Water Sample Analysis

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Introduction

The Androscoggin is a beautiful, multi-purpose, and working river. It is used for making paper, for recreation, kayaking, canoeing, and previously for fishing. Now, fish taken from the river are considered unsafe to eat. Historically, the Androscoggin has been used to transport wood and supply the paper mills. These paper mills employ many people, and thus are extremely important to the communities. The foul odor of the river is the ubiquitous objection, but the prime concern is the water safety. According to the AMC River Guide, the farther you are downstream, the better the water quality. Furthermore, "the lakes in the headwaters form a vast storage area of impounded water to run the mills and power stations on the Androscoggin" (AMC).

In the 1920's, the Gulf Island Dam in Androscoggin County, Maine, was built, which in effect created a Gulf Island Pond (Bethel Historical Society). Its construction spelt disaster. The river became clogged with silt and wood debris, and oxygen levels fell. The Metcalf & Eddy firm of Boston was hired to survey the Androscoggin River. By February 1942, they issued a report dealing with the need to cleanup of the river. In 1947, Dr. Walter Lawrence, Chemistry Department Chair of Bates College, was appointed to take charge of the cleanup. As River Master, he defined the discharge limits, which helped lessen some forms of river pollution. Some paper mills changed their processes to reduce the biological oxygen demand (BOD) of their effluent.

However, by the 1960s, the river was so overworked that dissolved oxygen levels dropped to zero – killing fish and aquatic life in the river. If dissolved oxygen reaches zero, according to Osborn, organic compounds begin to decompose without oxygen – anaerobically – releasing a smell of raw eggs (Osborn 39). In 1967, the Maine legislature certified a trash removal program

for the whole state, but did not install complete treatment plants until the end of 1976 (Osborn 66). The Water Pollution Control Amendments of October 1972 stressed the goal of "eliminating all discharges of pollution into navigable waters by 1985 and establishes two deadlines." It also gave the federal government authority to make sure that the deadlines were met (Osborn 95). With that in mind, my job on the Androscoggin deals with the following goals.

Objectives

- Collect Water Samples and test them for turbidity, pH, dissolved oxygen, and specific conductance. Analyze the results on site.
- Gather E. Coli Samples and deliver them to the Rumford-Mexico Treatment Plant for tests for E. coli. Analyze the results.
- Describe discrepancies in Maine and New Hampshire water sampling data with respect to Dioxin levels.
- Analyze last year's water sampling data.

Equipment

- Turbidity Meter
- 1.0 NTU standard
- 10.0 NTU standard
- DI Blank (0.0 NTU Standard)
- Sample Vial
- pH meter and electrode probe
- pH electrode storage solution
- pH electrode filling solution
- 4.0 pH buffer
- 6.0 pH buffer
- 7.0 pH buffer
- Dissolved Oxygen (DO) /Temperature/ Conductance meter
- Zero DO H_2O dissolved oxygen standard
- Extra DO Membranes and Membrane solution
- 200 µS conductivity standard
- Conductivity Solution
- Plastic Sample Container
- Deionized (DI) Water Bottle
- Deionized or distilled water
- Kimwipes

- Clipboard
- Pencils and Pens (Waterproof)
- Extra Batteries (AA and 9V)
- Extra Field Data Sheets
- Bucket and Rope Coil
- Water shoes
- Bathing suit and towel
- Watch
- Cell phone
- E. Coli Cooler
- Ice packs for cooler
- Plastic sample/laboratory bottles
- Post Its
- Permanent Ink Markers
- Safety Triangles used by truck drivers
- Heavy Duty gloves
- Mosquito repellent
- Portable table
- Tissue Box
- Paper Towels

Procedure – Excerpted

- All water sampling should be done before 10:00 am due to the sun's heating of the water.
- Water Sampling – Using the bucket and rope, throw the bucket, from the bridge, into the Androscoggin River. Rinse the bucket with water from upstream three times, each time throwing the rinse downstream. The fourth time, collect the water in the bucket, on the upstream side, for the sample. In terms of depth, go down as far as necessary without touching the bottom of the river.
- E. coli – E. coli samples should be collected from the sampled water immediately after the water is collected. To do this, take the plastic sample bottle and slowly pour water from the bucket into it. Fill until the 100 ml line. Don't touch the neck, inside the bottle or cap, so to not pollute the sample. Deposit the bottle (s) into a cooler with ice packs. Later on in the day, take the samples to a waste water treatment plant.
    - E. Coli test run – the test is called *Idexx* (the procedure is given in the lab notebook)

- Turbidity – First, turn the meter on and calibrate the meter (only needs to be done once). Rinse the plastic sample container with DI water, and then rinse twice with river water from the bucket. Dispose of water outside the bucket. Pour sample water (from bucket) into the container (2/3 full) slowly, to limit bubbling. Retrieve the Sample (S) vial, and rinse it with DI water twice. Next, rinse the sample vial three times with river water from the plastic sample container. Fill the sample vial with river water slowly by pouring the water down the side of the vial. Wipe off dust, water, and fingerprints from the sample vial with a Kimwipe. Open the turbidity meter lid, and align the single, squared-off notch (vertical white line on vial) on the cleaned ("Sample") vial with the vertical, white indexing line that is on the tube. Close the lid. Scroll down on the meter to "Scan Sample" and press Ok. Record data on sheet. Turn off the meter.
- pH – turn the meter on and calibrate the meter (calibrate each time you use this meter). Make sure to rinse the electrode probe with DI water, and then wipe it with a Kimwipe. Next, submerge the probe in the sample plastic container. The meter should be in MEAS mode. Submerge the bottom two inches of the electrode and move around slowly. Don't touch the bottom of the container with the probe. Wait for the READY indicator to show, and then record the pH. Remove the probe and rinse it with DI water and wipe with a Kimwipe. Return the probe to the electrode solution storage container. Turn the meter off.
- Dissolved Oxygen and Specific Conductance – Conduct an initial conductivity test, and then calibrate the meter. Remove the probe from the calibration chamber and rinse it with DI water. The mode should be in % Saturation. Immerse the probe 2/3 of the way into the bucket and move it around slowly for two minutes or more. Record the % saturation, % saturation in mg/L, water temperature, and specific conductance (μS). Remove the probe from the bucket, and hold it in the air to find the air temperature. The reading should stabilize quickly, and the membrane might get damaged if left in the air for long, so return the probe to the chamber quickly. However, rinse the probe with DI water after the air temperature is found and before returning the probe to the chamber. Once the probe is in the chamber, turn the meter to % saturation mode. Record the stabilized value on the data sheet. This meter should be left on until the last sampling.

- Meter Checks – should be carried out near the end of the sampling. Instructions in guide listed below.
- Note: calibrations and full detailed steps found in *NH Volunteer River Assessment Program Water Quality Monitoring Field Sampling Protocols for Volunteer Monitors handbook.*

Results

Listed below are the results of both the E. coli testing and water sampling collected this year.

Additionally, the 2007 water sampling data is given.

Table 1 - Results of E. coli Testing

Date	Location	Site	MPN (most probable number; amount of E. coli) in Col/100ml
6-23-08	B	Bethel Bridge	70
	C	Veteran's Bridge	104
6-30-08	B	Bethel Bridge	365 High due to rain downpour
	C	Veteran's Bridge	261 High due to rain downpour
7-7-08	B	Bethel Bridge	13 Lower due to lack of rainwater
	C	Veteran's Bridge	12 Lower due to lack of rainwater
7-16-08	B	Bethel Bridge	44
	C	Veteran's Bridge	22
7-23-08	E	Sunday River	31.8 Low possibly due to Sunday River treatment plant
	D	Alder Brook	248.1 Very high due to large downpour
	A	Railroad Trestle Bridge @ Gorham	272.1 High due to large downpour

A map of the Androscoggin River is found at the end; letters correlate with sites on map

E. coli has some interesting characteristics. It exists only in warm-blooded animals. Furthermore, E. coli begins to die when it leaves the animal's body; however it may get trapped in sediment in the riverbed or in mud. An essential observation to note is that the amount of E. coli varies with the amount of rain the river absorbs; it becomes large after a heavy downpour. There are several possible reasons why the amount of E. coli raises with rainwater: 1. During a storm, sewage treatment plants receive increased volumes due to input from storm-water drains as well normal amounts of sewage, and are unable to disinfect the E. coli fast enough, 2. During rain storms the sewage can be directly discharged without any treatment into the river if the water inflow is higher than the treatment facility can handle, 3. Warm-blooded animal waste, such as droppings from birds and runoff from farms which are conveyed to the river, 4. Failing home septic systems, which are illegal – the discharge forces leftover E. coli in pipes directly into the river, and 5. residues of E. coli in river beds might get churned and released with the increased movement of the river's water.

The results of tests performed on July 23 are interesting. Samples were drawn after a rain storm. The water at the Trestle Bridge is from Berlin. It had a very high level of E. coli. The town of Bethel discharges its treated waste water into the Adler stream, and it had a very high level of E. coli. Surprisingly, Sunday River's readings appear to be unaffected by rain since their readings were very low. It was noted that the Sunday River Ski Area collects, in a tank truck, waste water from its various sites (hotels, restaurants, condominium...), and hauls it to a central treatment facility. In this way the input volume is controlled. Sunday River is also fed by many smaller mountain streams, including Jordan and Merrill brooks, which helps in diluting any pollution. On the other hand, Berlin and Bethel have storm drains which feed into the water

treatment plants. Apparently these plants are overtaxed during rain storms, preventing proper disinfecting of the E. coli.

I found the employees of the Rumford-Mexico lab to be extremely helpful. I was able to perform the E. coli on the July 23 samples. I learned much about the surrounding towns and about the work they do to treat the water. The drinking water for both towns comes from wells in East Andover. This plant does not treat river water or paper mill water; it only treats waste water from the town, before it enters the river. The paper mill gets its water directly from the river. Furthermore, the mill has its own treatment center.

Note: The procedure for the E. coli test is given in the laboratory notebook.

pH and Dissolved Oxygen Results

Four tests were performed on the samples that were taken at twelve locations along the Androscoggin River. The sampling and testing was performed during the period June 2 - July 24, 2008. All data obtained was entered on a Field Data Sheet and submitted to Barbara Barrett. Selected pH and Dissolved Oxygen Results data from 57 samples (228 tests) are given in Appendix 1. A summary of the pH and dissolved oxygen means and ranges (highest – lowest value at given site) are given below.

Table 2 - pH and Dissolved Oxygen Results

Location	Number	Distance from Previous Site (Miles)	pH Mean	pH Range	DO % Sat. Mean	DO % Sat. Range	Adjacent to Paper Mill
Berlin	1	Start	6.08	0.08	77.6	11.0	
Railroad Trestle Gorham	2	6.4	6.13	0.16	76.1	8.7	Yes
North Rd. – Shelburne	3	3.0	6.19	0.28	75.6	9.0	
Meadow	4	5.3	6.19	0.40	73.7	5.1	

Rd. – Shelburne							
Gilead	5	6.6	6.16	0.10	76.1	3.5	
West Bethel	6	6.1	6.08	0.25	73.8	8.7	
Bethel Rt. 2	7	4.2	6.12	0.27	76.4	11.2	
Sunday River	8	3.0	5.81	0.35	76.6	4.5	
Rt. 232 Hanover	9	9.0	6.15	0.19	73.2	4.6	
South Rumford	10	8.7	6.13	0.13	74.6	4.8	
Veterans Bridge	11	1.4	6.20	0.30	74.5	4.7	Yes
West Peru	12	4.0	6.19	0.26	74.2	5.1	Yes

A map of the Androscoggin River is found at the end; numbers correlate with sites on map

While the sources of the Androscoggin are lakes Umbagog and Richardson in western New Hampshire and Maine, the river technically begins at a dam in Errol, New Hampshire, west of these lakes. The river then flows past only two New Hampshire towns, Dummer and Milan, before entering Berlin. Then, according to the Appalachian Mountain Club, "The river that flows into Berlin clear and almost drinkable becomes severely polluted, like the air above it" (AMC). Although this might be an overstatement, the water samples taken at the 12th Street Bridge just north of Berlin should be fairly pure. The mean pH at this point was 6.08 (Pure rain water's pH is 5.6; Acid rain is less than 5.6) (Girard 216). Although there was high variability in the dissolved oxygen readings, this site produced the highest levels of dissolved oxygen.

The river, as it passes through Berlin, receives discharges of effluent from the Fraser Paper Company and the City of Berlin's waste water treatment plant. The effects are seen in samples taken at the railroad bridge just north of Gorham, NH. Although the average pH here was very close to that of Berlin, two individual readings (6.19 and 6.31) were among the highest obtained during this study. Dissolved oxygen appears to have decreased slightly.

The river, as it passes through Gorham, receives discharges of effluent from Gorham's waste water treatment plant. Then, during the 25 miles between Gorham and Bethel, ME, the river receives substantial amounts of mountain water (e.g. Peabody, Rattle, Wild, Pleasant rivers). It might be assumed that this water is pure; however there is housing development along some of these, particularly the Peabody. The Peabody also passes by hiking, skiing and camping facilities. There are no sizable towns nor industry along this stretch of the Androscoggin River. Sampling sites here were at the bridges at Meadow Road and North Road, both in Shelburne, NH; the bridge at Gilead, NH; Newt's Landing boat launch in West Bethel, ME. The pH values slowly decrease, from a mean high of 6.19 in Shelburne (downriver from Gorham) to 6.08 in West Bethel. The pH begins to slightly rise as the river passes houses, farms and business in Bethel. (The town of Bethel's waste water treatment plant discharges its effluent downriver from the sampling point– in a feeder stream named Adler Brook). As one would expect, the dissolved oxygen levels tend to improve from Shelburne to Bethel, with the exception of West Bethel, which had an average of 73.8% DO.

Samples were taken at Sunday River, which feeds into the Androscoggin. Sunday River, as mentioned above, is fed by a number of mountain streams, including Jordan and Merrill brooks. In spite of the fact that the Sunday River Ski Area discharges treated waste water into it, Sunday River's mean pH was 5.81, close to pure rain water, and the DO levels were 76.6%. This might change in ski season as more people use the ski area.

There are a number of streams feeding the Androscoggin as it heads north from Bethel to Rumford. There are no cities along the way, but there are small towns/ settlements such as Rumford Point, Hanover and Rumford Center, as well as campgrounds, farms and small businesses. The sampling points here were the bridge at the junction of Route 232 and 26, and

the bridge in South Rumford, just south of the power plant. The pH levels appear to be unchanged from those of Bethel (the last place sampled on the Androscoggin). However, the dissolved oxygen levels taken at Route 232 in Hanover were low (73.2%). This might reflect the effects of runoff from the farms and campsites in this area.

Then the river passes through Rumford. There, the New Page Rumford Paper Company discharges treated effluent. It is easy to say that the mean pH of 6.2 (the highest mean obtained, with individual highs of 6.32 and 6.34) is caused by the paper mill. However, there are many houses and businesses along the river. In addition, the Swift River enters at Rumford. The Swift was not tested. However, it is likely that there are a number of campgrounds recreational sites along its shore. Dissolved oxygen levels in Rumford were not significantly lower than in other parts of the river.

The Rumford and Mexico Water Treatment Plant is 1.1 mile north of the Veterans Bridge, and the last sampling point, in West Peru, is an additional 2.9 miles. There, both the pH and dissolved oxygen levels were almost identical to that obtained on the Veterans Bridge. This means that the cities of Rumford and Mexico's discharge did not change the quality of the water.

Turbidity measurements were also taken. These data are given in Appendix 1. Since turbidity values increase dramatically after a rain storm, there is considerable variation in the numbers.

Table 3 - 2007 Androscoggin River Water Sampling Data

Location	pH Mean	pH Range	DO % Sat. Mean	DO % Sat. Range
Magallowy, NWR, NH	6.60	-----	88.9	------
13 Mile Wood, NH	6.56	-----	81.2	------
Pontook Dam, NH	6.37	-----	87.1	------
12th Street Bridge, NH	6.61	.36	91.1	.80
Railroad Trestle Bridge, Gorham, NH	6.78	.50	90.8	4.0

North Road Dam, NH	6.81	.68	88.2	4.6
Meadow Road, NH	6.63	.49	91.1	6.8
Festival Park, Auburn	6.81	-----	72.3	------
Bethel Bridge	6.28	.65	97.7	20.2

Data supplied by Androscoggin Valley Council of Governments (AVCOG)
---- = range is incalculable

Comparing 2007s data to this year of '08 can only be done on certain sites. Magallowy, 13 Mile Wood (NH), Pontook Dam (NH), and Festival Park (Auburn)'s data cannot be compared since I did not sample at these sites. In regards to the others, the dissolved oxygen is relatively higher in '07 as compared to the year 2008. The pH tends to be more neutral in 2007.

Conclusion

Water samples were collected at various sites, and a series of tests were run on each of them. The results of the pH and DO tests have been averaged and compiled above. The water sampling data of this year (2008) has been analyzed. This year's water sampling data has been successfully compared to the data of 2007. E. coli samples were collected, and E. coli was found to increase with heavy downpours of rain. The sources of the increase have been postulated.

Appendix 1

Found at the back of this report is an appendix with further collected water sampling data for summer 2008.

Works Cited

AMC River Guide. Boston: Talman Company, 1986.

Girard, James E. Principles of Environmental Chemistry. Sudbury, MA: Jones and Bartlett Publishers, 2005.

Osborn, William C. The Paper Plantation – The Nader Report. New York: Grossman Publishers,

1974.

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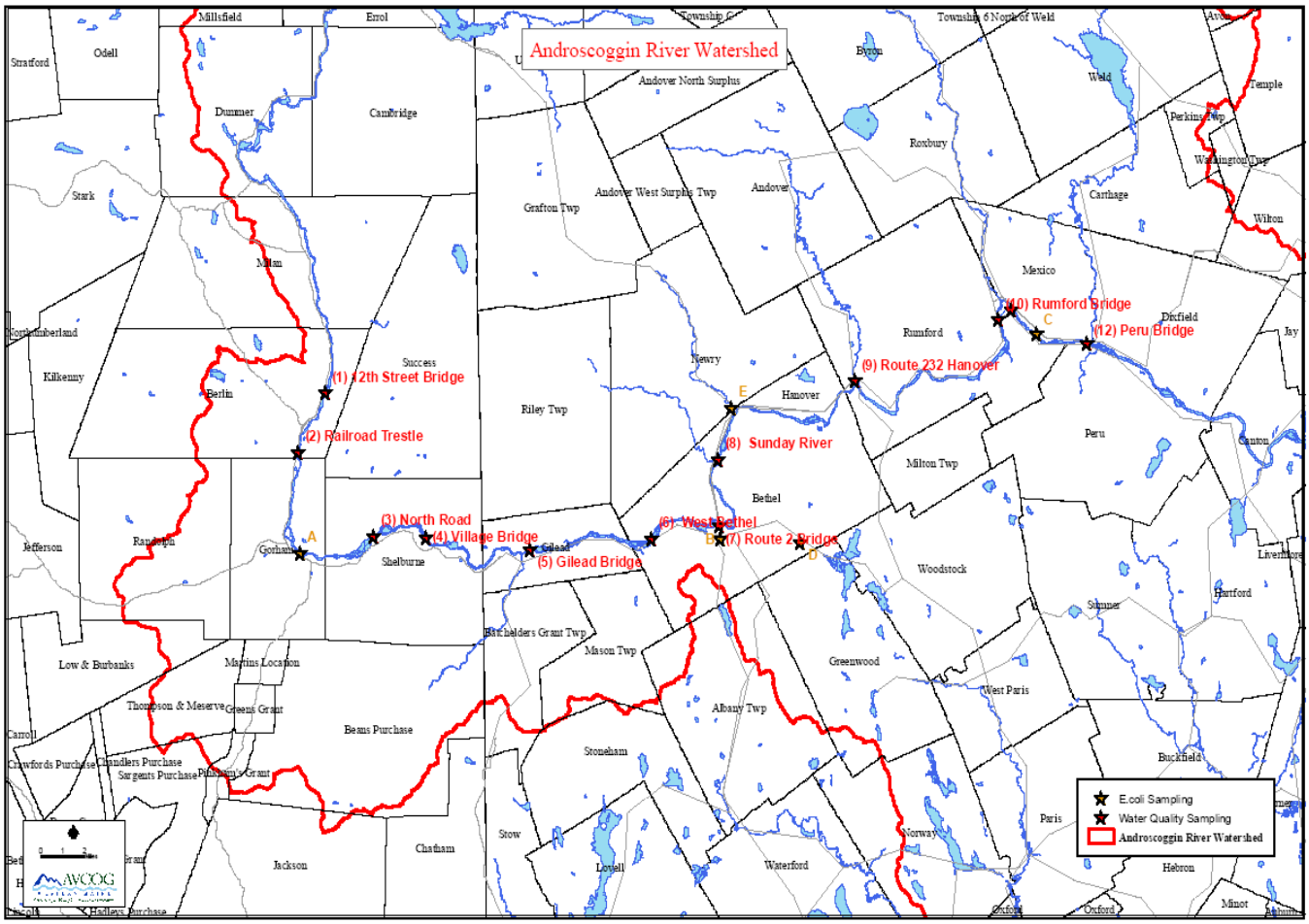
Bethel Historical Society for Androscoggin River Exhibit

Map of Androscoggin River



Selected Sampling Sites

Car Laboratory

Gilead Bridge, NH

Railroad Trestle, Gorham NH

Meadow Rd., Shelburne NH

Railroad Trestle, Gorham NH

Road Hazards