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New Hampshire's Wetlands Monitoring Strategy

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1 INTRODUCTION

New Hampshire's formerly glaciated landscape and its wetlands are diverse; from tidal salt marshes to northern white cedar swamps, silver maple floodplain forests to alpine bogs. New Hampshire is represented by two major ecoregions, the Northeastern Highlands and the Northeastern Coastal Zone, and 12 subregions, which better portray the diversity of habitats and wetlands across the state (EPA, 2007, derived from Omernik Level III). Estimates of the extent of wetlands in New Hampshire range between 290,000 and 576,386 acres (Tiner, 2007); thus wetlands occupy as much as ten percent of New Hampshire's landscape, although the state has lost about nine percent of its historical wetlands between the 1780s and 1980s (Dahl, 1990).

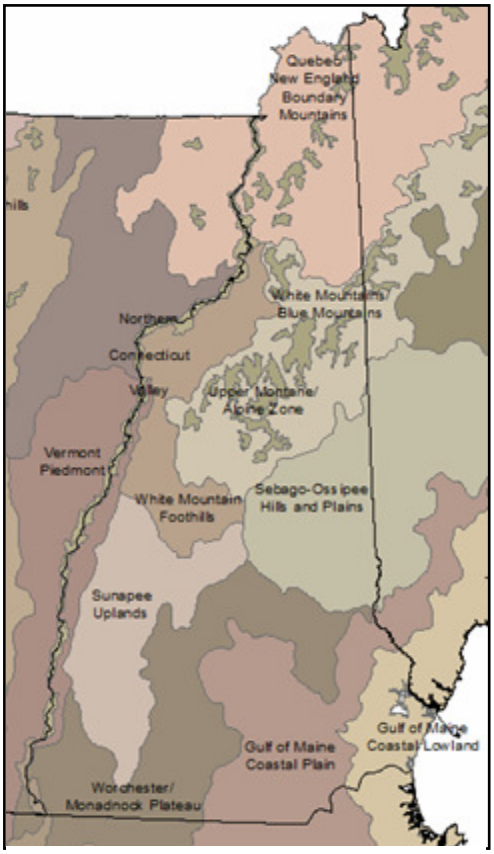

Figure 1-1. Map of Omernik Level IV ecoregions (Griffith et al, 2009).

The importance of wetlands to wildlife, water quality and New Hampshire's economy are well documented (DES 2008b; NHFG, 2005; NOAA, 2013). In the mid-1960s, this recognition led to the creation of New Hampshire's permitting program for dredge and fill impacts in wetlands and surface waters. New Hampshire tracks the amount of impacts to wetlands for activities for which permits have been granted. However, research has demonstrated that development in a watershed (and increase in impervious surfaces) can cause degradation of wetlands without direct permitted impacts (Wright, et al, 2006).

What is lacking today is information on the health of New Hampshire's wetlands. Wetlands provide many beneficial services, but are they being degraded because of their "over use"? If they are in a degraded condition, what does that mean for the quality of streams, lakes, aquatic life, and drinking water? Has their condition been affected by climate change, and if so, how?

To properly manage the activities that affect the state's wetlands and answer questions such as these, a wetlands monitoring and assessment strategy is needed. This document is intended to serve that purpose. In addition, it addresses the elements of a state water monitoring and assessment program for *wetlands* required by the U.S. Environmental Protection Agency (EPA) for Clean Water Act (CWA) section 106 funding (EPA, 2006). The ten elements of EPA's guidance documents and where they are addressed in this document are described in section 2.

In 2011, the New Hampshire Department of Environmental Services (DES), in coordination with EPA, developed a Wetland Program Plan to provide direction for DES and its partners to strengthen its wetlands program and protect wetlands and aquatic resources statewide. The New Hampshire Wetland Program Plan provides a framework and direction for the wetlands program activities 2011-2017 timeframe and references various monitoring and assessment-related activities that are described in this strategy (DES, 2011).[1]

[1] See http://des.nh.gov/organization/divisions/water/wetlands/documents/epa-plan-2011-17.pdf

2 EPA'S TEN MONITORING AND ASSESSMENT STRATEGY ELEMENTS

According to EPA guidance (EPA, 2006) the following ten elements must be included in wetland monitoring and assessment strategies.

Element 1: Monitoring Program Strategy
Element 2: Monitoring Objectives
Element 3: Monitoring Design
Element 4: Core and Supplemental Indicators
Element 5: Quality Assurance
Element 6: Data Management
Element 7: Data Analysis/Assessment
Element 8: Reporting
Element 9: Programmatic Evaluation
Element 10: General Support and Infrastructure Planning

A brief discussion of each element is provided below as well as where each element is addressed in this document.

Element 1: Monitoring Program Strategy

EPA Requirement: The State has a comprehensive monitoring program that serves its water quality management needs and which addresses how the state plans to address each of the remaining nine elements.

The implementation of an effective surface water quality monitoring program serves as the foundation for informed water management decisions. The collection, analysis, and reporting of surface water quality data educates water managers and the public about waterbody conditions, the factors that affect these conditions, and the geographical context where protection or restoration measures are necessary. As part of this foundation, the EPA requires that states receiving section 106 Clean Water Act (CWA) funding prepare and submit a water monitoring strategy. In 2003, EPA issued " Elements of a State Water Monitoring and Assessment Program" and in 2006, EPA issued "Application of Elements of a State Water Monitoring and Assessment Program for *Wetlands*" to specifically address how EPA's 2003 guidance pertains to wetland monitoring and assessment (EPA, 2003; EPA, 2006).

The DES developed its surface water monitoring strategy in 2005, in response to the 2003 guidance. DES serves as the agency responsible for implementing the CWA with the primary goal of restoring and maintaining the chemical, physical, and biological integrity of New Hampshire's water resources. In support of this goal, DES monitors its surface waters in order to satisfy federal reporting requirements [CWA sections 305(b) and 303(d)], assist in regulatory decisions, and for use in planning activities (developing Total Maximum Daily Load (TMDL) requirements and Section 319 restoration activities). The standards by which DES assesses the quality of its waters are outlined in state law RSA 485-A and further clarified in administrative rules, Chapter Env-Wq 1700, Surface Water Quality Regulations. Water quality data collected in support of these efforts are subject to strict quality assurance measures and managed within a comprehensive data management system. New Hampshire's surface water quality regulations include narrative water quality criteria for wetlands (Env-Wq 1703.02) but do not include any wetland-specific numeric water quality criteria, although a plan to develop them is being drafted. The following text provides New Hampshire's current water quality criteria for wetlands:

Env-Wq 1703.02 Wetlands Criteria.
(a) Subject to (b), below, wetlands shall be subject to the criteria listed in this part.
(b) Wherever the naturally occurring conditions of the wetlands are different from the criteria listed in these rules, the naturally occurring conditions shall be the applicable water quality criteria.

In the 2005 water monitoring strategy, DES focused on the importance of making data-driven management decisions, clearly stating the purposes for the collection of water quality data, and the value of maintaining a mechanism for managing high quality, well-documented data that are accessible for multiple uses (DES, 2005). The 2005 strategy recognized DES's needs with respect to instituting a basic model for the valuation of current and new surface water monitoring efforts and the subsequent management of the data collected through these programs. The outcome of the 2005 strategy has been a gradual movement towards developing monitoring programs to generate information that is directly linked to measurable environmental outcomes through the quantification of water quality conditions. As evidence of this progress, DES now has one of the most advanced processes for evaluating water quality data for its sections 305(b)/303(d) biennial reporting requirements, dramatically increased its TMDL development productivity, become more efficient in completing Section 401 water quality certifications, and remained current in the development of new or renewal of existing water quality criteria. Further, all of the DES water quality data are now stored in a single, unified, agency-wide database known as the Environmental Monitoring Database (EMD). To date, the EMD houses nearly 25,000 individual monitoring stations from 638 individual projects, and millions of individual results. Data generated by the DES and outside organizations are entered through automated lab imports, batch uploads, and manual entry. The data are then flowed directly to EPA's STORET/WQX using a node to node transfer. Thus, clearly the pathway envisioned through DES's 2005 monitoring strategy was an important one that benefited the agency.

While the 2005 strategy increased DES water quality monitoring effectiveness through a data-driven water management process, it provided little direction for the collective design, implementation, and ultimate usage of data collected across multiple monitoring programs -- and minimally addressed wetland monitoring and assessment. DES is in the process of revising the water monitoring strategy for lakes and rivers through the identification of individual programs and the implementation of a unified monitoring design. The design is one that meets the objectives of the Clean Water Act and is used to inform the general public of the conditions of New Hampshire surface waters and the factors affecting them. Further, the design will, to the extent possible, maintain a current catalog of data that can be used for a variety of purposes including reviewing and developing water quality standards, determining designated use attainment, TMDL development, documenting waterbody restoration efforts, and permitting needs. The revised strategy builds upon the concept of maximizing the use of data to evaluate waterbody conditions through quantifiable measures within a structured approach to data collection and evaluation. It also is built about specific analytical questions (like "how's the water?") that may be asked by identifiable audiences (such as local decision-makers).

This document represents the first wetlands monitoring and assessment strategy developed for New Hampshire. It has similar objectives and monitoring design concepts of the revised water monitoring strategy that is being prepared for lakes, rivers and streams, and coastal waters, but highlights the unique aspects of wetlands and variations in approaches. The strategy presented herein focuses on monitoring and assessing for wetlands condition. Wetlands monitoring in New Hampshire is in its early stages with one of the top priorities being to collect data for the purpose of determining the appropriate indicators and numeric thresholds for assessing designated uses, such as aquatic life, for the many types of wetlands. As

such, descriptions of the monitoring designs are somewhat general at this time. Once indicators and thresholds are developed, DES intends to update this strategy with more specific information.

Element 2: Monitoring Objectives

EPA Requirement: Monitoring objectives are identified that are critical to the design of a monitoring program.

Monitoring objectives are addressed in Section 4.

Element 3: Monitoring Design

EPA Requirement: The State has an approach and rationale for selection of monitoring designs and sample sites that best serve its monitoring objectives.

Monitoring designs are addressed in section 5.

Element 4: Core and Supplemental Indicators

EPA Requirement: Core and supplemental indicators are identified to evaluate surface water condition.

A discussion of indicators for probabilistic monitoring designs is included in section 5.2.3. A general discussion of core and supplemental indicators and potential indicators for targeted designs is provided in section 5.3.4.

Element 5: Quality Assurance

EPA Requirement: Monitoring programs include Quality Management Plans (QMP) and Quality Assurance Project Plans (QAPP).

Quality Assurance is addressed in Section 5.

Element 6: Data Management

EPA Requirement: Store data in an electronic data system available to the public and store assessment information in an accessible electronic database such as the EPA Assessment Database (ADB) which serves as the basis for CWA Section 305(b) / Integrated Reporting.

Data Management is addressed in Section 6.

Element 7: Data Analysis and Assessment

EPA Requirement: Specify data analysis and assessment procedures and relate them to objectives in element 2.

Data Analysis and Assessment is addressed in Section 7.

Element 8: Reporting

EPA Requirement: Produce timely and complete CWA §305b/§303d water quality reports (i.e., Integrated Reports) to EPA.

Reporting is addressed in Section 8.

Element 9: Programmatic Evaluation

EPA Requirement: Conduct periodic reviews of each aspect of the monitoring program.

Programmatic Evaluation is addressed in Section 9.

Element 10: General Support and Infrastructure Planning

EPA Requirement: Identify current and future monitoring resources to implement the monitoring strategy.

General Support and Infrastructure Planning is addressed in Section 10.

3 WETLANDS COVERAGE AND MAPPING

A current inventory of the State's wetland resources is necessary to accurately determine how well a monitoring and assessment program represents and characterizes the resource. For most states including New Hampshire, the National Wetlands Inventory (NWI) provides the only state-wide mapped wetlands data available.[2] Although the NWI mapping is outdated given when it was undertaken (circa 1984) and development has occurred since then, for lack of a better alternative, it remains the base map for wetlands in New Hampshire.

3.1 Creation of State Wetland Base Map

DES has applied the following approaches in the development of a state wetland base map for assessment purposes, using the NWI digital maps created by U.S. Fish and Wildlife Service based on 1984 imagery.

DES first created mapping units from NWI to support the Level 1 (i.e., screening level) assessment for NH's 2008 Section 305(b)/303(d) integrated surface water quality report (DES, 2008; DES, 2008c).[3] Using a geographic information system (GIS), DES consolidated 83,565 NWI wetland polygons into 23,626 wetland assessment units (AUs), based on the Cowardin classification (Cowardin et al, 1979) and methods used by the New Hampshire Fish and Game Department (NHFG) for the 2005 Wildlife Action Plan. The NWI wetland polygons were aggregated to reduce the number of wetland polygons to more realistically evaluate them as functional units. One wetland that a person may view in the field may be represented as multiple wetlands on the NWI maps, because the "scrub-shrub" wetlands areas are represented as a polygon, the "emergent marsh" is another polygon, and a forested wetland is another polygon. Figures 3-1a. and 3-1b. below illustrate the approach to aggregate wetland polygons within a complex to create one assessment unit.

In 2010, DES revised the methodology for creating wetland complexes from the individual NWI wetland polygons (DES, 2010). This was done in accordance with the revision of the *Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire* (NH Method) (Amman and Stone, 1991) now referred to as the *Method for Inventorying and Evaluating Freshwater Wetlands in New Hampshire* (Stone and Mitchell, 2011, see http://nhmethod.org/index.htm). The methodology to create wetland complexes was applied to both freshwater, marine and estuarine wetlands, although the *NH Method* addresses the evaluation of freshwater wetlands only. As the methodology differs from that used in the 2005 Wildlife Action Plan, the NH Method-based AUs total is 52,426. This base layer and associated assessment units represent the State's current wetlands coverage for use in assessments or other purposes. The wetlands base layer is available for download from GRANIT[5] as the "NH Wetlands Base Map" or for direct use online in the "NH Wetlands Mapper."[6] In 2012, these new AUs were the foundation for a revised Level 1 (i.e., screening level) assessment for DES's 2012 Section 305(b) surface water quality report.

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[2] According to the U.S. Corps of Engineers guidance manual and DES rules, field delineation of wetlands must be conducted by the applicants applying for federal or state wetlands permits, however this information is not readily available state-wide.

[3] See Appendix 36 at http://des.nh.gov/organization/divisions/water/wmb/swqa/2008/index.htm

[5] See http://www.granit.sr.unh.edu/data/downloadfreedata/category/databycategory.html

[6] See http://nhwetlandsmapper.unh.edu/

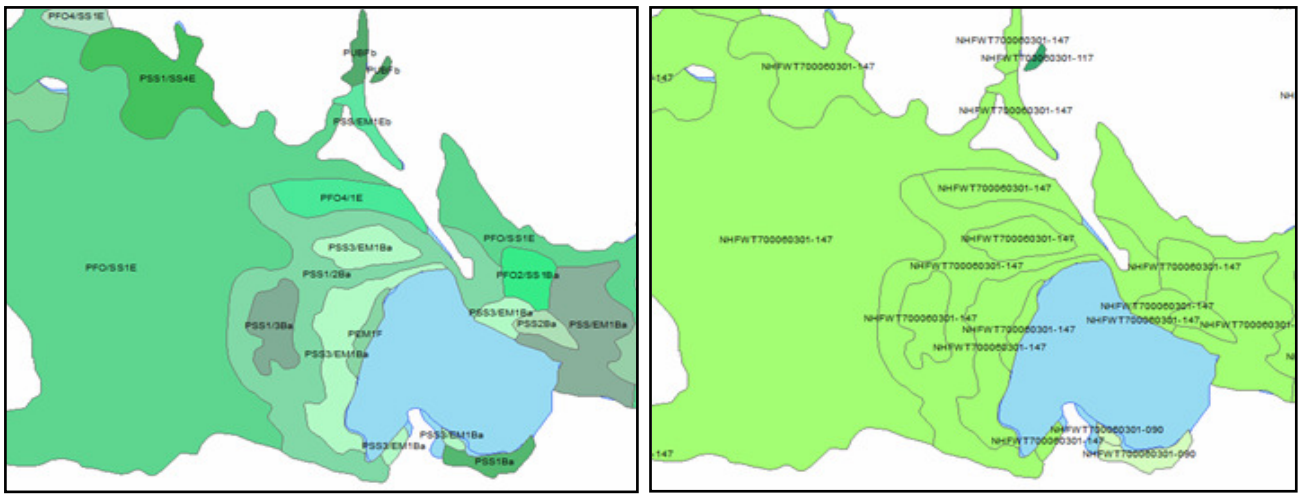

Figure 3-1. Aggregation of wetland polygons and emergent wetland not mapped

a. (left) The map depicts a large wetland complex that shows each NWI polygon as a different color (with its NWI code). **b.** (right) The map illustrates the aggregation of multiple NWI polygons into an assessment unit. The contiguous wetland complex is one assessment unit (brighter green) and there is a small semi-non-contiguous wetland at the bottom (in lighter green) that is identified as a separate assessment unit, as well as an isolated wetland to the north (in darker green) that is identified as a separate assessment unit. The lacustrine polygon in the center (the pond) is not labeled here. North is to the top**.**

c. Photograph of part of wetland complex shown in Figures 3-1a and 3-1b. Notice emergent vegetation here and lack of mapped emergent wetland in southwest area of NWI map (shown only as open water), as Tiner (2007) has described.

3.2 Protocols for State Wetland GIS Coverage

DES has investigated the potential to improve its wetland base mapping with information from other sources. DES worked with the Wetland Water Quality Standards Subcommittee[7] and surveyed municipalities and others on the type, extent, accuracy, and utility of available data sources. Among the

[7] The Wetlands Water Quality Standards Subcommittee is a subcommittee of the Water Quality Standards Advisory Committee which provides advice to DES on issues related to water quality standards and consists of stakeholders representing a diverse set of interests. See: http://des.nh.gov/organization/divisions/water/wmb/wqs/wetlands-subcommittee.htm

various wetlands mapping formats are town-wide field delineations (rare), delineations for wetland permit applications, town interpretation of new aerial imagery, and imagery for new regional projects (such as highway projects). Given the "mixed bag" of mapped wetlands, the additional data may be useful as an add-on to the state wetland base map at some point in the future. However, before this can occur, issues such as data acquisition and data quality will need to be addressed.

3.3 Wetland Mapping Tools

An online mapping tool, the NH Wetlands Mapper[8] was developed to complement the NH Method, a method for communities, conservation groups, and natural resources consultants to evaluate wetland functions and values. The tool was specifically designed to assist users conducting functional evaluations of wetlands based on the NH Method. It includes a set of map displays, navigation, query, and printing tools, as well as the companion forms required to conduct the evaluation. Its base map was created from the NWI information.

[8] See http://nhwetlandsmapper.unh.edu/

4 MONITORING GOALS AND OBJECTIVES

The over-arching **goal** of DES water monitoring efforts is the:

> ***Collection of high quality data for the purpose of making informed and accurate water management decisions and communication to the public regarding the protection, health and safety of the state's waters.***

The goal is based on DES's obligation and responsibility in acting as the steward of its water resources and satisfying the requirements of the CWA, and is achieved, in part, through the following wetland-specific monitoring and assessment objectives:

- **Develop numeric water quality thresholds for wetlands.** How do we determine if the condition of a wetland is good or bad? What are the parameters that should be sampled and what are the thresholds for determining if a wetland is high quality or impaired? Before many of the following objectives can be accomplished, it is first necessary to develop numeric thresholds for water quality of wetlands and protocols for assessing the condition of wetlands.
- **Determine the condition of wetlands in New Hampshire.** What portion of the state's wetlands are in excellent condition? In fair or poor condition? Do any wetlands appear to be threatened more than others?
- **Report on the water quality status of all wetlands, as required by the Clean Water Act (CWA).** In accordance with CWA, and once numeric water quality thresholds for wetlands have been developed, DES will report on the condition of wetlands in the biennial Section 305b/ Section 303d integrated report to EPA.
- **Identify trends in wetland condition and their cause (i.e., stressors).** Is the quality of the state's wetlands improving or declining over time? What is causing or contributing to poor wetlands water quality or a declining trend? Are we observing evidence of climate change or impacts from it?
- **Provide information to evaluate the effectiveness of current permitting programs (wetland and others) with respect to wetland condition.** Is there a need to modify current permitting or other programs to address sources of pollution/pollutants or other stressors to wetlands? Are current state and federal programs effective in protecting the state's wetlands?
- **Prioritize wetlands for protection or restoration.** How should we use wetlands monitoring results and other information -- such as NH's Aquatic Resource Mitigation (ARM) Fund, acquisition or other land protection tools -- to prioritize wetlands for protection or restoration?
- **Inform the public.** Communicate with the public and decision makers about the condition of the state's wetlands, their importance to the economy and quality of life in New Hampshire, the impacts of land use decisions on wetlands, and threats to wetlands. Provide a meaningful public input process for the development of numeric thresholds.

5 WETLANDS MONITORING DESIGN

5.1 Overview

Wetlands are unique aquatic resources. They are complex due to varied hydrology, biology and landscape position and they are numerous as described in Section 3. For example, the NH Natural Heritage Bureau (NHB) has classified 27 wetland systems in the state (Sperduto, 2011). If each of the 27 wetland system requires different indicators or thresholds to assess their condition, one can appreciate the challenge associated with developing and implementing monitoring programs to develop numeric thresholds to determine the statewide condition of wetlands.

EPA's 2006 guidance recommends using a tiered approach for wetland monitoring and assessment, commonly referred to as Levels 1, 2 and 3. The resources required at each level increase as more sampling and comprehensive field work associated with that monitoring and assessment "level" are conducted. Data collected at a higher more resource-intensive level (such as Level 3) are typically used to inform and validate the approach used at a lower, less-resource intensive level (such as Level 2) (EPA, 2006; Stein et al, 2009).

New Hampshire's wetlands monitoring and assessment program is employing the three-tiered approach to maximize monitoring effectiveness. The following table provides a description of the monitoring levels.

Table 5-1. EPA's tiered monitoring approach[9]

Monitoring and Assessment Level	Description
Level 1 - Remote sensing/ GIS/landscape analysis	A desktop assessment of wetlands based on their characteristics and those of the landscape in which they are located. Involves an evaluation of the location and extent of human activity. Typically conducted using a geographic information system (GIS) with digital data and aerial imagery.
Level 2 - Rapid ground-based method	Involves some desktop assessment followed by a half day of field assessment. Used to evaluate aspects of the ecological features of the wetlands – physical, hydrologic and biologic – and to assess impacts of human activities that stress the local ecology. Verification of potential landscape impacts and natural features observed in the desktop evaluation.
Level 3 - intensive ground-based method	The most comprehensive approach, involves intensive field assessment to collect data on the biological, physical/chemical, and hydrologic attributes of a site. Level 3 data are used to develop indicators and numeric thresholds for assessing wetlands condition (such as indices of biological integrity) and to calibrate Level 2 assessments (in particular).

DES has conducted monitoring and preliminary (i.e., screening level) assessments of wetland condition using each of these level-of-effort approaches (levels 1, 2 and 3) under past Wetland Program Development Grants (WPDG). Table 5-2 provides a chronology of the wetland monitoring and assessment work that New Hampshire has conducted in each level between 2008 and 2013. To efficiently use resources to generate scientifically valid data, DES will consider use of these methods to achieve the monitoring objectives presented in section 4.

[9] See http://www.epa.gov/ord/gems/scinews_123-scienceapproach.htm

Table 5-2. New Hampshire's Wetland Monitoring and Assessment Work

Level of method applied	Year completed/ field work conducted	Goal/Approach/Results
Level 1	2008	**Goal:** Make preliminary determinations as to what wetlands were likely to support aquatic life and those that were potentially unlikely to support aquatic life. **Approach:** Evaluated the condition of a wetland based on the condition of the 125m wetland buffer, specifically the percentage of impervious surface cover. **Threshold:** Based upon research that demonstrated when a watershed exceeds 10 percent impervious surface cover, exceedances of water quality criteria are likely. **Results:** Of a total of 23,626 wetland assessment units, 80 percent (18,909) were assessed as potentially supporting aquatic life and 20 percent (4,717), were assessed as potentially not supporting aquatic life (DES, 2008c)
	2010	**Goal:** Make preliminary determinations as to what wetlands were likely to support aquatic life and those that were potentially unlikely to support aquatic life. Assessment based on the 2010 revision of wetland assessment units. **Approach:** Similar to 2008 Level 1 assessment, except for evaluation of buffers. Evaluated the amount of each land cover class within each wetland buffer. **Results:** Eighty-two percent of the assessment units were identified as potentially supporting aquatic life and 18 percent assessed as potentially unlikely to support aquatic life (DES, 2010)
	2013	**Goal**: Create a more robust Level 1 assessment for aquatic life designated use **Approach:** Incorporate functional analysis elements developed for the Merrimack River Restoration Project under the DES Aquatic Resource Mitigation Fund (DES's in-lieu fee mitigation program) and the NH Method**.** **Results:** Scores generated will be used to identify potential reference sites, including those representing a gradient of human disturbance.
Level 2	2011	**Goal:** With NHB, adapt and apply a multi-level Ecological Integrity Assessment (EIA) method to quantify the status of known critical and at-risk wetlands. **Approach:** NHB applied the EIA approach to exemplary wetlands in its database and other wetlands in central and southern New Hampshire. **Results**: Developed the *Level 2.5 Ecological Integrity Assessment Manual*, documented the condition of wetlands at 99 sites, including additional priority wetlands and benchmark reference sites, and increased the knowledge of wetland resources for permitting activities.
	2011	**National Wetland Condition Assessment:** - DES applied the USA RAM (as well as Level 3 protocols) at 11 sites (with two revisits). Results are not yet available.
	2012	**Goal:** 1) Conduct a field-based comparison of four rapid assessment methods that are function- or condition-based for use in NH water quality and permitting program activities. 2) Evaluate application of criteria for successful mitigation projects **Approach:** Applied the New Hampshire Method, Ecological Integrity Assessment (EIA v2.5) (Nichols and Faber-Langendoen, 2012) and Floristic Quality Assessment Index at 27 bogs and fens and five mitigation/restoration sites. **Results:** Information on usefulness of methods applied and appropriateness to mitigation. Identified other issues, such as use of non-native seed sources at mitigation sites (NHB, 2013).
Level 3	2011	**National Wetland Condition Assessment:** DES applied the Level 3 protocols at 11 sites (with two revisits). Results are not yet available.

In order to meet the overall goal and objectives of the DES monitoring strategy, two basic monitoring designs will be implemented in the long term:

1. Probability-based monitoring,
2. Targeted monitoring.

The relationship of each of the strategy's objectives to the monitoring design is outlined below in Table 5-3 and described in the remainder of this section.

Table 5-3. Wetlands Monitoring Strategy Objectives and Associated Sampling Design(s)

Goal/Objective	Sampling Design
Develop numeric wetlands water quality criteria.	Probability-based; Targeted
Determine the condition of wetlands in New Hampshire.	Probability-based; Targeted
Report on wetland condition of wetlands in the CWA §305b/§303d report.	Probability-based; Targeted
Identify any trends in wetland condition and their causes (stressors).	Targeted;
Provide information to evaluate the effectiveness of current wetland programs with respect to wetland condition.	Targeted
Prioritize wetlands for protection (or restoration).	Targeted
Inform public and decision makers about the condition of the state's wetlands, their importance to the quality of life in New Hampshire and the effect of land use decisions on wetland condition.	All of the above

These monitoring designs provide a unified approach for DES in the collection and reporting of surface water quality data. The following sections provide more detail regarding how each approach in the monitoring design will be implemented.

5.2 Probability-based Monitoring

Probability monitoring refers to the randomized selection of a set of sample locations that are representative of the entire population of a particular waterbody type. By collecting data from each of the randomly selected sites, the overall condition of the waterbody type can be predicted with a known level of confidence.

Probability surveys represent a cost-effective means for estimating and reporting on the physical, chemical, and biological conditions by waterbody type and the factors that affect these conditions and thus are most useful for Section 305(b) reporting purposes. For example, if a randomized survey of marshes was conducted and 30 percent of the random samples indicated that the marshes do not support the aquatic life designated use and are therefore impaired, it could be stated that 30 percent of the all marshes were impaired for aquatic life. Another benefit of randomized designs is that statistical analyses can be conducted to determine the margin of error or confidence limits in the assessment. Probabilistic

designs, however, are less useful at describing localized impacts and monitoring for regulatory compliance (Stein and Bernstein, 2008).

Indicators for probabilistic monitoring surveys are discussed in section 5.2.3.

5.2.1 EPA National Probability-based Surveys

Probability-based surveys have been utilized by the EPA since 2004 to evaluate the overall condition of the nation's surface waters (fresh and marine). The National Aquatic Resource Surveys are completed on a 5-year rotating schedule by waterbody type (EPA, 2011a). To date, DES has participated in the national wadeable streams assessment (2004, 2005), national lakes assessment (2007, 2012), national rivers and stream assessment (2009, 2010), and the national wetland condition assessment (2011). DES remains committed to future participation in these surveys at the national level.

5.2.2 Statewide Intensifications

Intensification surveys are additional randomly selected sites that are sampled in conjunction with those in a national survey to provide sufficient data for DES to conduct a probabilistic assessment of the state's wetlands. The statewide intensification survey may apply the same protocols as the national wetland condition survey, or a subset of them. Protocols will be developed after indicators and quantitative thresholds for each indicator have been determined (see section 5.3.1).

Similar to the approach for lakes/ponds and streams/rivers, it is expected that the statewide intensification for wetlands will require approximately 50 randomly selected sampling locations. Based on past experience, this represents 30 to 40 additional sites above and beyond the national survey and a significant investment of state resources to complete. For this reason, statewide intensifications are planned to occur over a two-year timeframe and once every 10 years for lakes/ponds and rivers/streams. A statewide probability survey of wetlands will eventually be added once DES fully develops its indicators and thresholds for assessing wetlands condition.

Table 5-4 provides the anticipated schedule for probabilistic monitoring through the year 2021 for wetlands and other waterbody types.

Table 5-4 Anticipated Probabilistic Monitoring Schedule: 2011-2021

Waterbody type	Year										
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Lakes/ponds-EPA		X					X				
Lakes/ponds-Intensification								X	X		
Rivers/streams-EPA			X	X				X	X		
Rivers/streams-Intensification				X	X						
Coastal-EPA					X					X	
Wetlands-EPA	**X**		**X**								**X**
Wetlands - Intensification	To be determined after wetland condition indicators and thresholds have been developed.										

5.2.3 Indicators

A general overview of core and supplemental indicators and what constitutes a good indicator is provided in section 5.3.4.

With regards to probabilistic surveys, the EPA National Wetland Condition Assessment (NWCA) first conducted sampling in 2011 to provide "multiple indicators to maximize the potential of detecting anthropogenic stress and describing its potential effect on wetland condition across multiple spatial scales" (EPA, 2011a; EPA 2011,b; EPA 2011,c).

The following data and samples were collected within a half-hectare assessment area (typically 40 m radius):

- Soils
  - Dug 4 soil pits (~60 cm deep); collect soil profile data – texture, color, saturation
  - Collected bulk density, soil enzyme, and soil chemistry samples from single "representative" pit.
- Vegetation
  - Five 10m x 10m plots were evaluated for numerous types of vegetation data (species presence and abundance, cover, structure, tree coverage and count, bryophyte/lichen, woody material, etc.).
- Algae
  - Samples of water and substrate were collected for algal taxonomic and toxin work.
- Hydrology
  - Water samples were collected for chemical analysis
  - Basic hydrologic data were collected at time of site visit (alteration, connectivity, water depth and sources).
- USA-RAM
  - An 11-metric "rapid" approach was tested for each wetland. Data on various habitat features and stressors were collected for the assessment area.

Within a 100 meter buffer around the assessment area:

- Twelve 10m x 10m buffer plots located along north-south and east-west axes were examined for large number of parameters, including invasive species presence, human disturbances, and cover of natural vegetation.

Once the NWCA data are available for review by the states, DES will evaluate and consider the results in its efforts to develop indicators and thresholds for determining wetland condition and the design of future monitoring for statewide intensification surveys.

5.3 Targeted Monitoring

Targeted monitoring designs are based on predetermined (i.e., non-random) stations and used for purposes such as criteria development, trend and stressor analysis, determining compliance with regulatory requirements and limits or the effectiveness of restoration or protection programs. They may also be used to gather data on wetlands that are underrepresented on the NWI maps. For example, palustrine aquatic bed and nonpersistent emergent marsh wetlands are among the under-represented wetlands on the NWI maps due to most aerial photography being conducted outside the growing season

(Tiner, 2007). See Figure 3-1 for an illustration of this situation. Using a targeted design, wetlands identified in the field as meeting the narrative description of PEM2 (palustrine emergent marsh - nonpersistent) or PAB (palustrine aquatic bed) may be monitored and assessed (Cowardin, 1979).

Targeted designs are not based on random samples and may leave large areas unmonitored; consequently, unlike probabilistic designs, the data from targeted designs cannot be extrapolated to support statistically valid conclusions about the condition of an entire waterbody type (Stein and Bernstein, 2008).

Indicators for targeted monitoring are discussed in section 5.3.4.

5.3.1 Wetlands Water Quality Criteria Development

DES's top priority for wetlands monitoring is to select indicators and develop defensible thresholds for assessing wetlands condition. Once these are developed, the other monitoring designs described will be refined and implemented as resources allow.

New Hampshire's work applying several rapid methods to evaluate wetland condition (see section 5.1) has contributed to an increased understanding of how well these methods represent wetland condition. However, these vegetation-based methods alone are currently insufficient to make defensible assessments of wetlands condition – in particular, to determine whether designated uses such as aquatic life are being attained.

Designated Use

A key need identified in multi-stakeholder meetings on wetland-specific water quality standards is development of indicators and thresholds for determining if wetlands are supporting the designated use of aquatic life. Therefore DES intends to focus initial efforts on development of indicators and thresholds for the support of aquatic life use.

Population of Wetlands

There are multiple considerations when selecting a target population of wetlands to monitor. For example, are there existing and reliable methods that will provide the data needed to address the monitoring objectives? Have specific resources been identified as being a priority to monitor and assess based on information from other programs or on their recognized sensitivity to disturbance or increased nutrient loads, etc.?

DES plans to use the NHB classification system of 27 wetland systems (along with Cowardin, since that is the basis of the wetland mapping - see section 3.1) as the basis for classification, augmented by the natural communities that exist within them. A list of wetland natural systems in New Hampshire is provided in Appendix A.

According to the Cowardin classification system, approximately half of New Hampshire's wetlands are palustrine forested wetlands (Tiner, 2007). These wetlands tend to be subject to a greater proportion of permitted dredge or fill impacts, so there is significant interest in developing biomonitoring methods that will assess the condition of this wetlands type. However, since these wetlands lack open water, the current state of the science for monitoring and assessing palustrine forested wetlands (especially in terms of support of aquatic life) is less developed.

Several states (including Minnesota, Maine, and California) are, however, monitoring depressional or other wetlands where standing water is present. While we expect to continue to apply and refine the vegetation-based assessment methods (EIA and US RAM), DES intends to take advantage of the excellent work done by other states and focus initial monitoring efforts on wetlands that have standing

water [e.g., palustrine emergent (PEM) and palustrine aquatic bed (PAB) under the Cowardin classification system] for the purpose of developing indicators and thresholds to assess the aquatic life use support. Monitoring wetlands with standing water will also facilitate greater integration of wetland monitoring efforts with on-going monitoring of lakes and rivers.

Site Selection

To assess the condition of a wetland, it is essential to understand the characteristics of a "pristine" or "best attainable" wetland, as well as the characteristics of a wetland as it becomes degraded. From this information we can make better assessments of the major stressors that affect the ability of wetlands to perform water quality-related functions and support aquatic life.

When a target population is selected for monitoring (such as PEM and PAB wetlands), DES will characterize the reference condition in the class of wetland being assessed and identify (through monitoring) a universe of reference sites along a gradient of human disturbance. This characterization effort will enable DES to identify the characteristics that represent the range of reference conditions, and establish a threshold to determine whether or not a wetland supports the designated use(s). An example of work done in Minnesota using floristic quality assessment indices to identify a gradient of disturbance by wetland type is presented in Figure 5-1.

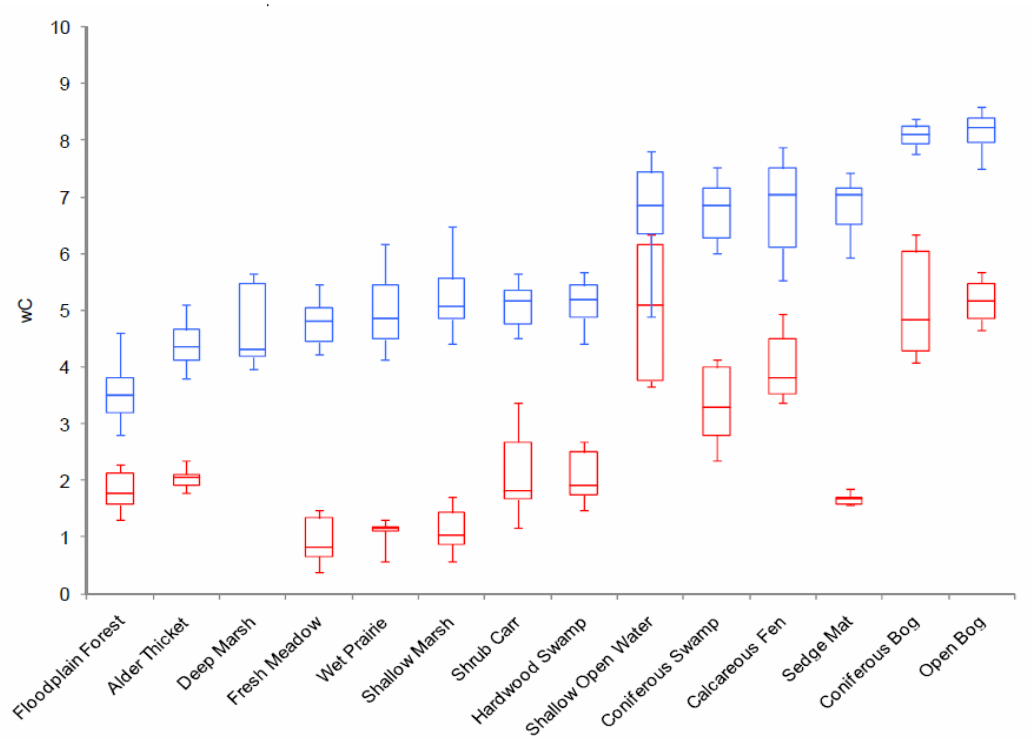

Figure 5-1. Weighted Mean C (wC) box and whisker distribution plots from all wetland system types in Minnesota. Blue plots = pre-settlement and minimally impacted examples; red plots = severely impacted examples. Arranged from left to right according to increasing median wC scores for the pre-settlement/minimally impacted plots (from Bourdaghs 2012).

To help ensure that we sample sites that represent the range of human disturbance, DES plans to use the Level 1 assessment results completed in 2013 (see Table 5-2) to identify wetlands for monitoring. An illustration of the results of the Level 1 scoring is presented in Figure 5-1.

Figure 5-2. Level 1 scoring results for PAB and PEM wetlands. No threshold was established, although the red polygons represent the low scoring PEM wetlands, yellow polygons moderate scoring PEM and PAB wetlands, and green polygons the highest scoring PEM and PAB wetlands. These data will be used to target wetlands for sampling that represent a range of human disturbance.

5.3.2 Trend Monitoring

To identify trends in the condition of New Hampshire's wetlands, DES will develop a fixed network of wetland monitoring stations that are repetitively sampled over the long term, similar to what is being proposed for lakes and rivers. The design of the trend monitoring network is partially based on the stressor--response--condition concept. Under this model, environmental stressors will be identified and related to the observed responses in indicators of wetland condition. In turn, responses in water quality indicators will be related to surface water condition outcomes. To the extent possible, trend monitoring will incorporate data collected from sites representing a range of human disturbance (stressors) in order to track trends and make comparisons to the response indicators and overall condition outcomes.

In order for the trend network to be effective, the data it produces must be capable of answering specific questions such as, “Is the quality of the state's wetlands improving or declining over time? What is causing wetlands water quality to be poor or to exhibit a declining trend? Are we observing evidence of climate change or impacts from it?” To answer these questions, DES will need to develop quantifiable measures for each indicator as discussed in section 5.3.1.

The dual effects of climate change and direct anthropogenic stress have been cited as the most likely to alter hydrological and geochemical processes and thus the biological communities of New England’s freshwater ecosystems (Moore, et al 1997). Therefore monitoring of wetlands to identify trends should include monitoring of wetland hydrology using equipment such as data loggers to measure and record ground water or surface water levels in wetlands.

5.3.3 Monitoring Based on Stratified Rotating Basin Approach

In the future, DES anticipates devoting a portion of its wetlands monitoring efforts to conduct targeted sampling at wetlands where data are needed but the wetland or wetland type might otherwise go unsampled. Monitoring for this purpose will be based on a stratified rotating basin approach centered on the 10-digit hydrologic unit code (HUC 10; n=81) as a way to systematically generate statewide data on a watershed basis. DES is proposing this approach for lakes and rivers beginning in 2013, and will apply this approach to targeted wetland monitoring, as resources are available. At least one representative lake or pond, one representative river segment and one wetland in 8 to 10 HUC 10s will be sampled every year. In this manner, a full statewide rotation of every HUC 10 watershed would be completed on a 10-year cycle. HUC 10s designated for sampling by DES staff in any given year will be spatially distributed throughout the state (Figure 5-3) and based on a predetermined schedule. A spatially balanced approach is

preferred to track the effects of widespread or regional uncontrollable environmental events (e.g., drought) in the state and having sufficient information to understand the patterns in the data which may not otherwise be possible with a geographically focused sampling design. The statewide rotational design is made possible by the relatively small geographic area of New Hampshire allowing field personnel to easily travel to and from most locations in the state on any given day or sampling multiple watersheds within a pre-planned timeframe.

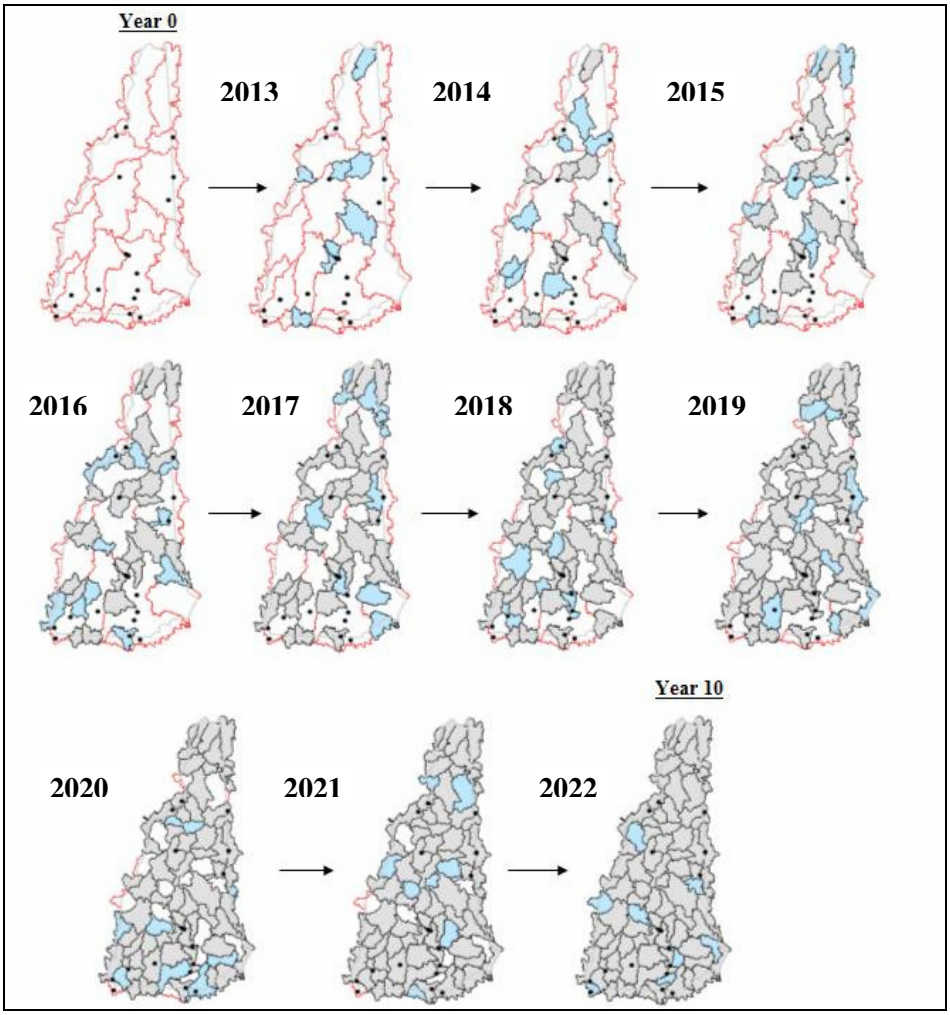

Figure 5-3. Spatial framework for monitoring design -- stratified by HUC 10. Red outline = HUC 8 boundaries; Blue area = HUC 10s to be sampled is a given year; Gray area= HUC 10s sampled previously within 10 year rotation. Black dots are historical ambient river monitoring trend stations, some of which will continue to be monitored.

Unlike probability and trend monitoring designs, monitoring based on the rotational design is meant to be flexible in order to satisfy the need for specific data. For this reason, the selection of waterbodies (including wetlands) identified for sampling will be done annually, based on the rotational schedule, with input from DES staff and others where possible. In this manner, DES staff responsible for planning water quality monitoring efforts will communicate to others the targeted HUC 10 watersheds to be sampled within the year and hold a series of pre-field season meetings to determine monitoring needs and make final selections for sampling in the upcoming field season. It is envisioned that monitoring will be largely

focused on the aquatic resources where water quality data are determined to be unavailable, unreliable, or out-of-date. For wetlands, it will likely be that data are unavailable.

As discussed in section 5.3.1, DES intends to utilize the rotating basin approach for the development of indicators and thresholds to assess wetland condition. However, DES also envisions using this approach to address the needs of other DES programs, including wetlands permitting and mitigation, which are discussed below.

Monitoring and Assessment for Wetlands Permitting

The importance of New Hampshire's wetlands to its residents and visitors and their interests has been formally recognized by its legislature since 1967, when the state's dredge and fill in wetlands act (now known as RSA-482-A) was enacted.

> When "it is found to be for the public good ... to protect and preserve its submerged lands ... and ... wetlands... from despoliation and unregulated alteration, because such despoliation or unregulated alteration will adversely affect the value of such areas as sources of nutrients for finfish, crustacea, shellfish and wildlife of significant value, will damage or destroy habitats and reproduction areas for plants, fish and wildlife of importance, will eliminate, depreciate or obstruct the commerce, recreation and aesthetic enjoyment of the public, will be detrimental to adequate groundwater levels, will adversely affect stream channels and their ability to handle the runoff of waters, will disturb and reduce the natural ability of wetlands to absorb flood waters and silt, thus increasing general flood damage and the silting of open water channels, and will otherwise adversely affect the interests of the general public.

New Hampshire's permitting program regulates impacts to wetlands and surface waters (under RSA 482-A). Similar to the Federal wetlands program, avoidance, minimization and compensation is the sequence of steps that permittees must demonstrate to obtain approvals for projects that will impact the wetland or surface water resource. In 2004, New Hampshire authorized a formal compensatory mitigation program that authorized wetland creation, restoration or protection of upland/wetland areas and, in 2007, added an in-lieu fee mitigation option known as the Aquatic Resource Mitigation (ARM) Fund.

Mitigation

The DES ARM Fund was created as one of several compensatory mitigation options available to applicants seeking approval for larger or more significant impacts to wetlands and other aquatic resources. The ARM Fund is an option that is available for use after avoidance and minimization of impacts to these aquatic resources have been addressed, and the three other mitigation options (wetland creation, wetland restoration, and protection of wetland buffers) have been eliminated as viable options. The ARM Fund seeks "no net loss" of aquatic resource acreage and functions using a watershed approach.

In the permitting process, evaluation of wetland condition (and function) is limited to the area proposed for dredge or fill impacts (and the proposed mitigation site, where appropriate), but not the entire wetland complex or assessment unit. Permittees submit annual reports subsequent to the completion of wetland creation or restoration projects to document compliance with permit conditions that tend to address vegetated coverage and absence of invasive species in terms of wetland condition. The inclusion of mitigation projects in the wetland monitoring and assessment program can build on field work conducted in 2012 (see Table 5-2).

5.3.4 Indicators

Environmental indicators are direct or indirect measures of environmental quality used to assess the status of environmental conditions. As such, indicators are critical components for assessing the overall water quality and biological conditions of the state's water resources and identifying sources and causes of pollution or degradation.

Carignan and Villard (2002) describe a good indicator of ecological integrity as one that:

- Provides early warning of natural responses to environmental impacts,
- Directly indicates the cause of change rather than the existence of change,
- Provides continuous assessment over a wide range and intensity of stresses, and
- Is cost-effective to measure and can be accurately estimated by all personnel (even non-specialists) involved in the monitoring.

Core indicators are the parameters that comprise the minimum data set needed to assess a wetland (or other water body) as fully supporting a designated use (such as aquatic life). Monitoring strategies designed to make use support assessments need to include the core indicators (DES, 2012). If one considers the designated use "aquatic life support," the core indicators for a wetland will be different than those used for a lake or river because the aquatic life in the wetland and its habitat requirements differ from those in a lake or river.

Supplemental indicators are used when there is a reasonable expectation that a specific pollutant may be present in a watershed, when core indicators indicate impairment, or to support a special study such as screening for potential pollutants of concern.

DES will select indicators based on the objectives of the monitoring, the type of wetland and resources available. Potential indicators, metrics and methods for assessing wetland condition are provided in Table 5-5.

Table 5-5. Potential indicators for wetland condition assessment

Indicator	Potential Metrics	Potential Methods
Plant community health	Floristic Quality Indices, such as Mean C, FQI, Mean C_w, FQI_w, native taxa, species richness[10]	Aerial photo interpretation, floristic survey
Invertebrate community health	Diversity indices, abundance, richness	D-net sweeps, funnel traps, artificial substrate sampling
Water quality measurements (where open water is present)	Phosphorus, nitrate-nitrite, temperature, dissolved oxygen (DO), pH	Hand held meters and grab samples
Landscape/ land use	Land use in watershed, proximity to wetland, impervious surfaces	Aerial photo interpretation, field confirmation

[10] A variety of floristic quality indices may be applied to reflect the condition of the vegetated community, among them, Mean C (the mean of all the C values for all species within the assessment area), FQI (the Mean C multiplied by the square root of the total number of native species), Mean C_w (abundance-weighted mean C), and FQI_w (abundance-weighted FQI).

To determine indicators and thresholds for assessing wetland condition, New Hampshire plans to apply and evaluate one or more of the vegetation-based rapid assessment methods (such as the EIA discussed in section 5.1). Additionally, DES will evaluate and consider applying methods used by other states and any core indicators identified from those methods. For example, of the states that monitor depressional or fringing wetlands, Minnesota and Maine have used biomonitoring results based on macroinvertebrates to identify aquatic life use impairments in wetlands.

Typically the use of more than one biological assemblage is considered more effective for assessing wetland condition (EPA, 2003). Therefore, to assess wetlands condition, DES plans to apply and evaluate plant-based indicators such as the floristic quality assessment indices (FQAI) in conjunction with biological indicators such as macroinvertebrates (where appropriate).

A floristic quality assessment index (FQAI) can be used to measure the richness of native plant communities and how they reflect the human disturbance gradient. Central to the Floristic Quality Assessment methodology is the assignment of Coefficients of Conservatism ("C" value) to each species in a region's flora. This concept was first developed by Swink and Wilhelm (Swink, 1979). This methodology is based on the premise that an individual plant species has a tolerance range to disturbance and fidelity to natural habitats and communities. The most conservative species require a narrow range of environmental and ecological conditions and are usually intolerant of disturbance, while least conservative species can be found in a variety of plant communities and are usually very tolerant of disturbance. This ten-point scale (typically) can be divided into ranges based on degree of disturbance and fidelity to natural areas. In a process coordinated by the New England Interstate Water Pollution Control Commission (NEIWPCC), New Hampshire participated in the development of Coefficients of Conservatism for use in a Floristic Quality Assessment for the state (in a process with the other New England states and New York). The final product became available in early 2012 (Bried et al, 2012). DES and the NH Natural Heritage Bureau (NHB) applied FQA at 32 wetlands at which four wetland assessment methods were applied (NH Natural Heritage Bureau (NHB, 2013).

Among the benefits of using FQA is its application to all vegetated areas – including all wetlands, from open water marshes to non-open water forested wetlands. It is also appropriate to apply FQA to upland areas bordering wetlands (in buffers), so the integrity of a buffer may be assessed floristically as well. In addition, plants are less costly to identify and identification can be done primarily in the field. Macroinvertebrates, used by numerous states in their wetland monitoring programs, are more costly to use as indicators because of the significant level of effort to prepare specimens and identification of the specimens in a lab by taxonomic experts.

As discussed in section 5.3.1, DES intends to focus initial indicator and threshold development on open water wetlands (PAB and PEM) for the purpose of assessing aquatic life. Use of macroinvertebrate indicators, along with the plant-based FQA and a rapid assessment method will provide a strong link to aquatic life support, and provide some validation and calibration for the FQA and any rapid assessment method that is used.

5.4 Site Selection Access Considerations

One challenge to monitoring programs is access to monitoring sites. With some surface water monitoring, access by boat or public right-of-way enables sampling without encroachment on private property. The need to obtain permission for access to wetland sites occupies a significant level of effort in other states' wetland monitoring programs (Guntenspergen et al, 2002 (prairie pothole region); Walz (NJ), 2013). New Hampshire plans to address this to the extent possible by identifying publicly owned lands (not only conservation lands) for monitoring. DES plans to identify publicly owned lands in the watersheds of interest through the use New Hampshire's Mosaic Parcel Map and database developed by the New Hampshire Department of Revenue (DRA) and the University of New Hampshire's Technology Transfer

Center (DRA/UNH, 2013). Data to identify publicly owned lands (not only conservation lands) are within the database and DES intends to use the information to minimize the level of effort needed to obtain landowner permission to access sites. However, DES does not intend to restrict its selection of monitoring sites based on ownership, as the water resources in the state are public resources.

6 QUALITY ASSURANCE

For environmental monitoring conducted by the department, DES maintains an EPA-approved Quality Management Plan (QMP). This document, prepared in accordance with *EPA Requirements for Quality Management Plans* (QA/R-2; EPA/240/B-01/002; March 2001 - http://www.epa.gov/quality/qs-docs/r2-final.pdf; Reissue Notice May 2006), describes the department's organizational structure, policy and procedures, functional responsibilities of management and staff, lines of authority, and processes for planning, implementing, and documenting all monitoring activities conducted under the quality management system. The QMP and Environmental Data Quality Policy emphasize DES's commitment to data quality. The QMP is reviewed annually to ensure all information contained within it is up-to-date. Every five years, DES undertakes a complete review of the document and submits a revised QMP to the EPA for review and approval The QMP is located at http://des.nh.gov/organization/commissioner/pip/publications/co/documents/r-co-06-3.pdf, and the QA Policy is located at http://des.nh.gov/organization/commissioner/p2au/pis/qap/documents/qa_policy.pdf.

In accordance with the EPA-approved QMP, all EPA-funded projects are required to have Quality Assurance Project Plans (QAPPs) that follow federal guidelines (e.g., "R-5") in place prior to monitoring. For non-EPA, federally-funded projects and state-funded projects, the DES QMP specifies that these projects must also have quality assurance/quality control documents in place although they do not necessarily have to follow EPA guidelines. The DES QA Manager regularly tracks the status of all pending and completed/approved QAPPs. This QAPP Inventory is submitted quarterly to the EPA Region 1 Quality Assurance staff. In addition, the DES Environmental Monitoring Database (EMD) can support electronic filing and storage of QAPPs for accessible project documentation to future secondary data users.

For wetlands monitoring, a Quality Assurance Project Plan (QAPP) will be developed for new data collection efforts. Appropriate training will be provided to field staff in advance of field sampling to ensure consistent data collection and adherence to standard operating procedures and protocols. DES will ensure that appropriate QA samples are taken consistent with the design and scope of the sampling projects.

7 DATA MANAGEMENT

7.1 Environmental Monitoring Database

DES maintains an Environmental Monitoring Database (EMD) as the repository for surface water monitoring information collected from within and outside of DES: http://des.nh.gov/organization/divisions/water/wmb/emd/index.htm. The EMD was first developed in March 2003 to store lake, river, estuary and ocean data. The original goals were to standardize the wide variety of data sets into one database system built according to existing national data standards for use in surface water quality assessments and to meet federal reporting requirements. The goal of the EMD has since been expanded toward developing a statewide repository of environmental monitoring data.

Data can be submitted by outside parties through the DES OneStop Provider web page: https://www2.des.state.nh.us/OnestopDataProviders/DESLogin.aspx. Providers must pre-register and obtain approval to upload data which typically takes less than a day or two. Data are submitted for stations and activities using Microsoft Excel templates. These templates contain information on the required format and domain lists as well an example of a data record. When templates are uploaded via a web interface, the data are automatically checked for validity and error messages (if any) are displayed detailing the row, column, and problem. Once a file passes validation, it is further reviewed by DES data management staff. If approved, it is incorporated into the database and the provider is notified of the inclusion. If there is a problem, the file is rejected and the provider is notified of what is needed to correct the file and encouraged to resubmit.

Data in the EMD are available to the public on the Internet through the DES OneStop web site: http://www2.des.state.nh.us/OneStop/Environmental_Monitoring_Menu.aspx. Guidance on querying the database is provided via links at the top of the respective query forms. Results are returned in a spreadsheet that can be opened via a web browser or saved as an Excel file.

The EMD was designed to be compatible with EPA's STORET database requirements and the subsequent Water Quality Exchange (WQX) (http://www.epa.gov/storet/wqx/index.html). The process for getting data into WQX involves running a program from the DES exchange network node to extract data from the EMD and format it into an XML file that meets the WQX schema requirements. The node sends the file to the WQX endpoint at the EPA. Each year DES uploads data to the WQX. Once the data are in the national WQX, the data are available to the public on the Internet.

Data in the EMD are spatially identified so they can be used in a geographic information system (GIS), and spatial analyses can be conducted (such as landscape or watershed-based analyses). In 2011, DES added a biological module to the EMD. This enhancement focused on enabling the recording of organisms and aquatic plants and algae for rivers and streams, lakes and ponds and estuarine and marine habitats.

DES's goal is to be able to enter all wetlands monitoring data into the EMD. As wetland indicators are developed and data are collected, it is anticipated that the EMD will need to be modified to accommodate the different types of wetlands monitoring data (such as plant species list and characteristics, site data and landscape information). As demonstrated in the past, DES is committed to making the necessary modifications as resources allow so that the wetlands data are available to the public and to DES for use in assessments as soon as possible.

7.2 Assessment Databases

To facilitate electronic assessments, EPA developed the Assessment Database (ADB) in the 1990s. Though not required, states were strongly encouraged to use this reporting tool to submit electronic reports to EPA. In 2002, EPA released a new Oracle-based version of the ADB that was based on the new integrated reporting approach and its seven categories. For the 2002 cycle, New Hampshire was one of the first states to use the new ADB. Since 2002, DES has used the ADB to submit biennial electronic assessment reports of surface water quality to EPA.

EPA's ADB tracks only those parameters causing impairment and does not give an indication of the degree to which that parameter exceeds the indicator. In response to public comment and the desire of DES to better track all information associated with a waterbody (i.e., not just impairments), DES created a database called the "Supplemental-ADB" in 2005. The Supplemental-ADB (SADB) allows DES to track and report on all parameters for which water quality data exist and allows for the assignment of sub-categories indicating the degree of support/non-support at the parameter and designated use level. Degrees of full support include Good (G), and Marginal (M). Degrees of Not Support include Marginal (M) and Poor (M). Information in the SADB is used to populate EPA's ADB.

Water quality assessments are governed by the Water Quality Standards as authorized by the statute, RSA 485-A:8, and adopted administrative rules, Env-Wq 1700. Detailed assessment protocols are described in the "Consolidated Assessment and Listing Methodology" (CALM), which is issued for public review and comment every two years. The latest version of the CALM is available on the Internet at http://des.nh.gov/organization/divisions/water/wmb/swqa/2012/documents/2012-calm.pdf.

The SADB automates the processing of the millions of data records in the EMD. The SADB automatically compares the monitoring data in the EMD using algorithms that are based on the CALM protocols to account for variables such as time of day, time of year, legislative class, waterbody type, depth of sample, calculated geometric means, and many other factors. In addition to automatically assessing data in the EMD, manual assessments of data outside of the EMD can also be made. As a last step, DES manually reviews the results of the automatic assessment provided by the SADB as well as any other information (if applicable) for each parameter and designated use in each assessment unit and manually assigns a final assessment status.

Another valuable feature of the SADB is that for each parameter that has insufficient information to make an assessment per the CALM, the assessor can assign a category of PAS (Potentially Attaining Standards) or PNS (Potentially Not Supporting). This information is often used to prioritize targeted "confirmation" monitoring efforts in subsequent years.

As indicators and assessment methodologies are developed for wetlands, the methodologies will be added to the CALM and the SADB. Information in the SADB will then be used to populate EPA's ADB.

For the 2008 assessments, the first GIS coverage of Wetland Assessment Units (AUs) was built on the National Wetland Inventory (NWI) polygons based on same methodology used by the New Hampshire Fish and Game Department to build wetland complexes for the Wildlife Action Plan. Those wetland AUs were used to conduct the first Level 1 Wetland Assessment and were included with the 2008 Section 305(b) Report as Appendix 36: http://des.nh.gov/organization/divisions/water/wmb/swqa/2008/index.htm.

Due to the coarse nature of the Level 1 Assessments, the goal was to conduct a landscape level assessment of the state's wetlands using a GIS model and make preliminary (screening level) determinations as to what wetlands were likely adequate to support aquatic life and to identify those that

were potentially not supporting. While the AUs were uploaded into EPA's ADB, the Level 1 assessment outcomes were not uploaded, as EPA's ADB does not accept screening level assessments. For the 2012 assessments, the wetland AUs were re-built (Stone and Mitchell, 2011). Further, a second version of the Level 1 wetland assessments was completed that was based on questions (metrics) from the New Hampshire Method related to the Aquatic Life Designated Use. DES anticipates uploading the revised wetland AUs into the ADB and providing the results of the revised Level 1 assessments on the DES website by the end of 2014.

8 DATA ANALYSIS / ASSESSMENT

During implementation of the wetland monitoring and assessment strategy activities, DES will identify appropriate data analyses, based on the objectives of the monitoring design, in the QAPPs prepared for each monitoring effort (see section 6). Based on the data collected and the geographic extent of the monitoring, the data analyses may include comparison of metrics and wetland condition parameters within and between watersheds, between ecoregions, between wetland types, within a wetland over time, within a *watershed* over time, within and between other parameters.

As discussed in section 5, for each wetland type, wetland monitoring and analyses will initially focus on identifying appropriate indicators and thresholds for assessing the condition of the wetland in terms of its ability to support the aquatic life designated use. That is, what are the appropriate indicators and thresholds for determining when a wetland is fully supporting aquatic life and when is it considered impaired? Once developed (for a designated use), appropriate analyses will be determined and included in the QAPPs for monitoring efforts designed to achieve the objectives in section 4.

Reporting

As noted earlier, one objective of the monitoring strategy is for DES to report on the condition of wetlands as required by the Clean Water Act (CWA) in the biennial sections 305b/303d Integrated Report to EPA.

The Federal Water Pollution Control Act [PL92-500, commonly called the Clean Water Act (CWA)], as last reauthorized by the Water Quality Act of 1987, requires each state to submit two surface water quality documents to the EPA every two years. Section 305(b) of the CWA requires submittal of a report (commonly called the "305(b) Report") that describes the quality of its surface waters and an analysis of the extent to which all such waters provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water. The second document is typically called the "303(d) List" which is so named because it is a requirement of Section 303(d) of the CWA. The 303(d) List includes surface waters that:

1. Are impaired or threatened by a pollutant or pollutant(s),

2. Are not expected to meet water quality standards within a reasonable time even after application of best available technology standards for point sources or best management practices for nonpoint sources, and

3. Require development and implementation of a comprehensive water quality study (called a Total Maximum Daily Load or TMDL study) that is designed to meet water quality standards.

DES has an excellent track record of complying with sections 305b/303d Integrated Report requirements. As previously discussed in section 7.2, and as encouraged by EPA, DES enters assessment data into the ADB and submits it to the EPA every two years.

To provide user-friendly information about New Hampshire's surface water quality assessments, DES developed "Watershed Report Cards." The report cards provide a one-page summary of the overall use support for aquatic life, primary contact (e.g., swimming), secondary contact (e.g., boating), and fish consumption designated uses for each Assessment Unit ID (AUID) within the HUC12 watershed. A HUC 12 map of the watershed with each AUID is provided and assessment details for each AUID in the report card and map. These reports are posted online:
http://des.nh.gov/organization/divisions/water/wmb/swqa/report_cards.htm.

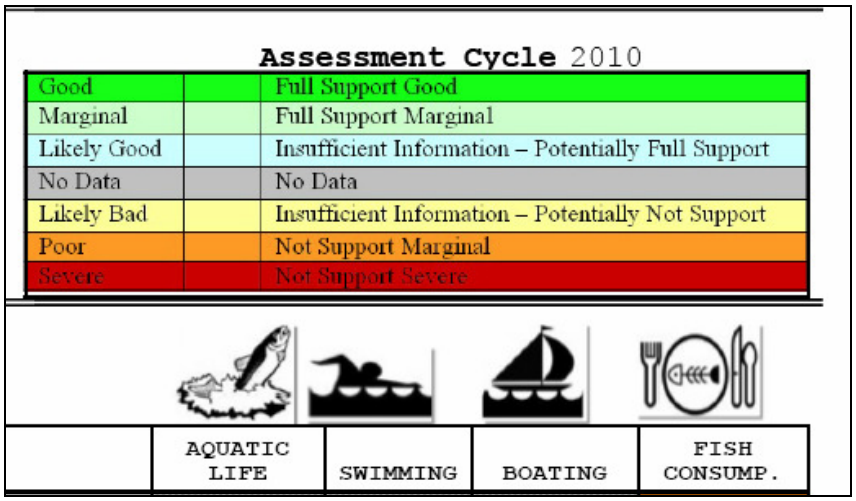

Figure 8-1. Key to reporting on support of designated uses for a waterbody in watershed report cards. A similar "report card" format will be developed for wetlands when monitoring and assessment results in attainment decisions for designated uses.

As discussed in section 7.2, DES will make attainment decisions for wetlands once indicators and thresholds have been identified for selected designated use(s) and monitoring data are available to support the decisions. As discussed in sections 7.1 and 7.2, DES is committed to making any necessary modifications to the EMD, CALM and Supplemental-ADB to facilitate storage and assessment of wetlands data as they are developed. Once wetlands have been assessed, the results will be input in the ADB.

DES will provide information about wetland monitoring and assessment to the public in an understandable format (such as the watershed report cards). As information is generated regarding wetlands condition by type or location, it will be made available so local decision makers and other members of the public will be able to make informed decisions, particularly in the area of local land use.

DES will provide annual updates to EPA regarding progress and accomplishments related to implementation of the wetlands monitoring and assessment strategy through the DES Measures Tracking and Reporting System (MTRS). The MTRS is an ORACLE database used by DES to track major deliverables for each program, including those associated with the EPA Performance Partnership Grant and Wetland Program Development Grants.

9 PROGRAMMATIC EVALUATION

Programmatic evaluation aims to periodically evaluate how well the monitoring programs meet their objectives and to determine how any revisions to the program procedures should be incorporated into future monitoring and assessment.

The DES Quality Management Plan (QMP) is discussed in section 6. The foundation of the DES quality assurance system relies on first-party audits ("self audits") which are conducted by DES programs that manage environmental data. Self audits are completed each year and reviewed by the DES Assistant QA Manager who acknowledges corrective actions noted in the report and identifies any areas for improvement the program manager may not have observed. A Quality Assurance System Status Report covering the previous year is then developed, which is available to EPA upon request.

As mentioned in section 6, QAPPs will be developed for any new wetland monitoring efforts. The QAPP for each program specifies the objectives and monitoring program necessary to meet those objectives. Following implementation of the wetlands monitoring program, a self audit will be performed to see if the objectives have been met and if revisions are necessary. If the self audit shows a need for improvements, programmatic changes will be incorporated into future QAPPs.

10 GENERAL SUPPORT AND INFRASTRUCTURE PLANNING

In developing the strategy it is important to recognize that DES currently has no established staff position(s) dedicated to wetlands monitoring and assessment. Wetland monitoring and assessment work conducted to date (described in Table 5-2, New Hampshire's Wetland Monitoring and Assessment work) has utilized staff from four programs within two agencies (the Wetlands Bureau,, Subsurface Systems Bureau and Watershed Management Bureau staff from DES, and Natural Heritage Bureau staff from the Department of Resources and Economic Development (DRED) Division of Forests and Lands). These efforts have been funded mostly by short term (two- to three-year) EPA Wetland Program Development Grants (WPDG) and the National Wetland Condition Assessment (NWCA) program wherein EPA provided $6,000 per NWCA site and additional funds for serving as the NWCA Vegetation Lab. Costs of sample analyses for water, algae and soil were paid for by the EPA. Staff funded by Clean Water Act section 106 grants have also assisted when available. While such partnerships are beneficial, the patchwork of funding does not contribute to a sustainable wetland monitoring and assessment program. A sustainable source of funding will be needed to implement this wetlands monitoring and assessment strategy.

10.1 Program Gaps

Current staff and funding levels significantly affect the ability of DES to implement and sustain an effective state wetland condition assessment program. The WPDGs provide resources to develop a program, but not to support it. DES faces significant obstacles to adequately staff monitoring programs, including obtaining stable multi-year funding. As required by EPA, New Hampshire has developed a Wetland Program Plan which may help secure additional multi-year funding, but it is not guaranteed.

We estimate that to conduct a basic wetland monitoring and assessment program, DES would need at least two full-time staff plus an intern available during field season. Staff and equipment are needed to prepare quality assurance plans, support the monitoring field work, sample analyses, data/statistical analysis and interpretation, and reporting of results. Sample analysis costs will likely include those for the identification and processing of biological samples such as vegetation and macroinvertebrates (the cost for identifying macroinvertebrates is expected to be significantly higher than for vegetation due to the specialized taxonomic skills needed for identification). Information technology (IT) support is also needed for GIS, to maintain the current databases, for modification of DES's current database and continued data management. In addition, funding will also be needed to cover other typical costs of a field program such as fuel and vehicle maintenance, equipment and supplies, vehicle purchase, as well as travel to meetings and training to develop expertise of monitoring staff.

10.2 Maximizing Resources

There are several ways that DES has and will continue to work toward greater efficiencies in establishing an effective and efficient wetland monitoring and assessment program.

New England Biological Assessment of Wetlands Workgroup

DES has been an active participant in the New England Biological Assessment of Wetlands Workgroup (NEBAWWG) since it was formed in 1998. The multi-state group, which includes New England and New York, is facilitated by the NEIWPCC. NEBAWWG is an excellent resource for exchanging information about the various state approaches to biomonitoring and wetland assessment and training. DES participated in the development of the Coefficients of Conservatism necessary to support the use of Floristic Quality Assessments for New Hampshire (and the northeast). A field demonstration of the various states' wetland monitoring and assessment methodologies was held in 2012 to inform other states on various approaches. DES anticipates continuing its involvement in NEBAWWG, in all capacities.

Volunteer Monitoring

Among the considerations in the development of a wetland monitoring and assessment program is the potential to create a viable rapid assessment method that can be used by a volunteer network. DES has successfully applied this model to its Volunteer Lake Assessment Program (VLAP) and Volunteer River Assessment Program (VRAP), although budget cuts have eliminated some DES staff coordination positions. DES will seek to develop or identify rapid assessment methods that are appropriate to integrate the use of volunteers in wetland monitoring and assessment, to the extent that appropriate monitoring protocols can be developed to attain useful results. The use of volunteer resources can reduce the costs but still require staff to oversee the volunteer monitoring program, provide training and conduct evaluations of the results. In 2011 state budget cuts resulted in the loss of the state-funded staff position that managed VRAP. Therefore, in order to implement a volunteer wetland monitoring program, sustainable federal funding to support a volunteer wetland monitoring coordinator will likely be needed.

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APPENDIX A - CLASSIFICATION OF WETLAND NATURAL COMMUNITY SYSTEMS IN NEW HAMPSHIRE (FROM SPERDUTO, 2005)

Palustrine (non-tidal, non-riparian)

Peatlands

Open oligotrophic peatlands

- Alpine/subalpine bog system
- Kettle hole bog system
- Poor level fen/bog system

Open minerotrophic peatlands (weakly to strongly minerotrophic)

- Medium level fen system
- Montane sloping fen system
- Patterned fen system
- Calcareous sloping fen system

Oligotrophic peat swamps

- Black spruce peat swamp system
- Coastal conifer peat swamp system
- Temperate peat swamp system
- Minerotrophic peat swamps
- Montane/near-boreal minerotrophic peat swamp system

Primarily mineral soil wetlands

- Minerotrophic mineral swamps (weakly to strongly minerotrophic)
- Temperate minerotrophic swamp system
- Forest seep/seepage forest system
- Open-basin and streamside wetlands
- Drainage marsh - shrub swamp system
- Sand plain pond shore and basin marshes
- Sandy pond shore system
- Sand plain basin marsh system

Riparian (non-tidal)

River channels (and associated riverbanks and open floodplains)

- Low-gradient silty-sandy riverbank system
- Moderate-gradient sandy-cobbly riverbank system
- High-gradient rocky riverbank system
- Floodplain forests (and associated riverbanks and open floodplains)
- Montane/near-boreal floodplain system
- Major river silver maple floodplain system
- Temperate minor river floodplain system

Tidal and subtidal (estuarine)

Intertidal wetlands

- Salt marsh system
- Brackish riverbank marsh system.
- Sparsely vegetated intertidal system
- Coastal salt pond marsh system

Subtidal wetlands

- Subtidal system