Volunteer River Monitoring Program

2016 Data Report

VRMP April 2017

Contact: Mary Ellen Dennis
Phone: (207) 215-7946

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION
17 State House Station | Augusta, Maine 04330-0017
www.maine.gov/dep/index.html

Lead Authors

Mary Ellen Dennis
Margaret Lynn

Contributing Authors

Angela Brewer
Robert Mohlar

VRMP Staff Team (Maine DEP)

Mary Ellen Dennis
Margaret Lynn (AmeriCorps)

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2016 VRMP Volunteers

Androscoggin River Watershed Council (Upper Androscoggin River)

Wally Elsmore
Carol Greenlaw
Barbara Haskell
Anne Reiter
Jeff Stern

Friends of Merrymeeting Bay (Lower Androscoggin River)

Rebecca Bowes
Ed Friedman
Ruth Inness
Kathleen McGee
Jeff Sebell
Bert Singer
Kermit Smyth

Friends of Weskeag/Georges River Land Trust (Weskeag River)

Kathleen Bachus
John Fancy
Kathleen Florance
Richard Matlack
Annette Naegel
Vivian Newman
Alfred Petterson
Sid Quarrier
April Thibodeau
Brent West

Mousam & Kennebunk River Alliance

Jake Aman
Nick Branchina
William Bullard
Fred Frodyma
Richard Lombardi
Beth Marass
Isaac Miles
Elizabeth Smith
Tatum Thomas
John White

Presumpscot River Watch

Gretchen Anderson
Rick Copeland
Fred Dillon
Reegan Leslie
Brooke Papineau
Lynda Reed
Hannah Shute
Tom Tero

Rockport Conservation Commission

Jim Chalfant
Robert Kennedy
Kimberly Kimball
Caleb Lincoln
Celeste Mosher (MCOA)

Skowhegan Conservation Commission

Joseph Dembeck
Peter Whitkop

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Executive Summary

The Volunteer River Monitoring Program (VRMP) was started by the Maine Department of Environmental Protection (DEP) in 2009. The program began for two primary reasons. There were groups interested in water quality monitoring but, they did not have the resources to do it on their own. Other groups were monitoring on their own but, were all using different methods, data management systems, and quality assurance/quality control requirements. Thus the VRMP was established to provide technical resources to watershed groups and a standardized approach with volunteer groups working under a Quality Assurance Project Plan. The VRMP further provides training, volunteer certification, data archiving, and an annual water quality report.

In 2016, volunteers in seven watershed groups collected water quality data in eight river/stream and coastal watersheds throughout the State of Maine. These groups monitored Kennebunk River and Mousam River in south coastal Maine (York County); Presumpscot River in southern Maine (Cumberland County); Upper Androscoggin River in western Maine (Oxford County); Lower Androscoggin River in mid-coast Maine (Androscoggin, Cumberland, Sagadahoc Counties); Rockport Harbor and tributaries in mid-coast Maine (Knox County); Weskeag River and tributaries in mid-coast Maine and two brooks in the Town of Skowhegan (Somerset County). The volunteers contributed countless hours to water quality monitoring efforts expanding the range and scope of data collected in the state.

The VRMP annual report is divided into five chapters as follows:

1. 2016 monitoring overview, VRMP background, and Federal Clean Water Act - Maine’s Water Classification overview
2. Explanation of water quality parameters
3. 2016 weather/flow data and water quality data requirements
4. Quality Assurance/Quality Control Program
5. 2016 River/Stream reports (attached as separate documents)

Chapter 1
Overview and Introduction

2016 Overview

The 2016 sampling season marked the eighth year of the Volunteer River Monitoring Program (VRMP). In 2016, seven volunteer river monitoring groups, comprised of 41 monitors, participated in the program. These groups represented a range of locations and watersheds. The Town of Skowhegan monitored two streams in central Maine. The Friends of Weskeag/Georges River Land Trust monitored the Weskeag River and tributaries in mid-coast Maine. The Rockport Conservation Commission monitored Rockport Harbor and the freshwater streams draining to the harbor. Androscoggin River Watershed Council monitored the upper Androscoggin River in western Maine. Friends of Merrymeeting Bay monitored the lower Androscoggin River, a large point and non-point source impacted river. Presumpscot River Watch monitored the Presumpscot River and tributaries, located in the highly developed area of southern Maine. The Kennebunk and Mousam rivers, located in the southern and coastal area of the state, were monitored by the Mousam & Kennebunk Alliance.

Monitoring groups covered an area of over 1000 square miles of river and stream watershed and collected a vast amount of data; a total of 453 sampling events were completed at 77 sites. Collected data parameters included water temperature, dissolved oxygen, specific conductance, bacteria, turbidity, chlorophyll and nutrients.

VRMP Background

The DEP is responsible for monitoring and assessing the State's waters. However, with limited State resources, it has long been recognized that there is value and a need for using volunteers for collecting water quality data. Therefore, there was interest in developing a statewide volunteer effort for streams and rivers, an effort similar to the very successful Lake Volunteer Monitoring Program which has been in existence since 1971. In 2007, DEP commissioned a needs assessment and determined that there was widespread support for a volunteer river monitoring program. After determining where the program would be housed and how it would be organized, the VRMP was launched in 2009.

Prior to 2009, with no or limited DEP assistance, a number of hard-working river and stream watershed groups had already developed monitoring programs on their own for a variety of reasons. According to a needs assessment done for the DEP, these reasons included: an interest in land preservation, protecting endangered species, dam removal, opening clam flats, upgrading water classification, and obtaining water quality data. The VRMP brought some of the established groups and also new groups into the program.

There are challenges with volunteer groups working independently: they may employ diverse sampling or analysis methods; they may use different data management systems; and they may adhere to a variety of quality assurance/quality control requirements. Additionally, these groups may or may not have an approved quality assurance project plan. Also, for interested parties, centralized access to the results of most volunteer sampling had not been available.

The VRMP was formed as an organization to address these problems. The VRMP unifies a network of volunteer groups that participate in quality assured volunteer sampling. Volunteer sampling is governed by a program level Quality Assurance Project Plan (QAPP) which was created and is maintained by VRMP staff. Volunteer groups develop individual Sampling and Analysis Plans (SAPs) tailored to their specific project situation. To ensure consistent sampling and analysis methods, each SAP includes Standard Operating Procedures (SOPs) that detail equipment or techniques.

The creation of an approved generic QAPP and the support by VRMP staff makes it easier for interested groups to tackle the rigors of water quality monitoring with reduced difficulty and time associated with the development of QAPPs, SAPs, and SOPs.
The VRMP therefore:

1. Created and maintains a Quality Assurance Project Plan
2. Assists groups with writing Sampling and Analysis Plans
3. Maintains an equipment loan program
4. Provides annual training
5. Provides quality assurance/quality control of data and a centralized database
6. Produces an annual report

Overview of the Federal Clean Water Act and Maine's Classification System

A brief overview about water quality classification and criteria is provided here to give a better understanding of how volunteer monitoring fits into the bigger picture of protection and restoration of Maine's waters. For more details, we recommend the following website: www.maine.gov/dep/water/monitoring/classification/index.html.

In 1972, the Federal government passed the Clean Water Act (amended in 1977) which provides the overall framework for the protection and restoration of all waters of the United States. Included in the many requirements that States must implement, the Clean Water Act mandates that States establish a water quality standards program consisting of three parts: designated uses, criteria, and an anti-degradation statement.

The designated human and ecological uses reflect the goals for each water body and include: support of aquatic life, fishing (including fish consumption), recreation, drinking water, navigation, and hydropower. Narrative and numeric criteria consist of minimum requirements for parameters such as dissolved oxygen, bacteria, and the health of aquatic life communities that ensure that a water body attains its designated uses. The anti-degradation statement protects existing uses and high quality waters by requiring that, when the actual quality of any classified water exceeds the minimum standards of the next highest classification, the higher water quality must be maintained and protected.

Maine defines uses for its water bodies through the Maine Water Classification Program. Each classification specifies the designated uses and water quality criteria (narrative and numeric) and may place specific restrictions on certain activities. Table 1 shows the classifications and associated designated uses for each class. Table 2 and Table 3 show the classifications and associated water quality criteria.

Maine has four water quality classes for rivers and streams: AA, A, B and C. Class AA waters are managed for their outstanding natural ecological, recreational, social, and scenic qualities. Direct discharge of wastewater, dams, and other significant human disturbances are prohibited. Class A waters are managed for high quality with limited human disturbance allowed; direct discharges are allowed but highly restricted. Physical and chemical characteristics should be similar to natural conditions. Class B waters are general purpose waters and are managed to attain good physical, chemical and biological water quality. Well treated discharges with ample dilution are allowed. Class C waters are managed to attain at least the swimmable-fishable goals of the federal Clean Water Act, including protection of spawning for indigenous fish species.

Maine has three classes for the management of estuarine and marine waters: SA, SB and SC. SA waters are outstanding natural resources that receive minimal human impact, and are managed for the highest water quality of the three classes. No direct discharges of pollutants, including those from finfish aquaculture, are allowed in SA waters. SB waters are general purpose waters that are managed to attain good quality water. Well treated discharges of pollutants with ample dilution are allowed. SC waters are the lowest quality class, but must be fishable and swimmable and maintain the structure and function of the biological community. Well treated discharges of pollutants are allowed in SC waters.

Table 1: Classification and Designated Uses (rivers/streams and marine/estuarine)

Water Class	Designated Uses
Class AA	Drinking water supply, recreation in and on the water, fishing, agriculture, navigation and habitat for fish and other aquatic life.
Class A	Drinking water supply, recreation in and on the water, fishing, agriculture, industrial process and cooling water supply, hydroelectric power generation, navigation and habitat for fish and other aquatic life.
Class B	Drinking water supply, recreation in and on the water, fishing, agriculture, industrial process and cooling water supply, hydroelectric power generation, navigation and habitat for fish and other aquatic life.
Class C	Drinking water supply, recreation in and on the water, fishing, agriculture, industrial process and cooling water supply, hydroelectric power generation, navigation and habitat for fish and other aquatic life.
Class SA	Recreation in and on the water, fishing, aquaculture (excludes finfish), propagation and harvesting shellfish, navigation, habitat for fish and estuarine and marine life.
Class SB	Recreation in and on the water, fishing, aquaculture, propagation and harvesting shellfish, industrial process and cooling water supply, hydroelectric power generation, navigation, habitat for fish and estuarine and marine life
Class SC	Recreation in and on the water, fishing, aquaculture, propagation and restricted shellfish harvesting, industrial process and cooling water supply, hydroelectric power generation, navigation, and habitat for fish and estuarine and marine life.

Table 2: Classification and Water Quality Criteria (rivers/streams and marine/estuarine)

Water Class	Dissolved Oxygen Numeric Criteria	Habitat Narrative Criteria	Aquatic Life (Biological) Narrative Criteria[1]
Class AA	As naturally occurs	Free flowing and natural	No direct discharge of pollutants; as naturally occurs
Class A	7 ppm; 75% saturation	Natural	As naturally occurs
Class B	7 ppm; 75% saturation	Unimpaired	Discharges shall not cause adverse impact to aquatic life in that the receiving waters shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes to the resident biological community.
Class C	5 ppm; 60% saturation; 6.5 ppm (monthly average) at 22° and 24°F	Habitat for fish and other aquatic life	Discharges may cause some changes to aquatic life, provided that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.
Class SA	As naturally occurs		As naturally occurs
Class SB	Not less than 85% of saturation		Support all indigenous estuarine and marine species Discharge not to cause closure of shellfish beds
Class SC	Not less than 70% of saturation		Maintain structure and function of the resident biological community Support all indigenous species

[1] Numeric biocriteria in Maine rule Chapter 579; Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams.

Table 3: Classification and Bacteria Criteria

Waterbody Class	Bacteria Criteria
Fresh water	
Class AA	As naturally occurs[1]
Class A	As naturally occurs[1]
Class B	Between May 15th and Sept. 30th *E. coli* of human and domestic animal origin shall not to exceed a geometric mean of 64/100mL or an instantaneous level of 236/100mL
Class C	May 15th – Sept. 30th *E. coli* of human and domestic animal origin shall not to exceed a geometric mean of 126/100mL or an instantaneous level of 236/100mL
Class GPA (for lakes and ponds <10 acres in size)	Between May 15th and Sept 30th *E. coli* of human origin shall not exceed a geometric mean of 29/100mL or an instantaneous level of 194/100mL
Marine/Estuarine	
Class SA	As naturally occurs
Class SB	Enterococcus of human and domestic animal origin not higher than geometric mean of 8/100mL or instantaneous level of 54/100mL from 5/15 to 9/30 May not exceed National Shellfish Sanitation Program criteria for shellfish harvesting
Class SC	Enterococcus of human and domestic animal origin not higher than geometric mean of 14/100mL or instantaneous level of 94/100mL from 5/15 to 9/30 May not exceed National Shellfish Sanitation Program criteria for restricted shellfish harvesting

[1] Defined in 38 MRSA §466(2): "As naturally occurs" means conditions with essentially the same physical, chemical and biological characteristics as found in situations with similar habitats free of measurable effects of human activity." In practice, the Class GPA standard for *E. coli* may be used as a surrogate target if a freshwater's "natural" bacteria levels are unknown.

While the Water Classification Program establishes goals, designated uses, and criteria, it does not necessarily mean that a water body is actually attaining water quality conditions as defined in its assigned class. Another part of the Clean Water Act is Section 305(b) which requires that states assess the condition of their waters toward meeting designated uses and prepare a report biannually to Congress. This report is referred to as the 305(b) report or "Integrated Water Quality Monitoring and Assessment Report". "The "Integrated Report" utilizes water quality data collected by the DEP; other state, Federal, and tribal government agencies; volunteer water monitoring organizations; and other sources. The report provides a general overview of the conditions of Maine's waters and the appendices give the conditions of specific water bodies. The report also includes a list of "impaired water bodies". The report is available on the Maine DEP webpage: http://www.maine.gov/dep/water/monitoring/305b/index.htm.

Chapter 2
Water Quality Monitoring

Why Monitor Certain Water Quality Parameters?

Water quality parameters commonly monitored to assess the quality of streams and rivers include dissolved oxygen (DO), biochemical oxygen demand (BOD), temperature, pH, alkalinity, suspended solids and turbidity, bacteria, and nutrients. Generally, all VRMP groups monitor DO, temperature, and conductivity. Additional parameters may be monitored depending on a number of factors including existing natural stream/river conditions, potential impacts, the group's monitoring objectives, and funding. For more information, see "Volume 2. A Citizen's Primer on Stream Ecology, Water Quality, Hydrology, and Fluvial Geomorphology (October 2010) on the VRMP website:
http://www.maine.gov/dep/water/monitoring/rivers_and_streams/vrmp/index.html.

Another good educational resource is the U. S. Environmental Protection Agency's "Volunteer Stream Monitoring: A Methods Manual" (USEPA, 1997), which can be found online at: http://www.epa.gov/sites/production/files/2015-06/documents/stream.pdf

Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD)

One of the most important measures of water quality is dissolved oxygen – the amount of oxygen dissolved in the water. Oxygen in dissolved form is used by organisms living in the water to breathe. It is measured in milligrams/liter (mg/L) or parts per million (ppm). When measuring DO, percent saturation should also be recorded with the meter. When using DO chemical kits, percent saturation can be calculated if water temperature is known. Percent saturation provides a measure of the capacity for oxygen to cross gill membrane barriers and enter the bloodstream of organisms. Both DO and percent saturation are used to determine whether a water body is attaining its water quality class.

If oxygen is low, it stresses aquatic organisms, affecting their growth and reproduction and, if it becomes low enough, it may kill aquatic organisms. Levels less than 5 mg/L are generally considered stressful. Levels between 5-7 mg/L are stressful to some coldwater fish if the percent saturation is low. Greater than 7 mg/L is generally considered optimal for all aquatic life. Early life stages of certain coldwater fish require higher DO levels.

Oxygen enters rivers and streams in several ways:

- ◦ It diffuses through the atmosphere at the water surface
- ◦ It mixes with the atmosphere as water moves over dams, waterfalls, and riffles
- ◦ Algae and aquatic plants produce oxygen as a product of photosynthesis

Oxygen is used up through two processes:

- ◦ respiration
- ◦ decomposition of organic materials (i.e. leaves and other materials)

If there is an increase in organic loading (addition of organic material to a watershed), oxygen may be used up. Sources of loading include discharges, increased runoff, and increased plant (particularly algae) growth. More sophisticated sampling may warrant testing for BOD which estimates the amount of oxygen demanding substances in the water sample.

Water temperature and altitude affect dissolved oxygen levels. Cold water holds more oxygen than warm water, and water holds less oxygen at higher altitudes. The most stressful period is the summer months because water temperature is highest, and flows tend to be lowest. Over a 24-hour period, lowest DO values occur in early morning and highest values late in the day. This is due to daily plant photosynthesis-respiration cycles and is the reason some early morning samples should be collected. In highly productive streams, there can be significant swings in dissolved oxygen over the course of a day.

Temperature

Temperature is a critical parameter affecting aquatic life and, along with DO, is one of the most important to monitor. Besides its effects on dissolved oxygen, temperature affects biological activity (e.g. metabolism of individual organisms). Aquatic organisms depend on certain temperature ranges for their optimal health. Both fish and macroinvertebrates are sensitive to temperature and will move within the stream to more favorable conditions if possible.

If organisms are exposed to temperatures outside their optimal range for a prolonged period, they can be stressed or die. Stress can alter their susceptibility to disease or toxins and affect reproduction. For fish, there are two kinds of limiting temperatures – the maximum temperature for short exposures, and a weekly average temperature that varies according to the time of year and life cycle of the species. For more information about fish species requirements, see Table 4-2- Maximum average temperatures for growth and short term maximum temperatures for selected fish in “Volume 2. A Citizen’s Primer on Stream Ecology, Water Quality, Hydrology, and Fluvial Geomorphology” referenced above.

A number of human activities can affect temperature. These activities include: removal of stream bank vegetation, impoundments, discharges, and stormwater runoff (e.g. runoff from heated surfaces such as parking lots, roads, and other sources).

Conductivity

Conductivity is a measure of water's ability to carry an electrical current and is directly related to the dissolved ions (charged particles) present in water. Dissolved ions in water originate from the geology of the area as well as from human sources such as wastewater discharges and stormwater runoff. Conductivity is affected by temperature – the warmer the water, the higher the conductivity. For this reason, conductivity is generally reported as specific conductivity. Specific conductivity is conductivity that is adjusted to what the reading would be at a temperature of 25˚ Celsius. Conductivity and specific conductivity are measured in micromhos per centimeter (µmhos/cm) or microsiemens per centimeter (µs/cm).

Conductivity is useful as a general measure of stream water quality and can be used to track down many kinds of pollution sources. The values for Maine undisturbed rivers and streams are generally low (30-50 µs/cm). Values significantly greater than 100 µs/cm may indicate that there is a potential pollution problem. Some degraded urban streams having serious pollution problems can have conductance values in the 300-400 µs/cm range or much higher.

There has been a growing concern in the Northeastern United States about potentially significant increases in chloride concentrations in freshwater surface and groundwater supplies, primarily originating from winter road and parking lot safety maintenance (salting) activities (Kausal et al., 2005; Mullaney et.al., 2009). Though conductivity is not a direct measure of chloride concentrations, high chloride concentrations are frequently associated with high conductance measurements, thereby making conductivity a valuable screening tool for this type of problem.

pH

pH is a term used to indicate the alkalinity or acidity of a substance as ranked on a scale from 1.0 to 14.0. The pH scale measures the logarithmic concentration of hydrogen (H+) and hydroxide (OH-) ions which make up water. When both types of ions are in equal concentration, the pH is 7.0 or neutral. Below 7.0, the water is acidic, and when the pH is above 7.0, the water is alkaline or basic. Since the scale is logarithmic, a drop in the pH by 1.0 unit is equivalent to a 10-fold increase in acidity.

Maine water quality standards allow a pH range of 6.0 to 8.5 for all freshwater quality classes (AA, A, B and C). pH outside this range reduces the diversity of aquatic organisms because it stresses the physiological system of most organisms and can reduce reproduction success. Low pH can also allow toxic elements (e.g. aluminum) to become available for uptake by aquatic organisms. pH is generally not measured by volunteers in part due to the difficulty of accurately measuring it. pH may be affected by acid rain/snowmelt, local geology, inputs from natural organic acids from the decomposition of organic matter, photosynthesis and respiration of aquatic plants, and certain wastewater discharges.

Alkalinity

Alkalinity is a measure of the capacity of water to neutralize acids and is also known as the buffering capacity. It is due primarily to the presence of naturally variable bicarbonate (HCO_3), carbonate (CO_3^{-2}), and hydroxide (OH^-) ions; bicarbonate is the major form. Sources of alkalinity include rocks and soils, salts, algal activity, and even certain wastewater discharges.
In Maine, there are wide natural variations due to the depth and type of soil material in a watershed. Alkalinity results are typically reported as milligrams per liter of calcium carbonate (mg/L $CaCO_3$). Rivers with alkalinity values less than 10 milligrams per liter (mg/L) are considered poorly buffered. Measuring alkalinity is important in determining a river's ability to neutralize acidic pollution from rainfall, acid deposition (polluted rain and snow), and other pollutants that may affect the strength of acids in a stream.

Sediment Pollution

Streams and rivers naturally transport sediments (sand, silt, or clay) through their systems. Excess sediments, usually resulting from human activities done carelessly, may enter into and become suspended, transported, and deposited within streams and rivers. These excess sediments can cause a number of harmful effects:

- reduce visibility which interferes with fishes ability to feed
- raise water temperature (suspended particles absorb more heat)
- damage fish and aquatic insect gills
- block sunlight, which impairs photosynthesis
- carry nutrients and toxics adsorbed to sediment particles
- fill in natural gravel-stone habitat areas – eliminating habitat areas and suffocating eggs

Total Solids, Total Suspended Solids and Suspended Sediment Concentration

"Total solids" is a measure of dissolved solids plus suspended and settable solids in water. In stream water, dissolved solids consist of calcium, chlorides, nitrates, phosphates, iron, sulfur, and other ion particles as well as humics and tannins that will pass through a filter with very small pores. "Suspended solids" include: sand, silt, and clay particles; plankton; algae; fine organic debris; and other particulate matter. "Total suspended solids" (TSS) and "suspended sediment concentration" (SSC) are measurements of suspended sediments (e.g., soil particles, sands, clays) originating both from outside and within a stream. The analytical methods for TSS and SSC differ. TSS data are obtained by several methods, most of which involve measuring the dry weight of sediment from a known volume of a subsample of the original sample. SSC data are obtained by measuring the dry weight of all the sediment from a known volume of a water-sediment mixture (sample).

Total solids, total suspended solids, and suspended sediment concentration monitoring is done by collecting water samples that are analyzed by a certified lab. Results are measured in milligrams per liter (mg/L) or parts per million (ppm).

Turbidity and Transparency

Turbidity is a measure of the degree to which material suspended in water decreases the passage of light. Suspended materials include soil particles (clay, silt, and sand), algae, plankton, and other decaying vegetation. Turbidity can be useful for monitoring the effects of runoff from construction, agricultural activities, logging activity, discharges, and other sources. Turbidity is generally measured by using a turbidity meter with values reported in nephelometric turbidity units or NTUs. During significant rainstorm (runoff events), turbidity can increase significantly (e.g. > 100 NTU), especially if substantial erosion is occurring in the watershed.

Transparency is strongly correlated to turbidity. It may be measured using a transparency tube. This is a 120 centimeter tube that has a black and white disk at the bottom of the tube. The tube is filled with the water sample and then water is slowly drained out until the disk is visible.

Sources of total solids, suspended solids/sediments, and turbidity include: in-stream erosion, waste discharges, and soil erosion from human activities and land use in the watershed (e.g. construction projects, bare soil on residential lots, logging, agricultural activities, and polluted urban stormwater runoff including eroded soil and winter sand).

Bacteria

Many types of pathogenic (disease causing) viruses, bacteria, and protozoans can be present in surface waters that are contaminated by fecal matter. When people drink, swim in, or eat shellfish from contaminated or untreated water, they can potentially become ill. Since it is not possible to test for all the possible pathogens present, members of two bacteria groups – *Escherichia coli* and enterococci – are used as indicators of possible sewage contamination because they are commonly found in human and animal feces. USEPA recommends *E. coli* as the best indicator of health risk from water contact in recreational waters. Enterococci are distinguished by their ability to survive in salt water and are recommended as the best indicator of health risk in salt water used for recreation. Fecal coliform are used for testing shellfish areas.

Some sources of bacteria and pathogenic organisms include malfunctioning septic systems, overboard discharge systems, combined sewer overflows, discharges from boats, improperly stored animal manure, wildlife, pet waste, and publicly owned treatment works (POTWs) that are not working properly. POTWs are heavily regulated and usually do a good job of treating and disinfecting wastewater. Bacteria can increase after a rain event due to run-off from farmland, urban areas, and lawns of pet owners as well as from naturally occurring local wildlife sources.

Nutrients

Nutrients important in stream and river ecosystems include cations [calcium (Ca^{+2}), sodium (Na^{+2}), potassium (K^{+1}), magnesium (Mg^{+2}) and chloride (Cl^{-1})] and anions [sulfate (SO_4^{-2}), nitrate (NO_3^{-1}), and phosphate (PO_4^{-3})]. These elements are sometimes referred to as nutrients because in small to moderate amounts, they are essential for healthy aquatic life. A nutrient that is the least abundant relative to a plant's need for it is called the limiting nutrient. Limiting nutrients limit the growth and reproduction of organisms. Phosphorus is usually the primary limiting nutrient for algal growth in freshwater while nitrogen is usually limiting for algae growth in marine waters.

The presence of algae and other aquatic plants in stream ecosystems is a natural condition, especially when adequate sunlight is available. When extra phosphorus from human activities enters freshwater, it may, given the right conditions (e.g., adequate sunlight), fuel excess growth of algae and aquatic plants. In some extreme cases, decomposition of dead algae and plants by bacteria, and the low dissolved oxygen levels resulting from this unnatural amount of decomposition, can stress aquatic communities (e.g. fish, macroinvertebrates).

There are many sources of phosphorus, both natural and human. Phosphorus enters freshwaters from activities such as:

- ◦ agricultural sites (e.g. eroding soil, chemical fertilizer, manure, organic matter)
- ◦ residential sites (e.g. eroding soil, chemical fertilizer, manure, organic matter)
- ◦ urban development (e.g. eroding soil, runoff from roads & parking lots)
- ◦ waste discharges (e.g. untreated or treated wastewater and sewage)

Monitoring phosphorus is challenging because it involves measuring very low concentrations by a qualified lab. Less sensitive methods should only be used to screen potential problem areas.

Nitrogen occurs in various forms (NH_3, NO_2, NO_3, TKN) and, in excess amounts, can cause significant water quality problems. It can cause excess growth of algae and dissolved oxygen problems as described above for phosphorus. High levels of ammonia (NH_3) can be toxic to some fish including trout. Excess nitrogen enters freshwaters from human activities such as:

- ◦ agricultural sites (e.g. chemical fertilizer, manure, organic matter)
- ◦ residential sites (e.g. lawn fertilizer, pet waste, failing septic systems)
- ◦ urban developments (e.g. chemical fertilizer) and
- ◦ waste discharges (e.g. untreated or treated wastewater and sewage)

Chapter 3
2016 Monitoring Data

Weather Data for 2016

The following information was summarized from the National Oceanic and Atmospheric Administration (NOAA) Weather Service Climate Reports for 2016. The information was obtained for four Maine stations: Gray, Augusta, Bangor and Caribou.

For the Gray weather station, the average temperature for 2016 was 47.9° F which was 1.5° F above normal. There were 59 days in 2016 where temperature reached 80° F (the most on record) and 123 days that reached 70° F (2nd most on record). Precipitation for the year was 47.19" which was 3.03" below normal. Snowfall for the year was 83.2" (0.6" below normal). January began warm with a temperature of 51° F and 2.5" of rain on January 10th. It was then cold with about 2 weeks where temperatures did not rise above freezing. February began warm, followed by snow and very cold weather in mid-February. It then warmed up again with a reading of 56° F on February 29 (warmest temperature on record for February). The warm weather melted all the snow and by March 1st, there was no snow on the ground. Warm weather continued through much of March. March 21st saw a snowstorm of greater than 6". April was mostly cold with a snowstorm of more than 4" on April 26th. It began to warm up in mid-May. It was cool and wet in early June with significant rain on June 5th (1.5"). It then remained warm through early July. It was cool and damp early-mid July and then was hot from mid-July to mid-August. It remained warm and dry into September with drought developing. Significant rain arrived October 21-22 (>4") and 1.5" a week later. December saw periods of cold and significant snowfall.

For the Augusta weather station, the average temperature for 2016 was 47.3° F which was 1.5° F above normal. It was the 8th warmest year on record and the driest since 2004. There were a few periods of extreme cold occurring in mid-February, April and mid-December. Total rainfall for the year was 35.25" (the average rainfall is 41.88"). Overall the year was prevailed by warm weather and developing drought. January began warm followed by a cold stretch and then it was warm from mid-February to mid-March. Snowfall was below normal for January and March. April was generally cold followed by a warm May-both months had below normal rainfall. June saw a period of cool-wet weather, followed by humid weather for the last half of the month. July began hot, and then it was cool and damp in mid-July. It was hot from mid-July to mid-August. Rainfall was well below normal for September. October had periods of cool and warm weather with more rainfall at the end of October-early November. From October 21-22, more than 3" of rain fell.

For the Caribou weather station, the average temperature for 2016 was 41.9° F. For the Bangor weather station, the average temperature was 45.9° F - this tied as the 7th warmest. Average temperatures for the region were 1.5-2.0° F above average. Precipitation was above normal for far northern Maine and much below normal for the rest of the region. Extreme northern Maine saw precipitation of 120 percent of normal while the rest of the region including downeast Maine received 75 percent of normal precipitation. Total precipitation for Caribou was 43.96"- the l1th wettest on record, while in Bangor the total precipitation was 34.35". In January, temperatures were above average and snow was 20-40% of average- this trend continued into February. In March at the Caribou station, there was a major rain event of 4.7" of rain and melted snow. It was the 6th wettest March on record for Caribou. Overall, December 2015 thru February 2016 was the warmest on record for Bangor and Caribou. It was cold and dry in April. September saw temperatures warmer than average. November was the 2nd warmest on record for Caribou. Two heavy snow events occurred in Caribou late in the month. December was very snowy in Caribou with it being the 7th snowiest on record.

Weather is important for interpreting river/stream data because temperature and flow strongly influence water chemistry and affect wildlife health and behavior. For instance, during the winter, cold weather reduces biological activity. However, cold water also has a greater capacity to hold dissolved gasses such as oxygen. In the heat of summer, oxygen solubility is greatly reduced and either water temperature or oxygen can become limiting for fish and other aquatic organisms.

Stream flow, which includes water depth and velocity, is also important. Large fish need more water depth than smaller fish. Water depth can limit access to upstream habitat. Culverts, dams (including beaver dams), and sometimes bridges can prevent fish migrations, especially during low flows. Severe storms can lead to scouring of the stream bottom. This disrupts invertebrate communities and can lead to poor feeding conditions for fish. High flows can also prevent wildlife migrations if the flows are too fast in poorly designed culverts. The vast majority of our road crossings have improperly sized or installed culverts. Maine DEP is working with towns and contractors to make sure fish passage provisions are included each time a road culvert is replaced.

While summer heat, low oxygen, and low summer flows are problems for fish and other aquatic organisms, rain storms are often life savers. The deeper water and higher velocities following storms revive oxygen levels due to the turbulent mixing of water and air. In general, flowing water is well mixed; but slow moving water often stratifies, collecting cold water on the bottom and warmer water on top. Slow moving, stratified, or deep water can be rapidly depleted of oxygen in the summer months and can result in fish kills. Fish avoid waters that are too hot or too depleted of oxygen, but they cannot always escape. In flowing water, deep shaded spots such as river bends, undercut banks, and pools below falls or obstructions are often summer refuges for fishes like trout and salmon that require colder water. Some fish also go into deep lakes during the summer months. Trout and salmon prefer waters around 60-64º F and will avoid waters with temperatures above 70º F.

Monitoring and Time of Day

In order to assess attainment of dissolved oxygen (DO) criteria within Maine's water quality standards, early morning monitoring may be necessary. DO values generally fluctuate depending on time of day with lowest values often occurring in early morning and the highest values late in the day. The fluctuation may be minimal or significant depending on a number of factors (e.g. streamflow, water temperature, and plant and algae growth). DO data collected during the early morning (between dawn and 8:00 AM) are therefore important for water quality monitoring purposes. Except as naturally occurs, if DO concentration falls below the applicable DO criteria at any time of day, this also signals non-attainment.

Not all of the samples need to be collected early in the morning, but it is important to include at least some early morning samples. Collecting water quality data at particular times of the day (e.g., very early in the morning or late in the day if looking for diurnal differences) can be difficult and inconvenient; however, it is encouraged whenever possible.

Water Quality Results and Associated Information from the VRMP Groups

Sections 5-1 through 5-8 present sampling overview, methods, result summaries, figures (graphs) of water quality data, discussion, and data for each group. The sections are as follows:

Section	River/Stream and Volunteer Group
5-1	Androscoggin River (Upper) – Androscoggin River Watershed Council
5-2	Androscoggin River (Lower) – Friends of Merrymeeting Bay
5-3	Cold Brook & Whitten Brook – Town of Skowhegan
5-4	Kennebunk River & tributaries – Mousam & Kennebunk Alliance
5-5	Mousam River & tributaries – Mousam & Kennebunk Alliance
5-6	Presumpscot River & tributaries – Presumpscot River Watch
5-7	Rockport Harbor & tributaries – Rockport Conservation Commission
5-8	Weskeag River & tributaries – Friends of Weskeag/Georges River Land Trust

Bacteria Data

The River/Stream reports contain the bacteria data collected by the volunteer groups and the calculated geometric means. Geometric mean is a special average that indicates the central tendency of a set of numbers. Because very high or low values can skew the mean, geometric mean is used. The means were calculated for all the sites, regardless of the number of samples taken. To calculate a mean for regulatory purposes, at least six samples are required throughout the season (May 15th - September 30th) and sampling effort is subject to review by DEP Division of Environmental Assessment staff.

Chapter 4
Quality Assurance/Quality Control

VRMP Quality Assurance Project Plan [QAPP], Sampling and Analysis Plans [SAPs], and Sampling Sites

The VRMP's network of volunteer groups monitor under quality-assured volunteer sampling as governed by:

(a) A program-level Quality Assurance Project Plan (QAPP)[1], which includes data quality objectives and Standard Operating Procedures (SOPs) for how to collect water samples and how to use various VRMP-approved water quality meters (Maine DEP, 2014), and;

(b) Individual Sampling and Analysis Plans (SAPs)[2] created by each volunteer group that tailor the program-level QAPP to their specific project situation and which are reviewed/approved by VRMP staff. A SAP provides specific information, including the group's goals and objectives. Project specific details include items such as detailed site location information and sampling logistics. They also include the parameters being monitored, brands and models of equipment being used, and specific SOPs (or reference to the SOPs). Individual SAPs also allow flexibility for groups to adapt the design of the program to local situations, conditions, and available resources.

This VRMP report will not describe the details (e.g., sampling methods, sample sites), but they may be found in the documents just described. To view the QAPP, visit the VRMP website[1]. For a copy of a SAP, contact VRMP staff.

[1] Maine Department of Environmental Protection (MDEP). 2014. Maine Volunteer River Monitoring Program (VRMP) – Quality Assurance Program (Project) Plan. Prepared by J. Varricchione and L. Vickers. Volunteer River Monitoring Program, Maine Department of Environmental Protection, Portland, ME. DEPLW-0984. Available at http://www.maine.gov/dep/water/monitoring/rivers_and_streams/vrmp/index.html

[2] Sampling and Analysis Plans (SAPs) for individual VRMP groups, which include site descriptions and photographs, are available from the VRMP.

VRMP Quality Control Steps

The following bullets summarize the various QA/QC measures that are a part of the VRMP.

- Individual volunteers are evaluated on the adequacy of their sampling techniques and certified/recertified at annual volunteer training workshops.
- VMRP maintains and calibrates equipment lent to monitoring groups. The accuracy of monitoring equipment or techniques is tested as described in Table 3a of the Quality Assurance Project Plan (Maine DEP [QAPP], 2014).
- Monitors follow an approved SOP for each parameter monitored. Additionally, field calibration and/or accuracy determination procedures are performed for monitoring equipment that require it, as listed in Table 3a or in the instrument's specific SOP.
- Field duplicates are obtained by each volunteer for at least 10% (1 duplicate per 10 samples collected or monitored) for all parameters. Comparisons of duplicate results versus "original sample" results are expected to meet the criteria listed in Table 3a.
- For water samples requiring laboratory analyses, field duplicate samples are obtained for at least 10% of samples (i.e. 1 duplicate per 10 samples) collected per parameter (Table 3c of the Quality Assurance Project Plan).
- Sample bottles or containers, if used, are appropriately prepared (e.g. rinsed, sterilized) prior to sampling, by either a laboratory or the volunteer group according to approved SOPs.
- Laboratories that are used by member organizations must meet the criteria listed in Appendix 11 of the QAPP. Also, they are expected to provide their own internal approach to quality control for each parameter being analyzed, and their testing should meet VRMP criteria outlined in Table 3a if the data are to be included in the VRMP's water quality database. Quality control data (Lab Reports) will be submitted by each laboratory to their patron volunteer monitoring groups who will, in turn, submit copies of this information to the VRMP. The volunteer group reviews the lab QA/QC data for potential problems first, and informs the VRMP of any problems. The VRMP will also review the lab reports.
- Water quality data is reviewed according to procedures outlined in the next section.

VRMP Quality Assurance Review of Data

After water quality and associated data are submitted, the VRMP undertakes a thorough review of field forms (hard copies) and electronic spreadsheets to assess the accuracy of the information submitted. VRMP also reviews the data to determine whether QA/QC (quality assurance/quality control) measures stipulated in the VRMP QAPP were carried out by volunteers and labs.

The volunteer groups continue to make improvements each year with QA/QC procedures. Overall, volunteers are completing the field sheets much better and calibrating meters correctly. Field meter duplicate sampling is almost always within acceptable precision range. Problems seem to occur primarily with new monitors. They are sometimes not as attentive to calibrating meters correctly and recording calibration values. VRMP staff now tries to perform QA/QC checks during the summer with new monitors. QA/QC issues the monitors need to pay attention to are:

- Make sure that all pertinent sections of the field sheet are filled in completely, including the QA/QC calibration section.
- Meters should be turned on for a minimum of 15-20 minutes prior to calibration
- Duplicate sampling should be done for 10% of all sampling effort.
- Zero dissolved oxygen tests should be done once in mid-season and end of season.

The following explains the steps taken to review the data and how problem data are handled:

1) VRMP water quality data are entered onto standard field forms. These VRMP datasheets include space for data elements that are entered into the VRMP database. This includes information on how samples were collected, sample location, equipment used, and other important notes or observations. The field form also includes a “QA/QC Check” section and chain of custody for the field form and lab samples.
2) Data are entered by the group’s data manager into a standardized spreadsheet template called a “pre-EDD” (Pre-electronic Data Deliverable).
3) The electronic data and hard copies of the datasheets are sent to the VRMP.
4) VRMP staff compares the group’s datasheets and electronic files to ensure the records match. A review of field duplicate data and laboratory quality assurance information is also conducted as noted below in the tracking step.
5) When reviewing the data, VRMP staff identifies any problems and may enter specific comments in the VALIDATION_Comments field of the Pre-EDD.
6) VRMP staff review lab reports provided by labs that analyze samples. Review includes reviewing procedures such as whether holding times were met, field and lab duplicates and lab blanks-spikes. Data may be rejected by VRMP staff or may include a qualifier (such as holding time exceeded).

7) Lab QA/QC data is entered in a "tracking" spreadsheet. The purpose of the tracking spreadsheet is to identify QA/QC issues, track duplicates, and allow further review of the data (i.e. compare to Data Quality Objectives) if warranted.

8) Some data may be excluded from the database. Reasons for possible exclusion are below.

   - Data values are outside the measurement range (detection limit) [3]
   - Calibration value for the dissolved oxygen meter was not recorded and/or there was no indication on the datasheet that it was calibrated
   - Calibration value for dissolved oxygen meter is outside the accepted calibration range [<97% or >103%]
   - There was a Pre-EDD, but no hardcopy of the datasheet
   - Samples for laboratory analyses did not adhere to handling requirements (e.g. did not use sterilized containers, did not get to lab on time, samples not kept cold)

9) Data are uploaded into the DEP's EGAD database.

Maine DEP Use of VRMP Data

The VRMP was designed to provide support to volunteer organizations interested in collecting water quality data. The support includes equipment loan and maintenance, annual training on use of equipment, data management and an annual monitoring report. The VRMP has a Quality Assurance Project Plan and each volunteer group has a Sampling & Analysis Plan specific to their monitoring efforts. Data that passes VRMP QA/QC review is uploaded to DEP's database. Thus all the data is stored electronically and is available for DEP use. Outside organizations or individuals may also obtain the data upon request.

While the data that VRMP affiliated groups gather is high quality, Maine DEP will decide how to use the data in decisions related to laws, enforcement, and other regulatory issues. In some cases, VRMP collected data will be viewed as primarily "advisory level data" since it may be difficult for DEP to defend the validity of volunteer collected data, regardless of the quality assurance steps that are in place.

[3] See "Maine Volunteer River Monitoring Program (VRMP) Quality Assurance Program Plan (2014)" Table 3a-Quality objectives for commonly measured stream assessment parameters under the umbrella of the VRMP.

In general, DEP uses data collected by DEP and quality assured data collected by affiliated groups to assess the water quality of the State's waters. This information is reported out in the 305(b) report, "Integrated Water Quality Monitoring and Assessment Report" that is completed biannually as required under the Clean Water Act. If impairment is identified, further action may be warranted.

Required River/Stream Monitoring Locations

Volunteers are advised that sampling should occur so that a flowing, well-mixed, representative sample is collected. If possible, volunteers should try to sample in the "center half of flow". Volunteers may also employ a variety of techniques to obtain a well-mixed sample including wading into the stream, using an extension pole or sampling from a bridge/culvert.

Each of the VRMP sampling sites is documented, and VRMP staff visit the sites to approve and certify them. It is critical that volunteers consistently sample from the same location (whenever feasible and safe) to ensure comparability of data at that particular river or stream location.

Maine DEP River Codes that Correspond to Volunteer Group Site Code Names

The VRMP creates unique River Code IDs ("VRMP Site IDs") for each of the local volunteer group sites ("Organization Site Codes"). VRMP Site IDs can be found alongside volunteer Organization Site Codes in the Stream Reports data. For example the Mousam-Kennebunk Alliance has a site named KB-05. The VRMP Site ID for this site is Kennebunk River-SKE148-VRMP. The "SKE148 is the unique identifier for the DEP database and "VRMP" identifies the site as a VRMP site. For simplicity, only volunteer Organization Site Codes were used in the figures (graphs) in this report.

Refer to Appendix A for an explanation of how Maine DEP River Codes are established for various river sites.

References

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Appendix A

Sampling Point Coding System
Maine DEP Bureau of Water Quality

Design

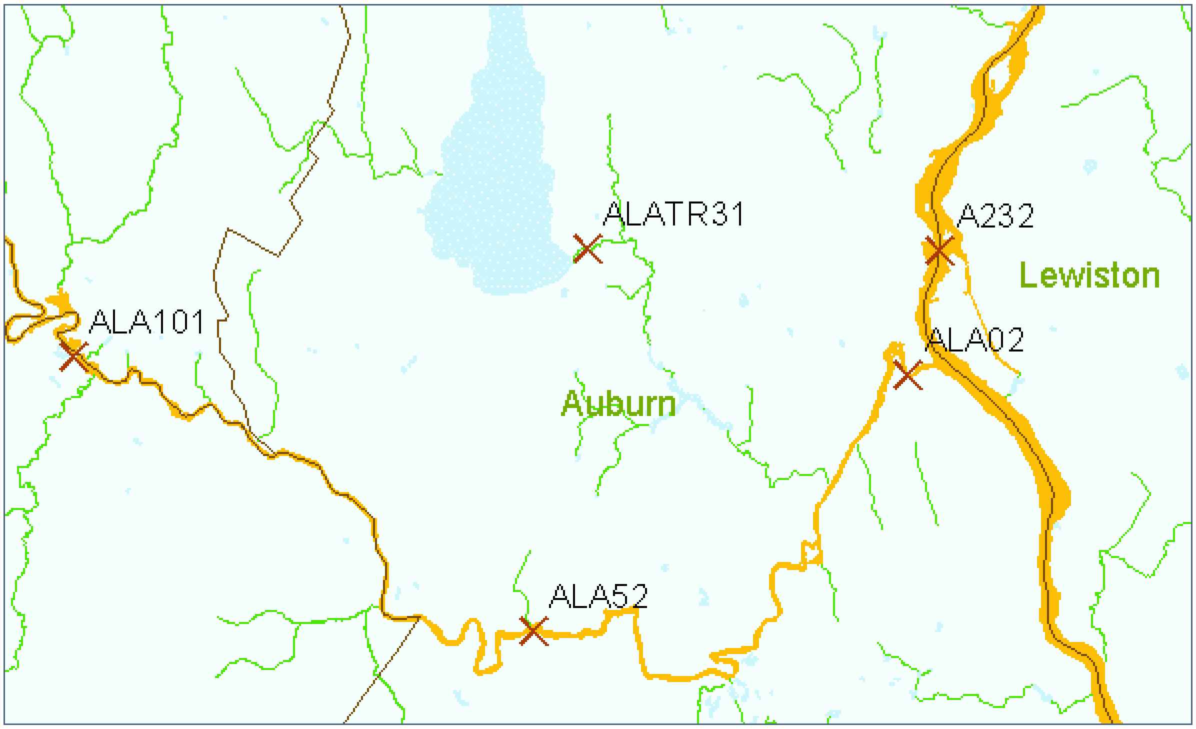
This document is designed to provide guidance on establishing unique IDs for sampling point data for Maine waters. This ID system is based on river hierarchy and the mile(s) upstream from where the target stream/river branches off from its parent water.

How sites are coded

Each order of stream is given a two digit letter code that adds to the unique ID for a specific site / sampling location. For example, the following shows part of the coding for Little Androscoggin River.

A					Androscoggin River
A	**L**	**A**			**Little Androscoggin River (01)**
A	L	A	A	N	Andrews Brook
A	L	A	B	G	Bog Brook
A	L	A	C	L	Cool Brook
A	L	A	D	S	Davis Brook
A	L	A	M	G	Morgan Brook
A	L	A	M	N	Minister Brook

A sampling point on Little Androscoggin (LA) would be assigned the prefix ALA and given a number suffix that represents, in 10^{th}'s of a mile, how far upstream it is from where it branches off the main stem of the Androscoggin River (A).



Examples:

A sampling point located 2/10th of a mile upstream from where the Little Androscoggin branches off the main stem of the Androscoggin River would be called: ALA02

A sampling point located 5.2 miles upstream stream from where the Little Androscoggin branches off the main stem of the Androscoggin River would be called: ALA52

A sampling point located 10.1 miles upstream from where the Little Androscoggin branches off the main stem of the Androscoggin River would be called: ALA101

River mile distance coding

For codes more than a mile upstream, the last digit always represents the closest 10th of the mile. For example:

11 = 1.1 miles upstream

101 = 10.1 miles upstream

1100 = 110 miles upstream