L	mg/L	mg/L	#/100 mL		° C	° C	mg/L	mg/L		%
Site 1	31.7	1.2	9.88	129	7.22	6.4	4	23	0.17	4900	82
Site 2	31	0.9	10.16	83	7.79	8.1	6	25	0.48	2255	92
Site 3	29.9	0.7	8.26	59	7.19	8.1	6.9	29	0.33	7155	72
Site 4	30.4	0.5	NA	44	7.18	7.2	4.3	25	0.14	NA	54

Fall Data For 2002

Test Type	Chloride	Nitrates	DO	Coliform	pH	Water temp	Air temp	Alkalinity	Phosphates	CFS	Percent Saturation
Units	mg/L	mg/L	mg/L	#/100 mL		° C	° C	mg/L	mg/L		%
Site 1	18.2	1.4	7.7	272	6.9	17.6	21.2	35.9	0.25	585	90
Site 2	14.4	0.55	7.6	53	7	20	19	28.7	0.14	483	84
Site 3	27.2	0.45	7.6	168	7	18.1	24	24.5	0.32	1068	83
Site 4	19.3	0.145	8.9	97	7	19.2	21.4	22.3	0.15	NA	100


Alkalinity
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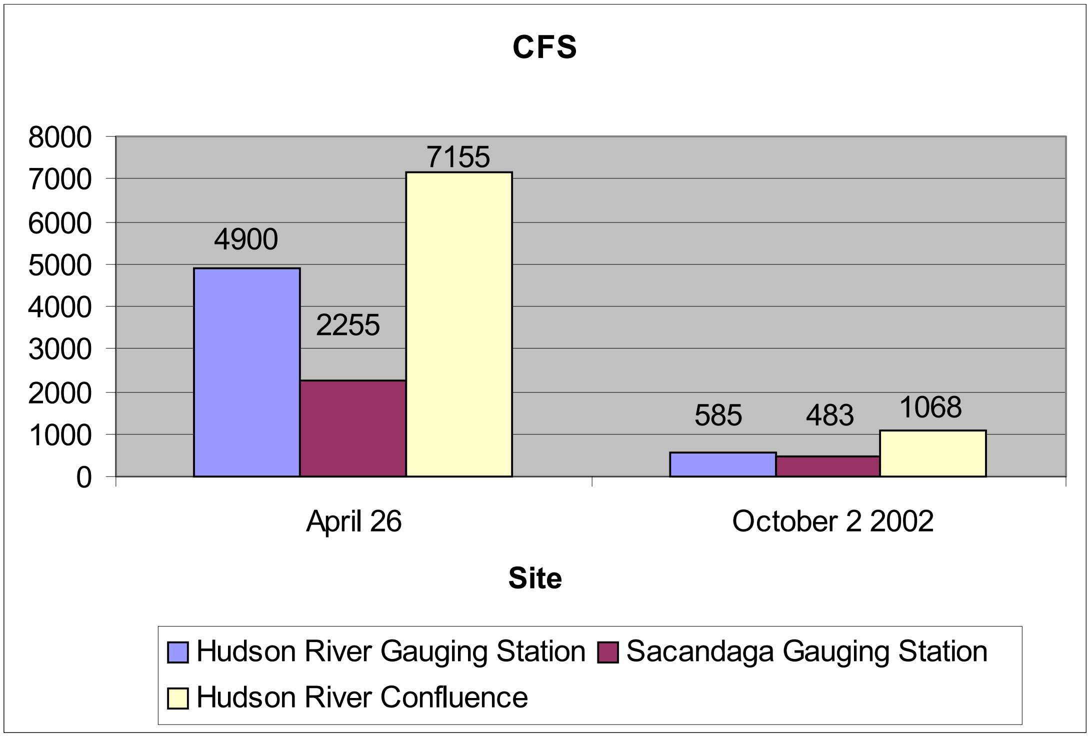
35
30
25
20
15
10
5
0
mg/L
23
25
29
25
35.9
28.7
24.5
22.3
April 26
October 2 2002
Hudson River Gauging Station
Sacandaga Gauging Station
Hudson River Confluence
Nevin'a Boat Dock/ Cartier's Boat Dock


CFS
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7000
6000
5000
4000
3000
2000
1000
0
4900
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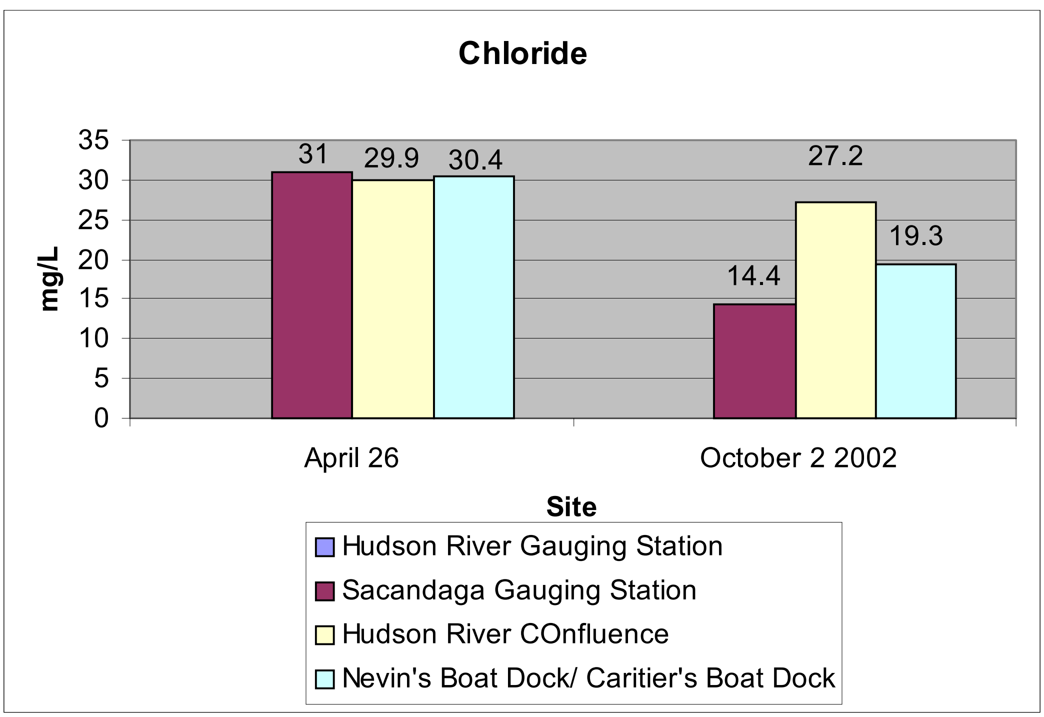
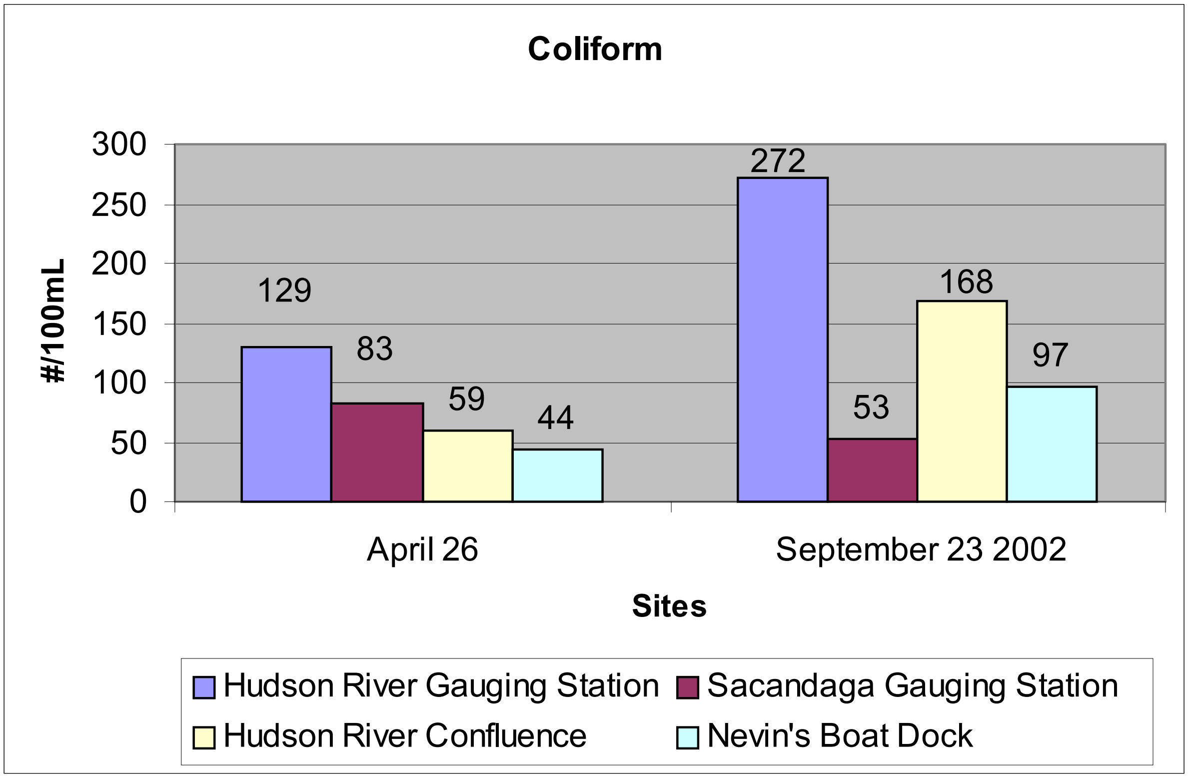
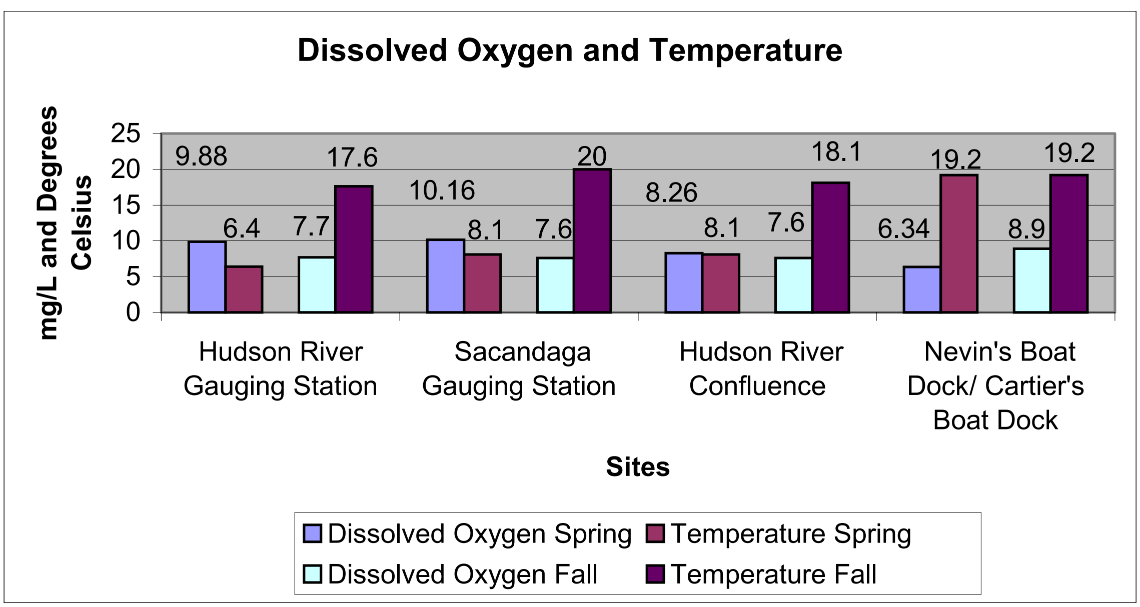
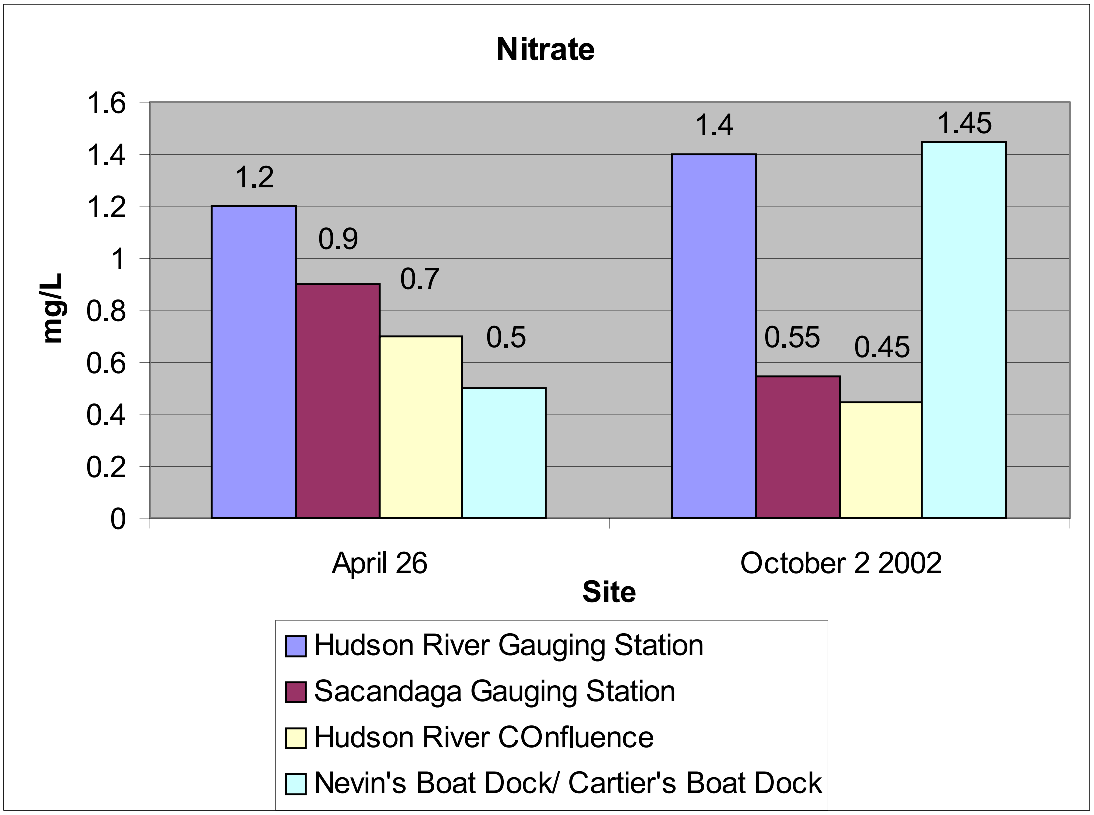
585
483
1068
April 26
October 2 2002
Site
Hudson River Gauging Station
Sacandaga Gauging Station
Hudson River Confluence


Chloride
35
30
25
20
15
10
5
0
mg/L
31
29.9
30.4
14.4
27.2
19.3
April 26
October 2 2002
Site
Hudson River Gauging Station
Sacandaga Gauging Station
Hudson River COnfluence
Nevin's Boat Dock/ Caritier's Boat Dock


Coliform
300
250
200
150
100
50
0
#/100mL
129
83
59
44
272
53
168
97
April 26
September 23 2002
Sites
Hudson River Gauging Station
Sacandaga Gauging Station
Hudson River Confluence
Nevin's Boat Dock


Dissolved Oxygen and Temperature
mg/L and Degrees Celsius
25
20
15
10
5
0
9.88
6.4
7.7
17.6
10.16
8.1
7.6
20
8.26
8.1
7.6
18.1
6.34
19.2
8.9
19.2
Hudson River Gauging Station
Sacandaga Gauging Station
Hudson River Confluence
Nevin's Boat Dock/ Cartier's Boat Dock
Sites
Dissolved Oxygen Spring
Temperature Spring
Dissolved Oxygen Fall
Temperature Fall


Nitrate
mg/L
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1.4
1.2
1
0.8
0.6
0.4
0.2
0
1.2
0.9
0.7
0.5
1.4
0.55
0.45
1.45
April 26
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Site
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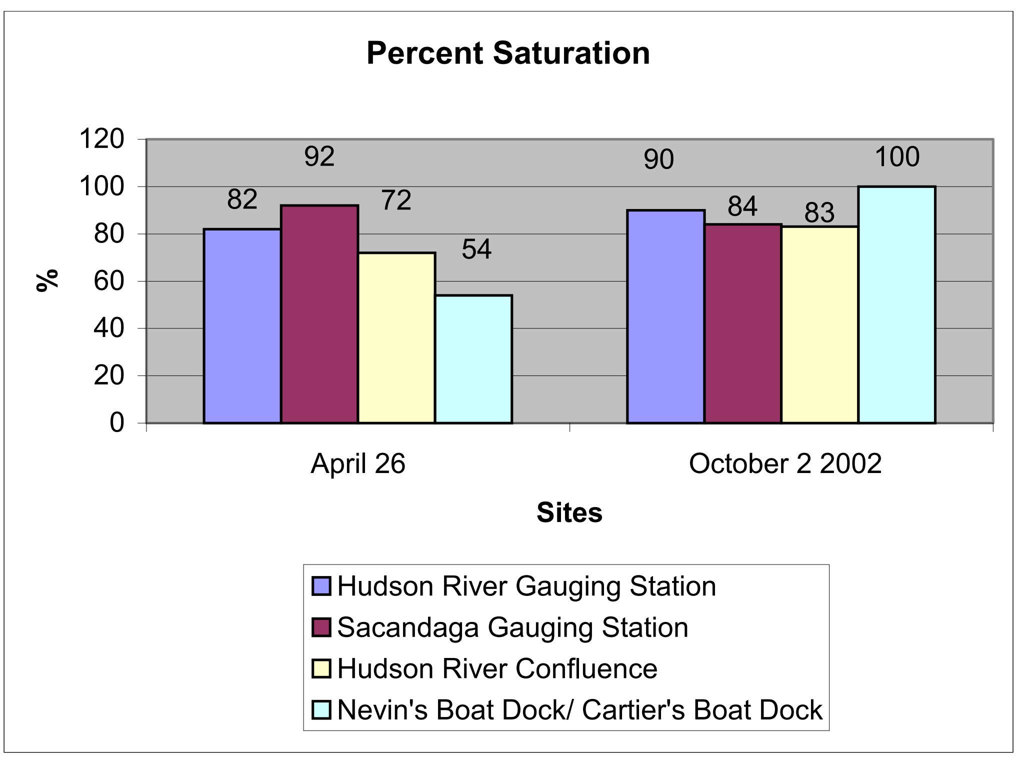
Sacandaga Gauging Station
Hudson River COnfluence
Nevin's Boat Dock/ Cartier's Boat Dock


Percent Saturation
%
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100
80
60
40
20
0
82
92
72
54
90
84
83
100
April 26
October 2 2002
Sites
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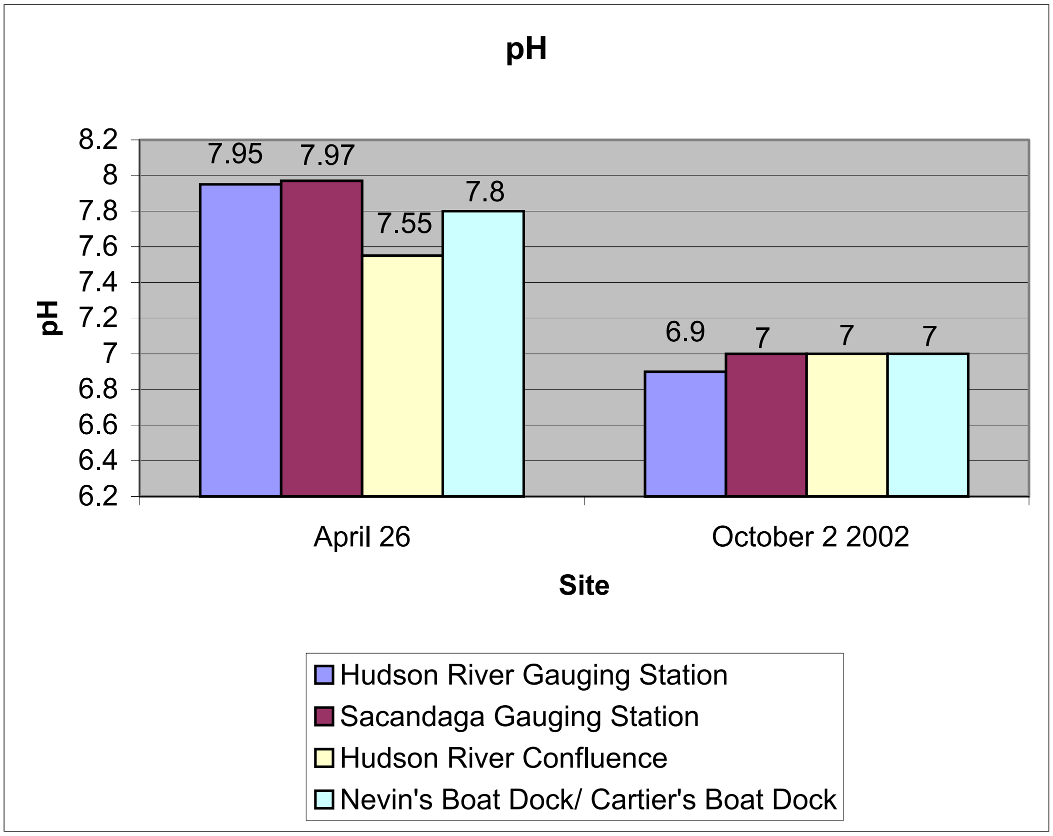
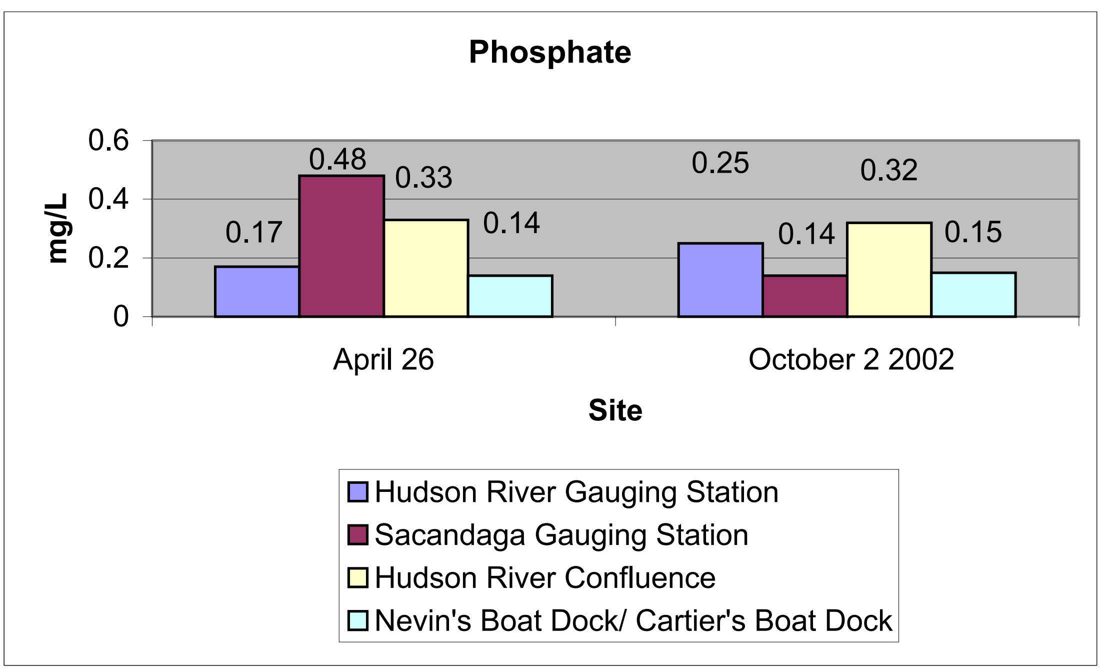
Sacandaga Gauging Station
Hudson River Confluence
Nevin's Boat Dock/ Cartier's Boat Dock



pH
8.2
8
7.8
7.6
7.4
7.2
7
6.8
6.6
6.4
6.2
pH
7.95
7.97
7.55
7.8
6.9
7
7
7
April 26
October 2 2002
Site
Hudson River Gauging Station
Sacandaga Gauging Station
Hudson River Confluence
Nevin's Boat Dock/ Cartier's Boat Dock



Phosphate
0.6
0.4
0.2
0
mg/L
0.17
0.48
0.33
0.14
0.25
0.14
0.32
0.15
April 26
October 2 2002
Site
Hudson River Gauging Station
Sacandaga Gauging Station
Hudson River Confluence
Nevin's Boat Dock/ Cartier's Boat Dock