

Ossipee Watershed Water Quality Monitoring Program 2003 Season



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**Green Mountain Conservation Group
Ossipee Watershed
2003 Water Quality Monitoring Program
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RIVERS Program

Executive Summary

In 2002, Green Mountain Conservation Group began testing the waters of the Ossipee Watershed by selecting ten sites in cooperation with the towns' conservation commissions. Impact of land use practices were heavily considered in selecting the site. All sections were further validated by natural resource experts from UNH. In 2002, fifteen volunteers were responsible for testing the ten sites.

2003 marks the second year of water quality monitoring for GMCG and a year of growth and expansion for the program. Five new sites were selected, and over twenty-five volunteers were recruited for testing. GMCG also created and implemented an informal macroinvertebrate sampling event to further augment water quality testing in the Ossipee Watershed.

A comprehensive assessment of the health of the water can only be achieved by observing water quality trends over a period of many years. As this was only the second year for this water quality monitoring program, and there is sparse historical data for the area, firm conclusions cannot yet be drawn. However, an important set of baseline data have been established. Continuing water quality monitoring efforts in the Ossipee Watershed over the long term will allow for observation of water quality trends over time and, in turn, the creation of strong conclusions of the state of the water. Thus, GMCG is working toward the long term sustainability of this program into the future.

1. Introduction

1.1 Green Mountain Conservation Group

The Green Mountain Conservation Group (GMCG) is a community-based, charitable organization dedicated to the protection and conservation of natural resources in the Ossipee Watershed in central Carroll County including the towns of Effingham, Freedom, Madison, Ossipee, Sandwich and Tamworth.

Founded in 1997, GMCG's mission is to coordinate and carry out environmental education, research, natural resource advocacy and voluntary land protection. GMCG is a networking and referral resource for area residents concerned about land use issues in their communities. It encourages individual and small group activism based on common sense and non-confrontational approaches to resolving problems. The guiding principle in its public education and activism is to present objective information in a neutral format with the belief that informed citizens will make good judgments about their area's natural resources.

During the summer of 2000 GMCG responded to growing concerns about Ossipee Lake by hosting a forum that featured a panel discussion by state experts and representatives of the New Hampshire Audubon Society and The Nature Conservancy. One of the conclusions drawn from the forum was that resolution of lake issues was being hampered by the lack of an organization representing the interests of a majority of the lake's stakeholders.

In 2000, GMCG worked with the University of New Hampshire Cooperative Extension and the Society for the Protection of the New Hampshire Forests to produce a series of Natural Resource Inventory (NRI) maps of each town in the Ossipee Watershed. The NRI maps include information on hydrology, soils, town conservation land, unfragmented land, public water supplies, known and potential contamination sites as well as co-occurrences of important resources. Copies of these maps were provided to each town in the watershed and are displayed at the town halls for public use.

A Water Quality Monitoring (WQM) program grew out of the NRI mapping project as a way to further study our natural resources and as a way to work with the broader community to plan for growth while protecting the environment. Since water does not recognize political boundaries, GMCG began working collaboratively on the WQM program with Saco River Corridor Commission (SRCC), an organization located in Maine.

Saco River Corridor Commission began its WQM program in 2001 and monitors 27 sites in twenty towns along the Saco River. GMCG modeled its Water Quality Program after SRCC. Beginning in 2002, GMCG monitored ten sites across the six towns in the Ossipee Waters, a subwatershed of the Saco Watershed. In 2003, GMCG increased the number of sites it tests from ten to fifteen. Together GMCG and SRCC monitor the quality of the water across two states, 26 towns and one watershed in the RIVERS (Regional Interstate Volunteers for the Ecosystems and Rivers of Saco) Program. These WQM programs enable the study the health of the entire watershed and track changes over time and educate the public.

Also in 2003, GMCG expanded its WQM program to include a biological monitoring component. With help from local Bug Experts, GMCG created and initiated a macroinvertebrate sampling event. Macroinvertebrates are tiny aquatic animals that lack a back bone but are visible to the naked eye. Often they can serve as unique water quality indicators.

1.2 Ossipee Watershed

The Ossipee Watershed (Figure 1) is part of the Saco River Basin, which is an area of about 379 square miles located in Carroll and Grafton Counties, New Hampshire. It contains 82 lakes and ponds that cover about 9,400 acres in thirteen towns. At its widest point the watershed extends approximately 29 miles east and west and twenty-three miles north and south. Water from the Ossipee Watershed flows into the Saco River and through Maine to the Atlantic Ocean. The watershed's drainage area is bound by the mountains of the Sandwich Range to the northwest, the Ossipee Mountains to the south and the sandy pine barren lands of the Ossipee-Freedom-Effingham plains to the east. Elevations range from 375 feet at the Maine-New Hampshire border in Effingham to 4,060 feet on Mount Passaconway in Waterville.

The Ossipee Watershed contains New Hampshire's largest stratified-drift aquifer. This type of aquifer is unique because it recharges more rapidly than any other. As a result of this quick recharge, stratified drift aquifers allow pollution and contamination to be carried more rapidly into the underground water supply. Therefore, conservation of the recharge lands is vital to the protection of drinking water supplies in New Hampshire and Maine.

The Ossipee Watershed is one of New Hampshire's most rural areas but is under developmental pressure. A study by the Office of State Planning, co-authored by The Society for the Protection of New Hampshire Forests and The Nature Conservancy, predicts that the population of Carroll County will increase 50% by 2020.

1.3 Water Quality Monitoring

Increased population, rapid residential and commercial development and expanded recreational use have put pressure and stress on Ossipee Lake and its rivers, making it necessary to implement a comprehensive Water Quality Monitoring (WQM) program. Routine water sampling and testing are essential for early detection of changes in water quality so that problems can be traced to their source before the lake becomes adversely affected.

Water quality data provides an understanding of how land use and underlying geological controls affect the water in our lakes, rivers and streams. Because we do not have past data or long term background information to review, it is difficult to determine if current land use practices are negatively affecting water quality. Compiling water quality data will allow us to determine the effectiveness or harmfulness of specific land use practices in maintaining good water quality. These determinations can further guide us in making informed decisions to protect the watershed's natural resources. Minimally impaired,

Figure 1:

reference sites, might serve as a standard by which data from other sites are compared to determine the level of impairment.

Water quality data commonly reflect land-use variations but can also be associated with short-term climatic variations, such as temperature and precipitation. For example, during dry periods pollutants accumulate in the uplands and are ultimately flushed into the receiving waters during storm events. However, some short-term data (immediately after a storm event) can be quite revealing.

2.0 Methods

2.1.1 Site descriptions

Testing occurred at each of the fifteen sites through out the Ossipee Watershed (Figure 1). The following sites were sampled during the 2003 season (note that volunteers helped to write many of these descriptions).

GE-1 Pine River, Elm Street, Effingham.

The Pine River flows from the southern boundary of the Ossipee Watershed, through the Pine River State Forest, through several wetlands including Heath Pond Bog and into Ossipee Lake near Ossipee Lake Natural Area. GE-1 is located where the Pine River flows under Elm Street. The site is in the downstream shadow of a modern bridge with substantial concrete abutments. A access lane leads to the site, which is obviously used regularly by recreational fishermen and beer drinkers. The river is about twenty feet wide. The current is steady enough to bend the subsurface weeds, but there are no surface ripples. Both up and downstream from the site, the river is open to the sky and mostly pines set back from both banks. This site was chosen because it is located downstream of two gravel pits as well as a designated drinking water zone. This site was also easily accessible

GE-2 South River, Plantation Road, Parsonsfield, Maine.

The South River flows from Province Lake and Lords Lake, through several wetlands and into Maine where it joins the Ossipee River. GE-2 is located just below the outlet of Lords Lake on Plantation Road. The testing site is immediately upstream from an aging concrete and steel bridge; the abutments are decaying and have clearly dropped cement into the river but some twenty feet below the actual test site. At the site, the river is about twenty feet wide, perhaps four to five feet deep toward the middle of the stream. The current is strong; there are several small rapids above and below the site. Much of the site gets direct sunlight, but the surrounding trees, mostly deciduous, overhang the river somewhat. There is some evidence of fishing activity. This site was chosen because it is located downstream of the town's transfer station and capped landfill. Potential road runoff is a concern as well. The site was also easily accessible.

GE-3 Ossipee River, Effingham Falls. New site in 2003.

The Ossipee River drains Ossipee Lake. GE-3 is located just below the Ossipee Lake dam. The site has a steep bank on one side. Deciduous trees dominate the landscape around the site. The flow is rapid, and the water level is largely variable due to dam

height and precipitation. This site was chosen to determine the quality of water as it leaves Ossipee Lake.

GF-1 Danforth Brook, Ossipee Lake Road, Freedom.

GF-1 is located where Danforth Brook flows under Ossipee Lake Road. It is a slow moving stream from Danforth Bay to Broad Bay. It is about 20 feet wide by 3-4 feet deep. Testing site is on the exit of Danforth about 150 feet. There is some outboard boat traffic entering Danforth from Broad Bay (1/day), but mostly canoe and kayak (2-3/day). Agitation exists in Danforth due to boat motors and water skiing. Site is surrounded by dense riparian vegetation. Some of this vegetation was cut early during the sampling season in 2003 and left exposed gravel. This test site was chosen to determine the impact of road run-off. Additional considerations were its accessibility and the fact that a previous study had been conducted.

GF-2 Cold River, Maple Street Bridge, Freedom

GF-2 is located in downtown Freedom Village where the Cold Brook flows under Maple Street. The sampling site is about 30 feet upstream from the dam that holds the Mill Pond. The pond is about 150 ft long, 20-25 feet across, with an average depth under 6 feet. The actual sample site is located within 10 feet of a bridge that carries much of the auto and foot traffic within the village of Freedom. The pond is quite still during most of the summer as water does not flow over the top of the dam, just through a particular spillway. There is little human interaction with the water in the pond except when it is stocked for the kids fishing derby and the plastic duck race. This test site was chosen to determine the impact of road run-off and because the Brook runs through the village of Freedom and is easily accessible. An additional consideration was that the Freedom Conservation Commission has data on this site that had been gathered over a 20 year period.

GF-3 Cold River, Inlet to Loon Lake, Freedom. New Site in 2003

GF-3 is located just upstream of its inlet to Cold Brook. Cold Brook flows through Freedom Village just below GF-2 and over a dam, and into Loon Lake. GF-3 is several hundred yards upstream of the Cold Brook inlet to Loon Lake. The sampling site has a rocky substrate with minimal aquatic vegetation. A swiftly moving riffle is directly upstream, but the flow is slower at the site. The site is surrounded by a mixed hardwood forest on one back and a pine forest on the other. Various wildlife inhabits the area including beaver and otter. This site was chosen because of concern over potential malfunctioning septic systems in Freedom Village.

GM-1 Banfield Brook, Route 113, Madison.

While not in the Ossipee Watershed, this site is in the greater Saco Watershed. The brook comes down from Pea Porridge Pond in Madison and runs under Route 113. There are some houses along the brook's upper reaches in the Eidelweiss development. Banfield is rocky, with generally clear water. It stumbles down over a low concrete ledge ten feet before our testing site. In the summer there are water striders on the surface of the brook. This test site was chosen to determine the impact of road run-off, erosion and

timber cutting to Pea Porridge Ponds. The stream also flows through the Eidelweiss development, located upstream of test site.

GM-2 Pequawket Brook, Route 113, Madison. New site in 2003

While not in the Ossipee Watershed, this site is in the greater Saco Watershed. GM-2 is off 113. It flows from a wetland at the edge of the watershed. There is a steep incline down to stream. The area surrounding the site is moderately wooded with deciduous trees. A large gravel operation near the stream is buffered only by twenty feet of forest. An abandon road leads up to stream embankment. Various wildlife such as beaver and river otter has been noted at the site occasionally. There is some erosion along banks and some dead fall of trees. Depth of stream varies with amount of rainfall. Stream has some aquatic growth and rocky/sandy in areas. This site was chosen because it's down stream of a large gravel operation.

GO-1 Beech River, Tuftonboro Road, Ossipee

The Beech River flows from Melvin Pond and Garland Pond in the southern Ossipee Mountains, along the Tuftonboro Road, and into the Pine River. The sampling location is where the river flows underneath the Tuftonboro Road. The stream is shallow with a rocky substrate. Deciduous trees surround the site. This site was chosen because of accessibility and because it is located upstream of a mill, dump and old tannery.

GO-2 Frenchman Brook, White Pond Road, Ossipee

GO-2 flows from Polly's Crossing, through a gravel pit, and into White Pond. This sampling site is immediately after the Brook flows under White Pond Road. The stream is less than one meter wide and has variable flow. There is a sandy bank on one side of the stream. The site is surrounded by dense riparian vegetation. This site was chosen because Frenchman Brook runs under Route 16 just upstream of the test site, and there is the potential for road run-off impact. In addition, dumping has previously occurred upstream.

GO-3 Frenchman Brook, Polly's Crossing, Ossipee. New site in 2003.

GO-3 is located in Polly's Crossing immediately downstream of a wetland. Sampling occurred where the stream flowed out of a culvert under a Class VI road. An upland forest surrounds the site. The stream is narrow and experiences intermittent flow during the drier months of the summer. This site was chosen because of concern over high nutrient levels seen at GO-2 in 2002 that suggest a disturbance is occurring upstream. This site will help pinpoint the source of the disturbance.

GS-1 Cold River, Route 113, Sandwich.

GS-1 is located where the Cold River passes under Route 113. Cold River drains several streams that flow out of the White Mountain National Forest and the Sandwich Range Wilderness including Flat Mountain Pond. The river is about ten meters wide. It is downstream from a riffle and has a rocky substrate. There is dense riparian vegetation on one side of the river and an upland deciduous forest on the other. This test site was chosen because of concerns about the gravel pit located upstream of the test site and because the river is situated upstream of Tamworth's drinking wellhead zone.

GT-1 Bearcamp River, Route 113, Tamworth.

The site is located under the bridge where Rout 113 crosses the Bearcamp in South Tamworth near the Community School. The Bearcamp drains several streams that flow from Mount Israel in Sandwich. At the sampling site, the Bearcamp is a straight stretch of slow moving tea stained water. The river is 50-60 feet wide with a sandy bottom with scattered cobble and boulder sized rocks. It is about four feet deep at its deepest spot during summer median water level. There is no forest canopy directly at the sampling site and it receives full sunlight with the exception of the portion under the bridge. There are red maples growing about 100 feet on either side of the bridge offering partial shade for much of the river. This site was chosen because of accessibility and because it provided a way for the students at The Community School to get involved with water testing. This site is located downstream of Tamworth's drinking water supply zone.

GT-2 Mill Brook, Earle Remick Natural Area, Tamworth.

This sampling site is located within the Earle Remick Natural Area. The Mill Brook flows from the White Mountain National Forest and the Sandwich Range Wilderness and past the recently-capped Tamworth landfill. The site is set amongst a hemlock forest. The stream is about five meters wide and is swift moving with a rocky substrate. This test site was chosen because Tamworth's recently closed dump is located upstream and because established and well-maintained trails provide accessibility.

GT-3 Mill Brook, Durrell Road, Tamworth. New site in 2003.

The site is located about one mile down Durrell Road on the North side of the road. The sampling site is on a straight stretch of stream with a steep slope leading down from the road and a relatively flat area on the opposite bank. Forest cover is dominated by eastern hemlock providing ample shade at the sampling site. The stream is straight, about 25-30 feet wide at the site and rather shallow: about 1-1.5 feet at its deepest point. It is about three to six inches deep where I sample. The bottom is dominated by sand and gravel with lost of cobble and bolder sized rocks scattered about. This site was chosen because of high nutrient levels seen at the downstream site (GT-2) in 2002 that suggests a disturbance has occurred up stream. Testing here will help pinpoint the source of this disturbance.

2.1.2 Testing Schedule

Sampling began on May 5 and ended on October 10. Sampling occurred twelve times (every other week) throughout this period. Sampling occurred between 7:00 and 9:00 am because of two factors that influence dissolved oxygen in streams. First, dissolved oxygen levels can be affected aw water temperatures rise throughout the day. Second, after a night of carbon dioxide-producing respiration, aquatic plants and algae begin producing oxygen through photosynthesis, thereby altering oxygen levels in the water. In order to maintain consistent dissolved oxygen measurements, it is important to test at the same time of day during each sampling period.

2.1.3 Parameters

Seventeen parameters were tested in the tributary monitoring program. Four parameters were tested in the field by volunteers and GMCG staff (Table 1). These parameters were recorded on a data sheet (Appendix A) and replicated. For instructions on how to use field parameter equipment, refer to Appendix B.

Table 1: Field parameters tested.

Parameter	Units	Instrument Used	Range	Accuracy
pH	pH units	YSI 60	0 to 14	±0.1 unit within 10°C of calibration ±0.2 unit within 20°C
Dissolved Oxygen	mg/l, %	YSI 550A	0-50 mg/L 0-500% air saturation	0-200 % : ±2% air sat. or ±2% of reading, whichever is greater 200-500% : ±6% of reading 0-20 mg/L : ±0.3 mg/L or ±2% of reading, whichever is greater 20-50 mg/L : ±6% of reading
Turbidity	NTU	HACH Model 2100P Portable Turbidimeter	0-1000 NTU	+/- 2% of reading
Temperature	° C	HACH Non-mercury thermometer	-5 to 45°C	+/- 0.3° C

Fourteen additional chemical parameters were tested (Table 2). Two water samples were collected in 250 ml bottles at each site. One sample was acidified with one milliliter of concentrated sulfuric acid then frozen. The other sample was filtered using a 47 mm diameter 0.45 micron mesh Whatman filter, stored in a 60 ml bottle and frozen.

Table 2: Lab parameters tested.

Parameter	Units	Instrument Used	Description	Sample Preservative
Total Phosphorus (TP)	ppb	Milton-Roy 1001 ⁺ Spectrophotometer	Std Methods Ascorbic Acid method. 10cm pathlength cuvette	1 ml concentrated sulfuric acid and frozen
Dissolved Organic Carbon (DOC)	mg C/L	Shimadzu TOC 5000 with autosampler	High Temperature Catalytic Oxidation (HTCO)	Filtered and Frozen
Total Dissolved Nitrogen (TDN)	mg N/L	Shimadzu TOC 5000 coupled with an Antekk 720 N detector	HTCO with chemiluminescent N detection	
Nitrate (NO ₃ ⁻)	mg N/L	Lachat QuikChem AE	Automated Cd-Cu reduction	
Ammonium (NH ₄ ⁺)	mg N/L		Automated Phenate	
Dissolved Organic Nitrogen (DON)	mg N/L		DON= TDN-(NO ₃ ⁻ + NH ₄ ⁺)	
Phosphate (PO ₄ ³⁻)	mg P/L	Lachat QuikChem AE	Automated Ascorbic Acid	
Silica (SiO ₂)	mg SiO ₂ /L		Automated Molybdate Reactive Method	
Anions (Cl ⁻ , SO ₄ ²⁻)	mg/L	Ion Chromatograph	Anions via ion chromatography with suppressed conductivity	
Cations (Na ⁺ , K ⁺ , Ca ²⁺ , Mg ²⁺)	mg/L		Cations via ion chromatography and conductivity	

3. Summary and Discussion

3.1 Precipitation

Precipitation can have a significant impact on water quality. Periods of heavy rainfall, as well as the period of spring snowmelt, often coincide with the increased transport of pollutants and sediments into our surface waters that include lakes, streams and wetlands. Likewise, the water that infiltrates the soil and enters our surface waters as groundwater recharge can be laden with minerals that occur naturally, through the weathering of mineral formations, as well as, from human sources such as septic system effluent, leaching fertilizers and road salt applications. However, dry periods are often characterized by a reduction in the overland pollutant transport into our surface waters. During these dry periods, pollutants often accumulate in the watershed until the following heavy storm event or wet period provides a means of transporting debris, nutrients and other materials into our water bodies.

Precipitation during the first half of 2003 was less than the three year average of 2001-2003 (Figure 2). However, precipitation in July through August of 2003 was higher than the previous two years. Through anecdotal and observational evidence, precipitation in September through November of 2003 was also higher than the three year average.

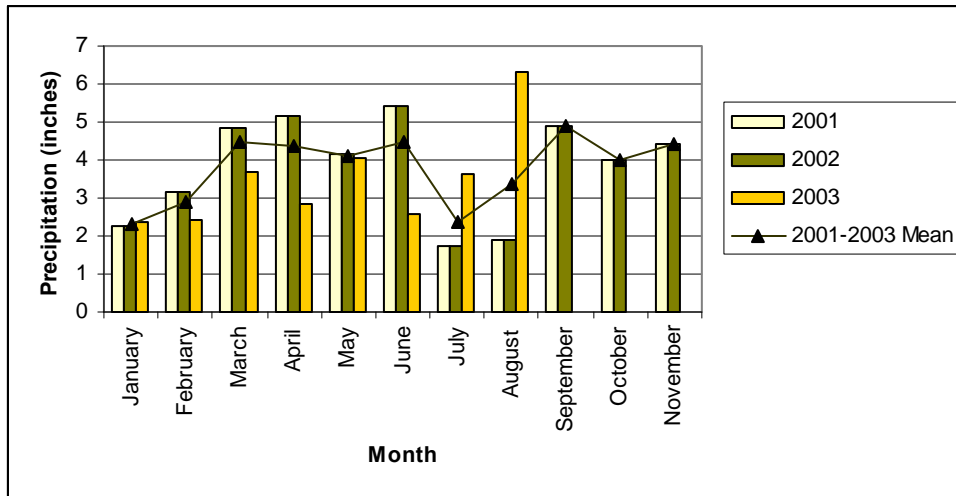


Figure 2: Tamworth precipitation, 2001-2003

3.2 Temperature

The temperature and range of temperatures that occur at the stream site will limit the type of stream organisms that can survive at their respective location. Processes, such as the removal of shoreside vegetation, that increase the water temperature, generally have a negative impact on the aquatic organisms. Raising temperatures will also reduce the water's capacity to hold oxygen and might further impact the suitability of these streams to harbor aquatic life including certain fish species. For example, temperatures in excess of 19°C are often considered intolerable to trout.

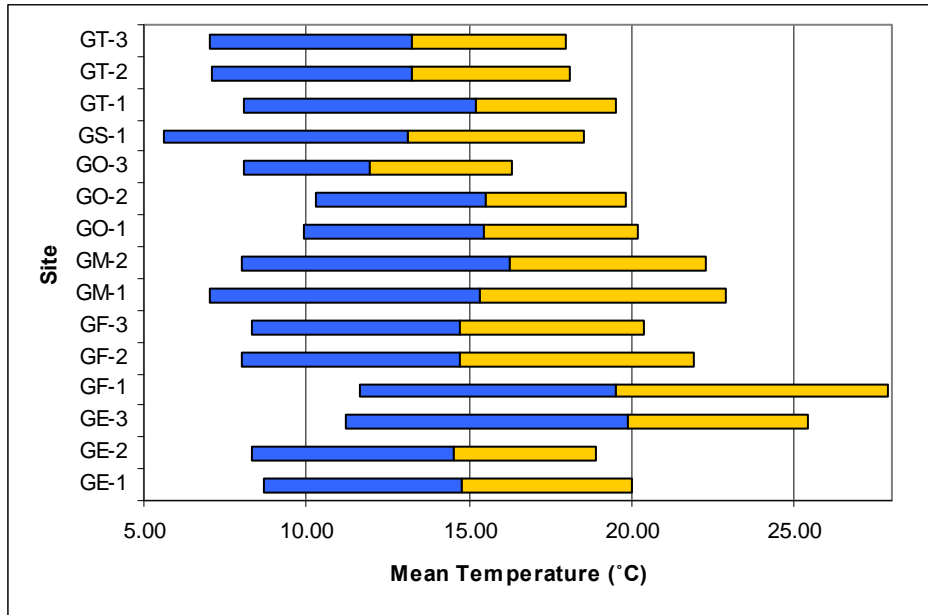


Figure 3: Ossipee Watershed inter site temperature comparison. Bars show range of temperatures. Darker bars show range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

Temperatures were variable across the Ossipee Watershed (Figure 3). The highest temperatures were observed at GF-1 and GE-3, both outlets to bodies of Ossipee Lake. While GF-3 was a new site this year, high temperatures were also observed in 2002 at GF-2. In fact, the temperatures at these two sites during the summer months are similar to temperatures seen at OLPP tributary sites. The lowest mean temperature was seen at site GO-3. However, this site was dry during the warmer months of the summer and was only sampled during May, June and October.

Mean temperatures at each site in 2003 were lower than 2002 (Figure 4). Lower temperatures could be attributed to higher rainfall experienced in 2003 than 2002.

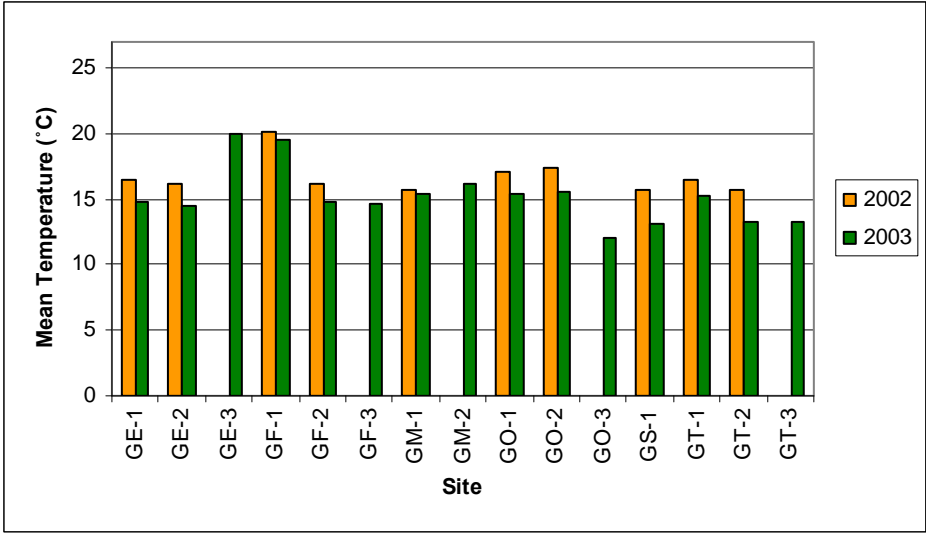


Figure 4: Ossipee Watershed site temperature comparison for 2002 and 2003.

3.3 Dissolved Oxygen

Oxygen is an essential component for the survival of aquatic life. Submergent plants and algae create oxygen through photosynthesis during the day. Respiration by both plants and animals consume oxygen continually. Respiration is associated with the natural bacteria, fungi and other decomposers in the stream that break down organic matter that enters the stream from upland sources, as well as, from the water originating from up-gradient lakes, wetlands and the stream itself. Oxygen can also be replenished in the streams through the turbulent mixing of the air and water, particularly in fast flowing and rocky stream reaches that facilitates the rapid diffusion of atmospheric oxygen into the stream water.

The capacity of the water to hold oxygen is temperature dependent; warmer water has a lower capacity to hold oxygen. Thus, you will generally measure less in-stream dissolved oxygen during the summer months than during the early spring and late fall months. To account for this interdependence of temperature and dissolved oxygen content, the dissolved oxygen data are oftentimes expressed as percent saturation which reflects the oxygen measured relative to the water's capacity to hold oxygen at a given temperature.

The dissolved oxygen concentrations in the Ossipee Watershed ranged from 3.74 mg/L at GE-2 and 5.34 mg/L at GM-2 to 12.65 mg/L at GT-3 and 12.60 mg/L at GS-1 (Figure 5). The low readings at GE-2 could be due to sampling error. Sites GT-3 and GS-1 are relatively undisturbed. GS-1 was found to be the site with that provides the best example of good water quality in the Ossipee Watershed during the 2002 RIVERS program. Percent saturations in the Ossipee Watershed ranged from 61.7% at GM-2 to 108.4% at GF-1 (Figure 6). As seen in Figure 7, most sites have a similar dissolved oxygen concentration in 2003 as in 2002.

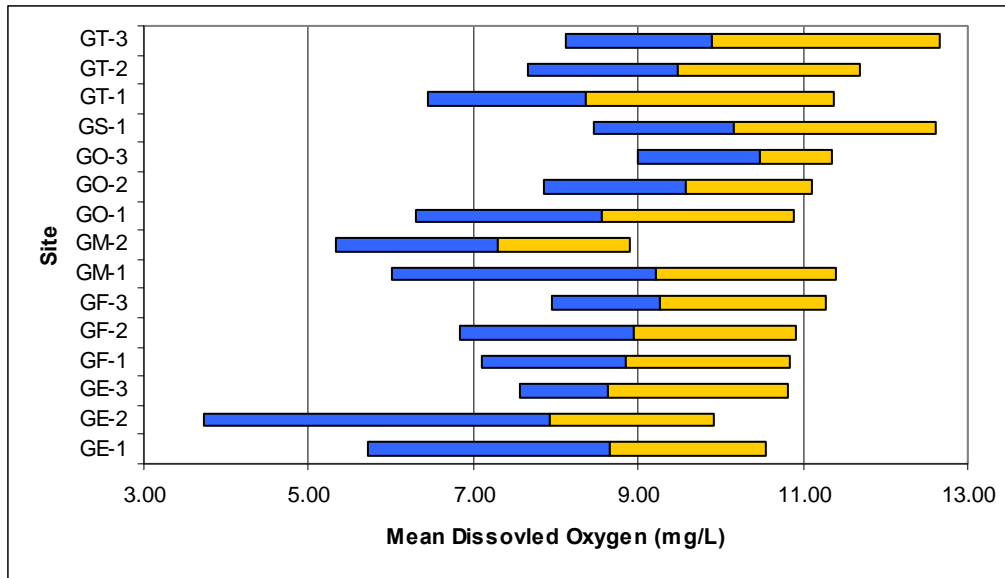


Figure 5: Ossipee Watershed dissolved oxygen concentration site comparison. Bars show range of dissolved oxygen concentrations. Darker bars show range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

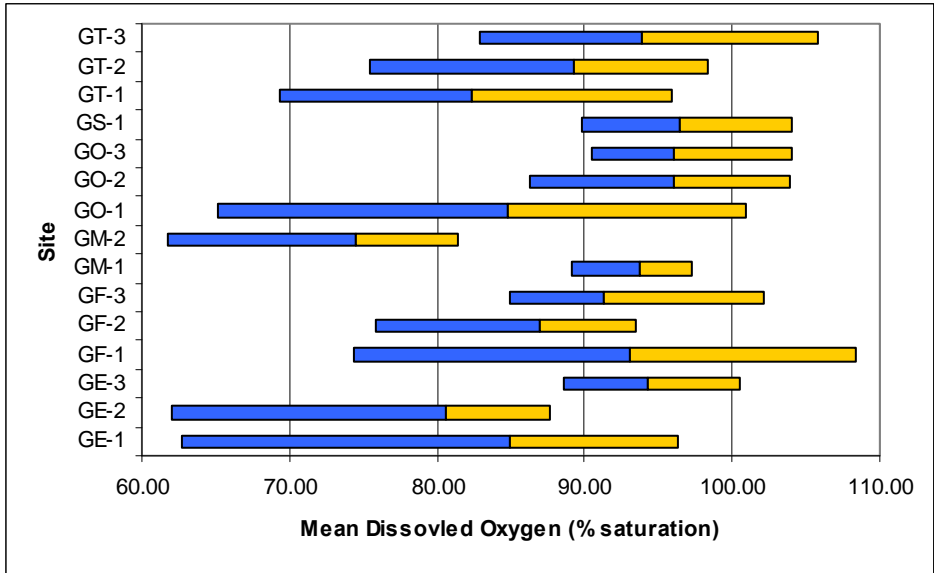


Figure 6: Ossipee Watershed dissolved oxygen percent saturation site comparison. Bars show range of dissolved oxygen concentrations. Darker bars show range less than the mean. Lighter bars show range greater than the mean.

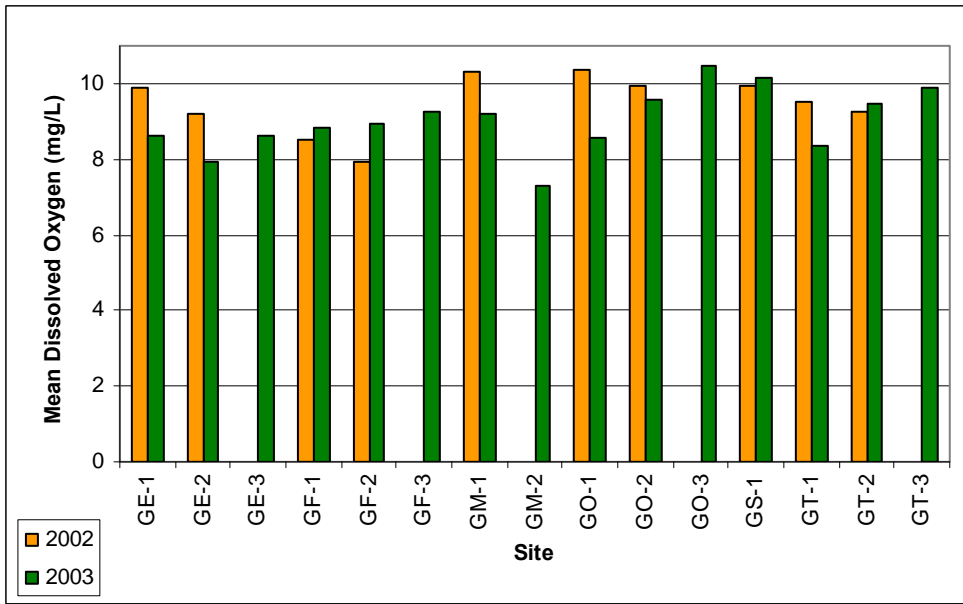


Figure 7: Ossipee Watershed site dissolved oxygen comparison for 2002 and 2003.

3.4 pH

The pH is a way of expressing the acidic level of stream water and is generally measured with an electrical probe sensitive to hydrogen ion activity. The pH scale has a range of one (very acidic) to fourteen (very “basic” or alkaline) and seven is neutral. The scale is neutral; changes in 1 pH unit reflect a ten times difference in hydrogen ion concentration. Most aquatic organisms tolerate a limited range of pH and most fish species require a pH of 5.5 or higher to grow and reproduce successfully. Wide pH fluctuations associated with industrial pollution and acid precipitation are generally considered the most severe acidic stressors to instream aquatic organisms. In New Hampshire, the spring runoff period is often considered the period during which the aquatic organisms are most susceptible to acid rain stress.

2003 pH in the Ossipee Watershed ranged from 2.40 at GT-2 to 7.88 at GF-1 (Figure 8). Mean pH in 2003 was lower at all sites and dates in 2003 than in 2002 (Figures 9). GMCG began using new pH equipment in 2003. Volunteers frequently had trouble with the new pH meter and one was sent back twice for service. It is unknown if the meters are the reason behind the pH discrepancy. In addition, the higher volume of rain in 2003 could be reason for lower pH. However, sites along the Saco River, as measured by the volunteers of the Saco River Corridor Commission, did not exhibit a similar trend.

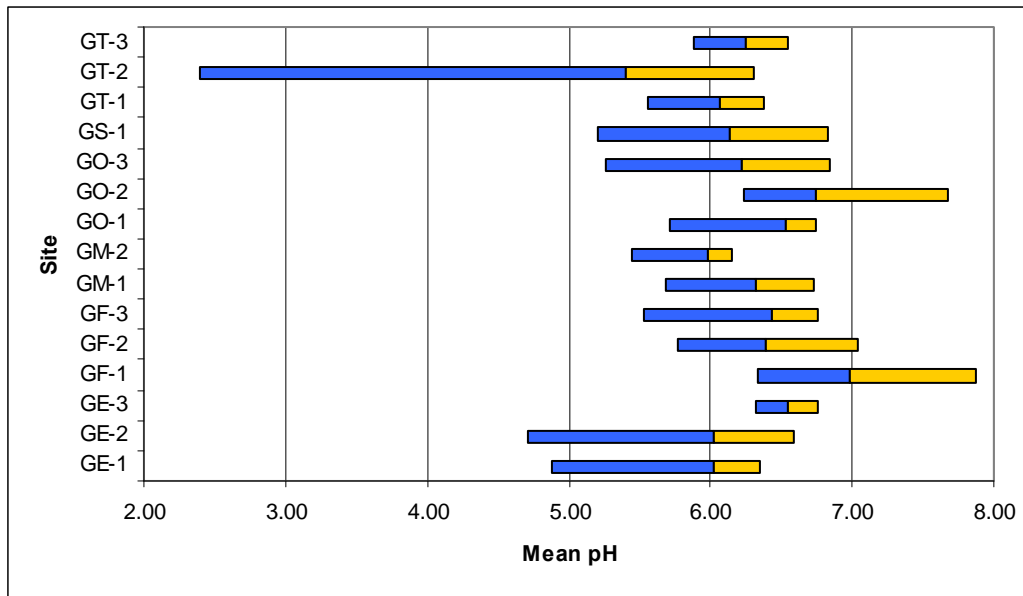


Figure 8: Ossipee Watershed site pH comparison. Bars show range of pH. Darker bars shows range less than the mean. Lighter bars show the range greater than the mean. Mean value is at point where dark and light bars meet.

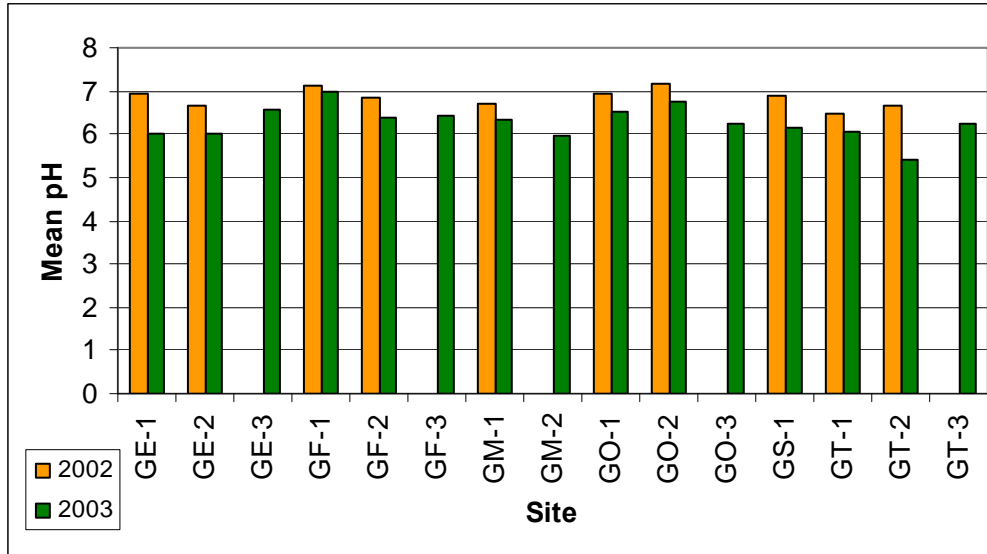


Figure 9: Ossipee Watershed site pH comparison for 2002 and 2003.

3.5 Turbidity

The amount of suspended material in the stream is referred to as the turbidity. Turbidity can be summarized by the amount of sediments, silt, algae, leaves, pollen and other solid debris that are suspended in the water column. The turbidity is measured with an electronic meter called a nephelometer and the turbidity is reported at nephelometric turbidity units (NTU). Many chemical pollutants and nutrient are commonly attached to silt particles and in some instances the turbidity might be used as a surrogate for other more expensive and involved analyses such as total phosphorus measurements (Figure 10). However, it does not appear that total phosphorus in Ossipee Watershed sites is related to turbidity. Besides the chemical pollutants and nutrients that are commonly attached to silt particles, the silt particles themselves can cause great in-stream changes. Silts can cover up nesting and prime habitat areas and can be highly abrasive to the gill structure of many aquatic organisms.

The mean turbidity in the Ossipee Watershed ranged from 0.19 NTU at GS-1 to 4.36 at GO-2 (Figure 11). With considerably more rainfall in 2003 than 2002, it is expected that some sites will exhibit higher turbidity (Figure 12).

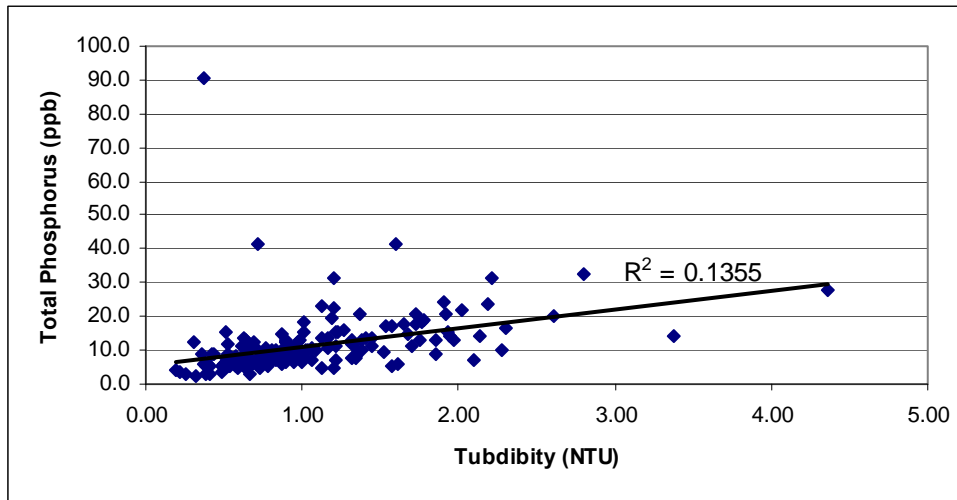


Figure 10: Total phosphorus vs. turbidity for Ossipee Watershed, 2003.

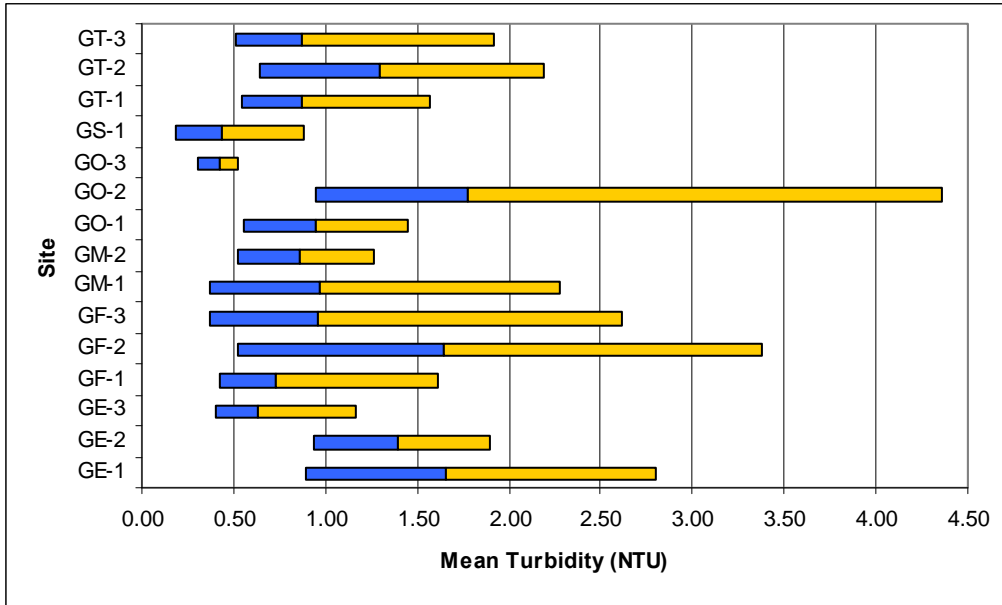


Figure 11: 2003 Ossipee Watershed inter site turbidity comparison. Bars show range of turbidity. Darker bars show range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

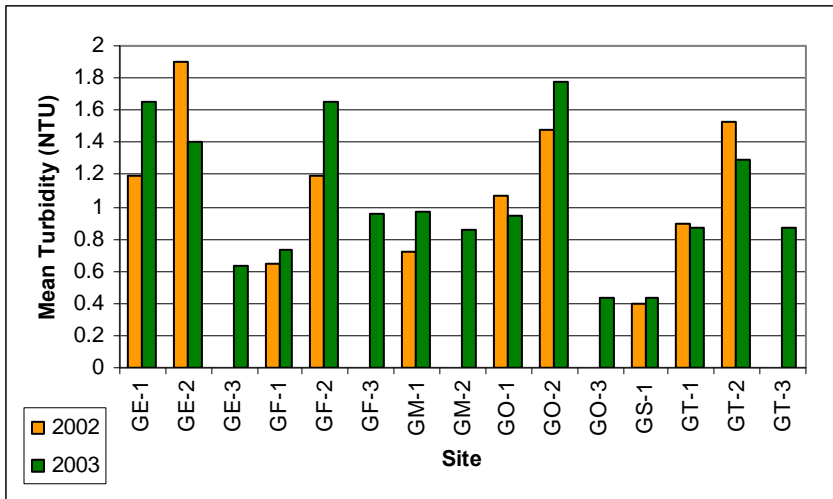


Figure 12: Ossipee Watershed site turbidity comparison for 2002 and 2003.

3.6 Total Phosphorus

Of the two nutrients most important to the growth of aquatic plants, nitrogen and phosphorus, it is generally observed that phosphorus is the more limiting to plant growth in freshwater systems. Phosphorus is primarily associated with human related activities within the watershed and is therefore important to monitor and control. The total phosphorus includes all dissolved phosphorus as well as the phosphorus contained in or adhered to suspended particles such as sediment and plankton. Total phosphorus will accumulate in the slow moving stream reaches and in impoundments where the particulate bound phosphorus settles out of the water column. These localized phosphorus rich regions can then serve as phosphorus sources that result in localized algal blooms and related water quality problems.

Total phosphorus in the Ossiipee Watershed in 2003 ranged from 2.50 ppb at GS-1 to 90.80 ppb at GM-1 (Figure 13). The low total phosphorus level at GS-1 is comparable to the low levels observed in 2002 (Figure 14). However, in 2002, the only site with a mean total phosphorus lower than GS-1 was GM-1. The high mean seen in 2003 was a one time event early in the sampling season. The cause of this total phosphorus surge at GM-1 is unknown.

Mean total phosphorus at each site was higher in 2003 than 2002 (Figure 14). This could be due to the high rainfall during the later part of the year. However, it should be expected that high total phosphorus due to rain is coupled with high turbidity. This was not seen in 2003.

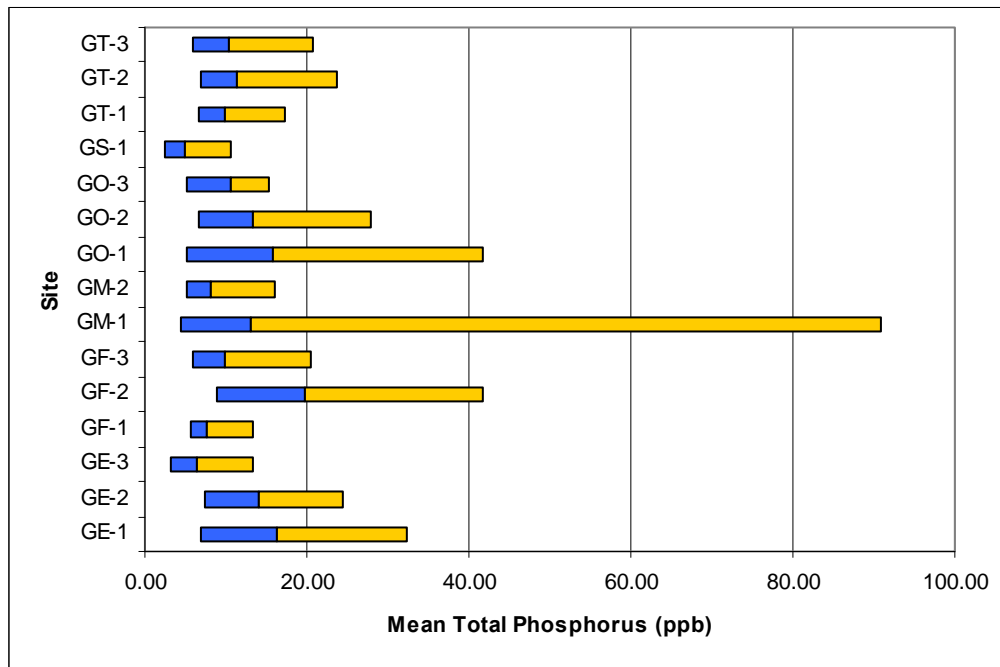


Figure 13: 2003 Ossiipee Watershed total phosphorus site comparison. Darker bars shows range less than the mean. Lighter bars show the range greater than the mean. Mean value is at point where dark and light bars meet.

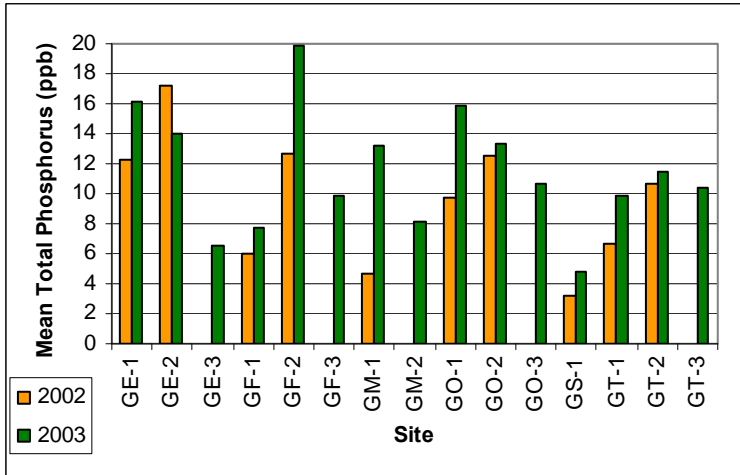


Figure 14: Ossipee Watershed site total phosphorus comparison for 2002 and 2003.

3.7 Phosphate

Phosphorus is often the limiting nutrient in streams and phosphate is the most biologically available form of phosphorus. Phosphate, a component of total phosphorus is typically very low in natural systems. Total phosphorus and phosphate are related. However, it is impossible for phosphate to exceed total phosphorus. By examining the total phosphorus and phosphate data, it is clear that there have been not lab errors, and total phosphorus exceeds phosphate levels (Figure 15). Sewage and agricultural inputs will increase PO_4^{3-} levels. High levels of phosphate can lead to problematic algal blooms and eutrophication. Sometimes low light levels limit production in a phosphate rich environment.

Phosphate ranged from zero at most sites to 21.2 $\mu\text{g P/L}$ at GF-2 at all sites except for GM-2 and GT-2 where the respective maximum phosphate concentrations were 74.1 and 44.0 $\mu\text{g P/L}$ (Figure 16). Phosphate levels in 2003 were varied from 2002 (Figure 17). For some sites, this variation could be a result of higher precipitation amounts.

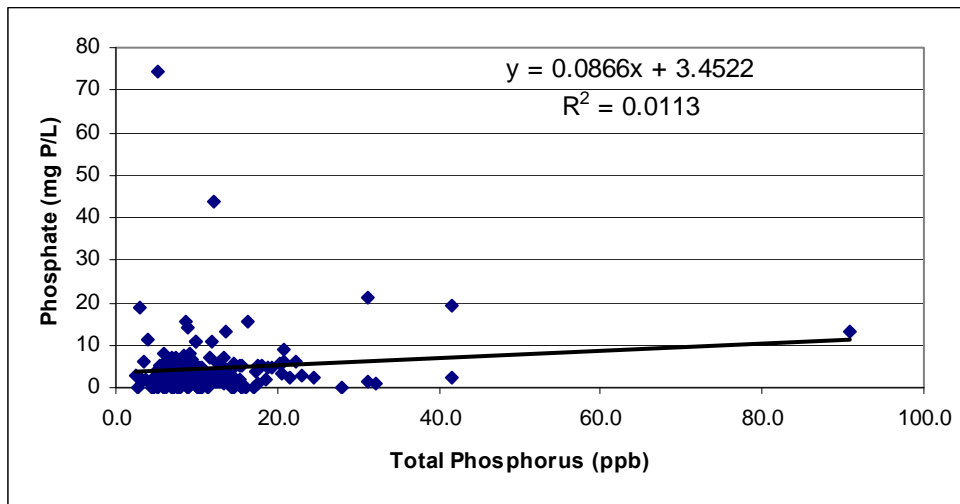


Figure 15: Comparison of phosphate and total phosphorus measurements in Ossipee Watershed testing locations, 2003.

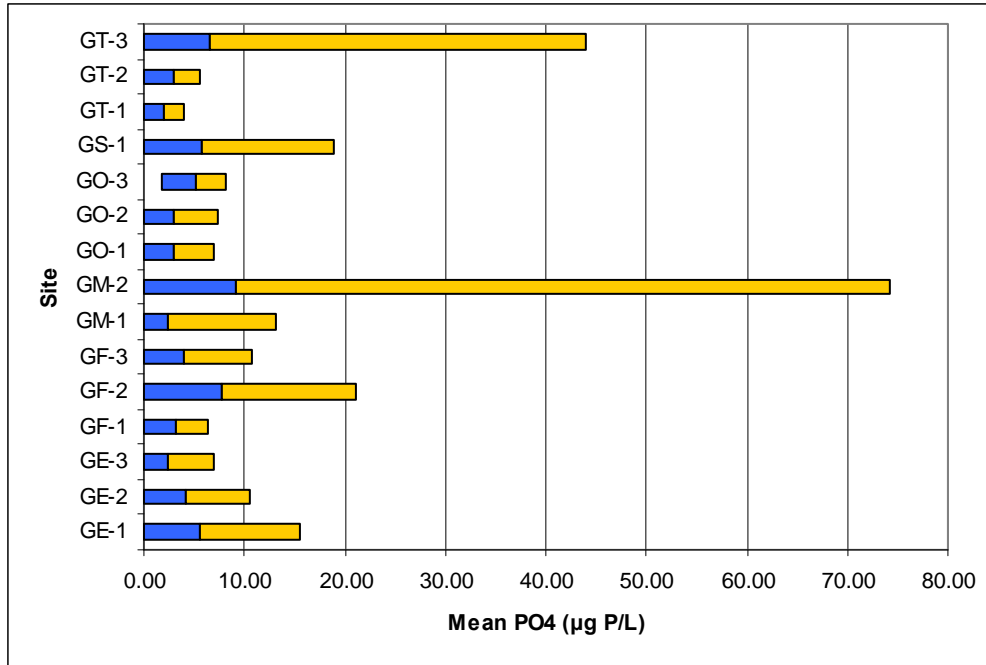


Figure 16: 2003 Ossipee Watershed site phosphate comparison. Bars show range of phosphate concentrations. Darker bars shows range less than the mean. Lighter bars shows range greater than the mean. Mean value is at point where dark and light bars meet.

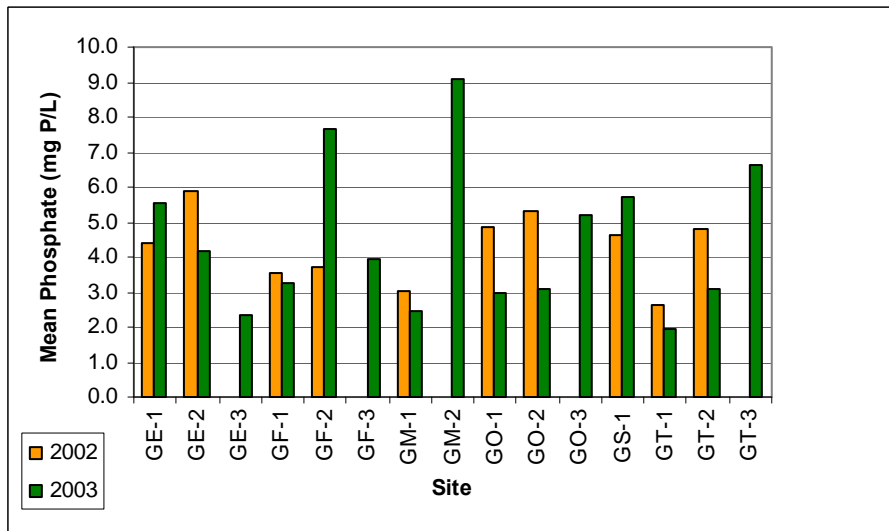


Figure 14: Ossipee Watershed site phosphate comparison for 2002 and 2003.

3.8 Dissolved Organic Carbon

Dissolved organic carbon occurs naturally, through leaching and breakdown of organic material. The brown color of stream water is due to DOC (although color is not always an indicator of DOC concentration). DOC can be naturally occurring. Most DOC in streams is terrestrially derived (comes from outside the stream). Forest soils and wetland are a source of DOC. In addition to natural sources, DOC can also come from anthropomorphic inputs. Dissolved organic carbon affects the complexation, solubility and mobility of heavy metals. Generally, if metals are present, they can complex with DOC and make their way to surface water. Chlorination of high DOC water can cause the formation of trihalomethanes, which have been linked to cancer, reproductive problems and other health issues.

Mean DOC concentrations in the Ossipee Watershed ranged from 1.38 mg C/L at GF-2 to 19.97 mg C/L at site GE-2 (Figure 15). The high concentrations at both GE-1 and GE-2 are most likely due to wetlands upstream of the sampling sites. Mean DOC concentrations in 2003 were higher at each site than in 2002 (Figure 16). This increase could be a result of increased precipitation.

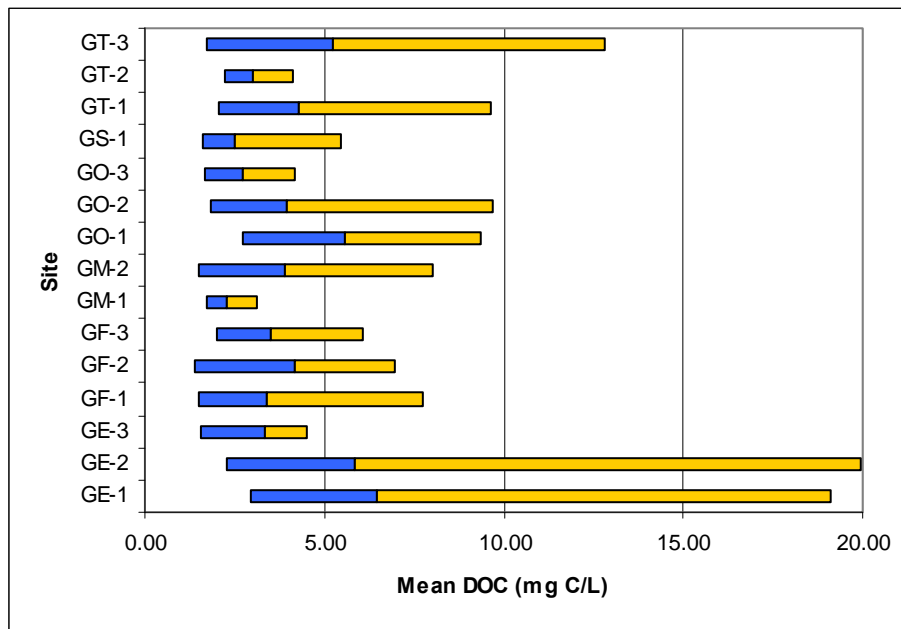


Figure 15: 2003 Ossipee Watershed site DOC comparison. Bars show range of DOC concentrations. Darker bars shows range less than the mean. Lighter bars shows range greater than the mean. Mean value is at point where dark and light bars meet.

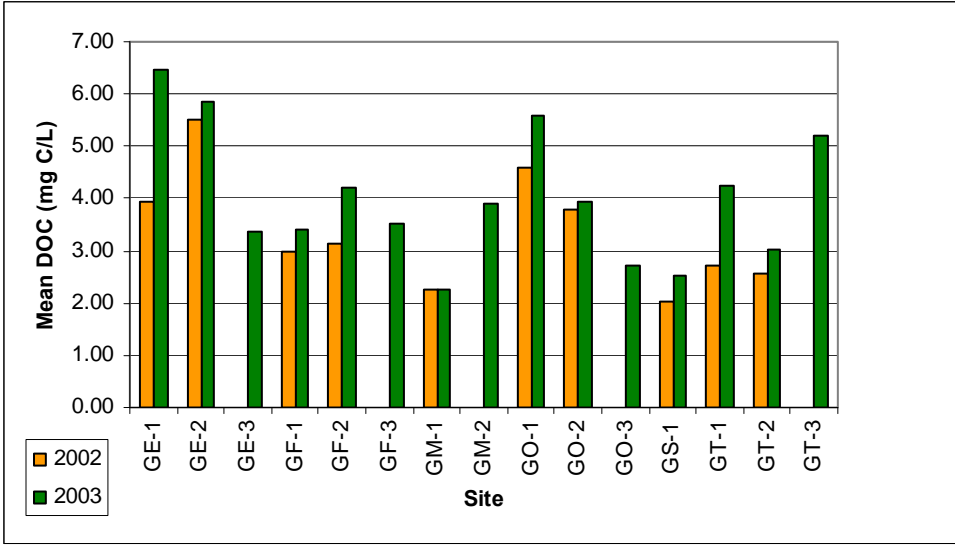


Figure 16: Ossiipee Watershed site DOC comparison for 2002 and 2003.

3.9 Nitrogen

Nitrogen is an important nutrient which is sometimes limiting in stream water, and unwanted algal blooms may result from excess nitrogen loading. Nitrogen is either organic or inorganic. Dissolved inorganic nitrogen (DIN) is the sum of the two forms of inorganic nitrogen, nitrate (NO_3^-) and ammonium (NH_4^+). Nitrate occurs naturally from nitrification of NH_4^+ to NO_3^- . Nitrification occurs in an oxic (oxygen rich) environment (such as stream water) where microbes convert NH_4^+ to nitrite (NO_2^-), and NO_2^- is quickly converted to NO_3^- for energy. The conversion of NO_2^- to NO_3^- is so fast that NO_2^- is usually undetectable in stream water, and NO_2^- is assumed to be zero. Elevated levels of nitrate indicate pollution from sewage, run off, agriculture or other anthropogenic activity. Nitrate contamination of drinking water can cause Methemoglobinemia, a serious illness in infants where respiration is inhibited. Ammonium is the preferred form of nitrogen for plant and microbial uptake since it is more energy efficient to use than nitrate. However, ammonium is typically very low in undisturbed streams. Ammonium is the product of organic breakdown and high levels of ammonium typically indicate some type of pollution (sewage, run off, agricultural). Dissolved organic nitrogen can be an important source of nitrogen for plants and microbes depending on the availability of DIN. In most undisturbed ecosystems, DON dominates TDN (DON is greater than DIN) and DIN tends to dominate TDN (DIN is greater than DON) in disturbed systems. Like DOC, DON complexes heavy metals and is generated largely in wetlands and forests soils.

Mean TDN concentrations among the Ossipee Watershed sites were relatively low (Table 3 and Figure 20) and ranged from 0.09 mg N/L at site GO-3 and GS-1 to 0.24 mg N/L at GO-2 and GT-2. Dissolved organic nitrogen ranged from 0.06 mg N/L at several sites including GO-3, GS-1 and GT-2 to 0.17 at GO-1. At all sites, mean nitrate concentrations were less than 0.09 mg N/L. Mean ammonium concentrations were less than 0.040 mg N/L at all sites except for GT-2, where the mean concentration was 0.095 mg N/L.

Table 3: Nitrogen concentrations in the Ossipee Watershed in 2002 and 2003. All concentrations are in mg/L.

Site	N as Nitrate		N as Ammonium		TDN		DON	
	2002	2003	2002	2003	2002	2003	2002	2003
GE-1	0.049	0.05	0.020	0.012	0.20	0.23	0.127	0.16
GE-2	0.016	0.02	0.030	0.015	0.22	0.17	0.178	0.14
GE-3		0.02		0.010		0.12		0.09
GF-1	0.007	0.01	0.017	0.012	0.14	0.12	0.112	0.09
GF-2	0.035	0.02	0.021	0.019	0.17	0.23	0.109	0.19
GF-3		0.06		0.008		0.18		0.12
GM-1	0.039	0.03	0.027	0.016	0.17	0.12	0.102	0.08
GM-2		0.02		0.013		0.13		0.09
GO-1	0.030	0.02	0.015	0.015	0.17	0.20	0.125	0.17
GO-2	0.082	0.09	0.024	0.016	0.27	0.24	0.169	0.13
GO-3		0.02		0.010		0.09		0.06
GS-1	0.049	0.03	0.014	0.006	0.14	0.09	0.053	0.06
GT-1		0.02		0.008		0.14		0.11
GT-2	0.027	0.09	0.018	0.095	0.15	0.27	0.086	0.08
GT-3	0.086	0.05	0.097	0.039	0.23	0.26	0.049	0.17

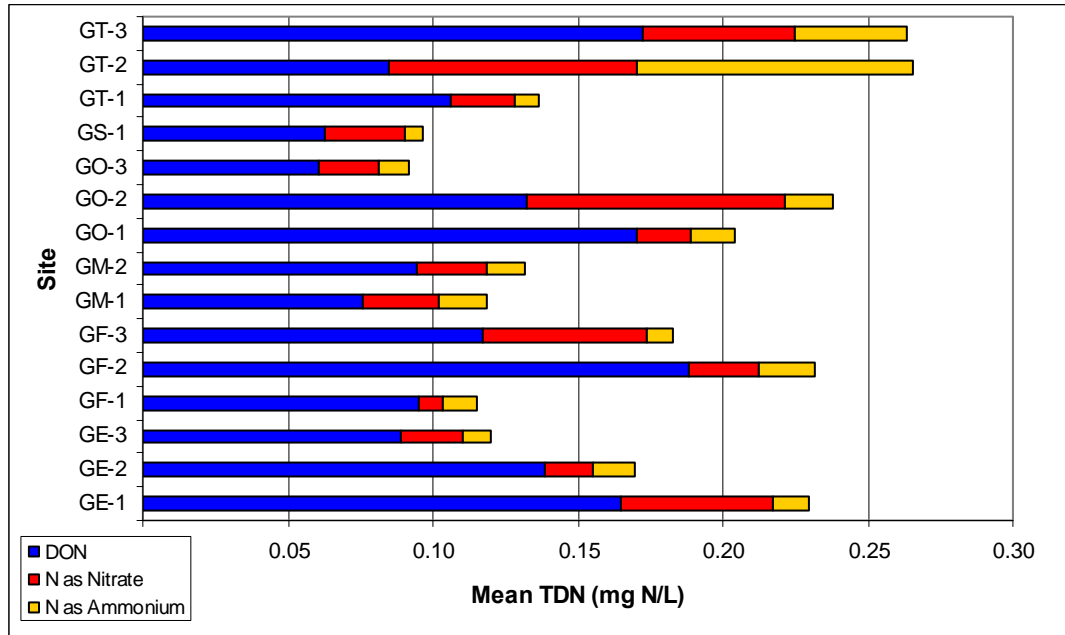


Figure 20: Mean TDM concentrations among the Ossipee Watershed sites in 2003 with fractions of DON, nitrate and ammonium shown.

Mean DON comprised of more than 55% of the mean TDN at all sites except for GT-2 and GT-3, where DIN dominated TDN. At site GT-3, mean DON was 49.34% of the mean TDN. As organic nitrogen typically dominates in unimpaired systems, the low percentage of DON at site GT-2 (27.2%) could be indicative of an impairing input. However, the percentage of organic nitrogen at site GT-2 has increased from 2002.

3. 10 Dissolved Organic Matter

Dissolved organic carbon and DON are both part of dissolved organic matter (DOM). An organic compound found naturally more than likely contains both carbon (C) and nitrogen (N). The quantity of C and N found in DOM is indicated by DOC and DON. Researchers often look at the DOC:DON (or C:N) ratios to determine the quality of the DOM (or how digestible it is). A lower C:N ratio generally indicates higher quality (more digestible) DOM. Dissolved organic carbon and DON are often positively related to each other as they are chemically bound together (when DOC increases so does DON), but this relationship may vary over space and time. Dissolved organic carbon and DON are not necessarily controlled by the same mechanisms. The regression line on Figure 21 does not seem to represent a strong linear relationship between DOC and DON. There is a lot of scatter around the line indicating that it may not be possible to accurately infer one from the other. This relationship is, however, more significant than in 2002.

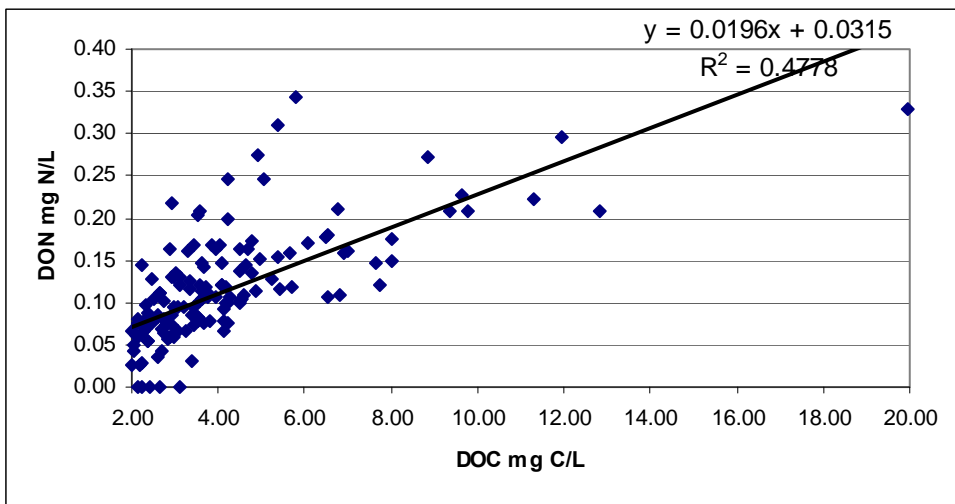


Figure 21: The relationship between dissolved organic nitrogen and dissolved organic carbon for samples collected from the Ossipee Watershed during the 2003 sampling season.

3.11 Sodium and Chloride

Sodium and chloride are present in nature, but higher levels can be indicative of road salt application and elevated chloride may indicate domestic sewage contamination. Natural levels can vary depending on geology. For example, in the Seacoast Region of NH, sodium and chloride are quite high due to marine clays and sediments in the landscape. Sodium and chloride are typically related to each other. Sodium and chloride were related to each other in the Ossipee Lake tributary sites. The linear regression line in Figure 22 appears to represent a strong linear relationship between sodium and chloride.

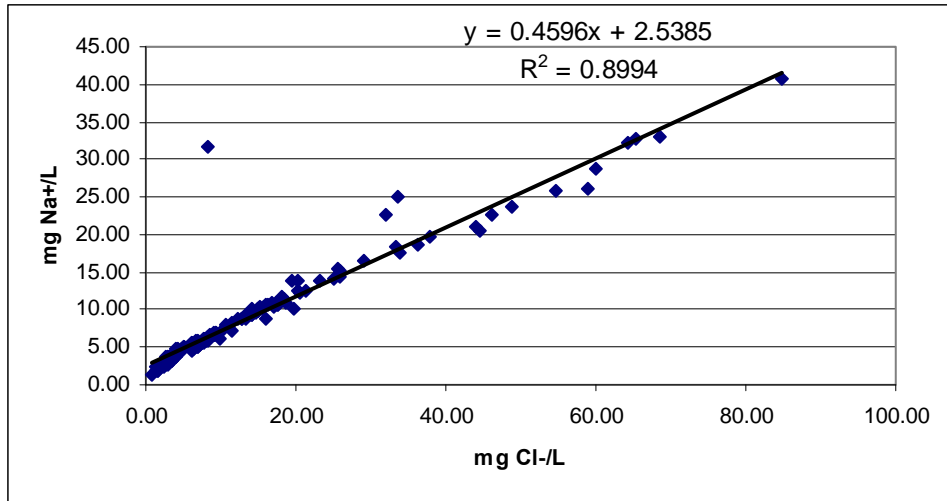


Figure 22: The relationship between sodium and chloride concentrations among the Ossipee Watershed, 2003.

Mean sodium concentration was 12 mg/L at all sites except for GM-1 and GO-2 (Figure 23). Mean chloride concentrations was less than 20 mg/L at all sites except for GM-1 and GO-2 (Figure 24). Elevated sodium and chloride concentration could indicate contamination from road salt application. Trends observed in 2002 were similar.

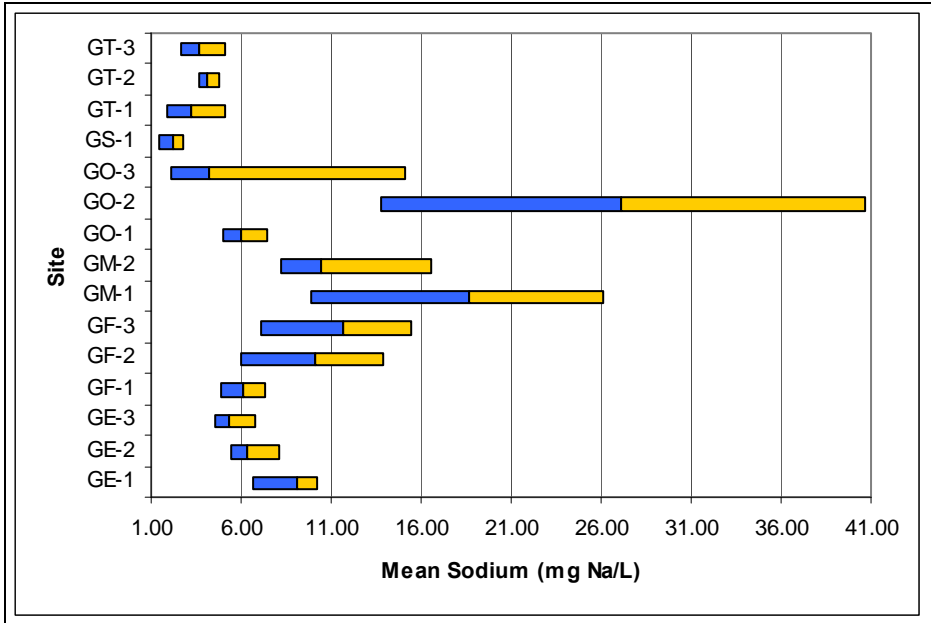


Figure 23: 2003 Ossipee Watershed site sodium comparison. Bars show range of sodium concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

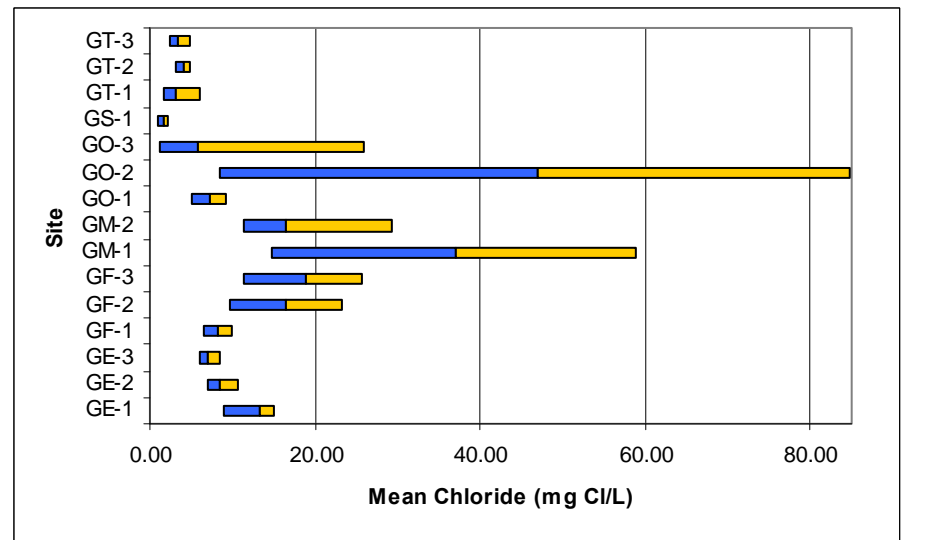


Figure 24: 2003 Ossipee Watershed site chloride comparison. Bars show range of chloride concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean.

3.12 Sulfate

Sulfate occurs naturally from weathering. Historically, acid rain resulted in elevated sulfate levels, but acid rain is not as problematic today. Sulfate concentrations ranged from 0.44 mg S/L at GF-2 and 11.37 mg S/L at GF-3 (Figure 25). Sulfate concentrations were lower in 2003 than in 2002 (Figure 26).

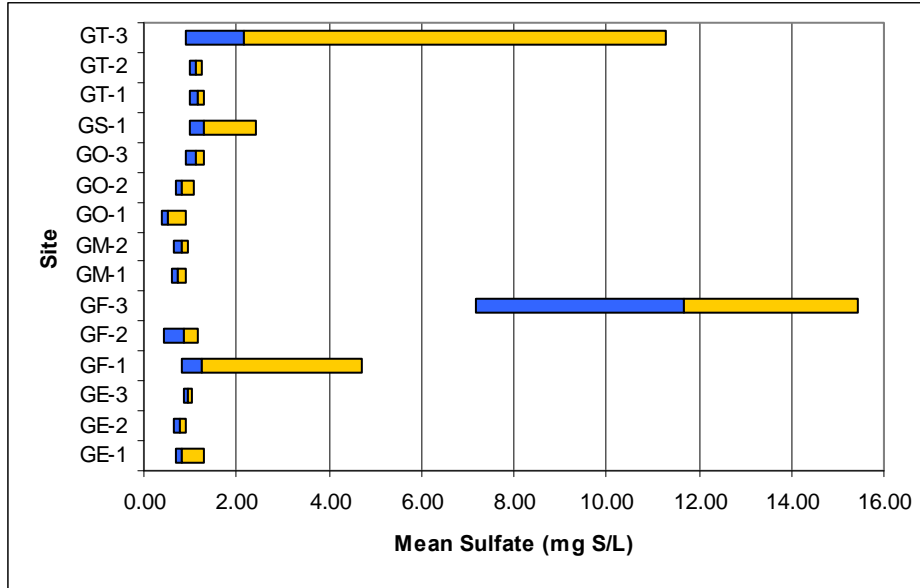


Figure 25: 2003 Ossipee Watershed site sulfate comparison. Bars show range of sulfate concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

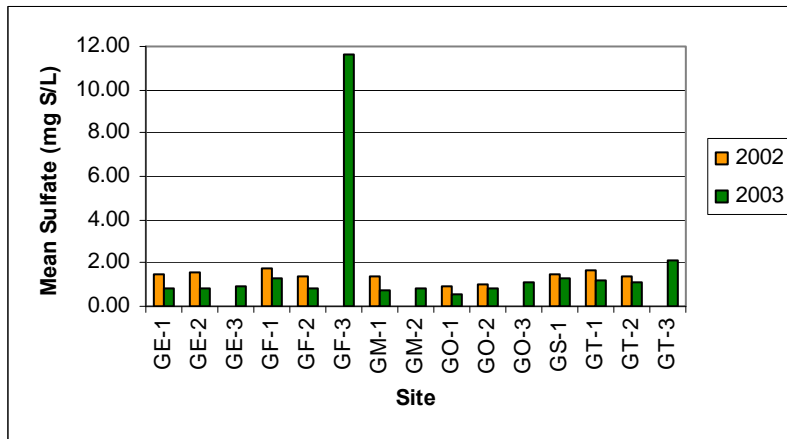


Figure 26: Ossipee Watershed site sulfate comparison for 2002 and 2003.

3.13 Silica

Silica is naturally produced during the weathering processes and is important for diatom growth and productivity. Silica can be used as a ground water tracer since groundwater has higher concentrations of SiO_2 than rain and run off. In the Ossipee Watershed sites, silica concentrations ranged from zero at GF-1 to 8.94 mg/L at GE-1 (Figure 27).

Though the maximum range in silica measurements was greater in 2003 than 2002, the mean silica concentration at all sites in 2003 was less than in 2002 (Figure 28). Several sites experienced a large decrease in mean silica values between the two years. These sites most likely received much of their flow through groundwater during 2002.

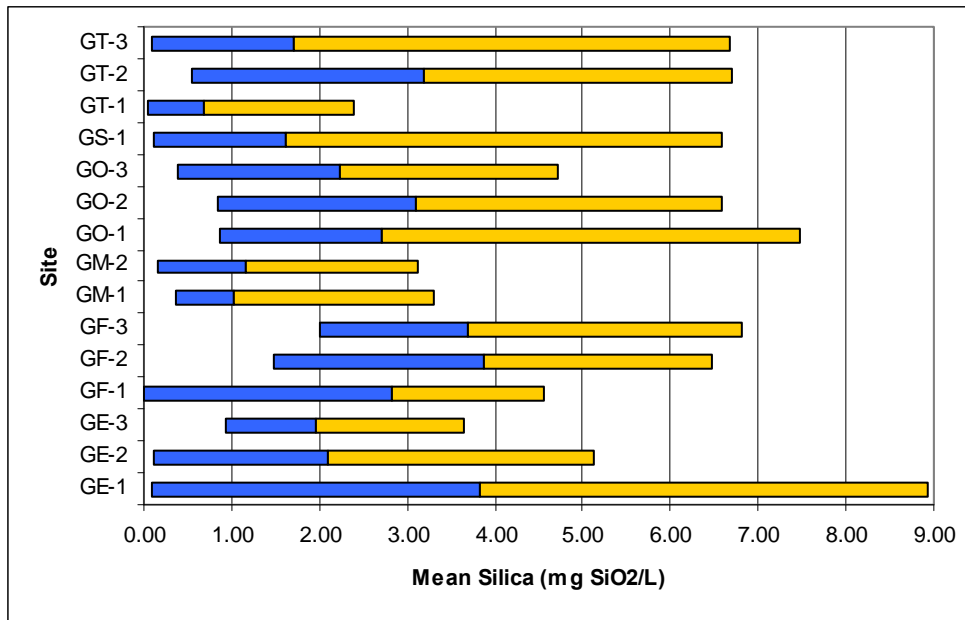


Figure 27: 2003 Ossipee Watershed site silica comparison. Bars show range of silica concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

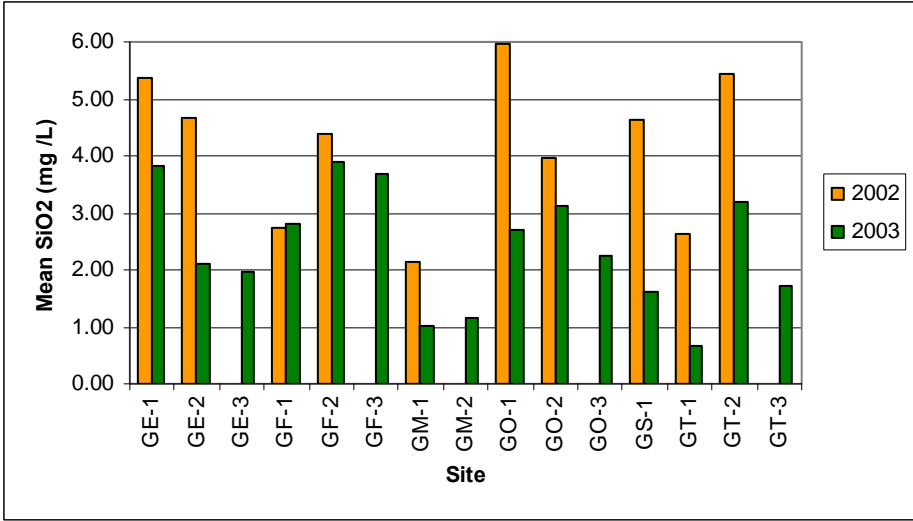


Figure 27: Ossipee Watershed site silica comparison for 2002 and 2003.

3.14 Potassium

Potassium occurs naturally from weathering and can be an important plant nutrient. Potassium concentrations ranged from 0.27 mg/L at GS-1 to 2.46 mg/L at GO-2 among sites in the Ossipee Watershed (Figure 28). Mean potassium concentrations in 2003 were similar to those in 2002 (Figure 29).

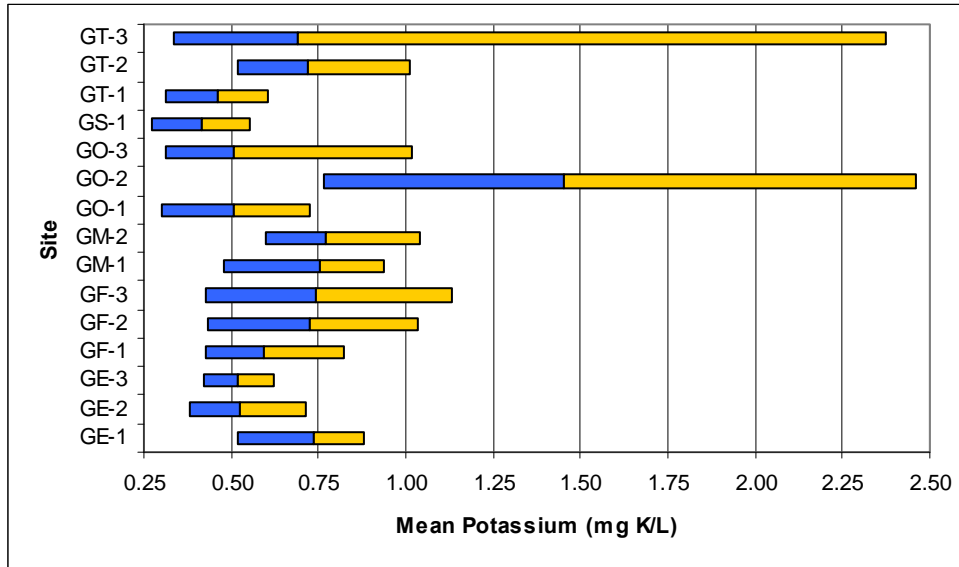


Figure 28: 2003 Ossipee Watershed site potassium comparison. Bars show range of potassium concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

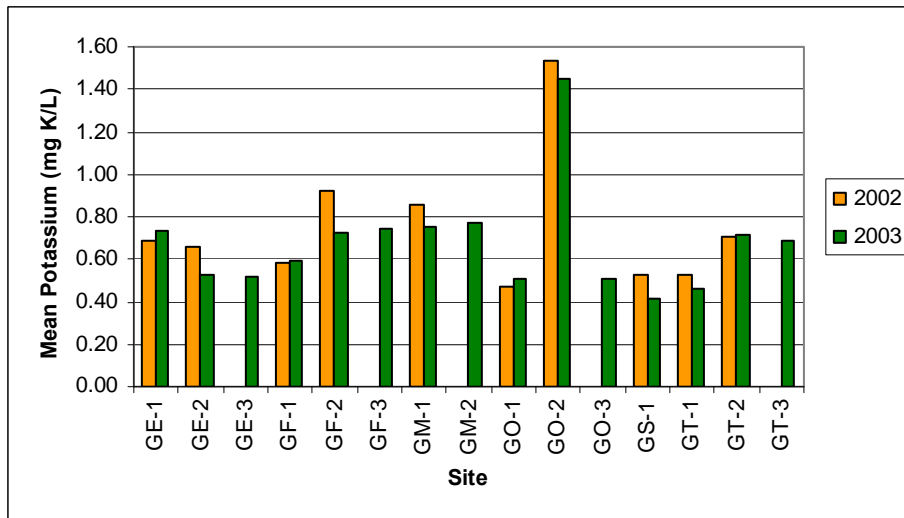


Figure 29: Ossipee Watershed site potassium comparison for 2002 and 2003.

3.15 Calcium and Magnesium

Calcium and magnesium result primarily from the weathering of rocks and are used to determine water “hardness”. In the Ossipee Watershed sites, calcium concentration ranged from 1.40 mg/L at GS-1 to 11.06 mg/L at GO-2 (Figure 30) and magnesium concentrations ranged from 0.28 mg/L at GS-1 to 1.32 mg/L at GO-2 and GF-2 (Figure 31). Both calcium and magnesium mean concentrations were less in 2003 than in 2002 at most sites (Figures 32 and 33).

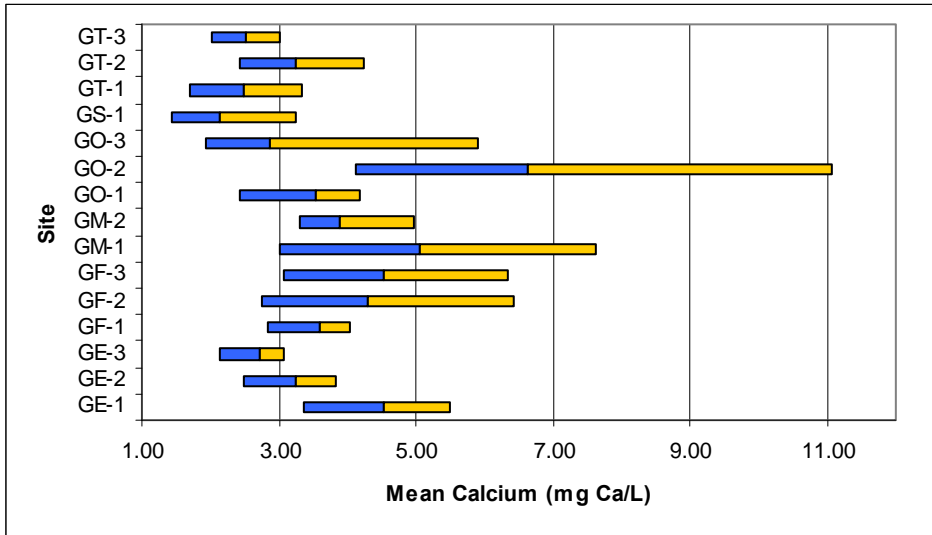


Figure 30: 2003 Ossipee Watershed site calcium comparison. Bars show range of calcium concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

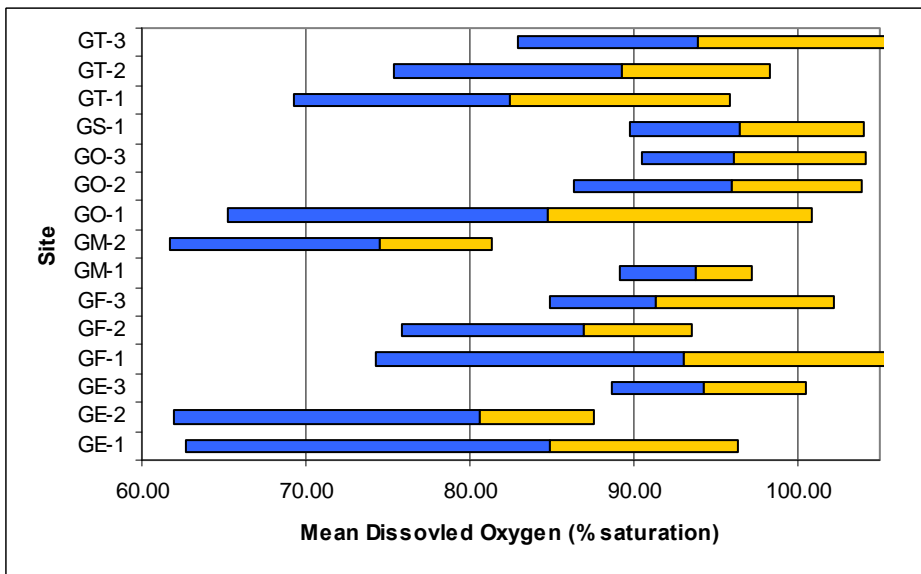


Figure 31: 2003 Ossipee Watershed site magnesium comparison. Bars show range of magnesium concentrations. Darker bars shows range less than the mean. Lighter bars show range greater than the mean. Mean value is at point where dark and light bars meet.

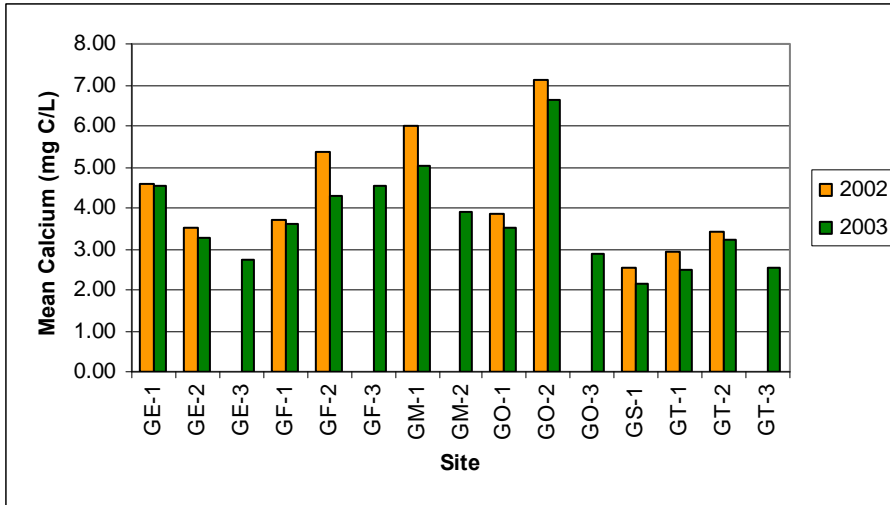


Figure 32: Ossipee Watershed site calcium comparison for 2002 and 2003.

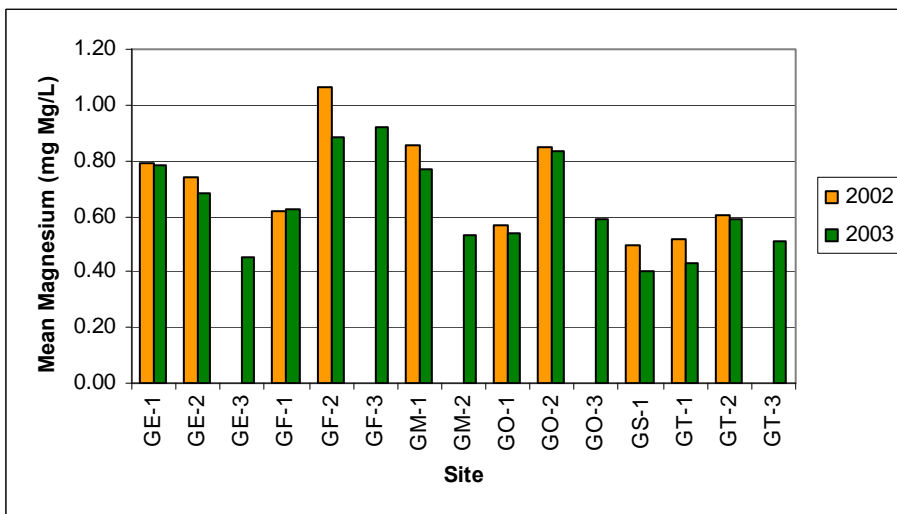


Figure 33: Ossipee Watershed site magnesium comparison for 2002 and 2003.

3.16 Relative Site Summaries

GE-1 Pine River, Elm Street, Effingham

GE-1 exhibited high levels of silica. In 2003, silica levels were less than 2002 due to increased rainfall that limited ground water input. 2003 silica levels at GE-1 were less than in 2002, but to a lesser degree than most other sites in the watershed. This may indicate that the Pine River receives a lot of input from groundwater flow. Indeed, the aquifer is at its closest point to the surface near this site. In addition, both DOC and DON levels were high at GE-1 indicating there is more decomposition at this site and possibly wetland input.

GE-2 South River, Plantation Road, Parsonsfield, ME.

GE-2 also exhibited elevated levels of DOC and DON indicating more decomposition at this site and possibly wetland influence.

GE-3 Ossipee River, Effingham Falls. New site this year.

Just below the Ossipee Lake impoundment the Ossipee River has low turbidity and higher temperatures. These are most likely due to the lake water that flows through this site. The top layer of the lake is predominantly the layer that flows over the dam and into the Ossipee River. This layer typically has warmer temperature and lower turbidity.

GF-1 Danforth Brook, Ossipee Lake Road, Freedom

Danforth Brook was characterized by some of the highest temperatures in the watershed. This could be explained by the high temperatures in Danforth Pond. Danforth Pond had the highest temperatures of all the Ossipee Lake water bodies sampled in the Ossipee Lake Protection Program. Danforth Brook also showed high pH which was consistent with the high pH found in Danforth Pond.

GF-2 Cold Brook, Maple Street, Freedom.

GF-2 exhibited high silica levels indicating groundwater input. Upstream of the sampling site, large, minimally moving wetland flows into Mill Pond that could have a large groundwater input.

GF-3 Cold Brook, Loon Lake inlet, Freedom. New site in 2003.

GF-3 exhibited some of the highest sulfate levels in the watershed. This was not seen upstream at GF-2. However, except for sulfate levels, there was little difference in water quality between GF-2 and GF-3 in 2003.

GM-1 Banfield Brook, Route 113, Madison

GM-1 experienced a very high surge in total phosphorus during the first sampling period in 2003. This was not seen the previous year. It is assumed that this was a one-time event. As was seen in 2003, sodium and chloride levels were high at this site, potentially indicating road salt influence.

GM-2 Pequawket Brook, Route 113, Madison. New site in 2003.

During the first sampling period in May 2003, GM-2 experienced a surge in phosphate. This is assumed to be an isolated event.

GO-1 Beech River, Tuftonboro Road, Ossipee

Mean silica levels at GO-1 in 2003 were more than half of the values in 2002. It could be assumed that GO-1 was receiving a higher amount of groundwater inflow in 2002 than 2003. This could be due to increased precipitation levels in 2003.

GO-2 Frenchman Brook, White Pond Road, Ossipee.

In 2002, this site was identified as impaired due to several factors. First, DIN was high relative to TDN. Calcium and magnesium were high. Sodium and chloride levels were high. In 2003, Ca, Mg, Na, and CL were again found to be elevated. There was even more DIN relative to TDN. This may indicate that this apparent impairment was not just single year event. Site GO-3 was added upstream in Frenchman Brook in an attempt to pinpoint the disturbance. Results from GO-3 indicate that the disturbance is in between GO-2 and GO-3.

GO-3 Frenchman Brook, Polly's Crossing, Ossipee. New site in 2003.

GO-3 did not experience the elevated nutrient levels as the downstream GO-2 site saw in 2002 and 2003. However, this site dried up during the most of August and a complete data set was not obtained.

GS-1 Cold River, Route 113, Sandwich.

With its low nutrient concentration, temperature, and turbidity and high dissolved oxygen concentration, all of which were seen in 2002, GS-1 can still serve as a minimally impacted reference site for the rest of the Ossipee Watershed.

GT-1 Bearcamp River, Route 113, Tamworth.

Though the water is quite tea-stained at this site, GT-1 had a relatively low DOC level. However dissolved oxygen levels were low. This could be a factor of the several wetlands that the Bearcamp winds through before passing by GT-1.

GT-2 Mill Brook, Earle Remick Natural Area, Tamworth.

As was seen in 2002, DIN dominated the TDN in 2003, indicating impairment. In addition, very low pH readings were measured consistently throughout the summer. GT-3 was established in 2003 to pinpoint the source of the impairment. GT-3 experienced neither DIN domination nor low pH, so it seems as though the impairment source occurs between GT-2 and GT-3.

GT-3 Mill Brook, Durrell Road, Tamworth

GT-3 did not experience the same DIN domination or low pH that its downstream counterpart, GT-2 showed. However, elevated levels of DOC indicate more decomposition in this area. Indeed, the water is quite tea-stained.

4. Bug Day

Green Mountain Conservation Group started its new macroinvertebrate sampling program at Watershed Weekend on July 12 and 13, 2003. Keynote speaker Michele Tremblay of naturesource communications enticed the crowd with stories of mayflies, stoneflies and rat-tailed maggots. UNH Cooperative Extension Bug Experts Bob Craycraft and Jeff Schloss led groups on an information macroinvertebrate sampling walk along Ossipee Lake (Figure 34).



Figure 34: Macroinvertebrate sampling at Watershed Weekend, July 12, 2003.

Macroinvertebrates are tiny aquatic animals including insect larvae, worms, and mollusks that lack a back bone but are visible to the naked eye. Macroinvertebrates are unique water quality indicators. They spend their entire lives in one small area and cannot swim away if that area becomes inundated with pollution. Certain species are more tolerant than others. Just as in human communities, it is desirable to have a healthy and diverse community of macroinvertebrates in any healthy stream or river. A marked absence of a member of that community indicates that something may be amiss.

For example, many species of stoneflies will perish in streams that exhibit low oxygen levels while the rat tailed maggots thrive by utilizing their snorkel like siphons that allow them to breath in even the most deoxygenated water. If you find many rat tailed maggots in a stream but no stone flies, you could be facing a low oxygen problem. Low dissolved oxygen can be a result of pollution inputs, but also has natural causes. Microorganisms decomposing organic material such as leaves will consume much of the oxygen in the water. Other nutrient inputs (such as fertilizers, septic input, or wetlands input) will cause a boom in plankton growth and thus a drop in oxygen levels.

Unlike traditional water chemistry testing, sampling for macroinvertebrates is easier and relatively inexpensive. Instead of complicated machinery, the necessary materials for macroinvertebrate sampling include a large net, tray, magnifying lens and an

identification guide. To gather macroinvertebrates, the stream bottom is kicked downstream into the net. The entire sample is picked through. All bugs are identified and tabulated using the identification guide.

On Saturday, September 20, 2003 GMCG hosted Bug Day, a macroinvertebrate sampling event. Volunteers joined GMCG and Bug Experts Bob Craycraft, Claes Thelemark and Ned Hatfield for a morning in the field (Figure 35). Inadvertently, groups were separated by age. A group of junior high students sampled from the Mill Brook in Tamworth while a group of older volunteers sampled in the Cold Brook in Freedom.

Group joined at the Community School in Tamworth for an afternoon in identification. There was a lot of interaction between the groups and sharing of specimens. Though it had originally been planned that useable data would come out of this event, no data were collected. However, macroinvertebrate sampling at Watershed Weekend and Bug Day were far more valuable as an education event. GMCG hopes to continue macroinvertebrate events in the future.



Figure 35: Macroinvertebrate sampling at Bug Day, September 20, 2003.

5. Recommendations

- Continue monitoring in the Ossipee Watershed to expand upon two years of data to create a long term database.
- Consider guiding volunteers in streamside assessment to gather qualitative data.
- Consider measuring or calculating acid neutralizing capacity.
- Harry Merrow suggested sampling lower Beech River because of the old mill.
- The Madison Conservation Commission and Selectmen would like to see testing in Forrest Brook or Frost Brook next year.
- It may not be feasible to sample GO-3 next year. Other sites that may be considered for deletion (so that new sites could be added): GT-3, GF-2.
- Conduct a watershed assessment of each of the ten sub watersheds.
- Consider examining the water quality data collected in many of the lakes and stream of Ossipee Watershed.

6. Work Cited

Green Mountain Conservation Group and Saco River Corridor Commission. 2003 *Saco Watershed Water Quality Monitoring Program QAPP*.

New Hampshire Office of State Planning, Society for the Protection of New Hampshire Forests and The Nature Conservancy. *New Hampshire's Changing Landscape*.

Field Data Sheet

PART I – SITE AND SAMPLER IDENTIFICATION

Site Code Number _____

Sample Collection Date _____

Site Location _____

Sample Collection Time Begin/Finish _____

Field Samplers Names _____

Signature of Sampler _____

PART II – WEATHER CONDITIONS

Current Weather: Clear Partly Cloudy Mostly Cloudy Fog Haze Sunny Drizzle Steady Rain Downpour Snow
(check all that apply)

Rainfall in previous 24 hours: None Light Heavy _____ inches

Source of rainfall information: _____ *(i.e. rain gauge, regional weather report, etc.)*

PART III – SITE OBSERVATIONS *(check all that apply)*

Water Appearance: Clear Milky Turbid Foamy Oily Light/Dark Brown Greenish Other
(explain) _____

Water Odor: None Fishy Chlorine Rotten Eggs

Other*(explain)* _____

Wildlife Observations: _____

Floatable Observations *(i.e. leaves, foam, or debris)*: _____

Bottom Observations *(i.e. color, bottom type, silt, rocky, algae, sand etc.)* _____

Local Observations (erosion, flooding, road work, littering or other disturbances) _____

PART IV – EQUIPMENT INFORMATION

pH Meter Used _____

Calibration Completed yes / no

Time Completed _____ a.m.

Volunteer Initials _____

DO Meter Used _____

Calibration Completed yes / no

Time Completed _____ a.m.

Volunteer Initials _____

Turbidity Meter Used _____

Calibration completed by water quality staff once every 3 months

PART V – FIELD MEASUREMENTS

Depth that measurements were taken _____ inches (Indicate the depth of the **probe** in the water when taking the measurement).

	Temperature	Turbidity	pH	Dissolved Oxygen	
Reading #1	° C	NTU		mg/l	% sat.
Reading #2	° C	NTU		mg/l	% sat.
	HACH Thermometer Reading ° C				

Averages (to be computed by staff)	° C	NTU		mg/l	% sat.
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PART VI – SAMPLE COLLECTIONS

Time Silica, DOC,TDN, NH4, PO4, cations, anions sample collected	a.m.	Time Total Phosphorus sample collected	a.m.
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REPLICATE SAMPLE COLLECTED? YES NO

Time Silica, DOC,TDN, NH4, PO4, cations, anions replicate sample collected	a.m.	Time Total Phosphorus replicate sample collected	a.m.
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Test Sites Codes / Locations	
GM-1 Banfield Brook, Rt. 113 Madison	GT-2 Mill Brook, Earle Remick Natural Area, Rt. 113, Tamworth
GM-2 Pequawket Brook, Rt. 113, Madison	GT-3 Mill Brook, Durrell Rd., Tamworth
GF-1 Danforth Pond outlet, Ossipee Lake Rd., Freedom	GE-1 Pine River, Elm St., Effingham
GF-2 Cold Brook, Maple St., Freedom	GE-2 South River, Plantation Rd., Parsonsfield
GF-3 Cold Brook, inlet to Loon Lake, Cemetery Rd., Freedom	GE-3 Ossipee River, Rt. 153, Effingham Falls
GS-1 Cold River, Rt. 113, Sandwich	GO-1 Beech River, Tuftonboro Rd., Ossipee
GT-1 Bear Camp River, Rt. 113 Tamworth	GO-2 Frenchman Brook, White Pond Rd., Ossipee
	GO-3 Frenchman Brook, Polly's Crossing Rd., Ossipee

Additional Comments (*i.e. problems with sampling procedures, etc.*)

APPENDIX B: OPERATING INSTRUCTIONS FOR FIELD EQUIPMENT

YSI 550A Dissolved Oxygen Meter Calibration

Step 1:

Turn on the DO meter ½ hour before you begin calibrating.

Step 2:

Press and release both the ↑ and ↓ keys to enter into calibration mode. The screen will display **CAL** and **%**.

Step 3:

Press the **ENTER** (↵) key.

Step 4:

The screen will prompt you to enter the altitude. The number **5** should be displayed. If necessary, use the ↑ and ↓ keys to select the number **5**. Then press the **ENTER** (↵) key.

Step 5:

A percent saturation value will appear on the screen. Wait for the reading to stabilize. It has stabilized when the number to the nearest tenth has stopped fluctuating. Press the **ENTER** (↵) key.

Step 6:

The screen will prompt you to enter a salinity value and should display **0.0**. If the value displayed is not **0.0** use the ↑ and ↓ keys to select the number **0.0**. Press the **ENTER** (↵) key. The meter will return to normal operation and is ready for use.

Step 7:

If you are not taking a measurement right away, return the probe to its storage chamber.

YSI 60 pH Meter Calibration

Step 1:

Turn the pH meter on ½ hour before you calibrate.

Step 2:

Rinse the probe with distilled water.

Step 3:

Pour 30 ml of pH 4 (YELLOW) buffer solution in the graduated cylinder.

Step 4:

Immerse probe in the cylinder.

Step 5:

Press and release both the \uparrow and \downarrow keys at the same time. The meter will display **CAL** and stand will flash on the bottom of the screen. The main display will read **7.00** (sometimes it may read **4.00**).

Step 6:

Press and release the **ENTER** key. **STAND** will stop flashing and the decimal point in the pH value will start flashing.

Step 7:

Watch the decimal point. When the decimal point has stopped flashing, the reading is stable.

Step 8:

Press and hold the **ENTER** key until the display reads **SAVE**.

Step 9:

The screen will now prompt you to use a new pH buffer solution. The display will read either **4.01** or **10.01** (+/- 0.01). You will see **CAL** and **SLOPE** flashing at the bottom of the screen.

Step 10:

Remove probe from solution and rinse well with distilled water. Pour the pH meter back into its container and rinse the cylinder well with distilled water.

Step 11:

Pour 30 ml of pH 7 (RED) buffer solution in graduated cylinder.

Step 12:

Immerse probe in the cylinder.

Step 13:

Press and release the **ENTER** key. **SLOPE** will stop flashing and a second decimal point in the pH value will start flashing.

Step 14:

Watch the decimal point. When the decimal point has stopped flashing, the reading is stable.

Step 15:

Press and hold the **ENTER** key until the display reads **SAVE**.

Step 16:

If you are a Tuesday through Friday volunteer, skip to **Step 17**. If you are a Monday volunteer, repeat **Steps 9-15** with the pH 10 (BLUE) buffer solution for a 3 point calibration. When you have completed the 3 point calibration, the meter will return to normal operation.

Step 17:

STOP. You have completed the calibration. Press and release the **MODE** key to return to normal operation.

HACH Thermometer Measurement

Step 1:

Place HACH Thermometer in the water when you arrive at your test site.

Step 2:

After finishing with the pH meter, remove the HACH thermometer from the water.

Step 3:

Being careful not to touch the bottom of the thermometer, read the temperature on the thermometer. Record the temperature value on the data sheet.

Step 4:

Return thermometer to the cooler.

YSI 60 pH Meter Measurement

Step 1:

Gently place the probe in the water. Be sure that both the pH (glass bulb at bottom of probe) and the temperature (black nub at top of probe) sensors are completely immersed. The pH meter does not need to be stirred.

Step 2:

Allow the reading to stabilize. It has stabilized with the number to the nearest tenth has stopped fluctuating. However, if the reading is changing in one continual direction (example: pH value is slowly increasing 0.01 every few seconds) wait until the value is fluctuating back and forth between several values (example: pH value changes from 6.56 to 6.57 and then back to 6.56 again).

Step 3:

Record the pH value and the temperature.

Step 4:

Remove the probe from the water.

Step 5:

Repeat [Steps 1-4](#) for a second reading.

Step 6:

If there is more than a 0.20 pH unit difference between the two readings, please take a third reading by repeating [Steps 1-4](#) again.

Step 7:

Return the probe to the storage chamber.

Water Sample Collection

Step 1:

Label each bottle as follows:

<i>Site Number</i>	
<i>Date</i>	
<i>Time</i>	<i>Initials</i>

Note: The time written on each bottle should be the same.

Step 2:

Remove caps from both bottles and rinse with stream water. Make sure you pour the rinse water out downstream of where you are gathering the sample.

Step 3:

With the mouth of the bottle facing upstream, fill each bottle **SIMULTANEOUSLY** to the shoulder (where the bottle starts getting narrower at the top) and cap. Return samples to the cooler.

HACH 2100P Turbidimeter Turbidity Meter Measurement

Step 1:

Turn the turbidity meter on by pressing the **POWER** key. The display should read **0.00 NTU** and say **AUTO RNG** and **SIG AVG** at the bottom. If **AUTO RNG** and **SIG AVG** do not appear, press the **MODE** until they both appear.

Step 2:

Take two glass vials out of the box and rinse with stream water. Make sure you pour the rinse water out downstream of where you are gathering the sample.

Step 3:

With the mouth of the vial facing upstream, fill each vial to the top and cap.

Step 4:

Set one vial aside.

Step 5:

Thoroughly dry the vial with the paper towel provided. Do not handle the glass after this point. Hold the vial by the cap.

Step 6:

Place one drop of silicon oil on the vial. Use the black cloth to rub the oil over the vial and polish the glass.

Step 7:

Open the lid of the turbidity meter. Place the vial inside so the white diamond (sometimes a triangle) lines up with the marker on the meter.

Step 8:

Close the lid and press the **READ** button. **NTU**, **AUTO RNG** and **SIG AVG** will flash while the meter is establishing an average of the readings.

Step 9:

When **NTU** has stopped flashing, the reading has stabilized. Record this value.

Step 10:

Repeat **Steps 5-9** with the second vial.

Step 11:

If the two readings differ by more than 0.20 NTU, please take a third reading by repeating **Steps 2-9**.

Step 12:

Pour the water out. Return the vials to the box. Turn the off meter of by pressing the **POWER** button.

YSI 550A Dissolved Oxygen Meter Measurement

Step 1:

Place the probe in the water and stir continuously with an even, steady rhythm.

Step 2:

Press the **MODE** key to change the measurement to **mg/l**.

Step 3:

Wait for the reading to stabilize. It has stabilized with the number to the nearest tenth has stopped fluctuating. However, if the reading is changing in one continual direction (example: value is slowly increasing 0.01 mg/l every few seconds) wait until the value is fluctuating back and forth between several values (example: pH value changes from 7.89 to 7.90 mg/l and then back to 7.89 mg/l again).

Step 4:

Record this value, but **DO NOT REMOVE THE PROBE FROM THE WATER YET!!!**

Step 5:

Press the **MODE** twice to change the measurement unit to % saturation. Record this value.

Step 6:

Remove the probe from the water.

Step 7:

Repeat **Steps 1-6**.

Step 8:

If there is more than a 0.20 mg/l difference between the two mg/l readings, please take a third reading by repeating **Steps 1-6** again.

Step 9:

Return the probe to its storage chamber.

Sample Processing Sheet

Step 1:

Pull samples out of coolers as soon as they arrive to let them dry off.

Step 2:

When all bottles have arrived in the office, check labels. Add GMCG codes to sample number.

Acidified samples: Site #,
Week#, A

Example: GO-2 3A

Filtered samples: Site #,
Week#, A

Example: GO-2 3B

Step 3:

To clear up some of the bottles, grab all "A" bottles (to be acidified). Put in the blue dish pan with the acid. Put dish gloves on. Bring dish pan to sink.

Step 4:

Remove all the caps from all the bottles. Make sure bottle are filled only to shoulder. If water level is higher, dump excess in sink.

Step 5:

Add 1 mL of acid (just below the bulb on the pipette) to each bottle. Recap bottles.

Step 6:

Put bottles on lower shelf in freezer. Return acid to storage.

Step 7:

Fill out chain of custody form. For examples of this form, look in total phosphorus file.

Step 8:

Label 60 mL bottles (one for each "B" sample) with tape and complete labels (Step 2).

Step 9:

Gather filtering equipment and bring to sink.

Step 10:

Begin running about 6 cups of water through coffee maker.

Step 11:

Place one filter using the forceps (no fingers!) on the part of the filter with the black ring. Reassemble the filter.

Step 12:

Add syringe to set up.

Step 13:

Add 20 mL (approximate) of sample to syringe and filter through.

Step 14:

Shake and empty water from bottle. Separate syringe.

Step 15:

Repeat Steps 13-14 two more times.

Step 16:

Add syringe and filter 60 mL of sample.

Step 17:

Make sure filtered sample water level is at the shoulder of the bottle.

Step 18:

Undo filter set up. Remove and dispose of filter. Dump out remaining sample in 250 mL bottle.

Step 19:

Repeat Steps 11-18 for each "B" sample.

Step 20:

When filtering is complete, rinse all components of filtering system including syringe and forceps, with hot water from coffee pot. Leave filtering system to dry on paper towels on microwave.

Step 21:

250 mL bottles (now empty) get saved for UNH to wash. 60 mL bottles get placed in upper level of freezer.