# WETLANDS MONITORING AND ASSESSMENT: CENTRAL REPORTING BASIN (Millers and Blackstone)



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#### **Executive Summary**

The Massachusetts Department of Environmental Protection (MassDEP) Wetlands Program conducted a study of the Millers River and Blackstone River watersheds within the Central Massachusetts reporting Basin for the purposes of reporting on wetlands water quality to comply with Section 305(b) of the Clean Water Act (CWA). The study involved use of tools developed by the University of Massachusetts at Amherst ("UMass-Amherst") in partnership with MassDEP and the Massachusetts Office of Coastal Zone Management (MACZM). In accordance with the U.S. Environmental Protection Agency (EPA) recommended concept for wetland monitoring and assessment,<sup>1</sup> this study consisted of a landscape level Geographic Information System(GIS)-based assessment using the Conservation Assessment and Prioritization System (CAPS) model, and a site level assessment (rapid and intensive) based on Indices of Biological Integrity (IBI's) developed specifically for forested wetlands. This study also used the Continuous Aquatic Life Use (CALU) assessment framework to determine whether individual sites meet, exceed, or fail to meet expected condition as predicted by the CAPS model.

The primary causes of ecological stress of forested wetlands within the Millers and Blackstone watersheds as identified by the CAPS model are: loss of terrestrial connectedness, increased traffic intensity, loss of similarity, the presence of non-native invasive plant species, and habitat loss. Based on this assessment, strategies were identified to combat these sources of stress including: establish terrestrial wildlife passage structures between areas of similar forested wetland habitat; protect buffer zones; identify and map potential important wildlife habitat for conservation and preservation; and identify and map the extent of invasive plants and prevent further expansion.

In addition to the CAPS assessment, a site level assessment was conducted to assess actual wetland condition at targeted sites. The Central Reporting Basin site level assessment was conducted by sampling plants at 20 sites across two watersheds, and using the IBI's and the CALU framework to determine whether sites met expectations. The assessments are based on the CAPS output referred to as the Index of Ecological Integrity (IEI) - which is a surrogate for, or prediction of, wetland condition or health – for the site and the landscape around the site. Sites were selected within two sub-watersheds that drain to waters with a high IBI-IEI delta and two sub-watersheds that have a low IBI-IEI delta. The waters with a high IBI-IEI delta have also been determined to be "impaired" by the MassDEP Division of Watershed Planning (WPP), and the waters with low IBI-IEI delta have been determined by the WPP to not be impaired.

The results of the IBI and CALU analysis indicate that two wetland sites in one of the subwatersheds that drain to impaired waters did not meet expectations. Further investigation revealed that both sites are located in areas that appear to be subject to frequent flooding from both natural and anthropogenic causes (i.e. storms, an upstream wastewater treatment plant (WWTP), and backwater from a nearby downstream dam). In addition, the quality of the nutrient impaired waters may be adversely affecting the wetlands during WWTP or natural flooding events - contrary to what may be predicted – that the wetland should be functioning to prevent

<sup>&</sup>lt;sup>1</sup> <u>http://www.epa.gov/wetlands/wetlands-monitoring-and-assessment</u>

pollution in the water. One wetland site draining to water that is not impaired did not meet expectations. It appears that the stress detected by the IBI and CALU analysis was due to a stormwater basin in the newly constructed sub-division adjacent to the wetland. In this case, the stormwater basin was likely undersized or not maintained, as evidenced by the trail of sediment that discharged into the wetland, affecting its condition. Again, this assessment indicates that the sediment laden waters impacted wetland condition, although the wetland should be acting as a filter for discharges.

### 1.0 Introduction

#### 1.1 What Are Wetlands and Why Protect Them



Wetlands are part of our Commonwealth's water resources and are vital to the health of waterways and riparian communities. Wetlands contribute to the protection of public and private water supply, protection of ground water supply, flood control, storm damage prevention, prevention of pollution, protection of land containing shellfish, protection of fisheries, and protection of wildlife habitat. Wetlands vary widely because of differences in landscape position, soils, topography, hydrologic regime, water chemistry, vegetation and other factors, however all wetlands resources are critical contributors to quality of life. Wetlands also contribute to a strong economy. For example, the Massachusetts Department of Fish and Game, Division of Ecological Restoration, estimates that the Town Creek restoration project in the Town of Salisbury will result in almost \$2.5 million in avoided flood losses over the next 30 years.<sup>2</sup>

<sup>&</sup>lt;sup>2</sup> Estimates of Ecosystem Service Values from Ecological Restoration Projects in Massachusetts, Summary of Report Findings, January 2014 <u>http://www.mass.gov/eea/docs/dfg/der/pdf/eco-services-summary-ma-der.pdf</u>

#### 1.2 Why Monitor and Assess



Section 303 of the federal CWA at 33 U.S.C. 1251 et. seq. requires that states adopt water quality standards. Since the CWA defines waters as including wetlands (40 CFR 230.3), water quality standards also apply to wetlands. Water quality standards are narrative (descriptive) or numeric standards used to define the range of physical, chemical, and/or biological conditions in "normal" ("clean" and uncontaminated) waters within the state or tribal boundaries. Waters that have been polluted or degraded have characteristics that fall outside of the normal conditions defined by the standards. States are obligated to provide a biennial report to the EPA that defines the extent of waters that fail to meet either state water quality standards, or to meet federal fishable/swimmable goals. In Massachusetts the most recent report is called the *Massachusetts 2014 Integrated List of Waters.*<sup>3</sup>

In Massachusetts, regulations have been developed to administer Section 401 of the federal CWA (314 CMR 9.00) and to define standards for Waters of the Commonwealth (314 CMR 4.00). In the regulations (314 CMR 9.02), wetlands are included in the definition of "Waters of the Commonwealth" (hereafter referred to as 'Waters'). Traditional surface water quality standards to restore and maintain the chemical, physical, and biological integrity of Massachusetts Waters have been developed primarily for water bodies and waterways (rivers, streams, lakes and ponds). Those standards are used as the basis for anti-degradation policies and water body/waterway monitoring and assessment programs tied to federal reporting requirements under the CWA. Although the Massachusetts water quality standards are applicable to wetlands, wetlands are primarily protected through the Massachusetts Wetland Protection Act (M.G.L. C. 131, § 40)(WPA) and 401 Water Quality Certification requirements, which are largely implemented through a regulatory permitting program that address direct physical alterations such as dredging and filling and chemical alterations such as stormwater discharges.

Much of the current system of surface water quality standards is focused on protecting designated uses related to human health and safety (drinking water, irrigation, recreation), and fisheries and shellfish that are strongly influenced by water quality (dissolved oxygen, bacteria, nutrients, pH, temperature, solids, turbidity, color, oil & grease, taste and odor). The designated use related to "fish, other aquatic life and wildlife" is also important and very relevant for wetlands. Fish, other aquatic life, and wildlife as a designated use is much more difficult to assess in the field than water quality-based uses. Biological integrity is affected by

<sup>&</sup>lt;sup>3</sup> <u>http://www.mass.gov/eea/agencies/massdep/water/watersheds/total-maximum-daily-loads-tmdls.html#2</u>

habitat connectivity and continuity as well as stressors that are derived from surrounding land uses and are difficult to detect in the field (e.g. domestic predators, edge predators and brood parasites, microclimatic alterations, traffic related road kill). Although "fish, other aquatic life and wildlife" is included as a designated use in all Classes of Waters, the biological condition or quality of those Waters is not currently a consideration in the designation of Class A, B and C Waters.<sup>4</sup> It is not clear what the relationships are between water quality parameters and designated uses for wetlands. However, differences between wetlands and water bodies/waterways makes it likely that the way that water quality standards are applied for wetlands will differ from how they are applied in water bodies/waterways, and much more effort is needed to fully understand these differences. Currently the Massachusetts Water Quality Standards include narrative criteria for fish, other aquatic life and wildlife use. The EPA is encouraging states to adopt numeric criteria in addition to narrative criteria in order to better determine and document whether Waters of the United States (including wetlands) are meeting standards for aquatic life and wildlife use. EPA is encouraging states to develop water quality standards that are specific for wetlands. The work described in this report will help us to develop narrative and/or numeric biological criteria to be used in assessing attainment goals for fish, other aquatic life and wildlife, and perhaps other designated uses. Further work may be done to assess chemical criteria pertaining to wetlands.

Regular mixing of water in water bodies and waterways makes it possible to sample for water quality parameters in one or a few areas within a water body or stream reach and make generalizations about the entire water body or reach. Our ability to generalize about wetland water quality from a limited number of sampling points is much more problematic due to the lack of regular mixing. In order to report accurately about wetland condition from site level assessments means that many more wetland sites would need to be surveyed to generate a comprehensive assessment than for water bodies or waterways. Thus, our strategy relies heavily on use of a landscape level assessment tool called the Conservation Assessment Prioritization System (CAPS) that can assess all wetlands.

<sup>&</sup>lt;sup>4</sup> However, a variety of Qualifiers are used to further refine the classification system, some of which ("cold water," "warm water," "aquatic life," and "shellfishing") are relevant for aquatic life use.

#### **1.3** Wetlands Monitoring and Assessment Strategy



Monitoring and assessment allows MassDEP to better understand the health and condition of our wetlands and to allocate limited resources to the greatest benefit. Understanding trends and concerns is a critical component of protecting wetland resources and allows for knowledgeable decision-making. Protection of ecosystem services and the wetlands interests identified in WPA (e.g. public and private water supply, flood control, wildlife habitat) provide a sustainable economic benefit to taxpayers.

The central feature of the Massachusetts monitoring and assessment strategy is CAPS, a landscape-level assessment model that has been under development by UMass-Amherst since 2000. CAPS is a computer software program and an approach to prioritizing land for conservation based on an assessment of ecological integrity for various ecological communities (e.g. forested wetlands, marshes, streams). Key components of CAPS are GIS and land cover mapping and the integration of 25 inland and coastal stressor or resiliency metrics (See Figure 1.3-1). The CAPS model combines this data and calculates a value between 0 and 1.0<sup>5</sup> for every 30 m<sup>2</sup> point in the landscape. The CAPS value represents the IEI or prediction about the degree of wetland stress and suitability as biological habitat and the ability of the wetland to sustain its ecological condition in the long term and to recover from stress. Since CAPS is based primarily on GIS level mapping data, SLAMs have been developed to provide consistent standard operating procedures for data collection. To date, SLAMS have been developed for forested wetlands and salt marshes.<sup>6</sup> Using these SLAMs, data was collected from 317 forested wetlands, 190 salt marshes that were randomly selected along a gradient of IEI values.<sup>7</sup> These data, plus additional data from 490 wadable streams collected by the WPP have been used for testing the CAPS predictions and modifying (as needed) the CAPS models; and for the development of IBI for use in assessing site specific wetland condition. For more information on CAPS development, please go to www.umasscaps.org

<sup>&</sup>lt;sup>5</sup> Zero is stressed, one is pristine. The number of sites represents the total to date, however, the IBI's used for this study only incorporate sampling from 250 forested wetlands. The IBI's are currently being updated to incorporate the additional sampling data.

<sup>&</sup>lt;sup>6</sup> A shrub swamp SLAM is under development.

<sup>&</sup>lt;sup>7</sup> These numbers represent sites sampled through the summer of 2015 for development purposes.





### 2.0 Landscape Level Analysis: Central Basin Watersheds



#### 2.1 Index of Ecological Integrity in Forested Wetlands

As a landscape level tool CAPS is particularly well suited for reporting on wetlands condition. It can be applied across watersheds and provides for direct comparison between watersheds by identifying which wetland areas are most impacted by ecological stressors and the likely source of those stressors. The Central Basin was selected for the study based on the WPP rotating basin scheme for sampling of water bodies and waterways. Because SLAMS have only been developed for forested wetlands and salt marshes, the focus of this report is on forested wetlands since there are no salt marshes in the Central Basin, and because that is the wetland community where CAPS has been most rigorously applied and field tested.

Using the spatial analysis tools in GIS, the average IEI value for forested wetlands within each major watershed in Massachusetts was calculated to gain an understanding as to whether the Millers and Blackstone Watersheds, within the Central Basin, are in overall better or worse condition than other watersheds in the state. As depicted by Figure 2.1-1, watersheds with low average IEI for forested wetlands are identified as the most stressed by anthropogenic activities and the higher average IEI, the less stressed the forested wetlands are. The IEIs for forested wetlands in the Millers Watershed averaged 0.60 which is higher than all but two other watersheds in Massachusetts. This is heavily influenced by the state forests in the western side of the watershed, which provide large areas of protected open space. The Blackstone Watershed averaged 0.44 which is around the statewide average of 0.45. This is likely due to the mix of forested and developed land within the watershed. In addition to calculating the average forested wetland IEI (i.e. all CAPS metrics combined); the value for each individual stressor in the CAPS model was averaged as well. By doing so, the stressors that are likely to have the most significant impact to forested wetlands in the watershed were identified. The average IEI was also calculated for each sub-watershed (see Figure 2.1-2) within the Millers and Blackstone Watersheds to identify which are predicted to be the most impacted by anthropogenic stressors.



Figure 2.1-1: Average IEI for Forested Wetlands within Each Major Watershed

The Millers Watershed forested wetlands (blue, central MA) has an IEI of 0.60, which is higher than most other watersheds in the state. The Blackstone Watershed forested wetlands (light green, central MA) has an IEI of 0.44, which is about the same as the statewide average of all watersheds (0.45).



Figure 2.1-2: Sub-watershed IEI Average for the Studied Watersheds

The more developed areas, which have lower IEI values, are shown in red. These are areas that are heavily developed. The less developed areas, such as the state forests in the western part of the Millers Watershed, are shown in blue, indicating higher forested wetlands IEI or condition. However, both watersheds are impacted by the same major stressors.

Within both study watersheds, the most stressed areas coincide with densely developed areas such as urban landscapes and interstate highways. An example would be the areas along I-90 and I-290 in the Blackstone Watershed (See figure 2.1-2). The least stressed areas are undeveloped such as the large amounts of open space in the Millers Watershed, for example Wendell State Forest and Birch Hill Wildlife Management Area. An analysis of the CAPS data finds that the stressors that are having the greatest overall impact in both watersheds are the same. They are:

- loss of terrestrial connectedness;
- intensity of road traffic
- habitat loss
- similarity; and
- invasive plants

While the same stressors are having the greatest impact on both watersheds, because of the differing level of development and anthropogenic alteration, the magnitude of those impacts differs (see Figure 2.1-3). For example, both areas are stressed by loss of connectedness and intensity of road traffic, however because there are so many more roads in the Blackstone Watershed the intensity of the loss of connectedness is significantly greater there.

![](_page_13_Figure_8.jpeg)

Figure 2.1-3: Stressor Metrics by Study Watershed

The stressor values represent the separate components of the composite IEI. The Millers and Blackstone Watersheds share the same top five forested wetlands stressor metric, but the magnitude of each metric is considerable higher in the Blackstone Watershed. This is due the Millers Watershed having less development and more protected land, therefore being less stressed by anthropogenic impacts.

#### 2.2 Connectedness and Traffic

![](_page_14_Picture_2.jpeg)

Loss of connectedness has been identified as the greatest source of ecological stress of the forested wetlands in the Millers and Blackstone Watersheds. In CAPS, connectedness is a resiliency metric, which means it measures the combined effect of anthropogenic stressors and landscape context in order to address the capacity of the ecosystem to recover from anthropogenic perturbations. As a measurement of resiliency, loss of connectedness considers both the natural landscape context of the ecosystem (e.g. large wetland complexes versus small isolated wetlands) as well as its anthropogenic impairment (e.g. road intensity surrounding an ecosystem). The metric then measures the disruption of habitat connections caused by impairments in the immediate vicinity as well as the surrounding landscape (See Figure 2.2-1). In other words, the connectedness metric is a measure of the degree to which a point in the landscape is connected with other points in the landscape that serve as a potential source of individuals or materials that contribute to the long-term ecological integrity of the wetland.

Traffic intensity was identified as the second greatest source of ecological stress of forested wetlands in the Millers and Blackstone Watersheds. Traffic is a stressor metric which is an indicator of road mortality, as well as noise and other local effects. It does not measure fragmentation, which is addressed in the connectedness metric. Instead, it focuses on the direct physical impacts that traffic creates.

Although these two metrics measure different things, they are highly correlated, and a strategy to address the connectedness metric will also address the traffic metric as well.

Figure 2.2-1: Connectedness Metric

![](_page_15_Figure_2.jpeg)

Note that areas in red and yellow represent low connectedness, and are consistent with dense road networks. The denser the road network, the lower the connectedness metric since roads serve as significant barriers to the movement of many species of wildlife

To address the ecological stress caused by loss of connectedness and traffic intensity that are impacting forested wetlands in the Millers and Blackstone Watersheds, two main strategies are recommended:

1) Restore Connections between Fragmented Forested Wetlands

#### Terrestrial Wildlife Crossings

As previously noted in this section, one of the primary causes of loss of connectedness is roads. As long linear structures, roadways fragment habitat and impair the movement of wildlife. The traffic itself is a direct cause of wildlife mortality as animals attempt to cross the road to reach other habitats. While it is impractical to suggest that roads be torn up and traffic re-routed, there are techniques that can be implemented to ameliorate those impacts. One such approach is the construction of terrestrial wildlife crossing structures that allow for improved wildlife passage. Wildlife crossing structures are essentially tunnels under the road that provide an opportunity for wildlife to travel under the road without risk of mortality from vehicle strikes. Along with their obvious role in reducing road kills, such structures allow for reconnection between habitats that can increase resiliency by providing access to additional habitat in the event of disturbance. Additionally, improved connections allow wildlife species that need to move between different ecosystems (such as wood frogs,

that breed in wetlands but migrate to uplands) or species that move through large expanses of wetlands systems, such as beaver, to access the ecosystems they need in order to carry out their life cycle.

UMass-Amherst, in partnership with The Nature Conservancy, has developed the Critical Linkages project which is a comprehensive analysis of areas in Massachusetts where connections could be employed in order to support the Commonwealth's wildlife and biodiversity resources. The Critical Linkages Project used the scenario testing capabilities of CAPS to assess how the construction of wildlife passages and culvert improvements at given points along major roads will improve the ecological integrity of adjoining wetland communities. It is an approach that does not focus on any particular species but instead considers ecological systems holistically, allowing for broad application and multi-species benefits. An assessment of the connectedness metric value was conducted and provides a baseline for comparison of wildlife crossing location options. The CAPS analysis then assessed the restoration potential of the location options and was applied statewide to road and highway segments that had traffic rates of 1000 cars per day or greater (the assumption being that roads with lower traffic rates pose less of a significant threat to wildlife crossings). Each point in the landscape along the road where a wildlife crossing could be established received a value (i.e. which is the change in connectedness weighted by IEI, known as the IEI-delta) that represents what the improvement in the ecological integrity would be if a wildlife crossing where to be established at that location. Once all points along major roads were analyzed, a relatively small number of well targeted wildlife crossings that would result in substantial improvements in connectivity were identified for this study. Figure 2.2-2 depicts the top 10% of all crossing locations that were identified within the Central Study Watershed by the Critical Linkages Project, that are also within 500-feet of forested wetlands. Installation or improvement of crossings at these locations would improve the biological health of forested wetlands. Individual municipal maps have been developed and are located in Appendix D, and on the MassDEP website.<sup>8</sup> Information on the Critical Linkages project, as well as the shapefile data for all municipalities statewide is available for download at the UMass-Amherst CAPS website.<sup>9</sup>

<sup>&</sup>lt;sup>8</sup> <u>http://www.mass.gov/eea/agencies/massdep/water/watersheds/wetlands-protection.html#2</u> Note that these maps present the top 10% of terrestrial and aquatic crossing improvement locations within the Central Study Watersheds identified by the Critical Linkages model that are also within 500 feet of forested wetlands. Some municipalities do not have sites within the top 10% that are also within 500 feet of forested wetlands and thus, municipal maps were not developed for those cities or towns.

<sup>&</sup>lt;sup>9</sup> <u>http://www.umasscaps.org/applications/critical-linkages.html</u>

Figure 2.2-2: Terrestrial Crossings

![](_page_17_Figure_2.jpeg)

![](_page_17_Figure_3.jpeg)

In this figure, the top 10% of the potential terrestrial crossings within 500 feet of a forested wetland were identified. Installation of terrestrial wildlife crossings structures at these locations would be likely to improve biological conditions of forested wetlands. The photos to the left are examples of locations identified by Critical linkages where terrestrial connections could be installed.

In addition to restoring habitat connections under roadways, where funding is available for wetland restoration, opportunities should be identified to reconnect large areas of similar habitat that have been fragmented by anthropogenic disturbance such as clearing, fill or development that has been abandoned. Information on funding sources may be available through the Massachusetts Ecological Restoration Program or other non-profit organizations.

#### 2) Avoid New Fragmentation

Another way to reduce the ecological impacts of fragmentation and traffic is to avoid new impacts when possible, minimize them when unavoidable, and mitigate for impacts that

cannot be avoided or minimized. As a general rule, the Massachusetts Wetlands Protection Act regulations prohibit the destruction or impairment of vegetated wetlands (310 CMR 10.55(4)(a)). However, the regulations allow the loss of up to 5000 square feet of bordering vegetated wetland (BVW) on a discretionary basis, provided that replication of the wetland occurs (310 CMR 10.55(4)(b)). In approving this loss, the issuing authority is required to consider "the magnitude of the alteration and the significance of the project site to the interests identified in MGL c. 131, §40, the extent to which adverse impacts can be avoided, the extent to which adverse impacts are minimized..."Some projects may have a footprint of alteration below 5000 sf, but may affect a much larger ecosystem by fragmenting the habitat (e.g. new roadway crossings). Wetland fragmentation can also result from projects that are authorized pursuant to the "limited project" section of the regulations at 310 CMR 10.53(3) (e). This regulation allows for new roadways or driveways where reasonable alternative means of access from a public way to an upland area of the same owner is unavailable. In these instances, the issuing authority may approve greater than 5000 square feet if it can be justified. In considering whether to approve a limited project, issuing authorities must consider "the magnitude of the alteration and the significance of the project site to the interests identified in MGL c. 131, §40, the availability of reasonable alternatives to the proposed activity, the extent to which adverse impacts are minimized..." Of all the filings MassDEP reviewed in calendar year 2016, a total of 46 new roadways/driveways across wetlands or waters were approved.<sup>10</sup>

To ensure that forested wetland condition in the Millers and Blackstone Watersheds do not continue to be impacted, and where new crossings cannot be avoided, impacts should be minimized by: 1) not lengthening culverts to the point where wildlife will not cross through them and otherwise meeting the Massachusetts Stream Crossing Standards<sup>11</sup>; 2) limiting crossings under 10.53(3)(e) to one per Notice of Intent application filed; 3) locating crossings at the most narrow point; 4) use of retaining walls to minimize impacts; and 5) collaboration with other municipal agencies such as the Planning Board to ensure that project impacts are minimized (e.g. roadways and driveways should be designed to the minimum legal and practical width, parking lot sizes are minimized, etc.). Mitigation should include providing wildlife crossing structures that connect terrestrial habitats. This effort will be competing with the incorporation of bicycle lanes and sidewalks that improve cyclist and pedestrian safety, an initiative known as "Complete Streets"<sup>12</sup>. Where streams are being crossed, culverts should be designed appropriately.

<sup>&</sup>lt;sup>10</sup> While this represents only 0.009% of the total 5220 filings between January 1 and December 22, 2016 (Note one filing had six crossings), it also means that 46 stream segments are now culverted or bridged that were not before - some which may restrict stream flow. The new stream crossing standards promulgated in 2014 require that new stream crossings fully meet standards. However, 5 new crossings are limited projects where the issuing authority may waive standards, and 41 are not limited projects and should meet standards.

 <sup>&</sup>lt;sup>11</sup> The standards can be accessed at the following link. See the version dated March 1, 2006, revised March 1, 2011 and corrected March 8, 2012. Note that the correction is depicted in the footer and not on the front page.
<u>https://streamcontinuity.org/pdf\_files/MA%20Crossing%20Stds%203-1-11%20corrected%203-8-12.pdf</u>
<sup>12</sup> http://www.smartgrowthamerica.org/complete-streets

#### 2.3 Similarity

![](_page_19_Picture_2.jpeg)

Another of the top five causes of ecological stress to forested wetlands in the Millers and Blackstone Watershed is loss of similarity. Similarity is also a resiliency metric, and addresses the capacity of the ecosystem to recover from anthropogenic perturbations. Similarity addresses how similar the surrounding landscape is to the focal cell, weighted by distance. In simplified terms, a given point within a large wooded swamp has a great deal of similarity to other wooded swamp points that are close by, whereas a given point in a small wooded swamp where there are few or no other wooded swamps nearby has a low degree of similarity. To avoid confusion with the connectedness metric it is important to recognize that the accessibility issues addressed by similarity primarily pertain to flying organisms: birds, bats, insects, seeds etc. The connectedness metric deals with terrestrial connectivity for organisms that move overland. It doesn't account for things that can easily fly over obstacles (development, roads) (Figure 2.3-1).

![](_page_19_Picture_4.jpeg)

Figure 2.3-1: *Heron Rookery* 

Birds, such as heron, depend on the similarity of the landscape to determine suitable habitat and safe areas to land.

To address the ecological stress caused by loss of similarity that is impacting forested wetlands in the Millers and Blackstone Watersheds, undeveloped buffer zones surrounding forested wetlands should be protected wherever possible. Land use surrounding wetlands can be the source of stress on the adjacent wetland, yet preventing and or controlling development in that buffer area can be a challenge. The Massachusetts Wetlands Regulations establish a 100 foot buffer zone around vegetated wetland resources. As an area subject to regulation, any activity proposed within the buffer zone is subject to review.

Undeveloped wetland buffers, which are the upland areas immediately adjacent to a wetland, help to reduce or minimize impacts to the adjacent wetland in several ways:

- erosion and sedimentation, which can adversely impact the health of wetlands, is reduced when soils adjacent to wetlands are stabilized by vegetation and leaf litter;
- vegetation acts as an obstruction to water flow, decreasing velocity and allowing for greater infiltration into the soil where soluble nutrients can be more efficiently removed or transformed by soil bacteria and the vegetation itself; this provides for better water quality, and reduces impacts of stormwater from paved surfaces;
- groundwater that has infiltrated into the soil in the buffer zone is then slowly released into the wetland allowing for less abrupt fluctuations in water levels within the wetland;
- buffers provide habitat for species that utilize wetlands and uplands, such as wood frogs, which breed in wetlands but spend much of the year in uplands (or vice versa), certain turtles which spend most of the year in wetlands but breed in uplands, or flying organisms requiring similar habitats.

In order to protect the buffer zones around wetlands, issuing authorities should request that project proponents consider alternatives to buffer zone development. When development in the buffer zone cannot be avoided, it should be minimized, and efforts should be undertaken to ensure: 1) that the project incorporates best management practices for stormwater control; 2) that the project is set back as far as possible from the wetland; and 3) that a vegetated strip (a portion of the naturally occurring undisturbed vegetation in the buffer zone) is left intact between the wetland and the development.

#### 2.4 INVASIVE PLANTS

![](_page_21_Picture_2.jpeg)

Invasive plants are non-native species that have spread into native or minimally managed plant systems. Invasive plants cause economic and/or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to naturally occurring ecosystems. The CAPS model identified invasive plants as another major cause of stress to forested wetlands in the Millers and Blackstone Watersheds. The CAPS model assesses the pervasiveness of non-native invasive vascular plant species<sup>13</sup> at the landscape level by measuring the intensity of development (i.e. anthropogenic land use) associated with invasive plants around each point in the landscape; it then assigns a value to that point based on its proximity to those types of development. Sources of potential invasive plants include residential development, roadways, and agriculture. The closer a point is to certain types of anthropogenic development, the more it is presumed to be impacted by invasive plants. Lists of invasive plant species specific to Massachusetts and New England have been compiled by the Massachusetts Invasive Plant Advisory Group (MIPAG) and the Invasive Plant Atlas of New England (IPANE).<sup>14</sup>

A major component of the assessment of the Millers and Blackstone Watersheds were site sampling on 20 forested wetland areas within four sub-watersheds; five sites were sampled in each sub-watershed. The sampling primarily involved documentation of plant communities. That sampling is discussed in detail in Section 3.0 of this report. The plant community assessments identified invasive plant species present on 16 of the 20 sites. Each site documented plant species at 100 points, and so any invasive plant could be documented up to 2000 times.

The invasive plant species encountered in the Millers Watershed include Glossy Buckthorn (Frangula alnus), Multiflora Rose (*Rosa multiflora*), Oriental Bittersweet (*Celastrus orbiculatus*),

<sup>&</sup>lt;sup>13</sup> CAPS assesses terrestrial (both wetland and upland) invasive plant species. However, it does not assess invasive aquatic plant species. Aquatic plants are plants that grow in permanent standing or flowing water (i.e. lakes, rivers, ponds) and disperse their seeds via that water. Examples of invasive aquatic plants include Eurasian milfoil (*Myriophyllum, spicatum*) or Fanwort (*Cabomba caroliniana*). Terrestrial plants grow on a soil substrate and depending on individual species, can tolerate a wide variety of hydrologic regimes, and thus may occur in wetlands or uplands. They may disperse their seeds via numerous methods, such as wind, water, animals or some combination thereof. Examples of invasive terrestrial plants include: Glossy buckthorn (*Frangula alnus*) or Purple Loosestrife (*Lythrum salicaria*).

<sup>&</sup>lt;sup>14</sup> Further information on invasive Plant management can be found at: <u>http://www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/land-protection-and-management/invasive-species/invasive-plants.html</u> and (<u>https://www.eddmaps.org/ipane/</u>)

Japanese Barberry (*Berberis thunbergii*), Purple Loosestrife (*Lythrum salicaria*), and Reed Canary-Grass (*Phalaris arundinacea*)(Figure 2.4-1). The most abundant invasive plant in the Millers Watershed was the Glossy Buckthorn, which was the fifth most abundant plant species found in the watershed.

The most abundant invasive plant in the Blackstone Watershed was Oriental Bittersweet, and it was the 18<sup>th</sup> most abundant plant found in the watershed (Figure 2.4-2). The other invasive plant species encountered in the Blackstone Watershed are Garlic Mustard (Alliaria petiolata), Multiflora Rose, Glossy Buckthorn, Japanese Barberry, Moneywort (Lysimachia nummularia), and Purple Loosestrife.

In addressing invasive species control it is important to understand that eradication of invasive species is often not feasible on a large (i.e. watershed) scale. However, eradication of specific invasive species on targeted sites can be accomplished to prevent the spread of these unwanted plants. Efforts that can be taken to reduce new invasive species for gaining a foothold, as well as to eradicate those that exist include:

- Work with landscapers and nurseries to discourage the use of invasive plants;
- Closely monitor wetlands projects, especially those involving wetlands creation, to track the occurrence of invasive plants and eradicate any occurrences before they are fully established;
- Look for funding opportunities to target specific sites for eradication (e.g. consult with the Department of Fish and Game, Division of Ecological Restoration);
- Participate with IPANE to map, inventory, and track the location of invasive species.
- Encourage recreational boaters to participate in decontamination measures, such as removal of all plant material from hulls, propos, and washing down all parts of the boat prior to entering another waterbody.
- Practice decontamination and disinfection of field equipment measures when leaving a wetland area. This involves removing all plant particles from clothing and rinsing rubber boots and equipment with a mild bleach solution prior to a final rinse down in order to minimize the risk of spreading invasive plant seeds or propagules as well as minimizing the risk of spreading amphibian pathogens such as Chytridiomycosis or Ranavirus.

Figure 2.4-1: Millers Watershed: Common and Invasive Plants Encountered

![](_page_23_Figure_2.jpeg)

Millers Watershed: 20 Most Common Plants

The most common plants and invasive plants encountered during the sampling of the Millers Watershed are shown in the graphs above. plants were tallied by the number of times they were throughout the sampling then divided by the total number of sample points to determine the relative abundance of each species.

![](_page_24_Figure_1.jpeg)

![](_page_24_Figure_2.jpeg)

**Blackstone Watershed: 20 Most Common Plants** 

The most common plants and invasive plants encountered during the sampling of the Millers Watershed are shown in the graphs above. plants were tallied by the number of times they were throughout the sampling then divided by the total number of sample points to determine the relative abundance of each species.

![](_page_25_Figure_1.jpeg)

![](_page_25_Figure_2.jpeg)

Shown in the maps above are the site locations where invasive plants were found. Invasive plants are more likely to be found in the more developed areas of the watershed.

![](_page_26_Figure_1.jpeg)

Figure 2.4-4: Sites with Invasive Plants in the Study Sub-watersheds

General locations where invasive species were found -See Appendix B for a list of specific species found at each site

#### 2.5 Habitat Loss

Land use change is a major driver in the fragmentation (breaking apart of habitat into several smaller pieces)<sup>15</sup> and loss of habitat as well as reduction of biodiversity. Conversion of intact ecosystems to anthropogenic land uses such as urban development, agriculture, highways, and dams can reduce or degrade the usefulness of an ecosystem as suitable habitat for plants and animals to survive and flourish. It is one of the top five stressors impacting the Millers and Blackstone Watersheds (Figures 2.1-3).

The habitat loss metric measures the intensity of habitat loss caused by all forms of development in the area surrounding each cell on the natural landscape. The first step in developing the metric is to characterize both the developed and undeveloped elements of the landscape. Land uses in developed areas are grouped into categories such as roads and highways, high-intensity urban, low-density residential, agriculture, and other elements of the human-dominated landscape. Mapping natural, or undeveloped, landscape is based on an ecological community classification such as swamp, marsh, bog, forest, meadow, or pond. With a computer based map depicting the various land cover classes, each point on the landscape can be assessed to determine the magnitude of habitat loss in the vicinity of the point. Large expanses of undisturbed land provide intact habitat for a wide variety of species, and make the ecosystem more resilient to anthropogenic incursion. <sup>16</sup> As development occurs around the edges, wildlife still has refuge to retreat into. Small patches of undeveloped land on the other hand, are more susceptible to land use change and heavy development since there is no further refuge. That makes them less resilient. Available and sustainable habitat contributes to the long term health and integrity of the ecosystem as a whole.

One solution discussed in the literature is to create wildlife corridors that link separate habitat zones making it easier for wildlife to move freely from one patch of habitat to another without injury. <sup>17</sup> The corridors can include crossing structures, discussed above; otherwise, highways, railways, and other development create obstacles to migration.

One of the most effective ways habitat loss can be addressed is by avoiding alterations in high quality habitat areas, and preserving these areas where possible. MassDEP, in partnership with UMass-Amherst, has developed maps for each municipality depicting *Habitat of Potential Regional or Statewide Importance*. Each map displays polygons (in green) that depict the top 40% IEI from CAPS, and are expected to have high ecological integrity. The polygons represent land parcels that may be good candidates for preservation due to the expected high ecological integrity, and should be investigated where habitat loss is a major cause of degradation. A map for each municipality is available on the UMass-Amherst website <sup>18</sup> Figures 2.5-1, is an example of the maps that are available.

<sup>&</sup>lt;sup>15</sup> Bird Jackson, H. and Fahrig, L., *Habitat Loss and Fragmentation*, Carleton University, Ottawa, ON, Canada 2013 Elsevier Inc. <sup>16</sup> Bartlett, L. J., Newbold, T., Purves, D.W., Tittensor, D.P., Harfoot, M.B., *Synergistic impacts of habitat loss and fragmentation* 

on model ecosystems, 2016.DOI: 10.1098/rspb.2016.1027 <sup>17</sup> Douglas J. Levey et al., "Effects of Landscape Corridors on Seed Dispersal by Birds," *Science*, vol. 309, July 1, 2005, pp. 146–

<sup>48;</sup> Cornelia Dean, "Home on the Range: A Corridor for Wildlife," New York Times, May 23, 2006, p. F1.

<sup>&</sup>lt;sup>18</sup> http://www.umasscaps.org/data\_maps/massdep-maps.html

![](_page_28_Figure_1.jpeg)

Figure 2.5-1: Habitat Map for the Town of Uxbridge, MA

Maps depicting 'Habitat of Potential Regional or Statewide Importance' (example shown above) display polygons (in green) that represent the top 40% IEI from CAPS. The polygons represent potential candidates for preservation of important wildlife habitat, and should be investigated where habitat loss is a major cause of degradation.

### 3.0 Central Basin Study Watersheds: Site Level Analysis

#### 3.1 Indices of Biological Integrity

![](_page_29_Picture_3.jpeg)

The onsite component of this study involved application of an empirically-based assessment method using IBI's for forested wetlands within the Millers and Blackstone Watersheds. The IBI reflects the field determined assessment of biological condition, as compared to the CAPS modeled prediction of biological condition - the IEI. The method to develop IBI's involved comprehensive sampling of biota, including vascular plants, diatoms, bryophytes, lichens, and macroinvertebrates on 250 forested wetland sites across a range of stressor gradients in three different watersheds across the state.<sup>19</sup> The IBI's were then developed based on statistical analyses that identified strong relationships between specific taxa or groups of taxa and specific stressor or resiliency metrics, or the IEI which is a combination of all metrics .

The IBIs developed for forested wetlands performed well for various taxa and groups of taxa (e.g. diatoms, macroinvertebrates); however vascular plants performed the strongest. Fortyeight of 120 IBI's developed across taxonomic groups and stressor metrics for forested wetlands had coefficients of concordance<sup>20</sup> ranging from 0.5 to 0.79 with vascular plants outperforming all other taxon. Of particular importance to this assessment is that certain taxa or groups of taxa were shown to have a strong relationship with sites that were predicted by CAPS to have a low or high IEI value. IBI analysis was conducted for 25 of the CAPS stressor metrics and for IEI (i.e. all metrics combined) but only the IEI and the following three metrics showed a strong enough statistical correlation to be reliable:

- Habitat Loss-the degree to which wetland habitat has been lost to development or other anthropogenic uses
- Loss of Connectedness-the degree to which wetland systems are fragmented

<sup>&</sup>lt;sup>19</sup> A detailed description of the methods used to develop the IBI's is contained in: *Empirically Derived Indices of Biotic Integrity for Forested Wetlands, Coastal Salt Marshes, and Wadable Freshwater Streams* which is available at: <u>http://www.mass.gov/eea/docs/dep/water/resources/a-thru-m/ibifin.pdf</u>

<sup>&</sup>lt;sup>20</sup> Coefficient of concordance is a statistical test of agreement or consistency between two or more variables using the same scale. Coefficient of concordance ranges from 0.0 to 1. 0.0 means there is no correlation and a 1 means there is total positive correlation. The closer the value is to 1, the stronger the correlation between the taxa and the stressor.

• Edge Predators-the degree to which mesopredators<sup>21</sup> are unchecked and impacting the wetland.

Plant data collected for each site was evaluated for the IBI's that demonstrated a strong relationship to IEI for forested wetlands.

#### 3.2 Continuous Aquatic Life Use

The CALU framework is based on the relationship between IEI (representing the constraints on biological condition due to the nature of the surrounding landscape) and IBI (representing the actual condition of a site based on assessments conducted in the field). In order to determine whether the biological condition at a given site is at the level where it is expected, a "normal" range was identified. The range reflects the dispersion and difference between the highest and the lowest values in the training dataset (i.e. data that were collected for development of the model) and was established to include 80% of the data. This means that scores that fall within that range are within the normal spread of values which would be expected. Sites that fall below the 10<sup>th</sup> and above the 90<sup>th</sup> percentile are presumed to be outside the expected range, and thus indicative that the site exceeds expectations and is near pristine, or fails expectations and something else is going on at that wetland site that is causing stress or transition.

#### 3.3 Site Selection and Sampling Procedure

![](_page_30_Picture_6.jpeg)

Site Selection

In 2016, MassDEP sampled a total of 20 deciduous dominated (<30% conifer cover) forested wetland sites in the Central Basin. The Central Basin was selected in accordance with the MassDEP 5-year basin cycle for water quality sampling and reporting pursuant to the CWA. The goal of the site sampling was to assess the role that healthy wetlands play in protecting downstream water quality. Sampling sites were selected in forested wetlands within two watersheds: the Blackstone and the Millers. Within each watershed, two sub-watersheds were selected: one that drains to impaired waters and one that drains to waters that are not impaired. The impaired waters were determined to have excessive nutrients and indicators of

<sup>&</sup>lt;sup>21</sup> Mesopredators are medium sized, middle trophic level predators that both predate and are predated upon. Examples include raccoons, skunks, and crows. In the absence of higher trophic level predators, such as coyotes, bobcats, and hawks, the mesopredator level is unchecked and can lead to a decline in small prey species such as songbirds, frogs, and small mammals.

eutrophication, as well as excessive turbidity by the WPP. Those are pollutants that could be mitigated by healthy wetlands. To support selection of impaired sub-watersheds, MassDEP used a tool previously developed by UMass-Amherst that identified stream points where the CAPS IEI value predicted a high ecological condition (i.e. pristine) whereas the IBI data indicated low condition (i.e. highly stressed). This difference between the IEI and the IBI is referred to as the IBI-IEI delta. Because of the strong concordance relationship between IBI and IEI, waters with a high IBI-IEI delta indicate that there may be something occurring on the landscape that is adversely impacting the waterbody. The IBI-IEI delta was used to identify the sub-watersheds and then correlated with the 303(d) impaired/not impaired status (i.e. high IBI-IEI delta sites were also impaired, low IBI-IEI delta sites were also not impaired). Five sites with IEI scores ranging between 0.4-0.7 were randomly selected in each of the four sub-watersheds (total 20). It was hypothesized that sampling in this manner may provide data on whether wetlands in sub-watersheds that drain to impaired waters are themselves impaired, thus contributing to the water impairment.

#### Sampling Procedure

Data was collected on presence of vascular plants, and physical alterations. The procedure for sampling plants is:

- a. Calculate species abundance of all vascular plants in a 30 m radius plot by using a point intercept method. Calculate percent cover as the tally of each plant species that is directly intercepted by a vertical projection from forest floor to canopy at one meter interval points along four 30 m transects (excluding a 5 meter reserved area at plot center) placed in the four ordinal directions. This creates 25 sample points along each of the four transects (See Figure 3.1-2).
- 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%.

While it was the intent of this study that the field crew implements the 30-meter radius plot sampling described above, "finger-like" or other odd shaped wetlands were encountered. If the standard plot described above did not fit within the wetland to be sampled, the plot could be reconfigured in accordance with the approved Quality Assurance Project Plan (QAPP).<sup>22</sup> A wetland was sampled as long as it was at least 30m across the short axis and long enough to add the difference onto the long axis (for example 30m wide x 90m long, and could be longer on one end of the long axis than the other). There were always be 4 transects established and vegetation tallies always occurred at one meter intervals along those transects. A five meter reserved area at plot center always remained reserved (i.e. no plant sampling is to occur within this area).

<sup>&</sup>lt;sup>22</sup> <u>http://www.mass.gov/eea/agencies/massdep/water/watersheds/quality-assurance-project-plans-qapps.html</u>

In most cases, taxonomic identification at the species level was achieved through the use of Regional Field Guides and technical keys. In a few cases taxonomic identification occurred at the genus level, i.e. when a *Carex sp*. without an inflorescence was encountered. All plants were identified in accordance with the United States Department of Agriculture (USDA) Plants Database nomenclature.<sup>23</sup>

![](_page_32_Picture_2.jpeg)

Figure 3.3-1: Sample Plot Set-up

Typical Plot set up in a forested wetland. Plant species are tallied in the four ordinal directions. Plant species are not sampled in the 5 meter reserved area at the point center since vegetation in this area typically gets trampled establishing the point. The Physical Alteration plot includes the entire assessment plot, and a 30 meter buffer outside of the assessment plot.

Physical Alteration data collection was added to the study to assess the degree of physical stressors that are affecting the survey plot, but may not be identified on any GIS data layer. Physical Alterations documented may be the result of natural occurrences or anthropogenic activities. The Physical Alteration Data collected is located Appendix E. The method for documentation of the physical alteration was:

a. Data is tracked in an excel spreadsheet and populated in the appropriate cells using the Trimble YUMA 2. A number from 0 to 4 must be entered in each cell in order to confirm the investigator reviewed that metric number pertains to the percent of alteration on the site, determined using percent cover charts:

<sup>&</sup>lt;sup>23</sup> <u>http://plants.usda.gov/java/</u>

- 0 = No disturbance present
- 1 = 1-24% of the plot is impacted
- 2 = 25-49% of the plot is impacted
- 3 = 50-74% of the plot is impacted
- 4 = 75-100% of the plot is impacted
- b. The investigators walked through the vegetation sample plot and the physical disturbance buffer plot (Figure 3.1-2 Sample Plot Set-up) and documented the presence and extent of the physical alterations observed on the Physical Alterations Form.
- c. In cases where the physical disturbance is determined via aerial photography, the cell was colored light blue.

The investigators walked the vegetation sample plot and the 30 meter buffer plot looking for signs of physical alteration, and they assigned values to each Physical Alteration on the spreadsheet based on their observations.

#### 3.4 Site Data Results

The focus of the Central Basin study was to sample ten sites in sub-watersheds that drain to high IBI-IEI deltas (impaired) and ten sites in sub-watersheds that drain to low IBI-IEI deltas (not impaired) to determine if the wetlands that drain into impaired waters are themselves degraded. The results of the assessments are depicted in Figure 3.4-1 and 3.4-2 below. Of the 20 sites sampled, 3 failed to meet expectations, and one 1 site exceeded expectations. As explained above, it is expected that most sites would fall within the "Meets" range. When a site falls out of that range it suggests that there is something different about the site that warrants further investigation. Two sites in the Blackstone Sub-watershed (impaired) failed to meet expectations and are referred to as Upper Otter 5 failed to meet expectations. In the same sub-watershed, the Upper Otter 1 site exceeded expectations. With the exception of the area containing the Blackstone 2 and 3 sites, no significant relationship between wetland condition and water condition was detected. It is probable that sampling 20 sites is not a sufficient dataset to make such a conclusion. Further investigation was conducted on the sites that failed to meet expectations and is described below.

Figure 3.4-1: CALU Graph for all Central Basin Sites

![](_page_34_Figure_2.jpeg)

The CALU model is the basis for determining whether sites sampled in the Central Study Watersheds meet expectations, or whether they exceed or fail expectation. The CALU assessment shows that 16 sites (green diamonds) are within the two dashed lines and thus, "Meet" expectations. Three of the sites "fail" to meet expectation (red triangles) because they fall below the range between the dotted lines and one site "exceeds" expectations (yellow square) because it had a higher IBI than the range predicted.

![](_page_35_Figure_1.jpeg)

Figure 3.4-2: Central Sub-watersheds IBI-IEI Delta and Sample Sites

The maps above show the IBI-IEI delta (blue triangle) and the sampling sites (green, yellow, and red triangles) for each of the study sub-watersheds in the Central Basin. Impaired rivers ran through the Lower Otter and Blackstone sub-watersheds (red lines).

#### Blackstone Watershed: Blackstone Sub-watershed Sites 2 & 3

Two sites located along the Blackstone River fell below the range of their expected IEI scores.

Site	IEI Score (Target)	IBI Score (Actual)
Blackstone 2	0.419	0.029
Blackstone 3	0.589	0.069

The plants encountered at these sites are located in Appendix B, and the plots in figure 3.4-3 depict the key plant species that are affecting the CALU Assessment. Figure 3.4-4 shows the location of the sites.

![](_page_36_Figure_5.jpeg)

Figure 3.4-3: Blackstone 2 and 3 IBI Plant Community Plots

The CAPS model predicted value is showed as a dashed vertical line, and the actual IBI value is shown as a solid vertical line. Each alternating layer in the graph represents the likely contribution of each taxon. Plants with labels are the primary contributors to the IBI value. The thickness of the layer indicates its dominance and the location of the plant name indicates the IBI value of that plant. Plants with a label to the left of the IEI line will draw the IBI down from the predicted IEI; plants to the right would increase the IBI. The Blackstone 2 (left side) plant community is influenced by the Rough-stemmed Goldenrod (Solidago rugosa), Giant Goldenrod (Solidago gigantea), and Black Cherry (Prunus serotina) which are species indicative of low IEI sites. The Blackstone 3 (right side) site was influenced by Poison Ivy (Toxicodendron radicans), Rough-stemmed Goldenrod (Solidago rugosa), Garlic Mustard (Alliaria petiolate), Giant Goldenrod (Solidago gigantea), and Common Wood Reed (Cinna arundinacea) which are also plants indicative of low IEI Sites.

![](_page_37_Figure_1.jpeg)

![](_page_37_Figure_2.jpeg)

The graphic shows the approximate locations of the sampled sites in the Blackstone Watershed, and the assessment of forested wetland condition for each site according to the CALU model. Both sites that failed in the Blackstone Sub-watershed were located on the 10-year flood plain. They are also downstream of a waste-water treatment plant and upstream of a dam.

While in the field at the sites Blackstone 2 & 3, the investigators noted drift material such as tires, Styrofoam, and other debris (figure 3.4-5) strewn throughout the site. The debris was clearly deposited by flood events. After further investigation, using Federal Emergency Management Agency (FEMA) Flood Insurance Maps to determine flood elevations and LIDAR to determine the elevation of the sites, we were able to establish that both sites are in the Blackstone River 10-year flood plain. It was also noted that the two sites that had failed had been directly down river of the Northbridge WWTP. The WWTP is permitted to release 2 million gallons per day (mgd)<sup>24</sup> of treated water into an unnamed tributary, which then discharges into the Blackstone River. In addition the two sites are located within three-quarters of a mile upriver from the Rice City Pond Dam in Uxbridge, MA. A composting site had been observed within a half mile from the sites, which could potentially be a source of weed seeds (i.e. poison ivy).

With multiple stressors present in the vicinity of the site it is difficult to determine which stressor is the primary cause. In fact, it is likely that the combination of all of these factors led

<sup>&</sup>lt;sup>24</sup> <u>https://www3.epa.gov/region1/npdes/permits/2008/finalma0100722permitmod.pdf</u>

to the stress on the ecosystem, causing the sites to have a low IBI scores. Given its landscape position, and the fact that the site is still an intact forested wetland, the site likely continues to provide some of the services and values one would expect from a floodplain forested wetland, such as sediment control, storm damage prevention and flood control. Other functions, however, may be compromised such as prevention of pollution and in fact, the adjacent impaired stream may be contributing to the degradation of the wetland by increased nutrient loading and regular flooding. The action recommended to reduce the stress on the wetlands is to maintain the existing efforts to improve the waters of the Blackstone River. The Blackstone River is subject to an existing Total Maximum Daily Loads (TMDL) and as those waters improve it is expected that the wetlands along the river may improve as well.

Figure 3.4-5: Anthropogenic Debris

![](_page_38_Picture_3.jpeg)

Large amounts of drift material and trash, such as tires and a soccer ball pictured above, were found on the site at both Blackstone Sub-watershed sites that did not meet expectations.

#### Millers Watershed: Upper Otter Sub-watershed Site 5

The third site that failed to meet expectations was Upper Otter 5. Based on its landscape position the predicted IEI is 0.660 however, the results of the field sampling determined the IBI score to be .287. The full plant community assessment is also included in Appendix B. The following plot (Figure 3.4-6) depicts the plant community and which species are having the most influence on the IBI, and the CALU results are shown in figure 3.4-7.

Figure 3.4-6: Upper Otter 5 IBI Plant Community Plot

![](_page_39_Figure_2.jpeg)

The presence of Impatiens capensis (jewelweed), Solidago gigantea (giant goldenrod), and Celastrus orbiculatus (oriental bittersweet) brought down the score on Upper Otter 5 because these plants are indicative of wetlands with low IBIs.

Figure 3.4-7: Millers Watershed CALU Results

![](_page_40_Figure_2.jpeg)

The graphic shows the approximate locations of the sampled sites in the Millers Watershed, and the assessment of forested wetland condition for each site according to the CALU model.

During the site investigation, sedimentation was observed on the Upper Otter 5 site (figure 3.4-8). The source of the sedimentation was the stream flowing through the wetland, and also from a drainage pipe located northwest of the site center point. That drainage pipe is the outfall from a stormwater management system. Similarly, that outfall is also eroding the adjacent upland which is resulting in sediment transport into the wetland. However, based on its relatively high IEI, the site was not predicted to be stressed by anthropogenic development. Further investigation was conducted to determine the reason why this stressor was not captured by the model.

![](_page_41_Picture_1.jpeg)

Figure 3.4-8: Erosion Observed On Upper Otter 5

*Erosion was found within the survey transect. We followed the erosion upland and it led to the outfall of a detention basin, and deep cuts into the slope of the upland.* 

The CAPS program utilizes GIS data to form the landscape level model and generate IEI's to predict the target score for the site. A limitation of the program is the availability of current data. One of the main data layers the CAPS program utilizes is the Massachusetts Office of Geographic Information (MassGIS) Land Use dataset to account for impacts from anthropogenic development, and the most up-to-date Land Use data on MassGIS is from 2005<sup>25</sup> (Figure 3.4-9). At the time land-use layer was created, the land-use bordering the wetland was forest and cropland, but currently it is a low-density neighborhood (figure 3.4-10). Statewide, The Mass Audubon reports that from April 2005 to April 2013, approximately 13 acres a day were converted from undeveloped land to residential or commercial developments.<sup>26</sup> The previously undeveloped land adjacent to this wetland appears to be an example.

<sup>&</sup>lt;sup>25</sup> <u>http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/lus2005.html</u>

<sup>&</sup>lt;sup>26</sup><u>http://www.massaudubon.org/content/download/12560/197561/file/MassAudubon\_LosingGround5\_FINAL\_me</u> <u>dres.pdf</u>

![](_page_42_Figure_1.jpeg)

![](_page_42_Figure_2.jpeg)

The 2005 Land Use datalayer presents the adjacent area around the Upper Otter 5 site as forest, crop land, and tranitional landscape.

![](_page_42_Picture_4.jpeg)

![](_page_42_Picture_5.jpeg)

The area around the Upper Otter 5 site is now residential neighborhoods.

Impervious surfaces, such as roads and buildings, typically increase the volume and velocity of the water flowing into the stream. Such runoff, accompanied with the highly erodible soil (a Becket-Skerry association), is resulting in sediment loading in the forested wetland. According to the EPA's *Protecting Natural Wetlands a Guide to Stormwater Best Management Practices*, high sediment loading in the wetland may cause adverse effects on the wetland plant community.<sup>27</sup> The recommended action for this site would be to review the stormwater management practices and ensure that the stormwater system is properly designed, functioning, and maintained. Proper sizing of stormwater basins in accordance with the MassDEP Stormwater Handbook<sup>28</sup> should be undertaken during initial system design; in addition, maintenance commitments should be documented and responsible parties identified prior to construction. The CAPS model is updated periodically as new GIS layers become updated. These updates are important to ensure that assessments are as accurate as possible.

#### Physical Alteration Data Analysis

The Physical Alteration Data collected is located in Appendix E, and the chart in Figure 3.4-11 shows the frequency of physical alteration that was encountered. In the Blackstone Watershed, Blackstone Sub-watershed the investigators found human trash and debris that had drifted in the plot and buffer areas during natural flood event(s). In Kettle Brook Sub-watershed there was evidence of man-made stone lined channels. The stream channels were likely constructed to improve water flow into the near-by reservoir. In the Millers Watershed, Upper Otter Sub-watershed, there was sedimentation found due to insufficient stormwater practices, and in the Lower Otter Sub-watershed there were signs of blow-down and broken branches from storm events and evidence of flooding. The flood events in Blackstone and the stormwater practices in Upper Otter are believed to have an impact on the wetlands.

 <sup>&</sup>lt;sup>27</sup> Protecting natural wetlands: A guide to stormwater best management practices. (1996). Washington, DC: Office
of Water, U.S. Environmental Protection Agency.

<sup>&</sup>lt;sup>28</sup> <u>http://www.mass.gov/eea/agencies/massdep/water/regulations/massachusetts-stormwater-handbook.html</u>

![](_page_44_Figure_1.jpeg)

![](_page_44_Figure_2.jpeg)

All but three sites experience some form of physical alteration. The type and number of sites where it occurred is depicted in the graphic above. Note that physical alteration can be a result of natural or anthropogenic occurrences.

![](_page_44_Figure_4.jpeg)

![](_page_44_Figure_5.jpeg)

Figure 3.4-12 depicts the percent cover estimates obtained for each Alteration Type shown in Figure 3.4-11, using a surrogate scale of 0-4: 0 being not present, 1 = 0=25%, 2 = 26-50%, 3 = 51 - 75%, and 4 = 76 - 100%. At each site, the surrogate numbers (i.e. 0-4) assigned to each Alteration Type were added together to depict the overall amount of physical alteration (maximum 12 Alterations x 4 (100% cover) = 48 maximum). No physical alterations were encountered at the Upper Otter 2, Blackstone 1, and Kettle Brook 1 sites. The site with the most different number of alterations (e.g. trash/litter, flood events ....) occurred at Blackstone 2.

## 4.0 CONCLUSIONS

The study of the Central Watersheds is the third MassDEP wetland monitoring and assessment study undertaken using recently developed tools including CAPS, SLAM's, forested wetland IBI's and CALU. Throughout this process strengths and weaknesses have been identified in the approach. The CALU results highlight the strength of the CAPS model to flag a site that has undergone stress, but the model is sometimes unable to pinpoint the exact cause of the stress when multiple culprits exist. Therefore, it is necessary for investigators to revisit a site or conduct further investigation to evaluate why the site had not met expectations. Overall, the CALU analysis has demonstrated that the forested wetland IBI's appear to be accurately predicting wetland condition in most cases. The CAPS model is undergoing continued development to further strengthen its ability to confidently factor more stressors and better assist the MassDEP with wetland monitoring and assessment. In addition, the CAPS model is also proving to be an effective tool to assist in prioritizing potential restoration and preservation sites. Opportunities for restoration that would improve wetland condition have been discussed in this report and include improving terrestrial connectedness by installing terrestrial crossings to mitigate the impact of high intensity traffic; and eradication of invasive species. To offset the adverse effects of habitat loss, potential high quality habitat should be investigated, protected and/or considered for preservation using the Habitat of Potential Regional and Statewide Importance maps.

The CALU analysis of the High IBI-IEI delta sites indicated that two of the ten sites in subwatersheds draining to impaired waters failed expectations. Further investigation concluded that the combination of being in a flood plain, downstream of a major WWTP, and upstream of a dam may be leading to the instability of the forested wetlands ecosystem. Although the model could not predict exactly which stressor caused the two sites to fail, it did correctly identify stressed biological condition. While the sites are located along waters determined to be impaired by the WPP, the poor condition of the wetlands does not appear to be contributing to the impairment of the adjacent waters – but rather, the waters may be a source of impairment of the wetlands. The wetlands, however, continue to serve important functions such as storm damage prevention and flood control, and may ameliorate the impairment of the water by filtering pollutants.

Documenting the *physical alteration* is also an important component to the onsite assessments, which helps to narrow down the potential source of stress, especially in situations where that stress is not identified by the model. Current and historical alterations may be identified using

a two-tiered approach of walking the site and interpretation of aerial photography. We found that flood events, trash/litter, and vegetation removal were the most common stressors encountered resulting in impacts to the integrity of the wetland.

While it is understood that a certain number of sites, due to model error alone, could naturally fall out of the normal range of variability, it is important to be able to discern when it is due to model error and when it is due to a stressor that has either not been identified or perhaps underestimated by the model.

MassDEP continues to apply and advance its monitoring and assessment program. This study has been an important step in testing the tools that have been developed, and understanding what the results tell us and do not tell us. To summarize, the data supports the findings that:

1. Not all degradation is anthropogenic (e.g. Source of two sites not meeting expectations in the Chicopee Watershed was due to beaver activity<sup>29</sup>);

2. Potential Secondary Impacts May be Occurring from Stormwater outfalls, WWTP, Flooding and Compost Facilities;

We have learned that the data does not tell us the following:

1. Which stressor is most significant when multiple stressors are present (e.g. in the Blackstone 2 and 3 sites, the primary stressor could be the natural flooding, the WWTP (flooding or quality of water), the compost facility or the downstream dam – or a combination).

2. Some causes of degradation cannot be identified and may be due to model error, or may be due to causes that were not investigated such as contamination.

As the MassDEP monitoring and assessment effort evolves, the strengths and weakness of its approach are better understood. The Department will continue to utilize the study findings to inform regulatory, policy and/or guidance development as well as identify opportunities to improve wetland condition through protection, restoration and preservation.

<sup>&</sup>lt;sup>29</sup> <u>http://www.mass.gov/eea/agencies/massdep/water/watersheds/chicopee-watershed-wetland-monitoring-and-assessment.html</u>