QUALITY ASSURANCE PROJECT PLAN
for
Biological Monitoring of Maine's Rivers, Streams, and Freshwater Wetlands

Prepared By:

Maine Department of Environmental Protection
Bureau of Water
Division of Environmental Assessment
Biological Monitoring Program
State House Station #17
Augusta, ME 04333
biome@maine.gov

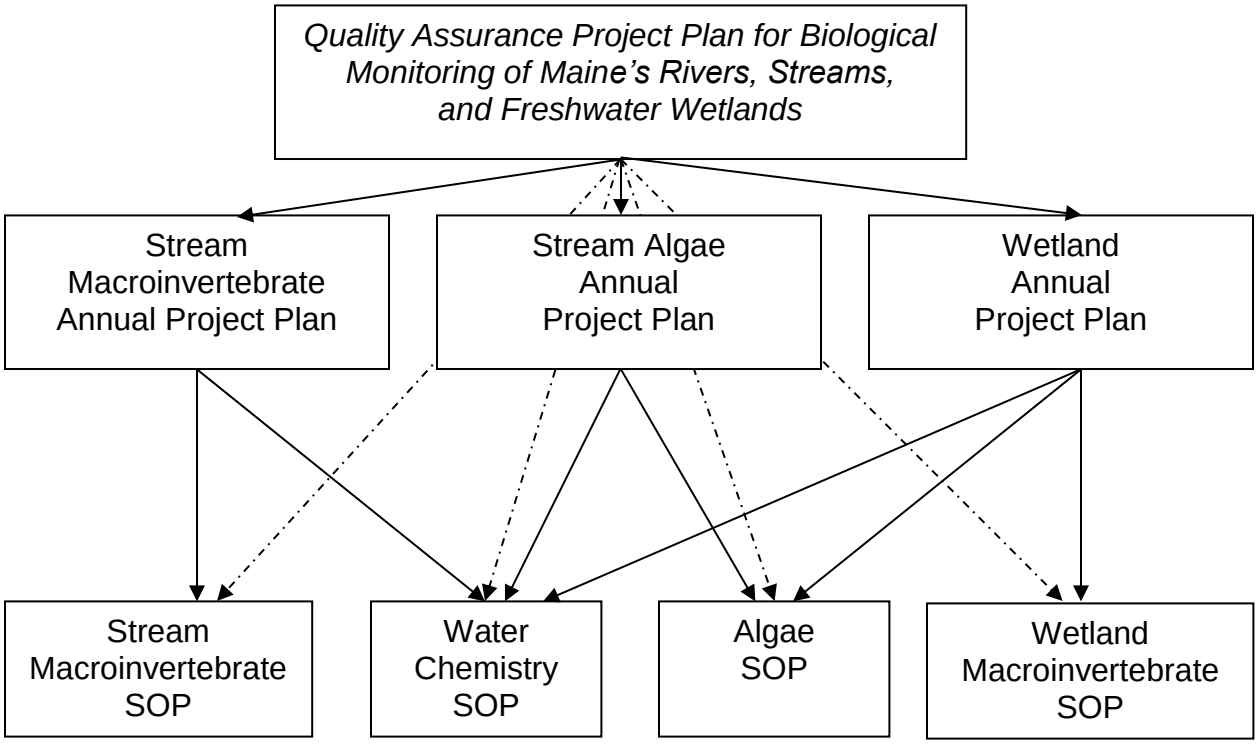
Date: June 1, 2019

DEP-LW-0638C-2014

Preamble

Relationship Between *Quality Assurance Project Plan for Biological Monitoring of Maine's Rivers, Streams, and Freshwater Wetlands* and Project Plans and Standard Operating Procedures

The following diagram provides the general relationships of the generic ***Quality Assurance Project Plan (QAPP) for Biological Monitoring of Maine's Rivers, Streams, and Freshwater Wetlands*** with Annual Project Plans (APPs; for sample see App. E) and associated Standard Operating Procedures (SOPs). This diagram is not intended to display all potential APPs or SOPs. The APPs describe individual sampling efforts and reference method SOPs. The SOPs describe in detail the methods used to sample rivers, streams and freshwater wetlands, such as how to collect water grab samples and use equipment to measure water conductivity. As shown below, several APPs may reference a single SOP. However, APPs may also reference SOPs that are not referenced by other Project Plans.



A1 – Title and Approval Sheet

Biological Monitoring of Rivers, Streams and Freshwater Wetlands in Maine
Quality Assurance Project Plan

Andy Johnson DATE
MDEP QAPP Review Coordinator

Donald T. Witherill DATE
MDEP Director Division of Environmental Assessment

Leon Tsomides DATE
MDEP PROJECT MANAGER

Rob Reinhart DATE
USEPA, Region 1 QA Officer

Hilary Snook DATE
USEPA, Region 1 Program Technical Contact

Karen McCarthy DATE
USEPA, Region 1 ME PPG Project Officer

A2 – Table of Contents

ELEMENT/SECTION

TABLES

FIGURES

APPENDICES

Appendix D Standard Methods and Standard Operating Procedures (SOPs)

i. Methods for Biological Sampling and Analysis of Maine's Rivers and Streams
ii. Protocols for Using the Dissolved Oxygen and Specific Conductance/pH Meters in Rivers, Streams, and Freshwater Wetlands
iii. Protocols for Using the Global Flow Meter in Wadeable Rivers and Streams
iv. Protocols for Collecting Water Grab Samples in Rivers, Streams, and Freshwater Wetlands
v. Procedure for Measuring Continuous Water Temperature Using an Onset Data Logger
vi. Protocols for Sampling Algae in Wadeable Rivers, Streams, and Freshwater Wetlands
vii. Protocols for Sampling Aquatic Macroinvertebrates in Freshwater Wetlands
viii. Protocols for Managing Biomonitoring Data
    a. Appendix 1 – Overview of how biological samples are handled
    b. Appendix 2 – Instructions for How to add New Sites (Monitoring Stations) to EGAD Using MESA2
    c. Appendix 3 – How to assign landscape level classification to wetland biomonitoring sites
    d. Appendix 4 – Procedures for Using the EGAD Uploader Module
    e. Appendix 5 – How to download data from HETL's StarLIMS to go into EGAD
    f. Appendix 6 –How to Assign New Codes to Macroinvertebrate Taxa from River, Stream and Wetland Samples
    g. Appendix 7 – How to Assign New Codes to Algal Taxa from River, Stream and Wetland Samples
    h. Appendix 8 – Instructions for Using EGAD, Maine DEP's Environmental and Geographic Analysis Database
    i. Appendix 9 – Delineating Watersheds for Biomonitoring Sampling Stations
    j. Appendix 10 – Biomonitoring MELCD Tool Summary
    k. Appendix 11 –Biological Monitoring Data Management SOP Duties
    l. Appendix 12 - How to Use the Garmin GPSmap 78s
ix. Protocols for Decontaminating Biomonitoring Sampling Equipment
x. Protocols for Completing the Biological Monitoring Wetland Human Disturbance Assessment
xi. Protocols for Sampling Aquatic Macrophytes in Freshwater Wetlands (DRAFT)
xii. Protocols for Sampling Fish in Wadable Streams (DRAFT)

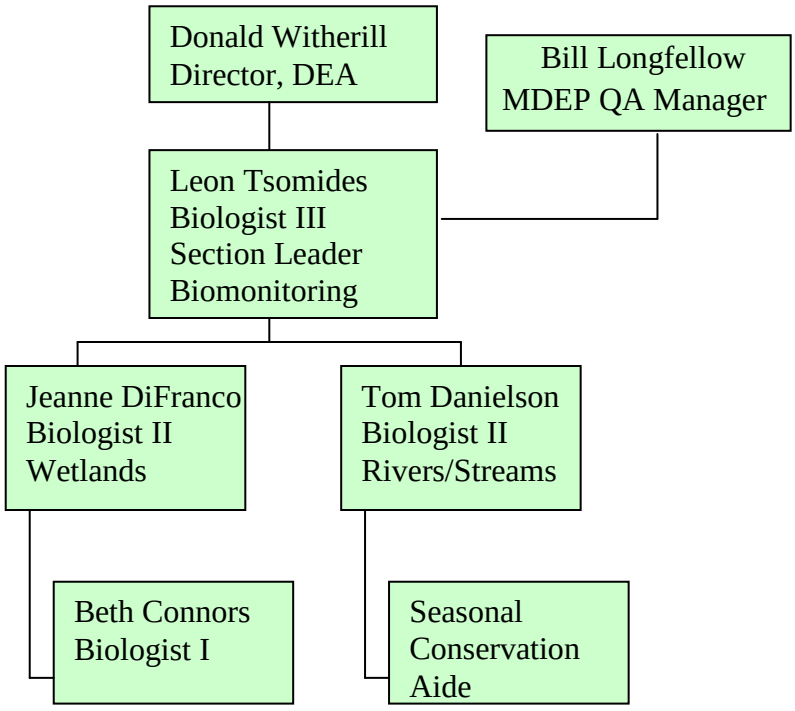
Appendix E Annual Project Plan (sample)

A3 – Distribution List

Name	Organization
Hilary Snook	U. S. Environmental Protection Agency, Region 1
Rob Reinhart	U. S. Environmental Protection Agency, Region 1
Karen McCarthy	U. S. Environmental Protection Agency, Region 1
Leon Tsomides	Maine Department of Environmental Protection
Andy Johnson	Maine Department of Environmental Protection

Other staff from Maine Department of Environmental Protection as appropriate.

A4 - Project/Task Organization



- Leon Tsomides is responsible for the overall quality assurance of the Biological Monitoring Program as well as the stream macroinvertebrate APP.
- Jeanne DiFranco is responsible for wetland SOPs and the wetland sampling APP.
- Tom Danielson is responsible for stream SOPs and for the stream algae APP.
- Beth Connors is responsible for maintaining the official approved QAPP and SOP coordination.

A5 - Problem Identification/Background

In 1986, the Maine State Legislature created the Water Classification Program (WCP) (Title 38 M.R.S. Art. 4-A) to improve the management of the State's waters. The Legislature declared that it is the State's objective to restore and maintain the chemical, physical, and biological integrity of the State's waters and to preserve certain pristine State waters. The Legislature also recognized that it was unrealistic to assign the same environmental goals to all of the State's fresh surface waters. As a result, the Legislature established four classes (AA, A, B, and C) with different levels of environmental protection, and assigned classes to all fresh surface waters in the State. For each class, the Legislature defined the desired environmental goals (designated uses) and established narrative and numeric criteria that must be met to attain the desired environmental goals (Table 1).

Table 1. Maine Water Quality Criteria for Classification of Fresh Surface Waters (Title 38 M.R.S. §465)

Class	**Dissolved Oxygen Numeric Criteria**	**Bacteria (E. coli) Numeric Criteria**	**Habitat Narrative Criteria**	**Aquatic Life (Biological) Narrative Criteria****
Class AA	As naturally occurs	As naturally occurs but may not exceed geometric mean of 64/100 ml over 90-day interval or 236/100 ml in more than 10% of samples in any 90-day interval	Free flowing and natural	No direct discharge of pollutants*; as naturally occurs**

Class A	7 ppm or 75% saturation From 10/1 to 5/14, 7-day mean concentration not less than 9.5 ppm and 1-day minimum concentration not less than 8.0 ppm in identified fish spawning areas	As naturally occurs but may not exceed geometric mean of 64/100 ml over 90-day interval or 236/100 ml in more than 10% of samples in any 90-day interval	Natural	As naturally occurs**
Class B	7 ppm or 75% saturation From 10/1 to 5/14, 7-day mean concentration not less than 9.5 ppm and 1-day minimum concentration not less than 8.0 ppm in identified fish spawning areas	May not exceed geometric mean of 64/100 ml over 90-day interval or 236/100 ml in more than 10% of samples in any 90-day interval from 4/15 to 10/31	Habitat for fish and other aquatic life, unimpaired	Discharges may not cause adverse impact to aquatic life in that the receiving waters must be of sufficient quality to support all indigenous aquatic species without detrimental changes to the resident biological community.**
Class C	5 ppm or 60% saturation 6.5 ppm (monthly average) at 22° and 24°C	May not exceed geometric mean of 64/100 ml over 90-day interval or 236/100 ml in more than 10% of samples in any 90-day interval from 4/15 to 10/31	Habitat for fish and other aquatic life	Discharges may cause some changes to aquatic life, but the receiving waters must be of sufficient quality to support all species of indigenous fish and maintain the structure and function of the resident biological community.**

* Limited exceptions apply.

** Numeric biocriteria in Maine rule Chapter 579, Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams.

The purpose of the Maine Department of Environmental Protection (MDEP) Biological Monitoring (Biomonitoring) Program is to evaluate the condition of fresh surface waters to determine if they are attaining their aquatic life use criteria. In 1983, the Biomonitoring Program started collecting benthic macroinvertebrates from streams and rivers (Davies *et al.* 1999). Macroinvertebrates are animals without backbones that can be seen with the naked eye, such as mayflies, stoneflies, caddisflies, snails, leeches and crayfish. The Biomonitoring Program uses a statistical model, which combines a database with a series of linear discriminant models to predict the likelihood of streams and rivers attaining their aquatic life use criteria (App. D i). In 2003, the MDEP completed the process of adopting its numeric biocriteria, based on this model, into state regulation. The Biomonitoring Program uses the data to determine the impacts of toxic contamination, report in the Maine Integrated Water Quality Monitoring and Assessment Report to USEPA, inform permitting, licensing, and compliance decisions, and measure the performance of restoration and conservation activities (Davies *et al.* 1999).

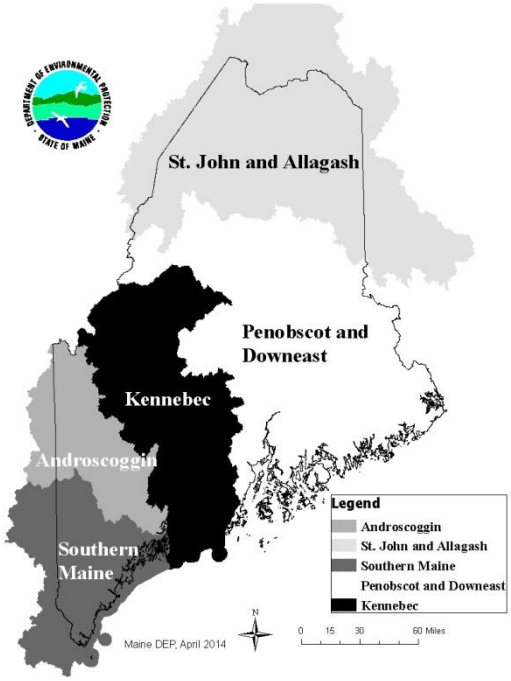
In 1998, the Biomonitoring Program began development of a biological monitoring and assessment program for freshwater wetlands. Under the Clean Water Act, states are required to adopt water quality standards and assessment programs for all waters of the U.S., including wetlands, and must report on attainment status in relation to standards every two years. The wetland biomonitoring initiative has been incorporated into the MDEP's existing water quality assessment division as part of the State's Biomonitoring Program. As of 2002, annual wetland monitoring is coordinated with river and stream biomonitoring using a 5-year rotating basin schedule (see Figure 1). Major wetland program functions include conducting monitoring and assessment to evaluate ecological integrity of wetlands, investigating causes and sources of wetland degradation, developing wetland water quality standards (including biological criteria), and providing technical support to other State programs. The Biomonitoring Program currently samples aquatic macroinvertebrates and algae as the primary taxonomic indicators for assessing the condition of emergent and aquatic bed wetland habitats. The unit completed a statistical model using macroinvertebrates in 2010 to predict the likelihood of wetlands attaining their narrative aquatic life use criteria and updated the model in 2018. A statistical model based on epiphytic algae was also completed in 2018, and a model based on phytoplankton is currently in development.

In 1999, the Biomonitoring Program started to collect algae samples from streams. Maine's narrative aquatic life standard is broad enough to encompass any plants or animals which live in fresh water for at least part of their life cycle, including fish, amphibians, mussels, crustaceans, insects, and algae. The Biomonitoring Program has collected over 2,000 algal taxa from streams and wetlands to date, in the following groups: blue-green algae (Cyanobacteria), diatoms (Bacillariophyceae), dinoflagellates (Pyrrhophyta), euglenoids (Euglenophyta), green algae (Chlorophyta), and red algae (Rhodophyta) (Wehr and Sheath 2003). In 2010, the unit completed a statistical model using algae to predict the likelihood of streams and rivers attaining their narrative aquatic life use criteria (Danielson et al. 2011 and Danielson et al. 2012). A model for fish in wadeable streams is currently under development.

A6 – Project/Task Description

The Biomonitoring Unit follows a rotating basin approach for sampling streams, rivers, and wetlands (Figure 1). Each basin is the focus of sampling efforts every five years. The Biomonitoring Unit has found it helpful to coordinate stream and wetland sampling in the same basin and year. Streams, rivers, and wetlands to be sampled in a given year will be chosen on the basis of the rotating basin approach and requests from various programs (*e.g.*, the Watershed Management Unit, Surface Water and Ambient Toxics). Although basins are emphasized, sampling in a given year is not limited to that year's basin. Special projects and management questions will require the Biomonitoring Unit to diverge from the basin approach in some cases. However, the majority of samples in a given year will come from the assigned basin. The final decision about which locations will be sampled in a given year rests with each project manager (see below).

Figure 1. Rotating Basin Schedule



The Biomonitoring Unit conducts four major types of sampling, including: (1) stream macroinvertebrates; (2) stream algae; (3) wetland macroinvertebrates, algae and macrophytes; and (4) stream fish. These four focus areas are defined as tasks in this QAPP. Outlines of the four major tasks included in this QAPP are presented below, while the details are presented in Section B1 - Sampling Process Design (Experimental Design).

Task 1. Stream Macroinvertebrate Sampling.

The macroinvertebrate community at each sampling station is sampled using artificial substrate samplers (rock bags, rock baskets, cones) during a 4-week period during the summer low-flow period using the protocol detailed in App. D i. In addition to macroinvertebrate data, information is also collected on physical habitat parameters (land use, upstream terrain, canopy cover, and stream substrate composition), water quality parameters (*e.g.*, instantaneous dissolved oxygen and temperature; see App. D ii), flow velocity (see App. D iii), stream width and depth, and geographic location (longitude and latitude). Furthermore, water chemistry samples (*e.g.*, for nutrient analysis) may be collected where deemed necessary (see App. D iv). Finally, at most stations, continuous temperature will be recorded while macroinvertebrate samplers are deployed (see App. D v). The final decision about specific methods to be used and parameters to be sampled in a given year rests with the task manager.

Major tasks for stream macroinvertebrate sampling occur during the following times:

MAJOR TASKS	J	F	M	A	M	J	J	A	S	O	N	D
Select sample locations			x	x	x	x						
Develop APP						x						
Recon sample locations					x	x						
Train staff (*e.g.*, sample methods, CPR)					x	x	x					
Collect samples							x	x	x			
Process samples	x	x	x	x				x	x	x	x	x
Send biological samples to taxonomists	x	x	x	x				x	x	x	x	x
Review data sheets for completeness and accuracy							x	x	x	x		
Enter Data	x	x	x	x	x					x	x	x
Analyze Data	x	x	x	x	x					x	x	x
Write Reports	x	x	x	x	x	x					x	x

Task 2. Stream Algae Sampling.

The Biomonitoring Unit collects several kinds of algal samples, including: (1) viewing bucket surveys; (2) Chlorophyll *a* (Chl *a*) samples from natural and/or artificial substrates; and (3) species composition samples from natural and/or artificial substrates. Guidance on where, when, and how to collect algal samples are described in App. D vi. In addition to algal data, information is collected on physical habitat parameters (land use, upstream terrain, canopy cover, and stream substrate composition), water quality parameters (*e.g.*, instantaneous dissolved oxygen and temperature; App. D ii), flow velocity (App. D iii), stream width and depth, and geographic location (longitude and latitude). Furthermore, water chemistry samples (*e.g.*, for nutrient analysis) may be collected where deemed necessary (see App. D iv). The final decision about specific methods to be used and parameters to be sampled in a given year rests with the task manager.

Major tasks for stream algae sampling occur during the following times:

MAJOR TASKS	J	F	M	A	M	J	J	A	S	O	N	D
Select sample locations			x	x	x	x						
Develop APP					x							
Recon sample locations					x	x						
Train staff (*e.g.*, sample methods, CPR)					x	x	x					
Collect samples						x	x					
Process samples								x	x			
Send biological samples to taxonomists									x	x	x	
Review data sheets for completeness and accuracy						x	x		x	x		
Enter Data	x	x								x	x	x
Analyze Data	x	x	x	x	x					x	x	x
Write Reports	x	x	x	x							x	x

Task 3. Wetland Sampling.

The Biomonitoring Unit collects several kinds of biological samples in wetlands, including: (1) macroinvertebrate samples (D-frame net 1-meter sweep); (2) epiphytic algae from natural substrates (plant stems), (3) phytoplankton (surface water grab sample); and (4) aquatic macrophytes (1-meter rake sweep and visual survey within 5-meter radius plot). Guidance on where, when, and how to collect samples are described in relevant SOPs (App. D vi, vii and xi). In addition to biological samples, information is collected on physical habitat parameters (land use, terrain, dominant plant species, and substrate composition), water quality parameters (*e.g.*, instantaneous dissolved oxygen and temperature; see App. D ii), and geographic location (longitude and latitude). Furthermore, water chemistry samples (*e.g.*, for nutrient analysis) may be collected where deemed necessary (see App. D iv). Continuous water temperature may also be recorded (See App. D v). The final decision about specific methods to be used and parameters to be sampled in a given year rests with the task manager.

Major tasks for wetland sampling occur during the following times:

MAJOR TASKS	J	F	M	A	M	J	J	A	S	O	N	D
Select sample locations			x	x	x	x						
Develop APP					x							
Recon sample locations					x	x						
Train staff (*e.g.*, sample methods, CPR)					x	x						
Collect samples						x	x					
Conduct macrophyte surveys; preserve unknown plants and voucher specimens						x	x	x	x			
Process samples	x	x	x	x				x	x	x	x	x
Send biological samples to taxonomists	x	x	x	x				x	x	x	x	x
Review data sheets for completeness and accuracy							x	x	x	x		
Identify unknown plants	x	x								x	x	x
Enter Data	x	x	x	x	x					x	x	x
Analyze Data	x	x	x	x	x					x	x	x
Write Reports	x	x	x								x	x

Task 4. Stream Fish Sampling.

The Biomonitoring Unit collects fish from wadeable streams with a backpack electroshock unit. Guidance on where, when, and how to collect fish samples are described in App. D xii. In addition to fish data, information is collected on physical habitat parameters (land use, upstream terrain, canopy cover, and stream substrate composition), water quality parameters (*e.g.*, instantaneous dissolved oxygen and temperature; App. D ii), flow velocity (App. D iii), stream width and depth, and geographic location (longitude and latitude). Furthermore, water chemistry samples (*e.g.*, for nutrient analysis) may be collected where deemed necessary (see App. D iv). The final decision about specific methods to be used and parameters to be sampled in a given year rests with the task manager.

Major tasks for stream fish sampling occur during the following times:

MAJOR TASKS	J	F	M	A	M	J	J	A	S	O	N	D
Select sample locations			x	x	x	x						
Develop APP					x							
Recon sample locations					x	x						
Train staff (*e.g.*, sample methods, CPR)					x	x	x					
Collect samples						x	x	x	x			
Process samples						x	x	x	x			
Review data sheets for completeness and accuracy							x	x	x	x		
Enter Data	x	x						x	x	x	x	x
Analyze Data	x	x							x	x	x	x
Write Reports	x	x	x	x							x	x

A7 – Data Quality Objectives for Measurement Data

a, b) Data quality objectives and indicators.

Collecting high quality data is of prime importance for the Biomonitoring Program. The specific data quality objectives of this program as discussed below include precision and accuracy, representativeness, comparability, and completeness.

Precision and Accuracy

The precision and accuracy levels desired for all data collected are shown in Table 2. All data collected will be compared with the criteria in Table 2 and will be handled according to procedures outlined in sections D1 (Data Review, Validation, and Verification Requirements) and D2 (Validation and Verification Methods) of this document.

Representativeness

The Biomonitoring Program does not attempt to collect data that are representative of the conditions year-round. Rather, data collection will occur mostly during the summer months (generally June through September, see schedules in section A6). For stream macroinvertebrates, sampling is conducted July through September when macroinvertebrate communities are at their most active and diverse, and when environmental conditions are at their most stressful, *i.e.*, when low flow and high temperatures combine to stress aquatic life resources. Stream algae samples, collected in June and July, target peak algal growth and minimize confounding effects of spring runoff. Wetland sampling for both macroinvertebrates and algae is conducted during June and July. During this index period, wetland invertebrates are mature enough for identification, and wetland hydrology is generally appropriate for sampling. Later in the summer, site selection may be limited because many wetlands have dried out. Aquatic macrophyte surveys in wetlands may be conducted throughout the summer months (June through mid-September). Identification of some plant groups may be more difficult earlier in the season however, if characteristic features such as flowers and fruits are not yet developed. Stream fish are collected between June and September in order to minimize confounding effects of spring runoff and leaf fall in autumn. To minimize effects of habitat heterogeneity, each task has provisions for sample replication as specified in the respective SOPs (see App. D i, vi, vii, xi, and xii). Each SOP also contains protocols for targeting specific habitats to ensure that samples represent

standardized conditions. Due to the way stations are chosen, they are not necessarily representative of typical conditions along an entire stream or wetland complex.

Completeness

The Biomonitoring Program uses a 5-year rotating basin sampling approach to strive for complete coverage across the State. The rotating basin schedule is described in Section A6 (see Figure 1).

Comparability

To ensure comparability among the data, the Biomonitoring Program will employ standardized sampling procedures. References for the methods employed can be found in section B1, and in Tables 2 and 3. Additional methods not included in the program's SOPs may be used, provided they are approved in advance by Biomonitoring Program staff. In such cases, full documentation of the methods used (*i.e.*, a relevant SOP) must be provided to the Biomonitoring Program; this documentation will be included in the program's QAPP binder located in the biomonitoring office area.

c) Measurement performance criteria.

Measurement quality objectives (*i.e.*, measurement ranges, method detection limits, and reporting units) desired for the Biomonitoring Program are shown in Table 2. The goal of these objectives is to allow a better assessment of the quality of each parameter or sample that is analyzed in either the field or the laboratory.

A8 –Training Requirements/Certification

Qualifications of New Hires

New permanent or acting capacity staff to be hired by the MDEP Biomonitoring Program shall meet all minimum State qualifications appropriate for the classification (Biologist , Environmental Specialist, Conservation Aide, etc.). In addition, candidates must possess specialized education and experience necessary for the particular position.

Qualifications of Field Personnel

All field sampling for Tasks 1-4 will be performed under the supervision of a trained Aquatic Biologist who has the qualifications specified in App. D i or equivalent qualifications as appropriate for the specific position. It is preferred that temporary (summer) field staff have a background in biology or environmental studies. At the beginning of their first field season and every other year thereafter, all field staff are required to attend CPR/First Aid training. Additional training on equipment handling and laboratory safety will be completed every year. The training status of permanent and field personnel will be tracked in electronic format in a dedicated file (Tracking staff training.xlsx) located in the Biomonitoring Program's "SOP-Instructions\BIOMON TRACKING LISTS" folder. All field staff will receive additional training as described in the Department and Bureau Safety Manuals, as applicable.

Qualifications of Macroinvertebrate Sorters

Handling of the macroinvertebrate samples in DEP's field service support area must be performed by qualified personnel working under the supervision of a professional aquatic biologist. It is preferred that these personnel have some college education and a background and/or interest biology or environmental studies. At the start of employment, personnel are required to attend a training session on field service support area safety.

Qualifications of Taxonomists

Sample taxonomy for macroinvertebrates must be performed or supervised by a professional freshwater macroinvertebrate taxonomist who has the qualifications specified in App. D i.. In addition, certification by the Society of Freshwater Science in the identification of eastern US taxa is preferred, however documented experience can be substituted. Experience or training must include Genus level categories, such as Ephemeroptera, Plecoptera and Trichoptera (EPT), General Arthropods and Chironomidae taxa. Taxonomic data will not be accepted without verification that the supervising laboratory taxonomist meets the above criteria. Sample taxonomy for algae must be performed or supervised by a professional freshwater algal taxonomist with a closely related advanced degree with specialized training or experience in the taxonomy of northeastern freshwater algae. Each contracted taxonomist, working for the Biomonitoring Unit or working for anyone submitting data to the Biomonitoring Unit, will be required to submit a reference collection (physical or digital) of taxa identified, as well as a list of the taxonomic references used in the identifications. Organism identifications will be checked against the Biomonitoring Unit's collection by a taxonomist approved by the Biomonitoring Unit. Unknown plant samples and voucher specimens are verified by qualified botanists or other personnel experienced in Maine plant taxonomy.

Qualifications of Other Organizations Submitting Data to the Biomonitoring Program

All samples of aquatic life that are collected for the purposes of classification attainment evaluation by other organizations must be collected and identified by qualified personnel (see above) and meet all the Data Quality objectives in this QAPP.

A9 – Documentation and Records

The QAPP and related SOPs for this project were written by Biomonitoring Program staff and will be sent to the appropriate USEPA Region 1 QAPP and Program Technical contacts for review. The QAPP also will be reviewed by competent MDEP staff appointed by the MDEP Quality Assurance manager. The most up-to-date version of this QAPP will be available through the Biomonitoring Program section leader.

The APP (App. E) for a task will be written by the respective project manager in the spring (see section A6). Apps will be reviewed by appropriate Division staff and signed by the Division Director before field work begins. All data collected for the Biomonitoring Program will be handled according to the Protocols for Managing Biomonitoring Data (App. D viii). The laboratory analyzing water chemistry samples will retain for a minimum of five years the raw data for all sample runs and related raw data obtained in the course of quality assurance/quality control (QA/QC) procedures (*e.g.*, results from lab duplicates, blank or spiked samples).

Laboratory reports and QA/QC results will be sent to the respective project managers as soon as they are available. Macroinvertebrate samples and algal slides will be returned to the Biomonitoring Program after identification and retained at the Biomonitoring Program for a minimum of ten years. Chl *a* and other water and sediment samples usually are destroyed during analysis. Taxonomists will send identification records to the Biomonitoring Program as soon as they are available; they will retain raw taxonomic data for a minimum of five years. Each task manager will keep originals of all field data sheets, laboratory taxonomic, quality control records, and miscellaneous correspondence and notes, and final sample reports related to the respective tasks in the appropriate dedicated storage locations and in accordance to the State of Maine Records Retention Policy. Electronic copies of these documents, if available, as well as databases developed specifically for the respective tasks will be stored on MDEP computers and backed-up on the State of Maine network at the end of each day and work week.

B1 – Sampling Process Design (Experimental Design)

Each APP includes a list of proposed sampling areas or sites for river and stream macroinvertebrates, algae and fish, or wetland macroinvertebrates, algae and plants which are chosen based on the rotating basin approach (see section A6 for details), and on requests from different programs (App. E). Sampling requests can be based on a variety of factors, for example the desire to extend the state-wide coverage of monitored sites, an effort to determine a potential impairment of a waterbody from point or non-point sources of pollution, or the need to ascertain the effectiveness of remedial actions. If a new area is to be investigated, a specific sampling location (aka station or site) may not yet have been established when an APP is submitted. In this case, a station is chosen either during a separate reconnaissance trip, if time permits, or on the (first) day of sampling (site selection criteria are discussed below). While the majority of sites to be studied each year are located in the basin designated for investigation during that year, sites located in a different basin can also be sampled if those data are required for a particular purpose.

Task 1. Stream Macroinvertebrate sampling.

The protocol employed in collecting and analyzing stream macroinvertebrate data is detailed in App. D i. Following is a brief description of these methods.

Selection of a specific station location on a given river or stream involves the following criteria:

a) the area should be representative of the habitat of the stream reach as a whole;
b) where available, a riffle/run section is the habitat of choice;
c) the chosen location should have a high degree of certainty that the samplers will remain fully submerged even if the water level drops significantly;
d) precautions should be taken to avoid atypical influences (bridges, channelized areas such as road crossings, culverts, or obstructions to flow), bank effects, or slackwater areas and eddies.

Sampling of the macroinvertebrate community occurs at stations proposed in an APP during a 4-week period between July 1 and September 30. At each station, three replicate rock-filled bags/baskets/cones are deployed in the stream or river for 28 ± 4 days in riffle/run habitats. However, extended periods may be necessary to allow for adequate colonization in the case of assessments of low velocity or impounded habitats. If such conditions exist, a 56 ± 4 days exposure period may be used. At the end of the colonization period, the samplers are retrieved and the contents washed into a sieve bucket. Bucket contents are transferred into labeled mason jars and preserved with 95% ethyl alcohol, to yield an approximately 70% solution of alcohol after dilution with sample water. Macroinvertebrate samples are sorted at the MDEP field services support area and identified by freshwater macroinvertebrate taxonomists. Taxonomic data are analyzed using a statistical model which assigns each sample to one of the State of Maine water quality classes, or to a Non-Attainment category (see section A5, Table 1).

In addition to sampling the macroinvertebrate community at each station, staff also collects the following information:

- potential stressors and the station's location relative to those stressors, land use, surrounding terrain, canopy cover, and the physical characteristics of the stream substrate are assessed once during sampler deployment;
- instantaneous dissolved oxygen (DO), specific conductance (SPC), temperature, pH, and stream flow velocity are measured twice, during deployment and retrieval of samplers, using field meters owned by the MDEP (detailed information on the meters and their use can be found in App. D ii and iii);
- stream width (bankfull and wetted) and stream depth is measured twice, during deployment and retrieval of samplers, using meter sticks, meter tapes, or range finders. These measurements are taken at the same location each time.
- to obtain a visual record of sampling sites, digital photographs of the waterbody upstream and downstream of the sampler locations are taken twice, during deployment and retrieval of samplers.
- longitude and latitude of the sampling site are recorded using a GPS (global positioning system) unit. If this information is available from a prior visit and considered reliable, coordinates do not have to be collected.

All information gathered, including the numbers of the digital photographs and the GPS site code, are recorded in the field on the Maine DEP Biological Monitoring Unit Stream Macroinvertebrate Field Data Sheet (App. B i a).

The following water chemistry parameters may be sampled once per station, during sampler retrieval, if deemed appropriate: total Kjeldahl nitrogen (TKN), nitrate plus nitrite-N (NO_3+NO_2-N), total phosphorus (TP), and ortho-phosphate-P (OPO4-P). If desired, the following additional parameters may also be sampled in the same manner: ammonia-N (NH_3-N), dissolved organic carbon (DOC), total suspended solids (TSS) and total dissolved solids (TDS). Detailed information on the sampling protocols can be found in App. D iv. All field sampling information regarding the water chemistry parameters will be recorded on the Maine DEP Biological Monitoring Unit Stream Macroinvertebrate Field Data Sheet (App. B i a). The chain-

of-custody form required by the analytical laboratory will be completed upon sample delivery to the laboratory (See Appendix C i as an example).

At most stations, water temperature is monitored continuously while samplers are deployed using temperature loggers. Detailed information on the loggers and their calibration and use can be found in App. D v.

Task 2. Stream Algae Sampling.

The MDEP collects several kinds of algal samples, including: (1) viewing bucket surveys; (2) Chl *a* samples from natural and/or artificial substrates; and (3) species composition samples from natural and/or artificial substrates. Guidance on where, when, and how to collect algal samples are described in App. D vi. This SOP also describes steps taken to minimize sources of variation, such as decision rules on locating sample stations. The Biologist responsible for Task 2 will decide which algal samples to collect based on in-stream conditions, associated management questions, and financial resource constraints. The viewing bucket survey provides qualitative assessment of algal biomass, which is time consuming in the field but is inexpensive and does not require lab analysis. The Chl *a* samples provide a quantitative estimate of algal biomass, are relatively inexpensive and require limited lab analysis. The species composition samples provide quantitative biomass estimates, taxa densities, and taxa biovolumes. While this type of sample provides the most information, it also requires the most money and lab analysis. The Chl *a* samples are sent to a qualified lab and the MDEP typically receives data within 1-3 months. The species composition samples are sent to a contracted taxonomist and data are typically returned within 6-9 months. Taxonomic data are analyzed using a statistical model which assigns each sample to one of the State of Maine water quality classes, or to a Non-Attainment category (see section A5, Table 1).

In addition to sampling the algal community at each station, staff also collects the following information:

- land use, upstream terrain, canopy cover, and the physical characteristics of the stream substrate;
- instantaneous DO, SPC, temperature, pH, and flow velocity are measured at each site visit using field meters owned by the MDEP (detailed information on the meters and their use can be found in App. D ii and iii);
- stream width (bankfull and wetted) and depth are measured using meter sticks, meter tapes, or range finders.
- to obtain a visual record of sampling sites, digital photographs are taken of the waterbody upstream and downstream of the sampling location and of the substrate.
- longitude and latitude of the sampling site are recorded using a GPS unit. If this information is available from a prior visit and considered reliable, coordinates do not have to be collected.

All information gathered, including the numbers of the digital photos and the GPS site code, are recorded in the field on the Maine DEP Stream Algae Field Data Sheet (App. B ii a), the Maine DEP Viewing Bucket Survey Data Sheet (App. B ii b), and the Maine DEP Canopy Cover Sheet (App. B ii c), the USEPA Physical Characterization/Water Quality Field Data Sheet

(App. B ii d), and either the EPA Habitat Assessment Field Data Sheet – High Gradient or the USEPA Habitat Assessment Field Data Sheet – Low Gradient, as appropriate (App. B ii e and f).

The following water chemistry parameters may be sampled, if deemed appropriate: TKN, NO_3+NO_2-N, TP, OPO4-P, and alkalinity. Detailed information on the sampling protocols can be found in App. D iv. All field sampling information regarding the water chemistry parameters will be recorded on the Maine DEP Stream Algae Data Sheet (App. B ii a). The chain-of-custody form required by the analytical laboratory will be completed upon sample delivery to the laboratory (See Appendix C i as an example).

Task 3. Wetland Sampling.

The MDEP collects several kinds biological data from freshwater wetlands. The protocols employed are detailed in App. D vi, vii and D xi. Following is a brief description of these methods.

Selection of a specific station location within a given wetland involves the following criteria:

a) aquatic macroinvertebrates should be collected in areas having emergent vegetation, or in shallow aquatic macrophyte beds consisting of floating and/or submerged plants. This may include appropriate sampling locations within or adjacent to other habitat types.
b) water depth in all locations sampled should be less than 1 meter.
c) locations selected for all three replicate samples collected at a site should be as similar to each other as possible with regard to water depth, vegetative community structure, and substrate type.

Sampling of the macroinvertebrate community occurs at stations proposed in an APP during June or July. At each site, three replicate samples are collected using a standard D-frame net by performing a 1-meter sweep. The contents of the net are placed into a sieve bucket, and bucket contents are transferred into labeled mason jars and preserved with 95% ethyl alcohol to yield an approximately 70% solution of alcohol after dilution with sample water. Macroinvertebrate samples are sorted at the MDEP field services support area and identified by freshwater macroinvertebrate taxonomists. Taxonomic data are analyzed using a statistical model which assigns each sample to one of the State of Maine water quality classes, or to a Non-Attainment category (see section A5, Table 1).

Sampling of wetland algal communities occurs at the same time and sampling locations as macroinvertebrates. The MDEP routinely collects two kinds of algae samples for wetlands: (1) epiphytic algae samples from natural substrates (plant stems); and (2) phytoplankton in water samples.

Wetland aquatic macrophyte surveys are conducted at the same sampling locations as macroinvertebrates and algae for selected sites between June and September, and include 3 replicates per site. Two types of plant surveys are performed: (1) 1-meter rake sweep to collect

and enumerate taxa using relative abundance categories; and (2) Visual survey within a 5- meter radius plot to document and enumerate taxa using relative abundance categories (cover classes).

In addition to sampling the macroinvertebrate, algal and plant communities, staff also collect the following information during the site visit:

- terrain, dominant vegetation, and the physical characteristics of the wetland habitat and substrate;
- an evaluation of the human disturbances in the wetland and immediate watershed (App. x),
- instantaneous DO, SPC, temperature, and pH using field meters owned by the MDEP (App. D ii);
- water depth using a meter stick,
- to obtain a visual record of sampling sites, digital photographs of the wetland are taken,
- longitude and latitude of the sampling site are recorded using a GPS unit. If this information is available from a prior visit and considered reliable, coordinates do not have to be collected.

All information gathered, including the numbers of the digital photos and the GPS site code, are recorded in the field on the Maine DEP Wetland Bioassessment Field Data Form, the Wetland Human Disturbance Assessment Form, the Maine DEP Epiphytic Algae Datasheet, and/or the Maine DEP Biological Monitoring Program Wetland Aquatic Vegetation Sampling Form (App. B iii a, b, c and d).

Water samples collected during the site visit may include all or a subset of the following, as deemed appropriate: TKN, NO3+NO2-N, TP, Chl *a*, OPO4-P, DOC, chloride, alkalinity (as $CaCO_3$), true color and silica. Detailed information on the sampling protocols can be found in App. D iv. All field sampling information regarding the water chemistry parameters will be recorded on the Maine DEP Wetland Bioassessment Field Data Form (App. B iii a). The chain-of-custody form required by the analytical laboratory will be completed upon sample delivery to the laboratory (See Appendix C i as an example).

A water temperature logger may be deployed during the site visit and retrieved later in the sampling season. Detailed information on the loggers and their calibration and use can be found in App. D v.

Task 4. Stream Fish Sampling.

The Biomonitoring Unit collects fish from wadeable streams with a backpack electroshock unit. Guidance on where, when, and how to collect fish samples are described in App. D xii. The final decision about specific methods to be used and parameters to be sampled in a given year rests with the task manager.

In addition to sampling the fish community at each station, staff also collects the following information:

- land use, upstream terrain, canopy cover, and the physical characteristics of the stream substrate;
- instantaneous DO, SPC, temperature, pH, and flow velocity are measured at each site visit using field meters owned by the MDEP (App. D ii and iii);
- stream width (bankfull and wetted) and depth are measured using meter sticks, meter tapes, or range finders.
- to obtain a visual record of sampling sites, digital photographs are taken of the waterbody upstream and downstream of the sampling location and of the substrate.
- longitude and latitude of the sampling site are recorded at the downstream and upstream ends of the sample reach using a GPS unit.

All information gathered, including the numbers of the digital photos and the GPS site code, are recorded in the field on the Maine DEP Stream Fish Field Data Sheet (App. B iv a), and either the USEPA Habitat Assessment Field Data Sheet – High Gradient or the USEPA Habitat Assessment Field Data Sheet – Low Gradient, as appropriate (App. B ii e and f).

The following water chemistry parameters may be sampled, if deemed appropriate: TKN, NO_3+NO_2-N, TP, OPO4-P, and alkalinity. Detailed information on the sampling protocols can be found in App. D iv. All field sampling information regarding the water chemistry parameters will be recorded on the Maine DEP Stream Fish Data Sheet (App. B iv a). The chain-of-custody form required by the analytical laboratory will be completed upon sample delivery to the laboratory (See Appendix C i as an example).

B2 – Sampling Methods Requirements

The sampling method requirements for tasks 1-4 of this project are shown in Table 3. This table presents information on the parameters, sampling techniques, sample area or volume, sampling preservation and maximum holding time, analysis location, and reference to the respective SOP detailing sampling and analysis procedures. Samplers and other equipment required for sampling biota (*e.g.*, rock bags, sieve buckets, glass vials and jars for macroinvertebrates; periphytometers for periphyton) are provided and maintained by the MDEP Biomonitoring Program as appropriate. For water quality sampling, labeled containers will be provided by the contracted laboratory. Where required, all materials used will be prepared as specified in the respective SOPs (App. D). Chemicals required for sample preservation will be provided by the MDEP or the lab contracted to analyze the water grab samples.

Cleaning or decontamination procedures for standard sampling equipment or instruments are detailed in the respective SOPs (App. D) and in the Protocols for Decontaminating Biomonitoring Sampling Equipment (App. D ix.). Information on data quality objectives for measurement data is presented in section A7, a and b, above and in Table 2.

B3 – Sample Handling and Custody Requirements

Each project manager will be responsible for ensuring correct sample handling by:

- ensuring availability of all required sampling supplies in the field (for required supplies see respective SOP in App. D);
- properly labeling all sample containers for biological samples in the field (for labeling details see respective SOP in App. D);
- recording all relevant sampling information on the respective field sheets and chain-of-custody forms (App. B and App. C); and
- coordinating the transfer of all samples from the field to laboratories for analysis (for sample transfer details see respective sampling SOP in App. D and App. D viii.).

B4 – Analytical Methods Requirements

Analytical information, and relevant SOPs for tasks 1-4 are listed in Tables 2 and 3. The Biomonitoring Program will contract with a lab to analyze the water quality grab samples, according to the Department's currently acceptable contract procurement procedures. The chosen lab will meet all data quality objective outlined in this QAPP and will follow approved analytical methods, such as those listed in 40 CFR Parts 136 *Clean Water Act Methods Update Rule for the Analysis of Effluent; Final Rule. September 27, 2017*.

B5 – Quality Control Requirements

Acceptable relative percent difference values and accuracy levels for quality control procedures for field and laboratory techniques required for tasks 1-4 are shown in Table 2.

Corrective actions for quality problems attributable to malfunctioning of lab equipment are specified in the respective SOPs used by the contracted lab. If problems with field duplicates for parameters analyzed in the lab are detected before the end of the field season, every effort will be made to resample that parameter. If quality problems are detected for parameters measured with field meters, the meter concerned will be recalibrated, repaired or replaced as specified in the respective SOP (App. D ii and D iii).

B6 – Instrument/Equipment Testing, Inspection, and Maintenance Requirements
B7 – Instrument Calibration and Frequency

Detailed information on testing, inspection, and maintenance requirements, and on calibration procedures and frequency of all meters, instruments and other equipment used in this study can be found in the respective SOPs (App. D ii, iii and v) as referenced in Table 3. An overview of these activities for field instruments is shown in Table 4.

B8 – Inspection/Acceptance Requirements for Supplies and Consumables

Supplies and consumables used in tasks 1-4 will be obtained from the MDEP Division of Environmental Assessment, contracted laboratories, or other respected sources. Rock bags/baskets/cones, periphytometers, and ancillary equipment used for macroinvertebrate, algal and fish sampling is part of the standard equipment used by the Biomonitoring Program, which ensures that everything is in working order at the beginning of the sampling season. Equipment used repeatedly (*e.g.*, nets, sieve buckets) is checked frequently throughout the sampling season to ascertain its functionality. Each task manager will obtain all sampling equipment and supplies used for each sampling event, ensure their quality and suitability for this project, and ensure that high quality equipment and supplies are indeed used to collect data. On each field day, multiples or spares of materials will be brought to minimize the risk of problems.

B9 – Data Acquisition Requirements (Non-direct Measurements)

GIS data required to generate maps will be generated by the Biomonitoring Program or obtained from the MDEP GIS program or Maine Office of GIS. Combining multiple layers of land features (hydrography, topography, roads, etc.) with station identification will allow the production of accurate and informational maps of the monitored waterbodies and their watersheds. These maps will be used to gather additional information and will facilitate interpretation of sampling results and help task managers put the data into a broader context. The quality of the map data will be assessed based on the accompanying metadata.

Project managers may obtain physical, biological, or chemical data that have been collected by other parts of MDEP (*e.g.*, DEA Watershed Management Unit) or outside organizations (*e.g.*, Acadia National Park). The project managers are responsible for determining if these data are of sufficient quality and confidence to be used in making management decisions. When making these decisions, project managers should consider the following factors:

- Were the data collected following standard operating procedures?
- Were the data collected and managed following an approved quality assurance project plan?
- Are the data in the right units of measurement? If not, then they must be converted.
- Do the data appear to be reasonable? Are there values that appear to be out of range?
- Are there limitations in the quality of the data based on sampling methods (*e.g.*, measuring pH with high quality meter vs. measuring pH with litmus paper, trained taxonomist identifying organisms vs. amateur taxonomist)?

B10 – Data Management

All data collected by the Biomonitoring Program will be handled according to the Protocols for Managing Biomonitoring Data (App. D viii).

C1 – Assessments and Response Actions

The project managers for tasks 1-4 are responsible for ensuring that all QA/QC procedures described above are adhered to in their respective task. The presence of a project manager or other experienced field staff at all sampling events ensures procedural consistency throughout the field season. Methods used to assess the correct working order of electronic meters used in the field are given in the SOPs for individual instruments as referenced in Table 3. Similarly, methods used to assess the correct working order of lab equipment are given in the contracted lab's SOPs for individual analyses. Actions taken to ensure data quality are described in section B10, Data Management, above. Each project manager is required to record any problems encountered during data collection, sample processing, or data analysis, and to take remedial action where required. Such action may include resampling a parameter, replacing/repairing equipment, qualifying data, or eliminating data from further consideration.

Biomonitoring Program staff discuss quality assurance issues at regularly scheduled section meetings, or as the need arises, and at meetings and conference calls as needed with laboratory personnel, taxonomic contractors and data management and computer support staff. Problems identified are promptly reported to project managers, who are responsible for determining appropriate corrective actions.

As mentioned in section A5, the MDEP Biomonitoring Program has developed a statistical model that determines whether a station sampled under Task 1 (Stream Macroinvertebrate Sampling) attains its assigned water quality class. The model used for analyzing stream macroinvertebrate data indicates the association of a sample to each of three water quality classes (Class A, Class B, Class C), or to a Non-attainment (NA) category. A sample is initially deemed to have achieved the class or category that has an association value of ≥0.60 as calculated by the model. Model results are reviewed by a Department biologist trained and experienced in the interpretation of macroinvertebrate data to ensure that the model results adequately classify the sampled community. Where there is documented evidence of conditions that could result in uncharacteristic findings, allowances may be made to account for those situations by adjusting classification attainment decision through use of professional judgment. The Department may make adjustments to the classification decision based on analytical, biological, and habitat information, or may require additional monitoring of affected waters be conducted prior to issuing a classification decision. Details about this statistical model and guidelines for the application of best professional judgment can be found in App. D i, Methods for Biological Sampling and Analysis of Maine's Rivers and Streams, in Department rules *Chapter 579:Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams* (Maine DEP 2003), and in *A Review of Biological Assessment Tools and Biocriteria for Streams and Rivers in New England States* (Shelton and Blocksom 2004).

Similar models have been developed for stream algae, wetland macroinvertebrates and epiphytic algae. These models are used in a similar manner to the stream macroinvertebrate model. Models are in development for wetland phytoplankton and stream fish.

C2 – Reports to Management

Quality assurance procedures and results are also addressed in reports required for various federal grants (Sections 106 and 104(b)(3)), special State initiatives such as the Maine Surface Water Ambient Toxics Monitoring Program (annual report required) and the biannual Maine Integrated Water Quality Monitoring and Assessment Report to USEPA.

D1 – Data Review, Validation, and Verification Requirements

It will be the primary responsibility of each task manager to review and, as far as possible, validate and verify all data collected by the Biomonitoring Program upon collection or upon receipt from a contractor or taxonomist to determine if the data meet QAPP objectives (Table 2 and App. D viii). The decision whether to accept, reject, or qualify data will rest primarily with each project manager.

D2 –Validation and Verification Methods

Each appropriate project manager will be responsible for data validation and verification for Tasks 1–4. Data recorded in the field will initially be validated by the person in charge as detailed in the Protocols for Managing Biomonitoring Data (App. D viii). Data will be further validated during entry into the MDEP's Environmental and Geographic Analysis Database (EGAD) as noted in the Protocols for Managing Biomonitoring Data (App. D viii). This task requires a reconciliation of data recorded on field sheets with those entered into the database, a critical review of spreadsheet print-outs, graphs and tables produced from the database, and the identification of any potential data gaps. A subset of the data entered will be reviewed by MDEP staff as detailed in the Protocols for Managing Biomonitoring Data (App. D viii), to further ensure data quality. Each project manager will perform an analysis of the quality control data collected for their task; this will include a review of the chain-of-custody information and all information available from equipment log books as well as a comparison of the results from quality control samples with those from regular samples. Any errors detected will be rectified by either editing incorrect entries, resampling (where possible), or qualifying and excluding questionable data.

Data collected by an outside source (consultants, corporations, businesses, organizations or individuals) must be consistent with the MDEP's standard sampling and identification methods as described in this QAPP, and personnel must fulfill the qualifications outlined in section A8 above.

D3 – Reconciliation with Data Quality Objectives

Each appropriate project manager will be responsible for the reconciliation of all data collected for their task with original data quality objectives as detailed in section A7, above. All data collected by the Biomonitoring Program will be reviewed on an ongoing basis for precision, accuracy, and completeness, and corrective action will be implemented if needed. If data quality indicators do not meet the specifications, data may be qualified or discarded, and resampling may occur as specified in sections B5 and C1.

References

Danielson, T. J., C. S. Loftin, L. Tsomides, J. L. DiFranco, and B. Connors. 2011. Algal bioassessment metrics for wadeable streams and rivers of Maine, USA. Journal of the North American Benthological Society 30(4):1033-1048.

Danielson, T. J., C. S. Loftin, L. Tsomides, J. L. DiFranco, B. Connors, D. L. Courtemanch, F. Drummond, and S. P. Davies. 2012. An algal model for predicting attainment of tiered biological criteria of Maine's streams and rivers. Freshwater Science 31(2):318-340.

Davies, S.P., L. Tsomides, J.L. DiFranco, and D.L. Courtemanch. 1999. *Biomonitoring Retrospective: Fifteen Year Summary for Maine Rivers and Streams*. Maine Department of Environmental Protection, Augusta, ME; DEP LW1999-26. 190 pp.

Maine Department of Environmental Protection. 2003. *Chapter579: Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams.*. Maine Department of Environmental Protection, Augusta, ME; 06-096 CMR 579.

Shelton, A.D., and K.A. Blocksom. 2004. *A Review of Biological Assessment Tools and Biocriteria in New England States.* U.S. Environmental Protection Agency, Cincinnati, Ohio.

Wehr, J.D. and R.G. Sheath. 2003. Freshwater Algae of North America: Ecology and Classification. Academic Press, Boston, MA, 918pp.

Appendix A : List of Acronyms

APP	Annual Project Plan
$CaCO_3$	Calcium carbonate
Chl *a*	Chlorophyll *a*
CPR	Cardiopulmonary Resuscitation
DEA	Division of Environmental Assessment
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
USEPA	United States Environmental Protection Agency
GIS	Geographic Information System
GPS	Global Positioning System
MDEP	Maine Department of Environmental Protection
NH_3-N	Ammonia-N
$NO_{3+}NO_2$-N	Nitrate plus Nitrite-N
SOP	Standard Operating Procedures
SPC	Specific Conductance
OPO4-P	Orthophosphate-P
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
WCP	Water Classification Program
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control