Quality Assurance Project Plan for Wetland Monitoring and Assessment Demonstration Project: Assessment of Wetland Mitigation Success

Prepared by:

Lisa Rhodes, Project Manager
MassDEP Wetlands Program
1 Winter Street, Boston MA 02108

Scott Jackson, Project Manager
Department of Natural Resources Conservation
UMass-Amherst, MA 01003

EPA RFA # EPA-REG1_WPDG-2011
2011-2013

MassDEP Project Manager

Name	Title	Signature	Date
Lisa Rhodes	Environmental Analyst, Project Manager	Lisa A Rhodes	2/7/13

One Winter Street, Boston, MA 02108; telephone (617) 292-5512, fax (617) 292-5696
email: Lisa.Rhodes@Massmail.state.ma.us

Program Director

Name	Title	Signature	Date
Lealdon Langley	Director, Wetlands and Waterways Program	[signature]	2/11/13

One Winter Street, Boston, MA 02108; telephone (617) 574-6882, fax (617) 292-5696,
email: Lealdon.Langley@Massmail.state.ma.us

MassDEP QA Officer

Name	Title	Signature	Date
Richard Chase	QA Officer	R. Ch	2/13/13

627 Main Street, Worcester, MA 01608; telephone (508) 767-2859, fax (508) 791-4131,
email: Richard.F.Chase@Massmail.state.ma.us

UMass Project Manager and QA Manger

Name	Title	Signature	Date
Scott Jackson	Program Director, UMass Extension	Scott Jackson	2/14/13

Department of Natural Resources Conservation, Holdsworth Hall, University of Massachusetts, Amherst, MA 01003; telephone (413) 545-4743, fax (413) 545-4358, email: sjackson@umext.umass.edu

EPA Project Manager

Name	Title	Signature	Date
Beth Alafat	Project Manager	Beth Alafat	2/14/13

One Congress Street, Suite 1100 (CMP), Boston, MA 02114-2023; telephone (617) 918-1686, fax (617) 918-1505,
email: Alafat.Beth@epamail.epa.gov

EPA QA Officer

Name	Title	Signature	Date
Steve DiMattei	QA Officer	[signature]	2/15/13

11 Technology Drive, North Chelmsford, MA 01863 telephone (617) 918-8369, fax (617) 918-8397,
email: DiMattei.Steve@epamail.epa.gov

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Name	Title	Signature	Date

Department of Natural Resources Conservation, Holdsworth Hall, University of Massachusetts, Amherst, MA 01003; telephone (413) 545-4743, fax (413) 545-4358, email: sjackson@umext.umass.edu

EPA Project Manager

Beth Alafat	Project Manager		
Name	Title	Signature	Date

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email: Alafat.Beth@epamail.epa.gov

EPA QA Officer

Steve DiMattei	QA Officer		
Name	Title	Signature	Date

11 Technology Drive, North Chelmsford, MA 01863 telephone (617) 918-8369, fax (617) 918-8397,
email: DiMattei.Steve@epamail.epa.gov

Table of Contents

1.0 Project Management

1.1 Distribution List

MassDEP, Director Wetlands & Waterways Program – Lealdon Langley
MassDEP, Wetland Program Chief – Michael Stroman
MassDEP, Environmental Analyst, MassDEP Project Manager – Lisa Rhodes
MassDEP, Quality Assurance Officer – Richard Chase
MassDEP, Advisor/Field Scientist – James Sprague
MassDEP, Advisor/Field Scientist – Michael McHugh
EPA Regional Director, Mathew Schweisberg
EPA Project Manager, Beth Alafat
EPA, QA Manager, Steve DiMattei
UMass Advisor - Dr. Kevin McGarigal
UMass Project and QA Manager, Scott Jackson
UMass Statistician – Ethan Plunkett

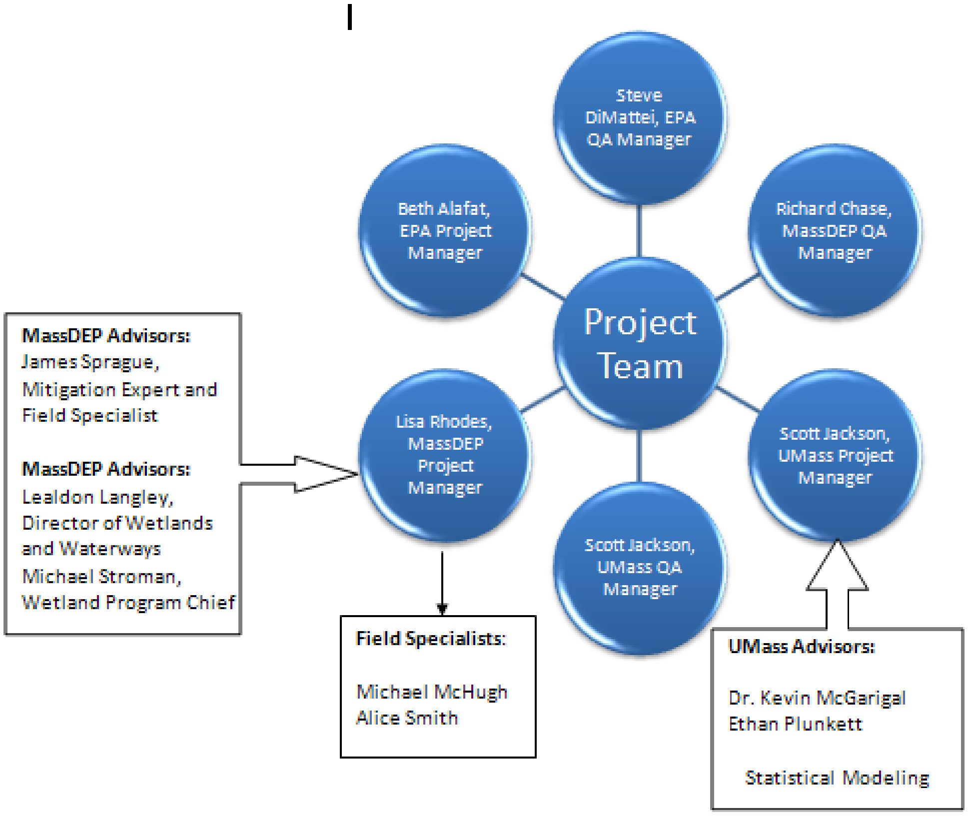
1.2 Project/Task Organization

The participating individuals and/or organizations and their roles include:

Beth Alafat – EPA Project Manager – Oversee Grant commitments
Steve DiMattei- EPA QA Officer- participates in the development and implementation of QA/QC procedures for the project.
Lisa Rhodes - MassDEP Project Manager/Field Scientist – oversee the involvement of MassDEP personnel and project commitments; coauthor of results.
James Sprague – MassDEP Advisor / Field Scientist – participate in data review and decision-making for mitigation evaluation; field data collection.
Michael McHugh – MassDEP Advisor / Field Scientist – participate in data review and decision-making relative to Mitigation evaluation; field data collection.
Alice Smith – MassDEP Field Scientist and Researcher – participate in research and field data collection.
Richard Chase – MassDEP QA Officer – participates in the development and implementation of QA/QC procedures for the project.
Lealdon Langley – MassDEP Advisor/Reviewer – participates in data review and decision-making relative to Mitigation study development.
Michael Stroman – MassDEP Advisor/Reviewer – participates in data review and decision-making relative to Mitigation study development.
Dr. Kevin McGarigal – UMass Project Manager - data review and decision-making relative to mitigation study development and statistical analyses.
Scott Jackson – UMass Project and QA Manager - Lead in Mitigation Study methodology development, participation in data review and decision-making and site selection for field work; coauthor of results.

Ethan Plunkett – UMass Statistician – participation in statistical analyses

1.2.1 Project Organization Chart



2.0 Problem Definition/Background

2.1 Demonstration Project: Assessment of Wetland Mitigation Success

The University of Massachusetts Research Bulletin 746/December 2001 entitled *Effectiveness of Compensatory Wetland Mitigation in Massachusetts* ("the Brown and Veneman Report") found that the majority of wetland replacement projects undertaken in MA were not in compliance with the Wetland Protection Act (WPA) regulations. The study notes that "*The state's goal of no net loss of wetlands cannot be met unless the regulatory program succeeds in compensating for all authorized wetland impacts*." In many projects, mitigation failed for a variety of reasons, including: 1) no replacement project was ever built, 2) inadequate wetland hydrology, 3) poor vegetation replanting plans, and 4) replacement areas were smaller than required. The study notes that the replicated wetland is often not the same as the impacted wetland (i.e. while 71% of the impacted wetlands were forested, the majority of the replicated wetlands were not). A similar report entitled *Compensation for Wetland Losses under the Clean Water Act* by the National Research Council (2001) documented similar failures.

In 2002 MassDEP developed guidance entitled *Massachusetts Inland Wetland Replication Guidelines* http://www.mass.gov/dep/water/laws/replicat.pdf to improve wetland replacement success and in 2010 conducted a review of 23 wetland replacement areas reviewed by MassDEP through Superseding Orders of Conditions (SOC). The 2010 study found noncompliance with WPA regulations (e.g. locating replacement areas in same stream reach, at similar elevation and with 75% vegetative cover within 3 years) at only two sites. These projects were permitted by MassDEP rather than Conservation Commissions and probably received a more thorough review than many replacement projects in MA. It is unclear whether or to what degree mitigation success has improved in MA since the Brown and Veneman report.

In the fall of 2011, the Environmental Protection Agency funded MassDEP and the University of Massachusetts at Amherst to undertake a new comprehensive study of wetland replacement success that is the subject of this Quality Assurance Project Plan (QAPP). This project includes two major components. First, we will evaluate recently constructed wetland mitigation sites across the state using methods similar to the Brown and Veneman Report, utilizing our wetland loss mapping and our new WIRE[1] data management system which now allows us to view the location of recent wetland mitigation sites geospatially. Our goal is to determine how successful wetland replacement sites are today and to identify ways we can improve wetland replacement success and achieve no net loss and wetland gain. The results of this study will be reported along with recommendations for policy or regulatory revision, including evaluation of 401 (314 CMR 9.00) and WPA performance standards for Bordering Vegetated Wetland replacement (310 CMR 10.55 (4) (b)).

Second, we will demonstrate how the Site Level Assessment Method (SLAM) and Indices of Biological Integrity (IBI's) currently being finalized for forested wetlands, and the landscape level Conservation Assessment and Prioritization System (CAPS) model can be used to assess biological integrity of forested wetland replacement areas, and to determine if they are meeting expectations for biological condition. An evaluation of the landscape context (CAPS IEI score) will be used to establish a target for biological indicators (IBI score). The M&A Team will monitor & assess a minimum of 5 mitigation sites and will demonstrate how CAPS can be used to locate appropriate mitigation sites in the watershed. Note that this second component of the study is covered under an approved QAPP for the forested wetland SLAM, and a CAPS QAPP is scheduled to be completed in June, 2012.

[1] WIRE was funded by an EPA Wetland Program Demonstration Grant (2005) and Wetland Program Development Grants (2008, 2010).

3.0 Project/Task Description

3.1 Selection of Towns for DEP Study of Wetlands Mitigation

The approach taken in the selection of towns for inclusion in the study is similar, although not exactly the same, as that taken by Brown and Veneman (1998). Both approaches yielded a randomized sample of Massachusetts cities and towns with an appropriate geographical representation. The differences in the approaches are small and the resulting samples are comparable.

1. Using a random numbers generator we assigned random numbers to each of the towns and cities in Massachusetts. These numbers were then arranged from lowest to highest.

2. We chose 40 communities as our initial sample (choosing the first 40 from the list).

3. This random sample of towns was then evaluated to ensure adequate representation by:

    - DEP Region
    - Ecoregion
    - Population
    - Numbers of Notices of Intent (NOIs) filed during the years 2004-2008

    Bins were designated for each of these sampling variables for purposes of evaluating the random sample of towns (see below for details on the designation of bins).

4. Additional towns were added until at least three towns were included in each bin for each of the four sampling variables considered (DEP region, ecoregion, population and NOIs). The process for adding towns involved running down the list of randomized towns and choosing the first one that was from an under-represented group (bin). This was repeated until all bins had at least three towns.

    A total of four towns were added to ensure adequate representation. One town each was added to increase to three the number of towns in each of the first two bins (≤ 10 and 11-25) for number of NOIs filed. Two towns (cities) were added to increase to three the number of municipalities in the highest bin (> 50,000) for population.

    Designation of Bins for Sample Variables

    DEP Regions
    - Northeast
    - Southeast
    - Central

- Western

Ecoregions

- Northeastern Highlands Central Plateau
- Connecticut Valley
- Central Plateau
- Boston Basin
- Cape Cod/Long Island
- Bristol Lowland/Narragansett Lowland
- Southern New England Coastal Plains and Hills

Population

- ≤ 3000
- 3001 – 10,000
- 10,001 – 50,000
- > 50,000

NOIs Filed from January 1, 2004 through December 31, 2008

- ≤ 10
- 11 – 25
- 26 – 50
- 51 – 100
- 101 – 200
- > 200

List of Towns (n=44)

ACTON	HOLDEN	READING
AGAWAM	LITTLETON	RICHMOND
AMESBURY	LOWELL	SAVOY
BEVERLY	MARBLEHEAD	SEEKONK
BRAINTREE	MEDFIELD	SPENCER
BUCKLAND	MILFORD	STONEHAM
CLINTON	NEW BRAINTREE	STOUGHTON
DRACUT	NEW MARLBOROUGH	SWAMPSCOTT
EAST BROOKFIELD	NEW SALEM	TEMPLETON
EVERETT	NEWBURYPORT	TEWKSBURY
FALMOUTH	NEWTON	WALTHAM
FREETOWN	NORTHBRIDGE	WEST SPRINGFIELD
GROTON	OXFORD	WEST TISBURY
HADLEY	PEPPERELL	WESTPORT
HARWICH	PRINCETON	Add alternate towns

Breakout of Towns by Sample Variables

DEP Region	Sample Towns	Sample Towns %	All Towns %
CERO	15	34.1%	21.7%
NERO	13	29.5%	23.9%
SERO	8	18.2%	23.9%
WERO	8	18.2%	30.5%

Ecoregions	Sample Towns	Sample Towns %	All Towns %
Boston Basin	5	11.4%	7.69%
Bristol Lowland/Narragansett Lowland	3	6.8%	9.12%
Cape Cod/Long Island	3	6.8%	6.55%
Central Plateau	5	11.4%	11.68%
Connecticut River Valley	3	6.8%	5.70%
Northeast Highlands	4	9.1%	17.38%
Southern New England Coastal Plains and Hills	21	47.7%	41.88%

Population	Sample Towns	Sample Towns %	All Towns %
≤ 3000	8	18.2%	22.5%
3001 – 10,000	6	13.6%	28.2%
10,001 – 50,000	27	61.4%	42.7%
> 50,000	3	6.8%	6.6%

NOIs Filed (2004 – 2008)	Sample Towns	Sample Towns %	All Towns %
≤ 10	3	6.8%	9.1%
11 – 25	3	6.8%	9.1%
26 – 50	7	15.9%	14.8%
51 – 100	9	20.5%	23.1%
101 – 200	17	38.6%	29.3%
> 200	5	11.4%	14.5%

Differences between our sampling approach and that used by Brown and Veneman

Here are some of the ways that our approach differed from that of Brown and Veneman.

- Brown and Veneman stratified their sample by weighting DEP regions by the relative number of NOIs filed. In our approach we assigned each town to an NOI class (see below) and then added towns to the random sample to ensure adequate representation from each of the NOI class bins.
- Brown and Veneman stratified their sample by seven ecoregions. We evaluated our random sample of towns and determined that each of the ecoregions was adequately represented and that no adjustments were needed. Our seven ecoregions differed somewhat from those use by Brown and Veneman as follows.

<table>
<tr><th colspan="2">Brown & Veneman</th><th colspan="2">Current Sampling Scheme</th></tr>
<tr><td>7 Categories</td><td>EPA Level IV Categories</td><td>7 Categories</td><td>EPA Level IV Categories</td></tr>
<tr><td>Northeastern Highlands Central Plateau</td><td>− Taconic Mountains
− Western New England Marble Valleys
− Green Mountains/Berkshire Highlands
− Lower Berkshire Hills
− Berkshire Transition
− Vermont Piedmont</td><td>Northeastern Highlands Central Plateau</td><td>− Taconic Mountains
− Western New England Marble Valleys
− Green Mountains/Berkshire Highlands
− Lower Berkshire Hills
− Berkshire Transition
− Vermont Piedmont</td></tr>
<tr><td>Connecticut Valley</td><td>− Connecticut Valley</td><td>Connecticut Valley</td><td>− Connecticut Valley</td></tr>
<tr><td>Central Plateau</td><td>− Worcester/Monadnock Plateau
− Lower Worcester Plateau/Eastern Connecticut Upland</td><td>Central Plateau</td><td>− Worcester/Monadnock Plateau
− Lower Worcester Plateau/Eastern Connecticut Upland</td></tr>
<tr><td>Boston Basin</td><td>− Boston Basin</td><td>Boston Basin</td><td>− Boston Basin</td></tr>
<tr><td>Cape Cod/Long Island</td><td>− Cape Cod/Long Island</td><td>Cape Cod/Long Island</td><td>− Cape Cod/Long Island</td></tr>
<tr><td>Northeastern Coastal Zone</td><td>− Part of Southern New England Coastal Plains and Hills</td><td></td><td></td></tr>
<tr><td>Southeastern Coastal Zone</td><td>− Part of Southern New England Coastal Plains and Hills
− Bristol Lowland/Narragansett Lowland</td><td></td><td></td></tr>
<tr><td></td><td></td><td>Bristol Lowland/Narragansett Lowland</td><td>− Bristol Lowland/Narragansett Lowland</td></tr>
<tr><td></td><td></td><td>Southern New England Coastal Plains and Hills</td><td>− Southern New England Coastal Plains and Hills</td></tr>
</table>

- The current approach adjusts the sample of towns to ensure adequate representation by population. Population was not considered by Brown and Veneman.

3.2 PHASE I: Site Research

3.2.1 Statewide Assessment Sites

Permit Activity during Research Timeframe

For each City or Town identified in Section 3.1, a MassDEP Analyst will access the MassDEP Wetland Program's database – the Wetland Information Resource (WIRe) - and cull from that database a spreadsheet of all NOI filings that occurred in the town between January 1, 2004 and December 31, 2008. This time frame was chosen for two reasons. First, by looking at projects approved after January 1, 2004 we can assess whether MassDEP's guidance (i.e. *Massachusetts Inland Wetland Replication Guidelines* dated March 2002) has resulted in more successful wetland replacement projects. The end date, December 31, 2008, provides a reasonable timeframe for projects in the permitting process to have progressed through it and to have been constructed. It is hoped that this timeframe will allow for the identification of a sufficient number of constructed wetlands replacement projects that have had at least two growing seasons for the replacement wetland to get established.

For the designated time period, the MassDEP WIRe database identifies a statewide total of 38,462 NOI filings. For the 44 towns identified for study, the WIRe database identifies 5046 NOI filings. These figures are comparable to the number of filings considered in the original study conducted by Brown and Veneman. Thus, we should have a large enough sample to allow for direct comparison of the results of the two studies. The WIRe spreadsheet provides a sequential listing of the NOI file numbers, as well as the filing date, site locus and applicant name; which will allow the MassDEP Analyst (i.e. Analyst) to research the appropriate documents. Note sample below:

NOI # ▲	F	SOC	Filing Date	City/Town	Locus	Applicant Name
085-0920			1/9/2006	ACTON	6 HATCH RD	DIRE, ALFONSO
085-0921			1/17/2006	ACTON	NAGOG PK/WESTFORD LN/B-5	RECREATIONAL REALTY TRUST LLC
085-0922			1/17/2006	ACTON	NAGOG PK/WESTFORD LN/LOT 4A	RECREATIONAL REALTY TRUST LLC
085-0923			1/20/2006	ACTON	33 SQUIRREL HILL RD	RIVARD, KRISTEN
085-0924			1/20/2006	ACTON	144 GREAT RD	BRAVERY REALTY TRUST
085-0925			2/10/2006	ACTON	100 POWDERMILL PL	ATLANTIC ACTON REALTY LP
085-0926			2/16/2006	ACTON	68 WILLOW ST-LOT 2	DUNN, WILLIAM
085-0927			2/16/2006	ACTON	5 LOTHROP ROAD	VANDERPOEL, LYNN
085-0928			2/24/2006	ACTON	436 GREAT RD	KERAMARIS, GEORGE
085-0929			4/3/2006	ACTON	30 GREAT RD	ACTON SPORTS PROPERTY LTD.

Protocol for Contacting City/Town Conservation Commissions

For each City or Town that has been selected for inclusion in the study, the Analyst will send an email to the Conservation Commission that will contain language similar to the following:

Dear [Name of Chairman]

> *We are writing to request your assistance with a study we are conducting to evaluate wetland replacement success in Massachusetts. The MassDEP Wetlands Program and the University of Massachusetts at Amherst recently received a grant from the Environmental Protection Agency to conduct a follow up study to "Compensatory Wetland Mitigation in Massachusetts," a study published in December of 1998 by the University of Massachusetts at Amherst and available at http://www.mass.gov/dep/water/resources/cwm.pdf*
> *Our goal is to determine the effectiveness, statewide, of wetlands replacement in order to guide our policy and regulation development and to document the findings of our research. The report will not include property owner names or addresses nor will it describe specific Town success or failure in meeting replication requirements. It is not our intention to use this study for enforcement purposes.*
>
> *Consistent with the parameters of the original study, MassDEP has randomly identified 44 towns for participation in the study update. That random selection process has selected your town for inclusion. We would appreciate it if you would respond to this email with dates and times that are convenient for you so that we can schedule a time to review all Notice of Intent applications and plans, and associated Orders of Conditions that were filed between January 1, 2004 and December 31, 2008 in order to identify and collect data pertinent to wetlands replacement.*
>
> *If you have any questions, please contact Principal Investigator Michael McHugh of MassDEP at 617.556.1163. An additional contact, if required, is Lisa Rhodes, Project Manager at (617) 292-5512. MassDEP and the University of Massachusetts at Amherst appreciate your assistance in this important study.*

If, after approximately one week a Conservation Commission has not responded, the Analyst will call the Conservation Commission office and schedule a time to visit and review the plans. If a member or representative of the Conservation Commission cannot be reached, contact can be made to the Town Clerks Office to inquire about availability of the pertinent records. In order to maintain the unbiased nature of the original town selection process, every effort will be made to get access to the files necessary for the study. If all efforts to obtain the records are unsuccessful (i.e. records lost, incomplete etc.), we will document the efforts made to obtain the files, and move to the next alternate town on the list. If only partial records are available we will make a decision on whether or not to reject that town based on how many of those sought are available.

Research at the City/Town Offices

Once in Town Hall, all NOI filings and associated Orders of Conditions (OOC's) within the specified time range will be reviewed for the purpose of identifying projects involving wetlands replacement. For all projects found to have freshwater wetland replacement approved, the information in the Site Data Form (See Appendix A) will be filled out for each such project. The Site Data Form will track project data including but not limited to:

- NOI File #

- Project Address
- Applicant Name
- Area of Wetland impacted
- Presence of Approved Mitigation Plans
- Details of the proposed compensatory wetland design and construction (including but not limited to the size of the replacement area, any proposed plantings, type of soil to be used) for the purpose of determining whether replacement areas: 1) meet regulatory requirements (310 CMR 10.55 (4)(b)); and 2) follow recommendations of Massachusetts *Inland Wetlands Replacement Guidelines* dated March 1, 2002 [2] as follows:

  - To determine whether the replacement area meets regulatory requirements at 310 CMR 10.55(4)(b)[3], we will collect information to answer the following questions.
    - Was the size of the proposed replacement area equal to or greater than that of the wetland loss?
    - Were the groundwater and surface elevations of the lost area and replacement area comparable?
    - Did the proposed replacement area have a horizontal configuration with respect to bank, and hydraulic connection/location to the water body or waterway that was comparable to that of the lost area?

  - To determine whether the replacement area meets the *Massachusetts Inland Wetlands Replacement Guidelines*, we will review the file to answer the following questions.
    - Does the file contain evidence of sequencing (avoidance, minimization, mitigation)?
    - Does the file contains details regarding site hydrology such as expected annual seasonal depth, duration and timing of inundation and saturation; installation of monitoring wells or discussion of hydroperiod?
    - Does the file contain details of soils to be used and creation of horizons?
    - Does the file contain details regarding the specific construction practices to create the replacement area such as minimization of stockpiling, keeping soils wet?
    - Does the file contain details regarding planting of vegetation within the replacement area such as timing and spacing?
    - Does the file contain a commitment to prevent invasive species from becoming established?
    - Does the file contain an erosion control plan?
    - Does the file contain a commitment or condition to monitor efforts during and post construction to ensure and document that the replacement area is becoming a wetland? If so, are monitoring reports in the file?

The Orders of Conditions will also be reviewed to determine if those same recommendations have

[2] http://www.mass.gov/dep/water/laws/policies.htm#wetlguid

[3] See 310 CMR 10.55 (4)(b) at http://www.mass.gov/dep/service/regulations/310cmr10a.pdf

been included in the permit approving the project. However, commitments in the permit application are considered binding even without specific conditions in the Order of Conditions. Also, we will document:

- Were as-built plans required and if so, were they in the file?

The Site Data Form is in an Excel spreadsheet or word format and the Analyst will enter the data electronically directly into a laptop, or into a hard copy form which is then entered into the electronic data base once back in the office. In addition, a user's guide has been developed for use with the Site Data Form to ensure consistency in the entering of data (See Appendix B).

In addition to completing the Site Data Form, copies of a site plan, an approved wetland replacement plan and permit conditions specific to the construction of the wetland replacement area will be acquired.

The described copies will be obtained utilizing a Canon Powershot SX150 IS or similar camera that can take clear photos of plans. While we have not yet purchased this camera, we have tested lower quality cameras and have had acceptable, though not preferable results. Therefore we believe this camera will produce high quality photos.

Once research at each City or Town hall is completed, the data on the Site Data Form will be down loaded or entered to a master copy on a shared and protected drive at MassDEP. Photographic records of the documents collected will also be downloaded and digitally stored in files which identify the Town and the DEP File number that the photographic documents pertain to and they will also stored on a shared and protected drive at MassDEP.

Property Access

Site visits will be conducted at as many of the projects involving wetlands replacement as possible. Based on the figures from the previous Brown and Veneman report we will conduct a minimum of 114 site visits of projects that involve wetland replacement.(See Section 3.3.1 below for assessment criteria). Since the majority of these projects will have occurred on private property, landowner permission will be necessary in order to enter onto the property to conduct an evaluation of the replacement wetland. Attached as Appendix C is a form letter that will be sent to landowners requesting that they contact MassDEP via phone or email to indicate their permission for us to access the site. If we do not hear back within 1-2 weeks we will call. A last resort effort will be to ring the doorbell and ask at that time.

<u>3.2.2 Forested Wetland SLAM sites how are these sites selected?</u>

In addition to conducting site visits for the purpose of determining compliance with the Massachusetts Wetlands Protection Act performance standards, we are also proposing to conduct site investigations to assess a more limited number of forested wetland replacement area to determine if they are meeting biological criteria established by the Massachusetts wetland monitoring and assessment strategy. The M&A Team will monitor & assess a minimum of 5 forested wetland replacement sites primarily from known wetland Variance projects since: 1) They are likely to be constructed by public agencies on property owned or managed by the Commonwealth of Massachusetts, thus access is not likely to be a complication; and 2) They are typically larger in size and since the SLAM protocol requires a minimum of a 50 meter radius circular plot, larger wetland replacement areas are more suited to this analysis. These sites will be selected by reviewing Variance project files to determine whether forested wetland replacement sites were proposed and approved, and if sufficient time has passed for them to have been built. Once sites identified, we will confirm that they have been built (if not already known) and will conduct a site visit to ensure that the replacement area, if not yet forested, is at least on a "trajectory" to become forested. For a site to be on a trajectory to become forested, they would have to meet the following criteria:

1. If recently built they must have woody (saplings) vegetation planted;
2. If the site is more than a year or two old, the site must be succeeding to at least a tall shrub and sapling community if not yet forested.
3. The site cannot be stressed, that is if all planted woody vegetation has failed, if the site is primarily emergent vegetation, or if the site is dry (not a wetland) or is a deep water habitat.

Additional sites that are permitted through Superseding Orders of Conditions or City/Town Orders of Conditions and that are identified by the City/Town research described in the previous section will also be considered if they are of sufficient size, accessible, and if they are on a trajectory to become forested using the criteria above. Detailed description of the forested SLAM protocol is attached as Appendix D.

3.3 PHASE II: Site Visits and Data Analysis

3.3.1 Statewide Assessment Sites

Site Visits

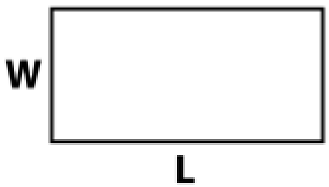
Each replacement area that is identified and where access permission is obtained will be visited to collect data. Wetland delineations or functional assessments will not be performed, and only data will be collected to help estimate if wetland replacement areas constructed have been successful or not. The following data will be collected and will be entered into a Field Data Form(Appendix E) to determine if the site meets regulatory requirements at 310 CMR 10.55(4)(b) and the *Massachusetts Inland Wetlands Replication Guidelines*:

1. Was the replacement area built? By using the project locus map and detailed replacement plan we will go to the site of the proposed replacement wetland to see if in fact it was actually constructed (or attempted). This involves a visual observation to determine if clearing, grading, planting, or other activities typically associated with wetlands replacement construction have been undertaken. If as-built plans are available, these plans could be ground truthed for any non-time-dependent inaccuracies.

2. Size of replacement area: Using measurements in the field, we will determine the size of the replicated wetland, as actually built. If as-built plans are available we will use them to determine the size in the office but we will ground truth that the plans are accurate. Field

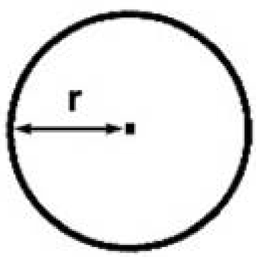
measurement involves using a tape measure on site and measuring the size of the replacement area in order to determine its areal extent. The measuring technique will be determined in the field, based on the shape of the replacement area.

Rectangular areas can be determined using length times width.



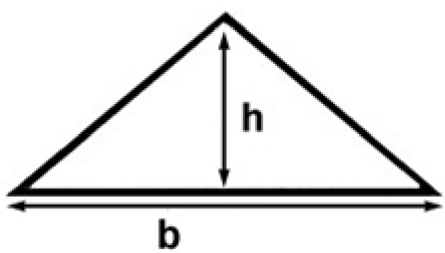
e.g. 10’ x 10’= 100 square feet

Circular areas using the formula: $Area = \pi r^2$



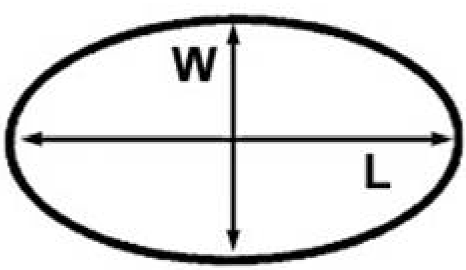
e.g. r=6’: (3.14)(36)=113 square feet

Triangular areas by using base time height then dividing the result by two,



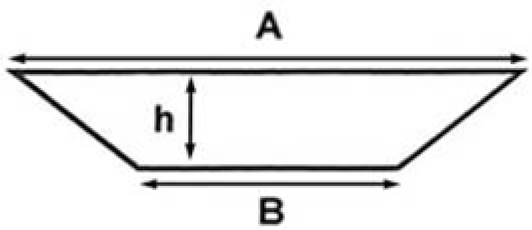
e.g. b=10, h=5 : $\frac{(10)(5)}{2}$=25 square feet

Oval areas by dividing the width by the length then multiplying the result by 0.8



e.g. w=10, L= 20: (10)(20)(0.8)=160 square feet

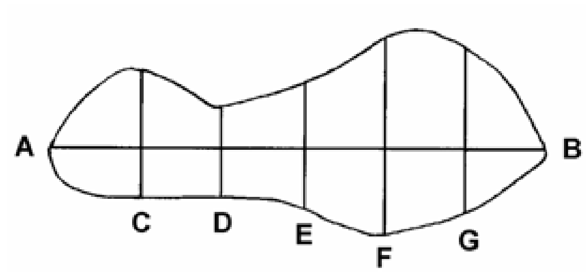
Trapezoidal areas by first finding the average length of the parallels sides then multiplying the result by the height



e.g. A=20’, B= 10’, h=5’

$\frac{(20)+(10)}{2}(5)=75$ square feet

However, due to the nature of replacement areas we are likely to encounter irregular shaped areas. In those situations we will use the “offset method”, whereby we first measure the length of the longest axis of the area (the length line), then we will divide the line into equal sections, and at each of these points we will measure the distance across the area in a line perpendicular to the length at each point (offset lines), and lastly we will then add the lengths of all offset lines and multiply the result times the distance that separates these lines.



e.g. AB=60’, C=15’, D=10’, E=15’,F=25’, G=20’; (15+10+15+25+20)(10’)=850 square feet

3. <u>Plant Name</u>: By using ocular estimate of percent cover, all plant species with a total percent cover greater than 1% of the entire area (i.e. additive percent cover), will be identified. Plant species will be identified by MassDEP staff or consultants who are trained in MassDEP and USACE Wetlands delineation methodologies and have experience at wetland identification, delineation, and evaluation. All Plant species will be identified in accordance with *Grays Manual of Botany* and *An Illustrated Flora of the Northern United States and Canada* and nomenclature will be same as used in the *National List of Plant Species That Occur in Wetlands: Massachusetts.* Plant species data will also be collected for an immediately adjacent remnant wetland if one exists, or if not, a similar wetland nearby (see further discussion below).

4. <u>Ocular Estimate Percent Cover</u>: An estimate of the total percent cover for each plant species will be recorded for each plant species that represents greater than 1% cover. Cover class estimation is a standard and accepted procedure for evaluating plant abundance and is in use by State and Federal Wetlands Regulatory agencies. Percent cover is the percent of the ground surface that would be covered if the foliage from a particular species were projected onto the ground, ignoring small gaps between the

leaves and branches. Percent cover is estimated visually. See page 13 of the MassDEP manual entitled *Delineating Bordering Vegetated Wetlands under the Massachusetts Wetlands Protection Act* dated March 1995. http://www.mass.gov/dep/water/laws/bvwmanua.pdf The wetland plant indicator status of each plant species that represents greater than 1% cover, based on the *National List of Plant Species That Occur in Wetlands: Massachusetts* (http://www.plants.usda.gov/wetinfo.html) will also be recorded.

5. Point-Intercept Percent Coverage: Using a series of transects we will sample vegetation at 2-foot intervals until we have 100 sample points. Random transects will be established by starting at an upland edge and flipping a pen in the air such that it twirls and falls to the ground. The direction the pen points into the replacement area is the direction of the first transect to the opposite edge. Upon reaching the opposite edge, the procedure is repeated until a total length of 200-feet is obtained. At every 2-foot point, each plant species along a vertical line will be recorded. The wetland indicator status will also be recorded.

In addition, the following field information will also be collected to assist in determining compliance with the *Massachusetts Inland Wetlands Replication Guidelines*.

1) Relative Elevation: Field scientists will review the replacement area using visual estimation to see if it is lower, higher, or equal to the elevation of the adjacent wetland or waterway.

2) Hydrology: field scientists will view the replacement area to determine if there is evidence of prolonged periods of inundation or excessive drying out (i.e. evidence of vegetation die back), and will document the degree of saturation and depth to water table The degree so saturation will be determined visually, by noting the presence or absence of standing water, and the presence or absence of a saturated soils (note Soils Data Section below). Depth to water table will be determined by observing the presence of free water in the soil pit also described in the Soils Data Section below. Water tables that are greater than 16 inches deep will not be located (i.e. we will not continue to dig till we hit water) They will also determine if the replacement area receives water from stormwater features and or if it has an unrestricted hydraulic connection to neighboring water body or waterway.

3) Soils Data: At each site, the field scientist will sample the soil at one representative location. Sampling shall consist of digging a soil pit 12 inches in diameter to a minimum depth of 16 inches. The field scientist will remove a representative pedon from the soil pit and record the depth and texture of the O, A, and B horizons, as appropriate (with a histisol, where the O horizon is greater than 16 inches, determining the A and B horizon depth and texture is not necessary). Also, the matrix color and the color and depth of any redoximorphic features will be recorded using the most recent Munsell Soil Color Chart.

4) Invasive Plant Data: In addition to the percent cover data outlined above, we will document the presence of specific invasive species listed in the replacement guidance. Those species are: Purple Loosestrife (*Lythrum salicaria*); Phragmites (*Phragmites*

australis); Buckthorn (*Rhamnus frangula alnus*) Honeysuckles (*Lonicera spp*.); Garlic Mustard (*Alliaria petiolata*); Japenese Knotweed (*Polygon cuspidatum* or *Fallopia japonica*); Japanese Stilt Grass (*Microstegium vimineum*); Reed Canary Grass (*Phalaris arundinacea*); Bittersweet Nightshade (*Celastrus orbiculatus*); Black Swallow-wort (*Cynanchum nigrum*) or Pale Swallow-wort (*Cynanchum rossicum*).

5) Removal of Erosion Control: Field scientists will document that all erosion controls have been removed and the soils and embankments are properly stabilized and vegetated. Haybales left to decay will not meet this criterion.

Comparison to Remnant Wetlands

While at the site we will also evaluate the condition of the adjacent remnant wetland using the same methodology outlined above. The area within the remnant wetland will be immediately adjacent to the lost wetland and the sample plot will be the same size and shape as the replacement area that was assessed. In the event that there is not remnant wetland remaining (i.e. the entire wetland was altered), then a reference wetland that is nearby, and consists of a plant community, based on the original Notice of Intent, that is similar to that of the lost wetland shall be utilized. Plant species composition will be compared to that of the replacement site utilizing either the method used in the Brown and Veneman report (i.e. two common indices, the Jaccard Index of similarity for presence-absence data and the Bray-Curtis index of similarity for abundance data Ludwig and Reynolds 1988) or a similar method identified by UMass. The Jaccard index analyzes the number of species that two sites have in common, using only presence and absence data. The Bray-Curtis index uses the relative abundance of each species in each sample to compare the relative dominance of species between the two samples. Soil structure and composition will be compared to that of the replacement area. The presence of wetlands hydrologic indicators will also be compared. This analysis will allow us to determine if wetlands replacement projects create wetlands with similar plant communities, soils, and hydrology as those that they were meant to replace. In situations where the proposed mitigation was not “in-kind” (i.e. a wooded swamp was altered but an emergent marsh was proposed for mitigation), the Jaccard index and Bray-Curtis index will still allow us to compare relative diversity between the mitigation wetland and the reference wetland (i.e. is the replacement area a monoculture compared to a highly diverse reference wetland).

Data Analysis

The data collected for the statewide assessment sites will be analyzed using similar parameters as the Brown & Veneman report to determine if: 1) sites are in compliance with Wetland Protection Act performance standards; 2) replacement areas have been constructed and maintained in adherence to the *Massachusetts Inland Wetlands Replication Guidelines;* 3) wetlands replication success ratios have improved since the time of the Brown and Veneman Study; 4) proposed and required wetlands mitigation rations have been achieved; and, 5)other variables may have played a role in the success or failure of mitigation areas (i.e. site was constructed but then altered by a subsequent landowner).

Was the replacement area built and is it the required size? Using field measurement of sites that were actually built, we will compare the size of the replacement area approved by the Conservation Commission with the size that was measured in the field to confirm that the sizing is as specified.

Is the replacement area too dry? Using the plant species data that are gathered and documented in the field, and the wetland plant indicator status, we will determine if the replacement area is too dry.   We will calculate a weighted average wetland indicator value for each plot based on the percent cover of each species present (at greater than 1% cover) and its wetlands indicator status. The *National List of Plant Species That Occur in Wetlands: Massachusetts* was developed by the US Fish and Wildlife Service, in conjunction with numerous other Federal Agencies (i.e. Army Corps of Engineers, USDA) and is the standard reference for determining which plants are indicative of wetlands. Each Plant species that is known to occur in Massachusetts was assigned a category to reflect the range of probabilities of species being found in a wetland. In other words, it provides a likelihood that the given plant occurs in wetlands area. Those categories and the estimated range of probabilities are: Obligate Wetland= > 99%; facultative wetland =67-99%; facultative = 34-66%; facultative upland = 1-33 %; and obligate upland < 1%

To determine if a given plot is too dry we will calculate a weighted average wetland indicator value based on the percent cover of each species present (at > 1%) and it's wetlands indicator status. The formula[4] is:

WI = $\sum_{i=1}^{n}(IVi * WISi)$ where:

WI= Wetlands Indicator Value

IVi (Importance value) = the percent cover of species 1 in that plot divided by the total percent cover of all plants in that plot

WISi = the wetlands indicator status weighting value for that species.

We are proposing to use the same weights that Brown and Veneman[5] used, which are:

Indicator Status	WISi
Obligate	1
Facultative Wetland	1.67
Facultative	3
Facultative Upland	4.33
Upland	5

[4] See page 12 of The University of Massachusetts Research Bulletin 746/December 2001 entitled *Effectiveness of Compensatory Wetland Mitigation in Massachusetts*

[5] See page 12 of The University of Massachusetts Research Bulletin 746/December 2001 entitled *Effectiveness of Compensatory Wetland Mitigation in Massachusetts*

A calculated Wetlands Indicator Value (WI) of 3.0 or lower indicates that the plot consists of wetlands vegetation. A value of 3.01 or higher indicates that the site is not dominated by wetlands plant species and is thus too dry. Assuming that the lower the WI value the wetter the wetland, we can use these data to compare hydrologic characteristics of the replacement and remnant wetlands. This data analysis will be used to compare results of this study with the results of the Brown and Veneman report, since this is the same wetness assessment they utilized.

Weighted Average Wetland Indicator Value: Example Calculation

Plant	**Indicator Status**	**WIS_i** (wetlands indicator status weighting value)	**Percent Cover**	**IV_i** (importance value)	**IV_i x WIS_i**
Red maple	Fac	3	40	0.36	1.08
Winterberry	FacW+	1.67	30	0.27	0.45
Cinnamon fern	FacW	1.67	15	0.14	0.24
Goldthread	FacW	1.67	10	0.09	0.15
Princess pine	FacU	4.33	10	0.09	0.39
Sheep laurel	Fac	3	5	0.05	0.15
Sum			110	1.00	**2.46**

Is the site ≥ 75% wetlands plants?

Using the plant species data that are gathered and documented in the field, and the wetland plant indicator status, we will determine if the replacement area is comprised of ≥ 75% wetland plants. To do so, we will use the point-intercept transect data. For each of the 100 points where plant species were identified along 200-foot transects, any point that contains 50% or more plant species that are designated as wetland indicator plants (i.e. FAC, FAC+ FACWET, or Obligate)[6] will be given a “Yes” ranking. Others will be given a “NO” ranking. If 75 or more of the points are given a “Yes”, then the replacement area will be considered to have met the 75% standard.

Analysis of the site data and data gathered from the permit review will consist of descriptive

[6] The wetland indicator categories in the 1988 *National List of Plant Species That Occur in Wetlands: Massachusetts* are used to calculate whether the replacement area is comprised of ≥ 75% wetland plants. A positive (+) or negative (-) sign was used with the Facultative Indicator categories to more specifically define the regional frequency of occurrence in wetlands. The positive sign indicates a frequency toward the higher end of the category (more frequently found in wetlands), and a negative sign indicates a frequency toward the lower end of the category (less frequently found in wetlands).

statistics and one way analysis of variances of wetlands mitigation success or failure relative to MassDEP Region, Ecoregion, town population, number of NOI's filed (in a given town).

3.3.2 Forested Wetland SLAM sites

Site Visits

As outlined in Chapter 3.2.2, a minimum of 5 forested replacement sites will be assessed using the CAPS SLAM protocol (See Appendix D: Standard Operating Procedures: Assessment of Wetland Communities). This methodology establishes a standard set of procedures for identifying and quantifying vascular plants, epiphytic macrolichens, algae, macroinvertebrates and other taxa to assess forested wetlands.

Data Analysis

For the forested wetland replacement areas where the SLAM has been conducted, we will use the data collected to determine if they are meeting expectations for biological condition. An evaluation of the landscape context (CAPS IEI score) will be used to establish a target for the site, and an IBI value will be developed based on the SLAM data collected. The two values will be plotted against each other to assess biological success of the replacement site as further described below.

Landscape Level 1 Assessment: "CAPS" is a landscape level model [7] that predicts ecological integrity based on GIS-derived metrics representing stressors on the landscape (e.g. habitat loss, buffer zone impacts, road traffic intensity, non-native invasive plants) or resiliency (i.e. connectedness, aquatic connectedness and similarity). The output of CAPS is the Index of Ecological Integrity (IEI), a weighted combination of metric outputs yielding a score ranging from 0 to 1 for each 30 m^2 point on the landscape. The CAPS IEI values approximate the generalized stressor gradient used in the 'Biological Condition Gradient' model for waters.

Level 3 Site Level Assessment Method (SLAM): As described previously in this QAPP, the SLAM describes our sampling protocols and Appendix D contains excerpts of the approved forested wetland SLAM QAPP. These protocols will be followed for this project.

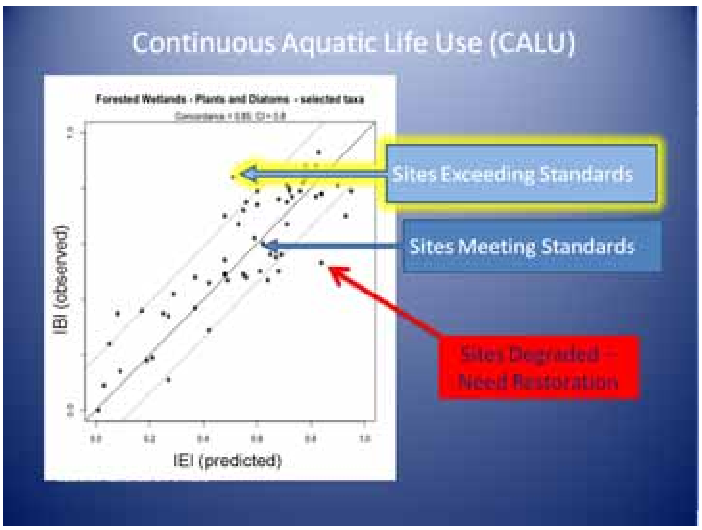
Index of Biological Integrity (IBI) Our approach for assessment of biological condition of the forested wetland replacement areas is based on the relationship between the CAPS IEI (i.e. constraints on biological condition from the surrounding landscape) and the IBI (i.e. actual condition of a site based on field assessments).[8] Development of IBI's for forested wetlands is

[7] CAPS reports submitted to EPA include *DRAFT – A Framework for Ecosystem Monitoring and Assessment: The Conservation Assessment and Prioritization System (CAPS), December 11, 2007; Conservation Assessment and Prioritization System(CAPS)Western Massachusetts Assessment – Final Report May 19, 2008*; *and Conservation Assessment and Prioritization System (CAPS) Preliminary Statewide Massachusetts Assessment – June 2, 2009.* Reports were authored by UMass-Amherst*. CAPS QAPP is due June 2012.See* www.masscaps.org

[8] *Development of a Comprehensive State Monitoring and Assessment Program for Wetlands in Massachusetts, Progress Report ("UMass Progress Report")* 5/23/11 By Scott Jackson, Kevin McGarigal, Ethan Plunkett, Theresa Portante and Brad Compton, Department of Environmental Conservation, UMass-Amherst; *Development and Use of Aquatic Life Use Standards for Wetlands in Massachusetts ("ALU Report") 5/12/11 By Scott Jackson, UMass-Amherst and Lisa Rhodes and Lealdon Langley, MassDEP*

underway and currently scheduled to be finalized in late 2012. UMass is using CAPS IEI and individual metric grids to look for relationships between IEI/metric scores and biotic communities in forested wetlands to create IBIs from data. See Appendix F for a detailed discussion of the methodology.

Once sites are sampled and IBI's are finalized, the selected forested wetland replacement site's biological condition relative to its landscape context can be assessed relative to the lines on the Continuous Aquatic Life Use (CALU) figure below. Sites that fall between the dotted lines (acceptable range of variability) would meet standards; those falling above the highest dotted line would exceed standards; and sites falling below the lowest dotted line would be flagged as not meeting standards.



4.0 <u>DELIVERABLE</u>

The final product will be a report that provides detailed and statistically robust information about the success of current wetlands replacement practices in Massachusetts. The report is designed to be comparable to the Brown & Veneman report so that direct comparisons of success rates can be made. It will address the following questions:

- Are wetlands replacement areas being constructed in such a way that they are in compliance with the MA Wetlands Protection Act regulations (310 CMR 10. 55 (4) (b))?
- How many projects proposing wetlands replacement are actually constructed, and do they follow the design specifications required or plans approved by the Conservation Commission?
- Are wetlands replacement areas being constructed in accordance with the *Massachusetts Inland Wetlands Replication Guidelines?*
- Are wetland plant communities in replacement areas similar to the plant community which was altered? And have mitigation projects allowed invasive plants to establish a greater foothold, in relation to remnant adjacent wetlands?
- Has wetland mitigation success improved in the time since the original Brown and Veneman study?

If possible, we will address whether specific requirements in the Order of Conditions result in more successful replacement areas and if so, which?

Lastly, by implementing the Site Level Assessment Methodology at a subset of the wetlands replacement areas, and assessing the data in accordance with the CALU model, we will assess whether the selected forested wetlands replacement areas are achieving acceptable levels of biological condition.

Table 4.1 Anticipated Schedules for Implementation

Project Tasks	Start/End (mo/yr)
Prepare QAPP	10/11 – 1/12
Identify wetland replacement sites that were permitted under WPA;	10/11 – 12/11
City/Town file review	2/12-5/12; 11/12-5/13 (if needed)
Obtain Landowner Permission	2/12-6/12; 10/12-8/13
Conduct site visits for statewide assessment sites	5/12 – 11/12; 5/13-9/13
Conduct site visits for forested wetland SLAM sites	6/12 – 9/12
Data Analyses for statewide assessment and forested wetland SLAM sites	1/13 – 11/13
MassDEP & UMass: Prepare/Publish Report	12/13

5.0 Quality Objectives and Criteria

5.1 Objectives and Criteria

QA/QC is laid out in the assessment sampling protocol as a system of audits, standard procedures, and training for each section of the data collection and management plan. These activities and procedures begin with the assessment protocol conceptualizations, where the data requirements are determined, and continue throughout all phases of the project to ensure the data quality meets those standards. Quality assurance is overseen by the Project Manager.

Along with proper methodologies, confidence in the quality of the data is critical in the subsequent assessment protocol development stages as well as during assessment protocol application. Therefore, quality assurance procedures must be incorporated into the assessment protocol and used in a reliable and consistent manner to provide reproducible data with known statistical properties. In addition to the standardized sampling, measurement, and data handling procedures listed above, the assessment protocol includes a statement of data quality standards and methods for: 1) training, 2) internal data audits, and 3) external data audits for which the Project Manager is responsible for coordinating.

Before quality assurance methods to maintain data quality standards can be developed, the quality standards must be determined. Terms used to express data quality standards and examples of the QA/QC used to assure those standards are given below (Sherman et al. 1991):

1) *Precision* - is a measure of mutual agreement among individual measurements of the same variable, usually under prescribed similar conditions. Data precision of the assessment protocol can be checked through the use of replicate field measurements and standard procedures.

2) *Accuracy* - is the degree to which a measurement reflects the true or accepted value of the measured parameter. It is a measure of the bias in a system. Accuracy depends on the technique used to measure a parameter and the care with which it is executed. Standard procedures and QA audits are used to maintain data accuracy.

3) *Completeness* - is a measure of the amount of valid data actually obtained compared with the amount that was expected to be obtained under normal conditions. Ideally, 100% of the data should be collected. Data may be incomplete due to incomplete data collection, lost or damaged data forms, or errors in data transcription.

4) *Representativeness* - expresses the degree to which data accurately and precisely represent a characteristic of the parameter measured. Representativeness is established by proper site selection and appropriate spatial arrangement of sampling areas (i.e. site selection stratified by frequency distribution of selected metrics).

5) *Comparability* - expresses the confidence with which one data set can be compared to another. Collection of data by different investigators is the primary cause of variability in the data. Standardized procedures, internal QA audits, and training minimize variability in the data. Field testing of the assessment models will be used to determine the level of comparability achieved.

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Table 5.1 Data Quality Objectives

Parameter	Units	Expected Range	Accuracy (+/-)	Precision
Measurement of size of replacement area	Square feet	500-130,680 square feet	+/- 10 %	95% agreement on actual measurements among separate observers
Site Hydrology, inc. depth to water	Presence absence	0-16 inches	100% accuracy of presence standing water, soil saturation and depth to free water	100% agreement on presence/absence &
Was replacement area constructed	Presence/absence	500-130,680 square feet	NA	100% agreement on presence/absence among separate observers
Vegetation	Species presence (or genus if species ID is not possible); Abundance: percent cover	500-5000 square feet Cover classes	100% accuracy of identification at either species or genus level;	100% agreement on presence/absence and 90 % agreement on cover class designation among separate observers
MassDEP and Cowardin et al. classification (wetland)	System, subsystem, class, water regime, modifiers	0-5; 0-100 %	100% accuracy of classification based on field verification by trained project staff and/or experts (as applicable)	100% agreement among separate observers
Soils	inches	0-16 inches	+/- 1% of identification of O, A, and B horizons.	95% agreement on horizon designation among separate observers.

5.2 Special Training/Certification

Field crew members will have sufficient previous training and experience to reliably conduct field data collection or they will receive training from the Project Manager, and/or other project scientists with relevant expertise. All Field Scientists will receive training from the Project Manager or designee on appropriate QA/QC procedures. The Project Manager will keep a list of those trained along with the dates that the training occurred (i.e. documentation to show who was trained and when).

5.3 Documents and Records

The most current approved version of the QA Project Plan will be provided to the appropriate personnel by the Project Manager. All data collected will be maintained in raw form (field data forms) and electronic form (database and image library) on a protected and backed up drive at the Boston Office of MassDEP, 1 Winter Street, Boston. The QAPP and SOPs will be dated to distinguish among different versions in case there are revisions made over the course of the project. The Project Manager will include all reports of the project status in the annual report, including any problems and the proposed recommended solutions. Annual status reports and final reports will be provided in electronic form to everyone on the distribution list. Hard and soft copies of reports, as well as all electronic data records, will be maintained at MassDEP and made available upon request.

6.0 Data Generation and Acquisition

6.1 Data Collection

Documents and plans relative to the proposed project will be gathered in Town Hall Offices. All other samples will be gathered on-site, at the mitigation area. The data to be collected is described in the following table:

Table 6.1 Data Collection

Data	Method	Units	Sample Holding Container	Method Sample Preservative	Minimum Holding Time
Completeness of the requirements in the NOI and OOC	Written notes on data sheets; Digital photography	NA	Data sheets Laptop	NA	NA
Plant Community	Percent cover will be estimated	Percent cover by species (or	Plastic bag samples will be collected	NA	48 hours

Data	Method	Units	Sample Holding Container	Method Sample Preservative	Minimum Holding Time
	using cover classes and ocular estimation	genus if species ID is not possible)	for off-site verification if necessary		
Cowardin et al. classification (wetland)	Observation from plot center	System, subsystem, class,	NA	NA	NA
Depth to water table	Observation from soil pit	Inches	NA	NA	NA
Size of replacement area	Measurements conducted on-site	Square feet	NA	NA	NA
Soil Horizons	Observation from soil pit	Inches	NA	NA	NA

6.2 Data Handling and Custody

All digital data will be downloaded immediately upon returning to the office. It will be downloaded to a master copy that is stored on protected and backed up drive at MassDEP. That master copy will be write protected, such that only specified members of the research team can edit it. All data analysis and manipulation will be conducted with a copy of that master copy to ensure the integrity of the source data. Field data forms will be stored in the office, in a protected file cabinet and only members of the project team will have access to them.

6.3 Quality Control

Quality Control will be maintained throughout the project through the following measures.

- Thorough review of comparable methodologies from other states and development of comprehensive field data collection methodologies (completeness, comparability)
- Computer aided use of stratified random sampling procedures for site selection (accuracy, representativeness)
- Use of standardized sampling procedures such as transect and time-constrained sampling (precision, accuracy, representativeness)
- Prompt review and documentation of any changes to the SOPs (precision, accuracy, comparability)
- Use of highly qualified field scientists (precision, accuracy, comparability)
- Rigorous training and mentoring of less experienced technicians in both structured and informal settings, the latter on an as needed basis (precision, accuracy, comparability)
- External validation of taxonomic identification for taxa with which the field crew has had

limited prior experience (100% of samples); minimum of 10% of total samples (precision, accuracy)
- Daily checks by field staff and periodic checks by the Project Manager to ensure that data forms are completely filled out (completeness). All data will be rechecked by the field scientist when it is entered into the final database from the site data or field form.

It is important to maintain consistency in data collection and handling methods throughout the effort. It is not uncommon for methods to change as new situations arise and must be incorporated into the data set. The Project Manager is responsible for periodically inspecting the methods used and inconsistencies will be documented and if possible, corrected. Any significant changes will be made in coordination with EPA. If corrections are not possible, documentation will be included with the reference data for interpretation during subsequent analyses and model variable calibration.

6.4 Instrument/Equipment Testing, Inspection, and Maintenance

Table 6.4 Instrument/Equipment Calibration, Inspection, Testing and Maintenance.

Equipment	Calibration	Inspection/testing	Maintenance
Camera		Daily inspection for damage or other problems; Instrument will be tested each day to ensure that it is working properly.	The camera will be maintained according to manufacturer's recommendations (see attached manual, H)

7.0 Assessment and Oversight

Reports to Management

The Project Manager will include all reports of the project status on the annual report, including any problems and the proposed recommended solutions. Any deviations to the QAPP will be reported.

8.0 Data Validation and Usability

Data Review, Verification, and Validation

All data will be reviewed by the Project Manager and to determine if the data meets QAPP objectives. Data will be reviewed, prior to being entered, in order to ensure completeness. The Project Manager will make the ultimate decisions to reject or qualify data. A peer-review workshop of scientists experienced in wetland assessment will be held to review data and data analysis.

Reconciliation with User Requirements

It is not uncommon for methods to change as new situations arise and must be incorporated into the data set. The data and methods will be periodically inspected for inconsistencies or user conflicts and will be documented and if possible, corrected. If corrections are not possible, documentation will be included for interpretation during subsequent analyses. If enough data are collected such that the final report can be written, then the project objectives will have been met and the project considered complete. If this is not the case, then the Project Manager will determine what additional information will be necessary to complete this project.

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APPENDIX A: SITE DATA FORM					
Site ID Number		NOI File Number:		Town:	
Site Address					
Applicant					
Applicant Address					
Wetland Loss Type : (MassDEP/Cowardin)			Proposed Wetland Replacement Type:		
Impact Size:			Replacement Area Size:		
NOI Date:			OOC Date:		
SOOC?			COC?		
NOI PLAN DATA					
Replacement Plan Show Site?	Y	N	Description of Site Prep?	Y	N
Construction Details?	Y	N	Planting Information?	Y	N
Erosion Control Plan?	Y	N	Invasive Species control?	Y	N
Soil Details?	Y	N	Groundwater elevations provided?	Y	N
Replacement plan shows horizontal configuration?	Y	N	Monitoring Information?	Y	N
ORDER OF CONDITIONS DATA					
Approved Mitigation Plan Present	Y	N			
Specific replacement conditions	Y	N	Site prep conditions? (grading, soils)	Y	N
Plant Conditions?	Y	N	Construction Conditions?	Y	N
Monitoring/Maintenance Cond.?	Y	N	If yes, who?		
What was monitored?					
Have Monitoring Reports been submitted?	Y	N			
Were as-built Plans Required?	Y	N			
Were As-Built Plans	Y	N			

submitted?				
DEP Staff:	Date:	Copy of OOC?	Y P	N
Comments:				

APPENDIX B SITE DATA FORM USER GUIDE

Id: This is a unique identifier for each record and is assigned automatically whenever a new record is created.
NOI_NUM: The DEP File Number of the Notice of Intent that is being reviewed.
TOWN: The Town Name
APPLICANT: Name of the applicant as it appears on the Notice of Intent.
SITE ADDRESS: The address of the project as it appears in the Notice of Intent.
APP_ADRS: Address of the Applicant as it appears in the Notice of Intent
WET_TYPE: The wetland type, using the MassDEP Wetlands classification Annotation and the Cowardin Wetland Classification. If the Notice of Intent does not identify the wetland type then the annotation is: "na" (not available).
REP_TYPE: The wetland type proposed in the replacement area, using MassDEP Wetlands Type Annotation and Cowardin Classification. If no wetland type is specified then the annotation is: "na" (not available).
IMP_SIZE: The size, in square feet, of the wetland area to be filled.
REPLC_SIZE: The size, in square feet, of the proposed wetlands replacement area.
NOI_Date: The date that the Notice of Intent was filed.
OOC_Date: The Date that the Order of Conditions was issued.
SOOC: a "yes/no" field. "y" meaning a superseding Order of Conditions was issued. No meaning no superseding order was issued.
COC: The date that a certificate of compliance was issued. If no certificate of compliance has been issued, then enter "0" (zero).

NOI PLAN DATA (WRP = Wetland Replacement Plan)
WRP_Show Site: a "yes/no" field. If there is a plan showing the location of the site enter "y". If there is no site plan enter "n"
WRP_Site Prep: If there is a description of the site preparation for the proposed replacement area then enter "y". If there is "n" description enter "n"
WRP_Constr. Details: a "yes/no" field.   Enter yes if the pal calls for specific construction techniques. Enter "n" if it does not.
WRP_Planting: a "yes/no" field. Enter yes if the plan calls for specific planting materials. Enter 'n" if it does not.
WRP_Erosion: a "yes/no" field. Enter "Y" if an erosion control plan is part of the application. Enter "N" if there is no erosion control plan.
WRP_Invasives: a "yes/no" field. Enter "Y" is the plan calls for specific measures to control invasive plant species. Enter "N" is there is no specific plan.
WRP_Soils: a "yes/no" field. Enter "Y" if the plan provides details about the soils in the replacement area. Enter "N" if it does not.
WRP_Groundwater: a "yes/no" field. Enter "Y" if the plan provides details about the ground water elevations in the replacement area. Enter "N" if it does not.

WRP_HorzPlan: a “yes/no” plan. Enter “Y” if the replacement area plan provides horizontal views of the replacement area. Enter “N” if it does not.
WRP_Monitoring: a “yes/no” field. Enter “y” if the plan calls for monitoring and/or maintenance. Enter ‘n” if it does not.

Order of Conditions Data:

OOC_Specific Conditions: a “yes/no” field. Enter “n” if there are no specific conditions regarding the wetlands replacement. Enter “y” if there are specific conditions.
OOC_Site Prep Details: a “yes/no” field. Enter “n” if there are no conditions specific to site preparation (e.g. grading, soils). Enter “y” if there are specific conditions.
OOC_Req Planting: a “yes/no” field. Enter “n” if there are no conditions that require specific planting requirements. Enter “y” if there are specific conditions.
OOC_Construction: a “yes/no” field. Enter “n” if there are no specific conditions related to the construction of the replacement area. Enter “y” if there are.
OOC_Monitoring/Maintenance: a “yes/no” field. Enter “n” if there are no specific conditions that require monitoring and/or maintenance of the replacement area. Enter “y” if there are.
MON-WHO: If monitoring or maintenance is a part of the plan or the order of conditions enter the name of the position, individual or organization conducting that maintenance. If no maintenance is proposed leave this field blank. If monitoring/maintenance is required but no one is specified then enter “ns’ (not specified).
MON_WHAT: Wetlands replacement monitoring will consist of monitoring plants and or soils and/or hydrology. List each one that is proposed for monitoring, separate by a forward slash (/) if there is more than one.

GENERAL

DEP_Staff: the person(s) who conducted the research
DATE: The date the staff went to the town hall to gather the information.
OOC_COPY: a “yes/no” field. Enter yes if a copy of the Order of conditions was acquired. Enter ‘n” if it was not. Enter “P” if partial OOC was obtained.
PLAN_COPY: a “yes/no” field. Enter “y” if a copy of the replacement plan was acquired. Enter “n” if it was not.
COMMENTS: a general comment field where any relevant data can be entered.

APPENDIX C – LETTER TO LANDOWNERS

[Date]
[Name and Address]

Re: MassDEP File [#]
[Project Name and Address]

Dear [Land Owner Name]
We are writing to request your assistance with a study we are conducting in partnership with the University of Massachusetts at Amherst to evaluate wetland replacement success in Massachusetts. As part of this study we randomly selected 44 towns in Massachusetts, including [TOWN]. For each randomly selected city or town we reviewed all projects conducted between [dates] to see if wetland replacement areas were proposed as mitigation for the project. A review of the wetland permit applications at the office of the [town] Conservation Commission has indicated that a wetland replacement area, relative to the construction of {project name} is present on your property. We are seeking your permission to access the wetland replacement area for evaluation. We expect that the evaluation will take 1-2 hours and we do not need you to be present for the evaluation. The evaluation will involve measurements, photos, observations, and excavation of a 12-inch diameter soil pit where all soil will be replaced. On rare occasion we may collect a small plant sample if the type cannot be identified.

Successful wetland replacement is critical to ensure that development results in no net loss of wetlands for the purpose of protecting water supplies from pollution, preventing flooding and storm damage, and protecting habitat for fish and wildlife. The results of this research will be documented in a report for the purpose of better understanding wetland replacement success or failure in Massachusetts, and to inform decision-making on policy, guidance and regulation. The report will not include property owner names or addresses nor will it describe specific Town success or failure. It is not our intention to use this study for enforcement purposes.

We are scheduling this field work for [date approximately 2 weeks after date letter is sent] and would appreciate it if you would call or email Principal Investigator Michael McHugh at 617.556.1163 Michael.McHugh@Massmail.state.ma.us to indicate your approval. If further assistance is required you may also contact Lisa Rhodes, Project Manager at (617)292-5512 Lisa.Rhodes@Massmail.state.ma.us. MassDEP appreciates your assistance with this important study.

Sincerely,

Lealdon Langley, Director

Appendix D

Development of a Comprehensive State Monitoring and Assessment Program for Wetlands in Massachusetts

Appendix F

Revised December 30, 2009

Standard Operating Procedures: Assessment of Wetland Communities

Phase 2c: 2009

Prepared by:

Theresa Portante, Wetland Field Manager
Kasey Rolih, Wetland Field Manager
Brad Compton, Computer Data QA Manager
and
Scott Jackson, UMass QA Manager

Department of Natural Resources Conservation, Holdsworth Hall
University of Massachusetts, Amherst, MA 01003

Standard Operating Procedures: Assessment of Wetland Communities

1. Scope and Application

This SOP establishes a standard set of procedures to be followed for data collection toward the development of a Site Level Assessment Method (SLAM) for MA freshwater forested wetlands and to validate/calibrate the Conservation Assessment and Prioritization System (CAPS) as a mechanism for a landscape level analysis (Level 1) of ecological integrity. This project will focus on assessment of wetland biological community condition in forested wetlands.

Described below are the procedures that will be followed in collecting data on algae, macroinvertebrates, vascular plants, bryophytes, epiphytic macrolichens and habitat characterization (e.g. water chemistry, hydroperiod, etc.) to serve as a basis for development of a SLAM, which will incorporate the use of Indices of Biological Integrity, for freshwater forested wetlands.

2. Summary

This SOP is applicable for freshwater deciduous/coniferous forested wetlands that have the hydrogeomorphic (HGM) classification of a slope or flat throughout Massachusetts (hereafter referred to as forested wetland). Data collection for phase 2c will focus on forested wetland communities in the Miller's and Concord (Sudbury-Assabet-Concord) Watersheds, however this SOP can be applied to all forested wetland communities. Sampling sites will be selected via a stratified random process. Field data collection will involve sampling of several biotic communities to determine if 1) there is a dose-dependent response in various attributes of the biological community to stressors within the landscape and 2) to validate/calibrate the ecological integrity metrics that are utilized in the CAPS model. Characterization of the wetland and assessment of its biological condition will be conducted in the field by assessing habitat, algae, macroinvertebrates, vascular plants, bryophytes, epiphytic macrolichens and habitat characterization.

3. Safety Considerations

- Fieldwork will not be conducted during heavy rain events or unsafe conditions such as electrical storms or high wind events. Practice "safety first".
- If there is no safe access to a plot point, the field sampling will not be conducted for that site.
- Private property will be respected using the following guidelines.
    - If property is in close proximity to buildings or other heavily used areas, landowner permission will be sought
    - Posted property will not be accessed without permission of the landowner

    - Otherwise, sampling will proceed without any special effort to gain landowner permission

    - If asked to leave private property by the landowner, samplers will discontinue work and leave.

- Each field technician will carry a personal first aid kit and a wilderness first aid guide
- Field personnel will not access sites alone without the instruction of a field manager
- No chemicals (other than ethanol) will be handled by personnel in the field

4. Sample Collection, Preservation, and Handling

Macroinvertebrates collected using the stovepipe sampler will be preserved in 95% ethyl alcohol solution. 70% ethanol will be used to preserve macroinvertebrates collected in the emergence traps. Macroinvertebrates collected in the pitfall traps will be preserved initially in a 50:50 propylene glycol/water solution and a drop of dishwashing liquid soap. The samples will be rinsed with tap water in the lab and transferred to a 70% ethyl alcohol solution. Samples will be labeled with the plot ID, date, surveyor, and collection method. They will be sorted and identified to order in the lab. Samples will be preserved and held in the lab until resources are available to identify the macroinvertbrates to genus and species (if possible).

Earthworms will be collected into 70% isopropyl alcohol and kept cool until transfer to the lab for permanent preservation in 10% formalin. Samples will be labeled in the field with plot ID, data, and name of surveyor. Transfer of worms into formalin will occur in a fume hood using safety glasses and gloves. Worms will remain in formalin for at least 24 hours before being permanently stored in 70% isopropyl alcohol. Tentative species IDs and counts may be made in the field. Official counts and IDs will be made in the lab using a dissecting microscope. Earthworm species identifications will follow Schwert (1990) and Reynolds (1977).

Algae will be collected and labeled with the plot ID, date, surveyor, and collection method. Algae samples will be preserved with M3 fixative (Potassium Iodide, Iodine (optional), glacial acetic acid, formalin) and stored until resources are available to identify them to genus and species.

Vascular plant, bryophyte and lichen collections will be limited to species that cannot be identified in the field. For species that cannot be positively identified in the field samples will be collected for lab identification and photographed for digital preservation. Taxonomic identification at the species level (preferred) or genus level (if species identification is not possible) will be achieved in the laboratory through the use of field guides, technical keys, and reference to regional herbaria housed at research universities such as UMass. Samples will be labeled in the field with the plant ID (e.g., “unknown sedge #1”) site location, date, and person who collected the sample, and assigned a code in the laboratory for use in digital preservation.

5. Equipment/Apparatus

Before leaving for the field the Field Manager will confirm the following equipment is available:

Backpack sprayer
Beaker
Bleach solution (1/2 cup bleach per gallon tap water)
Clipboard
Compasses
Cooler with ice
Data sheets
Deionized water
Digital camera w/extra batteries
Dip net, small, 500 micron mesh
Dishwashing soap solution Emergence traps
Ethanol (95%, 70%)
Field notebook
Flagging
Forceps
GPS (Global Positioning System)
Hand lens
Hanna ph/conductivity meter
Hip chain
HOBO Pendant Temperature/Light Data Logger
iButtons
Isopropyl alcohol
Labels for algae samples
Labels for earthworm samples
Labels for macroinvertebrate samples
Labels for vascular plant, bryophyte & lichen samples
Lids, closed
Liquid dish soap or hand soap (phosphate-free and biodegradable)
Location maps
Meter stick
Meter tape
M3 preservative
Nalgene bottle (500ml)
Palm Tungsten E2 Handheld (PDA)
Pencils
Permanent markers
pH/CON 10 pH/Conductivity/C^{o} Meter
Plastic collecting bags
Plastic cups
Plastic containers (32 oz and 16 oz)
Plastic amber bottles (100 ml-250 ml)
PVC pipe (2 ½” diameter)
Rite-in-rain paper and pen

Scissors or jack knife
Screens
Stakes
String
Soil auger
SOP
Spoonulet
Squirt bottle
Standard solutions for calibration of pH/Conductivity/Temp meter
Stovepipe sampler
Tap water
Trowel or bulb planter
Turkey baster (large Pipette)
Vials
Water/detergent solution
White bowl

6. Reagents

Bleach solution (1/2 cup bleach per gallon tap water)
Deionized water
Ethanol
Formalin solution (10%) *
Glacial acetic acid *
Isopropyl alcohol
Liquid dish soap or hand soap (phosphate-free and biodegradable)
Potassium Iodide *
Propylene glycol/water solution
Standard solutions for calibration of pH/Conductivity/Temp meter
Tap water
* M3 solution

7. Calibration & Training

Equipment calibration procedures for the GPS units, Oakton pH/CON 10 pH/Conductivity/C^o Meter, Hanna portable ph/EC/TDS/Temperature Meter, Thermocron ibutton, and HOBO Pendant Temperature/Light Logger will be done according to the manufacturers' recommendations. See section 2.6 of the QAPP for details.

Field crew members will have sufficient previous training and experience to reliably conduct field data collection or they will receive training from the UMass QA Manager and/or other project scientists with relevant expertise. The QA Manager will ensure that all field crew members receive specific training on macroinvertebrate sample sorting and identification (to order), plant identification, and delineation of a Bordering Vegetated Wetland.

All Field Managers and Field Scientists will receive training from the QA Manager on appropriate QA/QC procedures.

8.0 Procedures

Sampling will occur between May 11 and September 30, to ensure adequate assessment of the targeted wetland biotic communities. Forested wetlands in the Millers and Concord Watersheds will be identified using the MassDEP Wetlands Mapping data (1:12,000 based on photography from 1993 and 1999).

Sample locations will be randomly stratified across deciles of buffer zone insults (one of the landscape metrics used in CAPS) and deciles of ecological integrity (results from CAPS analysis) from the CAPS assessment of 2009. This will create 100 buffer zone insults x IEI bins. Up to five random points that fall within deciduous or mixed forested wetlands (as depicted in MassDEP wetlands; 1:12,000 based on photography from 1993 and 1999) will be selected for each bin. Samples within 100 m of a fourth order or larger stream will be excluded to avoid areas that might potentially be floodplain forests. All points will be separated by at least 500 meters. The 150 (75 in each watershed) sampling plots will be selected randomly from among the 100 bins. Within each bin, potential plots are ordered. If a plot needs to be dropped, the next-higher plot in the same bin will be used. Note that some bins will have fewer than five points or may be entirely empty because some combinations of IEI and wetland buffer insults are rare or absent in the landscape.

A random identifier will be assigned to each bin to obscure the IEI/wetland buffer insults class that each bin represents. Field personnel will not have access to the original classes, thus sampling will be blind with respect to CAPS predictions.

Plots will be compared to aerial photographs (1:5000, 2005 Color Orthophotos available from MassGIS) and GIS data for hydrography (MassGIS, 2005), Potential Vernal Pools (NHESP, 2000) and Certified Vernal Pools (NHESP, 2008). Plots that fall within 30 m of potential or certified vernal pools, dominated by conifers, or fall within 30 m of a 3rd order stream or greater will be dropped. Areas in close proximity to vernal pools and larger (> 2nd order) streams will be dropped to avoid sampling invertebrates too close to areas characterized by longer hydroperiods than our target wetland community. Likewise, areas dominated by conifers will be avoided because they do not match the target wetland community (freshwater deciduous/coniferous forested wetlands that have the hydrogeomorphic (HGM) classification of a slope or flat).

GPS navigation will be used to locate each wetland plot. GPS precision must be 10 m or less and the navigator will stop and establish the plot once the distance to plot center is 0m. In the case of GPS interference from tree-canopy or atmospheric effects two procedures may be followed. The first is to wait 10 minutes for satellite reception to improve. If a dense forest canopy appears to be the problem use triangulation to locate the plot. We will approach the plot from three different locations where the canopy is mainly deciduous. Using compass and distance measurements provided by the GPS (precision must be 10 m or less), the plot will be located.

It will not be necessary to hit the plot exactly (since it's randomly selected) it just needs to be selected without bias. However, a reasonably precise GPS point is needed of where the plot actually ends up. The strategy is (1) do the best we can when locating the plot and (2) take a precise location (precision ≤ 10 m RMS) once the plot has been established. Field workers will be on the plot for 2-3 hours and will be able to keep trying until they get good GPS coverage.

8.1 Establishing Sampling Area

A 30 m radius plot will be used to sample the wetland point (Figure 1)**.** A reserved 5 m radius area will be established in the center of the plot. Eight 25 m transects will be run from plot center at 0^o, 45^o, 90^o, 135^o, 180^o, 225^o, 270^o, and 315^o compass bearings. Vascular plants and bryophytes will be surveyed on transects run at, 45^o,135^o,225^o, and 315^o. Plant transects (transects 2, 4, 6, 8) and bryophyte plots will be denoted to prevent trampling, by flagging the transects and marking them on the Plot Information A form (Appendix L). The plot will be subdivided into 4 quarters, A-D.. They will be established in a clockwise direction beginning with transect 1 (Quarter A between the N and E transect, etc.)

Figure 1.

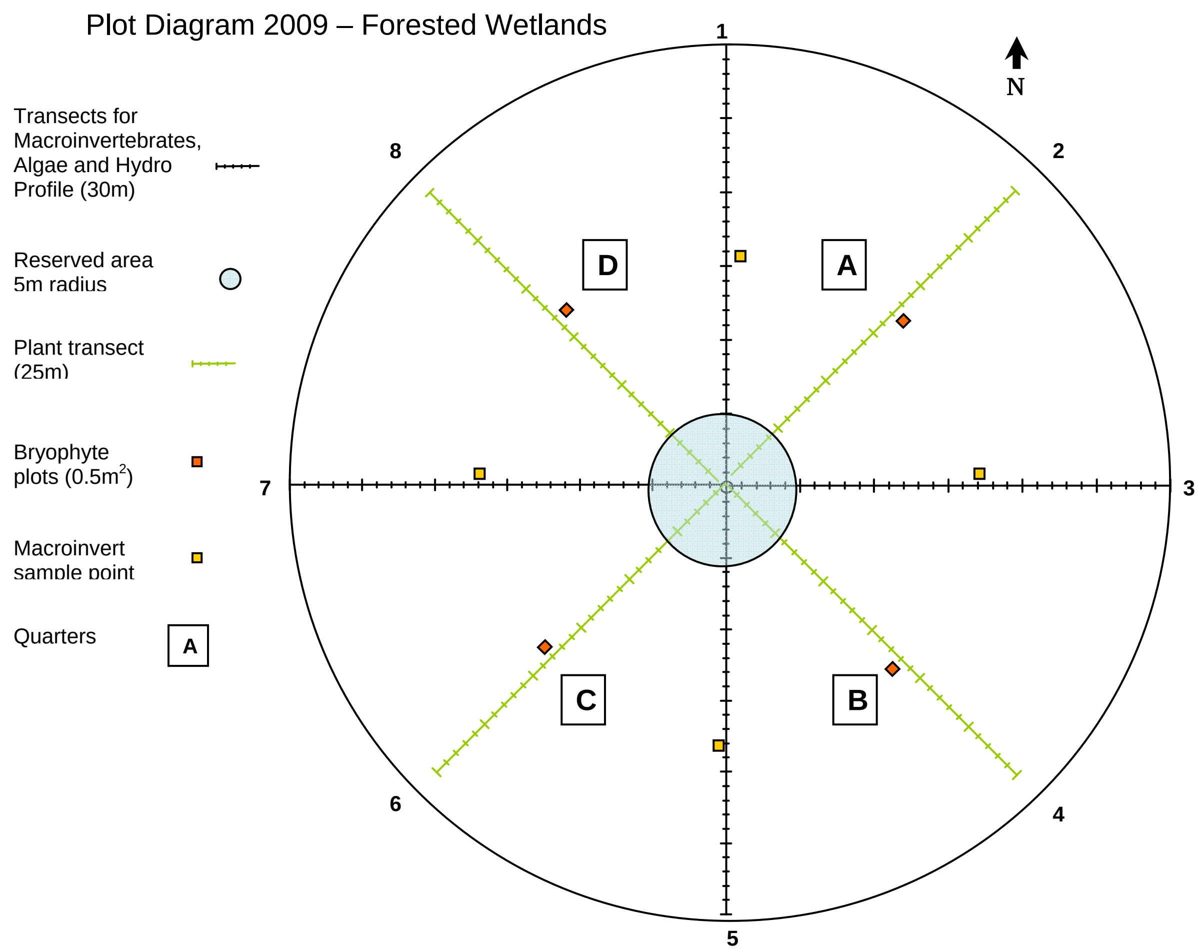


Diagram of sampling area. Eight 25 m transects run at 0°, 45°, 90°, 135°, 180°, 225°, 270°, and 315° compass bearings. The location for all samples (algae, water chemistry, etc.) will be noted on the plot diagram.

A sampling point will be moved if any of the following conditions are encountered.

- The dominant tree cover in the plot area is <30% as determined by visual estimation
- Any transect length is <15 m, as may occur in narrow wetlands (e.g. fingerlike projections, narrow bands of wetland along streams)
- Plot area is inundated due to beaver dams
- Point falls within 30 m of a mapped 3rd order stream (or larger)

The sampling point will be moved to the nearest location that does not violate the previously stated conditions, but no greater than 30 m away. If a suitable sampling point cannot be found within 30m of the original point the site will be dropped and another sampling point from the same bin selected.

8.2 Overview of Wetland Biotic Community and Habitat Assessment

Each point will be sampled for algae, macroinvertebrates, vascular plants, bryophytes and epiphytic macrolichens. Samples will be taken within a 30 m radius plot. Samples will be analyzed to determine if the attributes of the biotic communities show a dose-dependent response to anthropogenic stressors in the landscape as measured by CAPS metrics. In addition a habitat assessment will be conducted to characterize the assessment area. A detailed description of the plot (includes hydrology, anthropogenic disturbance, etc.) will be recorded in a field notebook by each surveyor. Data will be recorded with a PDA and paper forms. Tungsten E2 Handheld PDAs will be used to record vegetation, bryophyte and lichen data in the field. Paper data sheets will also be completed to serve as backups. Data from the PDAs will be downloaded to the master database on a daily basis.

8.2.1 Habitat Assessment

(a) Topographic complexity

Topographic complexity will be determined to assist in the characterization of the wetland. Each odd numbered transect will be walked to observe and record variations in slope/elevation.

From the center point of the plot walk four 30 m transects and count the number of micro-topographic depressions ("pits") at least 1 m^2 in size encountered along each transect. Counts will be recorded on a data sheet Topographic Complexity form (Appendix L) Depressions will only be counted if they are sufficiently obvious that they could be recognized even if groundcover vegetation is dense. If a pit is divided along the transect line by a mound it will be counted as two separate pits. A mound is defined as ≥ 15cm in height relative to the base of a pit and has the development of soil. Vegetation (e.g. tussock sedge) will not count as a mound. Topographic complexity will be expressed as the number of micro-topographic depressions per 100 m of transect length.

(b) Hydrology

Hydroperiod

A HOBO Pendant temperature/light data logger will be placed in the water for the duration of the study period (about 4 months) to determine the relative hydroperiod of the wetland surface water. The HOBO will record temperature at two hour intervals.

Place the data logger in a location within the plot that is judged by the field manager likely to remain inundated longest whether or not there is any standing water at the time. Place the logger inside a plastic white container to protect it from direct sunlight. Holes will be drilled into the sides of the cup to allow water to flow through. The cup will be held flush to the surface of the ground with a plant stake with a metal ring at the top to keep the cup from moving. Label the container with the serial number of the HOBO. Measure the depth of the water where the HOBO is placed at each plot visit (7 measurements) and record on the Hydrological Characterization form (Appendix L).

An ibutton will be hung against the North side of the closest tree to the location of the HOBO. The ibutton will record ambient air temperature every two hours in sync with the HOBO. The ibutton will also be protected by direct sunlight with a white plastic container and holes will be drilled to allow air passage. Label the container with the serial number of the ibutton.

Record the placement location and the serial number of the loggers on the Plot Information A form. Collect data loggers upon the completion of the biotic community assessment.

The temperature data from the loggers will be uploaded following procedures according the manufacturer's instructions (See QAPP Appendix J). The temperature data will be used to determine the relative hydroperiod (i.e. the duration of the sampling period).The coefficient of variation (CV) in temperature for each 24 hour period will be calculated for both the ambient air temperature (AAT) and water temperature (WT). The assumption is the ratio of AAT(CV)/WT(CV) will approach 1 as the depth of the water decreases. This will be verified with the recorded water depth of the HOBO location (recorded at 7 dates throughout the sampling period). This relationship will be used to estimate the depth of water for each day based on the temperature data. This data will be used to characterize the relative hydroperiod of surface water for each plot (method to be determined).

Hydologic Profile/Characterization

A hydrologic profile along odd numbered transects will be taken using a point intercept method each time a site is visited (eg. trap deployment, trap collection, etc.) The profile will be used to characterize the surface hydrology during the field season.

At the first site visit, odd numbered transects will be flagged every 5m. At each 5m point intercept along the transect, the presence of saturated soil, surface water (>2.5cm), or dry surface will be recorded on the Hydrologic Characterization form. The percent cover of each category will be determined for each visit and for the duration of the field season.

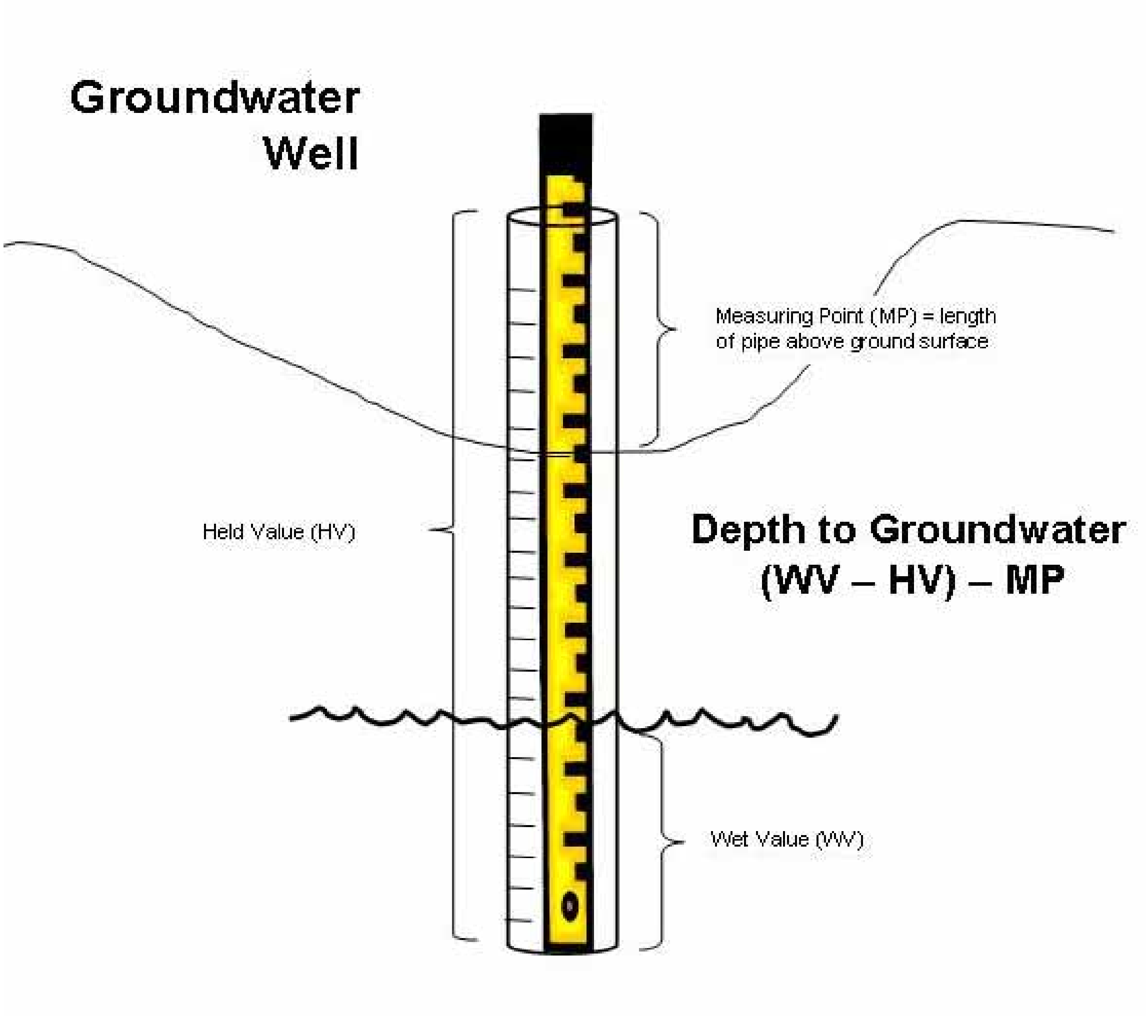
Hydrologic features such as a single channel or braided stream channel that is located in the plot will be described (direction of flow, etc.) and recorded on the Plot Information A form.

Groundwater

Groundwater will be monitored using shallow groundwater monitoring wells to determine the fluctuation in the water table throughout the field season. Readings will only be taken 6 or 7 times and will not be monitored daily.   This information will provide information to characterize the influence of groundwater to the wetland point.

A PVC pipe, 1.2 m in length and 6.35 cm in diameter, will be installed to monitor groundwater (Fig. 2). A single pipe will be installed at the lowest point in the wetland, based on topography and depth of surface water. This will be determined after setting up the hydrologic profile transects and walking around the plot. The hole for the pipe will be dug using a soil auger. 0.90 m will be placed below the surface. Slits will be cut every 4.8 cm along the length of the pipe on each side through about a quarter of the pipe. The slits will allow the passage of water while preventing the soil from entering the pipe. The bottom of the pipe will be capped with a water tight seal. A 4.8 cm diameter cap will cover the top of the pipe for ease of removal to take water measurements. A meter stick lined with chalk will be used to measure the depth to groundwater. First determine the measuring point (MP) by measuring the length of the pipe above the surface. Insert the meter stick lined with chalk above the well and record when it crosses into the pipe (held value). Remove the stick and note where the chalk is wet (wet value). To determine the depth to groundwater first subtract the wet value from the held value to determine the water level below MP. Then subtract MP to determine the level below the land surface. (*/personal correspondence/*, R. S. Socolow, USGS) Measurements will be taken each time the site is visited. The data will be recorded on Hydro Profile form.

Figure 2. Groundwater well measurements.



(c) Water geochemistry

Conductivity, temperature and pH will be measured for surface water (if present) using a portable pH/Conductivity meter at 4 locations in the plot.

Take readings from surface water closest to the midpoint of each of the odd numbered transects running in cardinal directions (location of algae samples). If there is no standing water present along a transect move in a clockwise direction to find the closest area with standing water. If there is no standing water present within the quarter plot keep moving clockwise until readings are collected from four locations within the plot. The minimum distance between readings must be 3 m. Take a reading from any major stream channel in the plot if present. Note on the Plot Information A form the transects and/or quarters from which readings were taken. Record pH, conductivity, and temperature on the Plot Information B form.

(d) Human disturbance

Visual observations of human disturbance to the wetland will be noted. Surveyors will note the following activities in the field notebook, describing the type and extent of each disturbance.

Walk the four odd numbered transects running in cardinal directions and record in the field notebook the type and extent of disturbance for each of the following.

- Water control structures (culvert, dam, weir, storm water input, fill (road/railroad), ditching, channelization, beaver dam, and other human activity affecting the hydrology of the site
- Soil disturbance (filling, plowing, grading, grazing, dredging, sedimentation, vehicle use.
- Obvious spills.
- Direct point or nonpoint source discharge from agricultural operations, septic or sewage treatment systems, or storm water affecting water quality of the site
- Walking trails, horse trails, logging roads, ATV trails, old cart paths, and roads (excluding wildlife trails)
- Evidence of mowing, burning, or timber harvesting.
- Presence of trash/litter.
- Presence of garbage dumping.

Also record any of these indicators of disturbance when encountered while implementing other elements of the SOP.

(e) Soils

A soil pit will be used to characterize the soil for each plot.

Select a location for the soil pit within 5 m of the groundwater well and 1 m distant from tree stems, animal holes, or other disturbances. Using a spade dig a soil pit 12 inches in diameter to a minimum depth of 16 inches; increase depth if more information is needed to characterize the soil. Dig a second soil pit for plots lacking uniform topography, where a change in the soil may be present. Conduct work only when the light allows for accurate color classification of the soil and its features.

Remove a clean slice of soil from the soil pit. If saturated conditions prevent a pit from being dug use an auger to sample the soil and collect the necessary data. Turn the auger no more than 4 times so that the core is not mixed and an accurate profile can be documented. Repeat this step until the profile reaches a depth of at least 16 inches.

Record on the Soils data form a description of the soil profile, including soil horizons, redoximorphic features and the associated colors. A Munsell Soil Color Chart (Munsell 2000) will be used as a guideline when describing the color and redoximorphic features of the soil pit. Soil Taxonomy, tenth edition (USDA 2006) will be used to define the soil horizons. Document on the data form additional information useful for classification, such as hydric indicators (USDA 2002), texture, depth to groundwater, stoniness, and slope. This information will be analyzed in order to classify the soil using Keys to Soil Taxonomy, tenth edition.

8.2.2 Protocols for Sampling Biotic Communities

8.2.2.1 Algae

Algae will be sampled as a indicator of water quality, community composition, and ecosystem health. Algae are an integral component to the wetland community and are a primary food source to many macroinvertebrates. Samples will be collected in June before water draw down occurs. Four samples, each 50 ml, will be collected from each microhabitat within the wetland (benthic, including leaf litter and surface sediments, and surface water) for a total of 12 samples per site. Algae samples will be preserved in M3 fixative (Potassium Iodide, Iodine (optional), glacial acetic acid, 25% formalin). One ml of M3 will be added per 50 ml sample. All algae samples will be recorded on the algae sample login form before storage in the lab. Protocols for sampling algae were adapted from Danielson, 2006, Hawkins et al., 2003, and Vermont DEP, 2003.

(a) Benthic algae

Leaf litter samples will be collected. Leaf litter will be collected from areas within the plot with surface water present. In the absence of surface water, leaf litter will be collected from wet depressions.

Collect leaf litter from areas of standing water closest to the midpoint of odd numbered transects If there is no standing water present along a transect move in a clockwise direction to find the closest suitable sampling location within the quarter plot. If standing water is lacking within a quarter plot collect leaves from a wet depression closest to the midpoint of the transect. If there are no suitable locations (surface water or wet depressions) present within a quarter keep moving through the plot until four samples have been collected. The minimum distance that samples must be spaced is 3 m. Note on the Plot Information A form the transects and/or quarters from which samples were taken and a description of the sampling location. Record the depth of the surface water if present on the Plot Information B form.

From each sampling location collect red maple leaves to cover the bottom of a small bowl (10.5 cm^2). Scrape the leaf surfaces using a metal spoonulet to scrape off the algae. If red maple leaves are not available collect other deciduous leaves of similar size and make a note of the species used. Rinse each leaf with DI water after scraping. Collect all scrapings from the small bowl into a 50 ml vial. Keep rinsing the pan with DI water until there is 50ml in the vial. Add 1ml of M3 per 50ml of benthic leaf scrapings for preservation.

Clean the pan and spoonula with tap water after sampling.

(b) Water grab sample (adapted from ME DEP)

Water samples will be collected to sample algae**.**

Take samples from surface water closest to the midpoint of the four odd numbered transects. If there is no standing water present along a transect move in a clockwise direction to find the closest suitable sampling location. If there is no suitable location present within the quarter plot keep moving clockwise until samples are collected from four locations within the plot. The minimum distance between samples must be 3 m. Note on the Plot Information A form the transects and/or quarters from which samples were taken. Record the depth of the surface water on the Plot Information B form

Use a clean and dry 50 ml vial to collect sample. Submerge the water sampler to collect the surface water taking care to minimize the collection of organic material**.** Water samples will not be collected in areas where the leaf litter must be depressed in order to collect a sample. Add 1ml of M3 per 50ml of the water sample for preservation. Repeat for each transect.

(c) Surface substrate sampling

Surface substrate samples will be collected to sample algae.

Using a turkey baster (large pipette) collect a 50 ml sample of the surface substrate from areas with surface water at the same location as leaf samples (see (a) above). To collect the sample, stick the end of the baster into the substrate and suck up a sample from the surface. If necessary, loosen up the substrate by moving around the tip of the baster before taking a sample. Pour the 50 ml sample into a 50 ml vial. Add 1ml of M3 per 50ml of the water sample for preservation. Note on the Plot Information A form the transects and/or quarters from which samples were taken. Repeat for each transect. Record the depth of the surface water if present on the Plot Information B form.

Clean the turkey baster with deionized water after sampling.

8.2.2.2 Macroinvertebrates

Macroinvertebrates are will be sampled as an indicator of water quality and community composition, and ecosystem health. Macroinvertebrates will be sampled from June-August. Stovepipe sampler and emergence traps will be used in June; pitfall traps to collect epigeal macroinvertebrates and soil pits to collect earthworms will be conducted from July-August.

(a) Earthworms

Earthworms will be sampled in forested wetlands from August through November using a combination of liquid extraction and midden counts (Lawrence and Bowers 2002, Hale et al 2005):

For midden counts place 1m^2 sampling frame on soil surface at 15m along each odd-numbered transect and count number of middens inside the frame.

Establish one earthworm sampling plots at the most suitable location (not standing water) within the assessment area. Place sampling frame (11' diameter or 613 cm^2) on top of soil and carefully remove any vegetation from within frame. Collect any earthworms found on soil surface or in vegetation and place in small plastic sampling tray with lid. Count number of juveniles, adults, and middens within the plot. Push sampling frame into soil. Pour ½ gallon liquid mustard solution into sample area and begin collecting worms as they surface. Wait three minutes before pouring remaining ½ gallon into soil. Liquid extraction sampling time for each plot is 10 minutes.

Earthworms encountered during the excavation pit traps or soil pits will be collected and preserved.

Kill all worms in 70% isopropyl alcohol. Place worms into alcohol-filled vial labeled with plot ID, subplot ID, and date, and collector's name. Keep earthworms cool until transfer into 10% formalin solution for permanent preservation at the end of the field day.

(b) Aquatic macroinvertebrates: Stovepipe sampler (adapted from ME DEP)

Macroinvertebrates will be collected using a stovepipe sampler (5 gallon plastic bucket with the bottom cut off). Collections will be made in two locations dispersed within the plot where surface water and/or wet depressions are present.

Samples will be taken from two locations within the plot where surface water is most suitable for sampling based on water depth and areal extent of inundation. If surface water is not present within the plot, sample in locations (depressions) with the wettest substrate. If possible locate the sampling locations in diagonal quarters of the plot (e.g. quarters 1 & 3 or quarters 2 & 4). If suitable sampling conditions are not present in diagonal quarters try to use sampling locations in each of two adjacent quarters. If necessary place both sampling locations in the same quarter. The minimum distance between samples must be 3 m. Note on the Plot Information A form the transects and/or quarters from which samples were taken.

At each sampling location place the stovepipe sampler firmly into the substrate (few cm deep) and hold it in place. Agitate the water in the sampler for 10 seconds to dislodge organisms from the substrate and vegetation. If surface water (>1.27 cm) is present take five sweeps within the sampler with a 500 micron mesh hand net (10.5x12.5 cm). After each sweep, transfer all material into a 32 oz collecting jar. Inspect the net, remove any clinging organisms and add them to the sample. The jar should only be filled halfway with sample material and additional jars may be used if necessary. Fill container with 95% ethanol. Record depth of surface water on the Plot Information B form.

For wet depressions (with little or no standing water) collect three, one-hand leaf litter grab samples from within the stovepipe. Distribute grabs evenly throughout the stovepipe area. Preserve the sample the same as for the dipnet samples. Record on the Plot Information B form. Label containers with site ID, date of collection, surveyor ID, and description of microhabitat. Samples will be strained and preserved with fresh ethanol within four months of collection. Containers will be stored in the lab for up to five years until they are processed.

(c) Insects: Emergence Traps

Four emergence traps per plot will be set and collected after 7 days. Emergence traps will be set on the water surface or on the surface of the soil in the wettest depressions in the absence of surface water. Site selection for trap placement will follow the protocol previously described for benthic algae, but will be placed 1m apart from areas that were disturbed while sampling for algae or using the stovepipe sampler**.**

Set emergence traps in areas of standing water closest to the midpoint of each transect. If there is no standing water present along a transect move in a clockwise direction to find the closest suitable sampling location within the quarter plot. If standing water is lacking within a quarter plot set the trap in a wet depression closest to the midpoint of the transect. If there are no suitable locations (surface water or wet depressions) present within a quarter keep moving through the plot until four trap locations are selected. The minimum distance that samples must be spaced is 3 m. Note on the Plot Information A form the transects and/or quarters where emergence traps are set.

Fill a jar (with funnel top) with 70% ethanol and place it upside down at the top of the emergence trap to collect emerging insects. Tie the traps with string to nearby vegetation or with stakes to prevent drifting. Make sure that there is enough slack in the string to ensure the trap will stay flush with the water surface if draw down or flooding occurs. Upon collection of the traps replace the jar lids with fully enclosed lids and add ethanol as needed. Samples will be kept separately. Label jars with site ID, start and end date of collection, surveyor ID, and description of microhabitat. If surface water is present record the depth at the time of placement and collection on the Emergence Trap Log form (Appendix L). In addition, record the setter and collector ID, microhabitat, condition of the trap, and the amount of ethanol in the jar when collected. Jars will be stored in the lab for up to five years until processed.

(d) Epigeal macroinvertebrates

Pitfall traps will be set out in July to collect epigeal macroinvertebrates. Traps will be 16 oz clear cups placed in the ground with the top of the cup flush with the ground surface. Cups will be filled with ~150ml of a 50:50 propylene glycol/water solution and a drop of dishwashing soap. A small screen made of hardware cloth (1x1 cm squares) will be placed inside the cups to prevent small vertebrates from entering the killing solution. A plastic plate held up with small stakes will be placed over the pitfall trap to serve as a roof.

Place eight pitfall traps, 2 on each transect at 10 and 15m. Place traps in areas where the chance of flooding by surface water (avoid pits) is reduced. Collect the contents of pitfall traps after 7 days. If the trap is >1/2 full of water it will be discarded. Each trap will be collected separately in a small container. Record the setter and collector ID, microhabitat, amount of water in the trap, and the condition on the Pitfall Trap Log (Appendix L). The samples will be rinsed with tap water in the lab (to remove the soap) and 70% ethanol will be added. Label jars with site ID and start and end date of collection. Samples will be stored for up to five years in the lab until they are processed.

8.2.2.3 Vascular plants

Vascular plant data will be collected as an indicator of community composition and species diversity (proportion of native to invasive), will contribute to the understanding of the status of species of conservation concern (rare, endangered, or invasive), and provide useful information on potential threats to natural systems. Invasive plants named as such in this assessment are those currently regulated by the Commonwealth of Massachusetts (Somers et al 2006). Data collection will occur throughout the field season, June – September 2008.

a. Estimate species abundance of all vascular plants in a 30 m radius plot using a point intercept method. Estimate percent cover as the proportion of the line directly intercepted by each species by vertical projection on four 25 m transects (excluding reserved area) placed in the four directions (even numbered transects). Tally each plant species that touches the transect line or is intercepted by a vertical projection from forest floor to canopy every 1m along the transect. Record tallies every 5 m to ensure an accurate count.
b. Following transect sampling conduct a 20-minute walk around (within) the entire plot and list species not encountered on transects. Assign these additional species a percent cover class of <1%. Record data on the vascular plant data form.
c. Estimate basal area using a wedge prism (10 or 15-factor). Stand near plot center, hold prism over plot center, view trees through prism at breast height (1.4 m) and tally trees, moving in a full circle starting north. List the species of each tallied tree.
d. Assign a forested landcover class according to MassWildlife Landcover Mapping Decision Rules (March 1996) and a natural community type according to the Massachusetts Natural Heritage & Endangered Species Program (Swain & Kearsley 1999).
e. Collect unknown species for lab identification under dissecting scope. Place each species in a separate collecting bag labeled with plant ID (e.g., "Unknown #1, etc.), plot ID and date. Take digital photographs on site as needed. List PhotoID # next to unknown plant ID on the vascular plant form.
f. Refer to resources on regional flora if necessary (Gleason & Cronquist 1991, Magee & Ahles 1999). Assistance from the herbaria and staff at the UMass herbarium will be requested as needed.

8.2.2.4 Epiphytic macrolichens

Epiphytic macrolichen data will be collected as an indicator of forest health, community composition, and species diversity.

Stand at center of established 30 m radius plot. Starting due north, use a 10 or 15-factor prism to select trees for lichen sampling. Identify and estimate percent cover for macro-lichens on all trees and shrubs with a diameter at breast height (dbh) of four inches or greater. Estimate percent cover on the trunk in the area between from base of tree up to 2m from base. On the Epiphytic Macrolichens form number and list each tree, record the tree species and dbh, and list macrolichen species present. Estimate percent cover for each macro-lichen species using the following cover classes: 0.1=<1%, 1=1-5%, 2=6-25%, 3=26-50%, 4=50-75%, 5=>75%.

Collect samples as needed into paper herbarium packets labeled with plot ID, date, collector, and sample number. Mark any samples collected with a "V" for voucher on the data sheet next to its tentative name or as "Unknown #1, Unknown #2, " etc. Nomeclature will follow (Esslinger 2007).

8.2.2.5 Bryophytes

Bryophytes have important roles in mineral cycling, water dynamics (some species may hold 10 times their weight in water), regulation of microclimate, and provide food and habitat to a host of invertebrates. Many are sensitive to human disturbance including forest management, and bryophytes may comprise a major component of the biomass and net productivity in wetland systems. Ground-dwelling moss and liverwort data will be collected on 4-0.5 m^2 plots located in representative areas along the vascular plant sampling transects.

Estimate percent cover for each bryophyte species in each quadrat using the following cover classes: 0.1=<1%, 1=1-5%, 2=6-25%, 3=26-50%, 4=50-75%, 5=>75%. Follow quadrat sampling with a 20-minute walk around the plot and list additional species not found in quadrats; species documented during the walk around will be assign a percent cover of 0.01%. Collect a voucher specimen in herbarium packets for each species found across all study plots. Nomenclature for mosses follows Anderson (1990) and Anderson et al (1990), for liverworts follows Schuster (1974).

8.7 Protocol for Decontamination of Field Equipment

Inspect all equipment for debris before leaving a site. Dispose of debris in a trash bag or on dry, high ground. When possible, leave equipment to air dry and inspect to remove any remaining plant fragments. Spray equipment with a bleach solution, scrub, and rinse with tap water to remove any additional debris. Clean the pH/conductivity meter according to manufacturer's recommendations.

9. Quality Control

Compliance with procedures in this SOP will be maintained through monthly internal reviews. Personnel will conduct periodic self-checks by comparing their results with similarly trained personnel working on the project. See sections 2.5 and 2.6 of the QAPP for details about QA/QC measures.

10. Interferences

Inclement weather (heavy rain) may interfere with our ability to collect representative data on a variety of parameters. Severe weather may delay field data collection due to safety concerns.

Access may be a challenging aspect of data collection in more developed areas of the study area. Posted property or sites that are too difficult to access or unsafe to sample will be replaced with alternative sites from the same stratified sampling bin.

11. Preventative Maintenance

Field equipment will be inspected by the UMass Field Manager each day before going out to collect field data. At the field site equipment will be tested prior to data collection to ensure that it is working properly. Equipment will be subject to regular maintenance as needed and as recommended by the manufacturer. GPS accuracy will be assessed once a month by a check of any units used in the field with a known location. See section 2.6 of the QAPP for more detail.

11. Corrective Actions

Data quality control ensures high quality data, however we are prepared to re-measure any plots within the same season or period of monitoring which contain data anomalies. Any plots that contain anomalous data that cannot be resolved will be removed from the data set.

12. Waste Minimization and Pollution Prevention

Care will be taken to avoid transport of vegetation and soil to other sites. This will be done by thorough cleaning and inspection of all equipment and clothing prior to departure from a site. Invasive plant samples will be disposed of in a way to avoid accidental release into the environment.

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Field Data Form Sheet 1

Appendix E: Field Data Form

DEP File #:_______________ Project location: ____ Date: _________

Property Owner:____ Project Built: _________ Replacement Area Built_________

Replacement Area Size:______________ MassDEP Staff: _____________________________________

Plant Species (scientific name)	Percent Cover	Wetland Indicator Category*	Index Value	(% Cover)x(Index Value)

* *Use an asterisk to mark wetland indicator plants: plant species listed in the Wetlands Protection Act (MGL c.131, s.40); plants in the genus Sphagnum; plants listed as FAC, FAC+, FACW-, FACW, FACW+, or OBL; or plants with physiological or morphological adaptations. If any plants are identified as wetland indicator plants due to physiological or morphological adaptations, describe the adaptation next to the asterisk. Use additional sheets as needed.*

Plant Sheet _____ of ______

Point Intercept Field Data Form Sheets 2-5

Point Intercept Field Data Sheet

Point #	Plant Species Present	Wetland Plant Present? Y or N
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Field Data Form Sheet 6

Calculate the weighted average Wetlands Index (WI) of each plot based on the following formula:

WI = $\sum_{i=1}^{n}(IVi * WISi)$ where:

WI= Wetlands Indicator Value

IVi (Importance value) = the percent cover of species 1 in that plot divided by the total percent cover of all plants in that plot

WISi = the wetlands indicator status weighting value for that species.

Field Data Form Sheet 7

AREA CALCULATIONS:

Is the Site:

Rectangular:__________ Circular__________ Triangular_____________

Oval____________________ Trapezoidal_________________ Irregular______________

Sketch Site and provide all measured distances:

Area Calculation Formula:

Field Data Form Sheet 8

SOILS:
Sketch soil profile, at a minimum identifying depth and texture of O, A, and B horizon and depth of any redoximorphic features.

Is the soil a Histisol? _______________
Histic Epipedon present? ____________
Is the soil: Mottled? ___________ Gleyed?_____________
Matrix Color: ________________ Mottle Colors:_______________________
Other Hydric Soil indicators: ____
Is the hydric soil criterion met?___________________________

HYDROLOGY:
Record the presence of any indicators of wetlands hydrology, such as: water stains, standing water, adventitious rooting, buttressing, oxidized rhizopheres, etc.

Field Data Form Sheet 9

Additional Field Data to Determine Adherence to the *Massachusetts Inland Wetlands Replication Guidelines*

1. Is replacement area is deeper than the adjacent wetland? _________
2. Any evidence of die back resulting from prolonged periods of inundation?
3. Any evidence of drying out of adjacent wetland?
4. Is replacement area not excavated deeply enough?
5. Any evidence that replacement area is converting to a non-jurisdictional wetland? (i.e. upland plants becoming predominant; isolated from adjacent wetland or waterbody, etc.)

6. Does replacement area have a seasonal source of groundwater and surface water source other than a stormwater discharge or does it appear to be fed by precipitation and sheet runoff flow only? _________________________________

7. Does replacement area have unrestricted hydraulic connection to neighboring water body or waterway and wetland: (Contiguous, isolated, channel connection): _______________

8. Are any drainage features that supply water to the replacement areas free-flowing without clogging from sediments, trash or other impediments? __________________________

9. Evidence of hydrology: Is soil saturated? ___________ If not, what is the depth to groundwater (use a soil pit dug by soil hand auger)? _________________________ Were oxidized rhizospheres or redoximorphic features observed? ___________

10. Do the soil profiles at the replacement site approximate the soil profiles at the nearest undisturbed existing wetland? Record the depth of each layer at a representative test pit in the replacement area and the remnant wetland
____

11. Record the Munsell hue, value and chroma, and any evidence of mottles, concretions or gleying
____

Field Data Form Sheet 10

12. Is the consistency of the replacement area soil loose to friable? Is texture loamy sand to silt loam? Are redoximorphic features forming?

13. Does replacement area contain invasive species listed in replacement guidance? _______

14. Any evidence of stormwater discharge to the replacement area that is not treated prior to discharge? _______

15. Are all erosion controls are removed and any soils surrounding the replacement area stabilized? _____

16. Are all embankments stable and properly vegetated? _______

17. Are the plants proposed for the replacement area common in nearby wetlands_______

18. Any signs of human disturbance impacting wetland area and/or functions?

Appendix F:

CAPS IBI Development methodology

Excerpt From:

Development of a Comprehensive State Monitoring and Assessment Program for Wetlands in Massachusetts

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Progress Report
May 23, 2011

Scott Jackson, Kevin McGarigal, Ethan Plunkett, Theresa Portante and Brad Compton, Department of Environmental Conservation
University of Massachusetts Amherst

The entire document can be found at:
http://www.mass.gov/dep/water/resources/wetlands.htm#mon

Forested Wetland Data Analysis and IBI Development

Introduction

These are the objectives for data analysis.

1. Determine whether we can detect a dose-dependent relationship between IEI scores and biotic community composition.

2. Create an IBI for assessing wetland condition using the full range of IEI scores to approximate a continuous Generalized Stressor Gradient (GSG).

3. Determine whether we can detect dose-dependent relationships between various metrics and biotic community composition.

4. Create IBIs for assessing wetland condition relative to individual stressors as characterized by CAPS metrics.

We used CAPS IEI and individual metric grids to look for relationships between IEI/metric scores and biotic communities in forested wetlands and create preliminary IBIs from data. Because we are looking for relationships across entire stressor gradients (rather than simply using reference and test sites) the analysis requires data from a large numbers of sites. We do not yet have data for all taxa at all sites. As a result the analyses presented below are preliminary in nature and the results are likely to change as more specimens are identified and larger numbers of taxa and sites are included in future analyses.

The analyses conducted for this report were selected to balance the desire to include a large number of taxa with an equally important need to include a large number of sites. Because some taxa groups have not yet been identified for the Miller's and Concord River watersheds (and may not be available for all sites in the Chicopee River watershed) as more taxa that are included in

the analysis fewer sites will be included (see **Table 1**).
Field based-ecological settings variables were only assessed in the Miller's and Concord River watersheds. The three ecological settings variables included in analyses were 1) water pH, 2) depth of soil organic layer and 3) an integrated hydrology variable. Because of the limited number of sites available for analysis ecological settings variables could only be considered individually, not in combination.

***Table 1**. Number of sites and number of taxa available for analysis as of February 28. 2011. "With settings" means taxa are available from sites in the Miller's and Concord River watersheds where field-based ecological settings data were collected. "No settings" means that settings variables cannot be used inorder to include data from the Chicopee River watershed where ecological settings data were not collected.*

Analysis	Number of Sites Available for Analysis	Number of Taxa Available*
Plants, worms, lichens (no settings)	213	357
Plants (no settings)	213	327
Lichens (no settings)	213	23
Worms (no settings)	213	7
Plants, worms, lichens (with settings)	139	321
Plants (with settings)	139	294
Lichens (with settings)	139	20
Worms (with settings)	139	7
Diatoms	67	81
Bryophytes	67	28
All taxa (except inverts)	62	345
Invertebrates†	61	133
All taxa (no settings)†	56	458

* Number of taxa that met our threshold for inclusion in the analysis (present at 10 or more sites)
† Invertebrates includes only those taxa collected via pitfall traps

Methods
At each taxonomic level we created counts of each taxon's abundance including all individuals in each sample that were in that taxon regardless of the level to which it was identified. This means that a sample, if it was identified to species, was counted at five levels (species, genus, family, order, and class). Then we dropped all taxa that were observed at less than ten sites. The number of taxa and number of sites included in each analysis varied.
We created an IBI (Index of Biological Integrity) by fitting models that predict the CAPS metrics or IEI scores from taxa abundances. The steps in this process were: 1) fit individual responses for each taxon, 2) use models from step 1 to predict the likelihood of different IEI values at each site based on the abundance of taxa, and 3) select the group of taxa that produce the most accurate predictions. There were two additional techniques woven through this process with the goal of optimizing reproducibility and reducing over fitting: 1) cross validation and 2) testing the significance of each taxon's fit against pseudospecies.
We modeled the relationship between each species and IEI with two or four functional forms and

eight error models. In the absence of settings variables we used two functional forms. The three parameter logistic function (Equation 1; Crawley 2007) allowed for threshold responses of taxa to the gradient while the constrained exponential quadratic (Equation 2) allowed for Gaussian and exponential responses to the gradient.

(1) $$y = \frac{a}{1 + b \times e^{-cx}}$$

(2) $$y = e^{(a+bx+cx^2)}$$

where c is constrained to always be negative.

In fits with settings (as covariates) we used four functional forms to model the relationship between species, IEI, and a settings variable. The functional forms allowed the response to IEI (x) and the settings variable (s) to each take either of the forms in equations (1) and (2).

(3) $$y = \frac{a}{1 + b \times e^{-cx}} + \frac{d}{1 + f \times e^{-gs}}$$

(4) $$y = e^{(a+bx+cx^2)} + e^{(d+fs+gs^2)}$$

where c and g are constrained to always be negative.

(5) $$y = e^{(a+bx+cx^2)} + \frac{d}{1 + f \times e^{-gs}}$$

where c is constrained to always be negative.

(6) $$y = \frac{a}{1 + b \times e^{-cx}} + e^{(d+fs+gs^2)}$$

where g is constrained to always be negative.

With runs that included settings variables each taxon was modeled without any settings variable and with each possible settings variable. Whichever settings variable option yielded the fit with the best AIC value was used with that taxon for the remainder of the analysis.

We modeled error with the Binomial, Beta Binomial, Poisson, and Negative Binomial distributions along with zero inflated (Zuur 2009) versions of those distributions. We included all these models to make sure that we had an error model in the mix that approximated the true error distribution for each taxon. The zero inflated models added a parameter to each model that allowed zeros to be modeled separately, helping to model taxa that occur infrequently and consequently have more zeros than otherwise expected by the distributions. With eight error models and two (no setting) or four (with a settings variable) functional forms we had either 16 or 32 models for each taxon. We used AIC weights to estimate the relative quality of each of the models based on how many parameters they had and how well they fit the data.

In model calibration, the second step, we predicted the log likelihood of every IEI (or metric) at each site from the error distribution and fit of each model given the abundance of the taxon at the sites. The predictions from the 16 (no settings) or 32 (with a settings variable) different models were then averaged (based on the AIC weights) to make a single IEI log likelihood profile for each site and taxon.

Finally, in step three, we added together the log likelihood profiles of individual taxa to make a prediction for the site based on multiple taxa; the IEI with the greatest log likelihood was the predicted IEI. We used a stepwise procedure to select the taxa in which we started with the taxon that, by itself, produced the most accurate IEI prediction (highest concordance) and then incrementally added the taxon that increased the concordance correlation coefficient (Lin 1989, 2000) of the prediction the most. We used concordance because it reflects both the correlation and the agreement of the metric and the IBI.

To reduce the potential to over fit the data we performed steps one through three (above) on 20 cross validation groups; in each group a different 5% of the sites was omitted and thus withheld from the model fitting process. The IEI of each site was then predicted (step 2) for each taxon based on the models from which the site was omitted. And in step 3 the taxa were selected based on how well they improved the cross validated prediction of IEI.

As an additional hedge against over fitting we created 1000 pseudospecies by randomly permuting the data from the original species. For each pseudospecies we performed the same model fitting (step 1) and calibration (step 2) as the real species. Then during taxon selection (step 3) we compared each selected taxon's improvement in fit to the improvement in fit garnered by each of the 1000 pseudospecies to estimate the significance of the improvement in fit of each taxon. We used this significance test to decide how many taxa to include in the final prediction set; we included all taxa up until the first taxon that didn't produce a significant increase in prediction accuracy.

The following analyses were completed.

1. All taxa in the Chicopee River watershed without settings variables for IEI (56 sites)
2. Plants only in the Chicopee River watershed without settings variables for IEI (68 sites)
3. Diatoms only in the Chicopee River watershed without settings variables for IEI (71 sites)
4. Plants, lichens and earthworms in the Chicopee River watershed without settings variables for IEI (68 sites)
5. Plants, lichens and earthworms in the Miller's, Concord and Chicopee River watersheds without settings variables for IEI (213 sites)
6. Plants, lichens and earthworms in the Miller's and Concord River watersheds without settings variables for IEI (145 sites)
7. Plants, lichens and earthworms in the Miller's and Concord River watersheds with settings variables for IEI (139 sites)
8. All taxa in the Chicopee River watershed without settings variables for the "Wetlands Buffer Insults" metric (56 sites)
9. Plants, lichens and earthworms in the Miller's, Concord and Chicopee River watersheds without settings variables for the "Wetlands Buffer Insults" metric (213 sites)
10. Plants, lichens and earthworms in the Miller's, Concord and Chicopee River watersheds without settings variables for the "Wetlands Buffer Insults" metric, log transformed (213 sites)

Results

For each of the analyses we created two figures and one table to summarize the results.

The first figure is a plot of the change in concordance as taxa are added in a stepwise fashion; at each step the taxa that yields the highest concordance when combined with the previously added taxa was selected. The blue lines indicate different criterion that could be used to choose a subset of taxa. We included taxa that were added prior to the first taxa that had a P-value greater than 0.05 (alpha = 0.05).

The table lists the taxa included in the model (in the order in which they were added) and the associated P-value.

The second figure is a plot of the response as predicted from species abundance (IBI score) against the "observed" response (CAPS model output).

1. <u>All taxa in the Chicopee River watershed without settings variables for IEI (56 sites)</u>

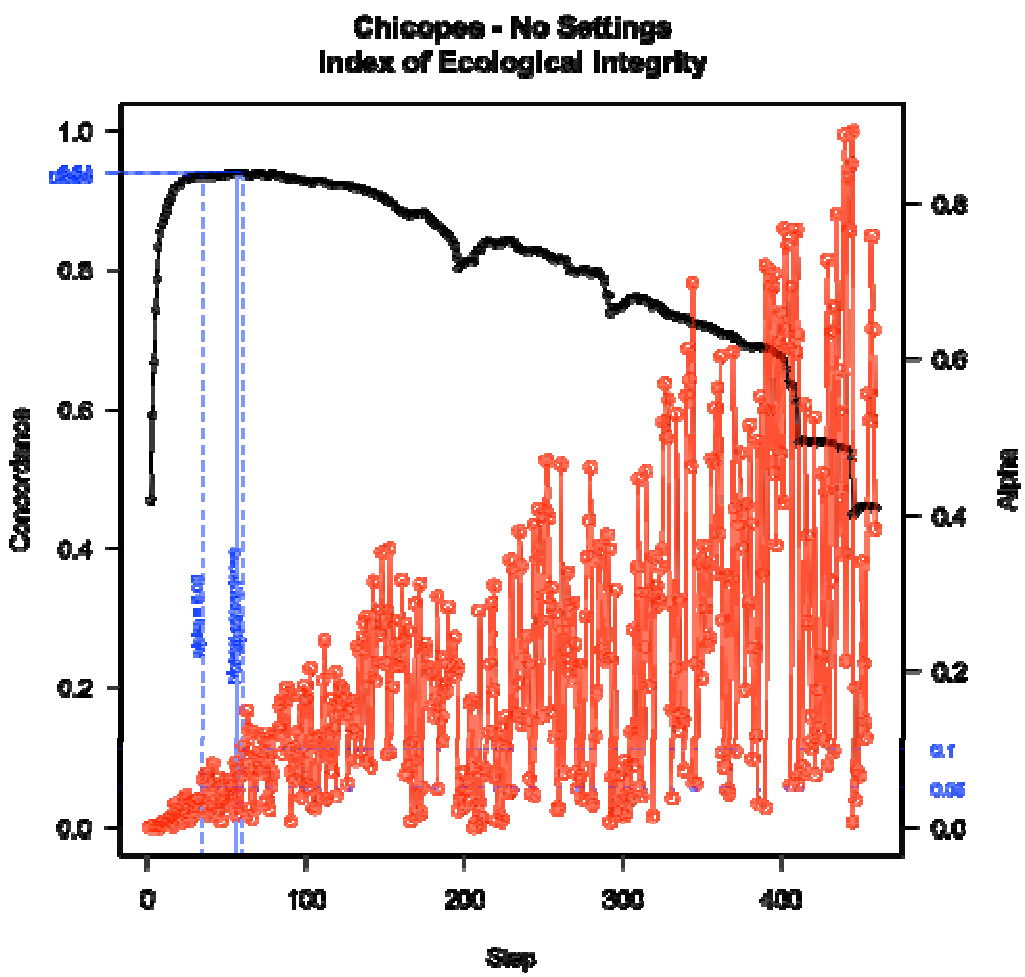

***Figure 1**. Plot of the change in concordance for IEI as taxa are added in a stepwise fashion for all taxa in the Chicopee River watershed analyzed without ecological settings variables.*

***Table 2**. Taxa included in the model (in the order in which they were added) for IEI and the associated P-value for all taxa in the Chicopee River watershed analyzed without ecological settings variables.*

Taxa	p.value	Group	Taxonomic.level
Solidago rugosa var. rugosa	0	vascular.plants	species
Hemiptera	0.001	invertebrates	order
Encyonema minutum (Hilse in Rabenhorst) D.G. Mann	0.002	diatoms	species
Eubaeocera (Coleoptera)	0	invertebrates	genus
Brachyelytrum	0.001	vascular.plants	genus
Eunotia paludosa v. paludosa Grun.	0	diatoms	species
Onoclea sensibilis	0	vascular.plants	species
Eunotia pectinalis (O.F. Muller) Rabenhorst	0.006	diatoms	species
Pterostichus coracinus (Coleoptera)	0.008	invertebrates	species
Neidium bisucatum (Lagerst.) Cl.	0.004	diatoms	species
Poaceae.1	0.004	vascular.plants	family
Rosaceae	0.009	vascular.plants	family
Rhododendron	0.012	vascular.plants	genus
Ceraphronidae (Hymenoptera)	0.006	invertebrates	family
Kalmia latifolia	0.002	vascular.plants	species
Synuchus impunctatus (Coleoptera)	0.016	invertebrates	species
Carabidlarva (Coleoptera)	0.031	invertebrates	genus
Acer	0.023	vascular.plants	genus
Leucobryum glaucum	0.011	bryophytes	Species
Betula lenta	0.016	vascular.plants	species
Pinnularia	0.006	diatoms	genus
Lasius niger gr. (Hymenoptera)	0.029	invertebrates	species
Teleasini (Hymenoptera)	0.038	invertebrates	tribe
Pinnularia rupestris Hantzsch	0.042	diatoms	species
Osmunda regalis var. spectabilis	0.029	vascular.plants	species
Carya	0.009	vascular.plants	genus
Iris	0.012	vascular.plants	genus
Betula populifolia	0.026	vascular.plants	species
Bazzania trilobata	0.018	bryophytes	Species

Polytrichum commune	0.035	bryophytes	Species
Calypogeia muelleriana	0.036	bryophytes	Species
Nitzschia	0.036	diatoms	genus
Maianthemum canadense	0.035	vascular.plants	species
Pinnularia termitina (Ehr.) Patr.	0.025	diatoms	species

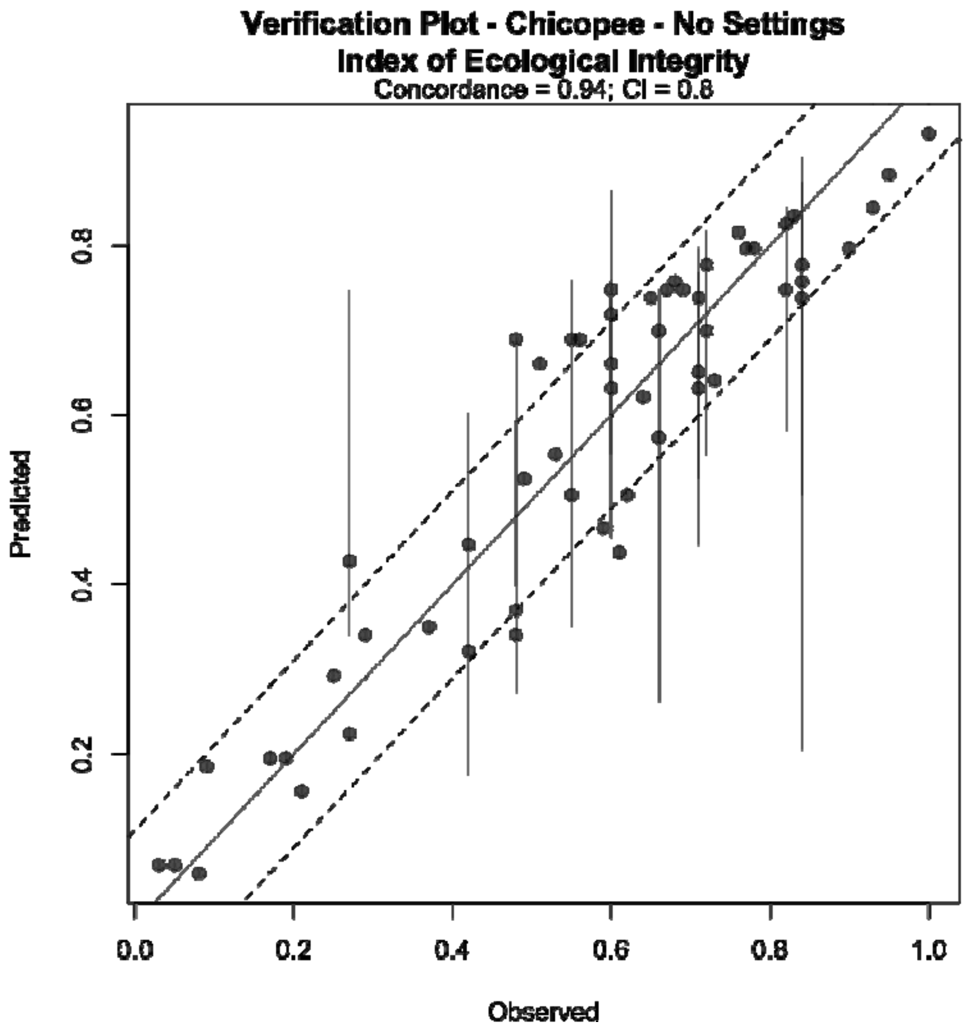

Figure 2. *Verification plot of IEI vs. IBI concordance for all taxa in the Chicopee River watershed analyzed without ecological settings variables (concordance = 0.94). Dotted lines are set to contain 80 percent of sites (40% above and 40% below the solid line).*

Appendix G:

Camera User's Manual

http://gdlp01.c-wss.com/gds/3/0300005703/01/pssx150is-cug-c-en-web.pdf

APPENDIX H: SAFETY

SAFETY

All staff will be advised that they must follow the safety rules listed below.

- Fieldwork will not be conducted during flooding events or unsafe conditions such as electrical storms or high wind events. Special attention shall be given to Department of Public Health warnings and outbreak locations for West Nile Virus and Eastern Equine Encephalitis (EEE). Notice shall be given to the Project Manager as to locations and time of field work to be conducted and participating personnel. Practice “safety first”.
- Sampling will always be conducted by two or more persons, unless otherwise approved by the Project Manager.
- Assessments may not be conducted outside of the specified timeframe in the project schedule without approval of the Project Manager.
- Each survey team must carry fully charged cell phones or other emergency communication devices while conducting field work. It is recommended they be waterproof or stored in a waterproof case or bag.
- All vehicles are to be parked off road as far as possible. If parked on the edge of the road a safety pylon or equivalent shall be placed near the rear bumper closest to the road.
- If there is no safe access to a site, the site assessment will be abandoned. Any decision to abandon a site must be reported to the Project Manager. Safety concerns for abandoning the site will be detailed in such report.
- Flagging tape will be used to mark access point locations for safe exit, in instances where such locations could be difficult to find as deemed appropriate by field crew.
- Good judgment will be used in selecting clothes and personal protection items. Common items needed include: high visible safety vests, extra clothing, sunshade, sunscreen, hats, insect repellent, and waterproof knee boots— or chest waders with appropriate restriction waist belt or quick release hip waders for highest anticipated depths. Any staff not dressed appropriately for field work should not participate in the site assessments. Proper footwear is a must (e.g., no “flip-flops” for field work).
- Good judgment will be used in walking on marsh surfaces; ditches/streams will be circumvented, or when deemed possible, crossed with caution.
- A safety equipment shall accompany all site visits and shall contain, at a minimum, the following items:
    - First aid kit

    - Emergency fresh potable water – 1 liter
    - Whistle
    - Insect repellant
- While the majority of the mitigation areas are likely to be on public lands, private property will be respected using the following guidelines.
    - If property is in close proximity to buildings or other heavily used areas, or if crossing private property is necessary to reach an assessment site, landowner permission will be sought
    - Posted property will not be accessed without permission of the landowner
    - Otherwise, sampling will proceed without any special effort to gain landowner permission

All personal and field equipment shall be cleaned and decontaminated upon exiting the wetland water and before entering a new area to prevent the spread of invasive species. Personal clothing checks shall be conducted for deer & dog ticks.