EXHIBIT B

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January 31, 2011

Ms. Susan Svirsky
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United States Environmental Protection Agency
c/o Weston Solutions
10 Lyman Street
Pittsfield, MA 01201

Re: Housatonic River Rest of River; *Comments on Housatonic River – Rest of River, Revised Corrective Measures Study Report*, October 2010

Dear Ms. Svirsky:

The Commonwealth of Massachusetts, through its Executive Office of Energy and Environmental Affairs (EEA), Massachusetts Department of Environmental Protection (MassDEP) and the Massachusetts Department of Fish & Game (DFG), is pleased to submit comments on General Electric's October 2010 Revised Corrective Measures Study. We commend EPA for requiring General Electric to present a wide array of potential remedial alternatives, and we commend the company for presenting a detailed and informative evaluation of the advantages and disadvantages of the different approaches.

After extensive review of the remedial alternatives presented to date, the Commonwealth has concluded that none of the current combinations of alternatives achieve the remediation goals without causing irreparable harm to this unique, diverse and vital ecosystem that has been designated by the Commonwealth as an Area of Critical Environmental Concern (ACEC). The Housatonic River watershed is one of the most biologically rich ecosystems in the Commonwealth, and supports many species found nowhere else in Massachusetts. The Commonwealth is concerned that in some areas the remediation of PCBs may result in destructive ecological impacts to this rich and unique system. We therefore propose an alternative: a phased, long-term remedy that minimizes human health risks posed by PCBs in the environment, while at the same time taking care to weigh potential benefits of remediation against potential injury to the ecosystem. Our proposed approach is to remove PCBs when needed to protect human health, or when other compelling goals may be achieved without causing ecological harm. This means that our approach leans away from performing intrusive work solely in the name of meeting purported ecological goals; because in virtually all instances the actual and inevitable damage to this existing, unique ecological resource will far exceed the theoretical benefit of lower PCB concentrations.

The key components of the Commonwealth's proposed remedy are as follows:

- Excavate Woods Pond to remove approximately 286,000 cubic yards of PCB-contaminated sediment and bring the average concentration of PCBs in Woods Pond to 1 ppm, with the highest concentration at 6 ppm. This excavation would eliminate up to 25% of the mass of PCBs in the *entire rest of the river* from Lenox to the Long Island Sound. It would also increase the sediment trapping efficiency of the pond, protect downstream public health and safety in the event of a dam failure, and enhance recreational uses of the pond. These benefits can be achieved without causing any significant ecological damage, as there are no rare species habitats within the pond; a nearby staging area is available; and a nearby rail line could transport the excavated material off-site.

- At this time, perform no bank or river excavation and stabilization, because this work is not necessary to meet the human health goals identified by the EPA (due to the low concentrations of PCBs) and will inevitably cause severe and long-lasting destruction of the Housatonic River ecosystem and state-listed rare species, which far outweighs any environmental benefits from PCB removal.

- In the floodplain, focus on locations totaling 57 acres where there are significant PCB concentrations. Avoid excavation in the highly sensitive rare species habitats and use institutional controls to address public health risk. In the less sensitive areas in this location, a combination of institutional controls, site-wide averaging, and carefully targeted excavation should be used to address the risk.

- Transport all excavated material off-site, taking advantage of the nearby rail line. Under no circumstances should there be a hazardous waste landfill constructed in Berkshire County for the excavated material. To do so plainly adds insult to injury.

- Perform ongoing monitoring of the success of past and future remediation efforts, ongoing consideration of new technologies as they become available, and reconsider final options for the remaining PCBs as more data is gathered.

- Immediately improve existing institutional controls to prevent human exposure, such as more plentiful fish advisory warnings, regular newspaper advertisements and other informational outreach programs.

Introduction

The Housatonic River suffers from a legacy of contamination resulting from PCBs that were released from the GE facility in Pittsfield from the 1930s through the 1970s, contaminating the Housatonic River sediment, banks, and floodplain soils. Despite this legacy of contamination, the Housatonic River Watershed encompasses a rich and unique ecosystem supporting many rare plant and animal species and their associated habitats, including wetlands, floodplains, vernal pools, surface waters, and forested areas. These are natural resources precious to the Commonwealth, and they must be protected, even as we rightfully demand that contamination from decades of industrial abuse be rectified once and for all.

The various sediment and floodplain alternative combinations presented to date, while potentially meeting remediation goals set through extensive public processes, would cause irreparable harm to this fragile ecosystem by disrupting habitats and ecosystem processes that have shaped the river and its floodplains for thousands of years. This is not acceptable.

After careful consideration of the alternatives by the Commonwealth's environmental agencies, we present and argue forcefully for a practical, incremental remediation approach that protects human health but also preserves the river, and the unique and irreplaceable habitat it creates, for the benefit of current and future generations. This approach has been developed by application of the Commonwealth's nation-leading environmental standards and is fully consistent with EPA's goal of Overall Protection of Human Health and the Environment. On this basis, we put our approach forward without reservation.

Recognition of the ecological uniqueness and importance of the Housatonic River watershed is at the core of this proposal, and we discuss in detail the dramatic impact the remedial measures evaluated in the CMS would have on the meandering character of the river, its banks, the floodplain, and on MESA state-listed species and their habitat to underscore the importance of preserving this ecosystem.

The tables and figures referenced throughout this discussion are contained in Appendix A to this letter.

The Ecological Uniqueness and Significance of the Housatonic River Watershed

The Housatonic River watershed is one of the most biologically rich and unique regions of the Commonwealth. Its limestone bedrock creates an exceptional hydrological base, supporting rich, calcareous soils and wetlands found only in this region. These rich soils and wetlands of the valley floor create a unique ecosystem which supports many species found nowhere else in Massachusetts. The Housatonic River watershed is home to 110 species of plants and 51 species of animals that are protected under Massachusetts Endangered Species Act, M.G.L. c. 131A, ("MESA") and the MESA regulations at 321 CMR 10.00. It also contains 13 high priority Natural Communities, 12 certified vernal pools and up to 107 potential vernal pools.

In addition to the wide range of state-listed species under MESA, the Housatonic River supports a substantial and highly productive fisheries resource. Thirty-seven species of fish have been found in the river and its supporting waters providing important, valuable and diverse recreational fisheries for both warm and coldwater species. Moreover, the Housatonic supports coldwater habitat including the main stem of the Housatonic River and its direct tributaries. These coldwater fisheries are protected under 314 CMR 4.06 of the MA Surface Water Quality Standards ("MA WQS") as coldwater habitat. The MA WQS require that both the fish population and habitat be protected and maintained as designated or existing uses. Recognizing these unique resources, the Commonwealth has designated the Upper Housatonic Watershed (which includes the primary study area of the CMS) as an Area of Critical Environmental Concern (ACEC). In that designation, the EEA Secretary found as follows:

> The Upper Housatonic River Area of Critical Environmental Concern (ACEC) encompasses the 13-mile corridor of the Housatonic River from southern Pittsfield to northern Lee, and portions of the supporting watersheds that drain into the river from the east and west. This section of the Housatonic River includes a complex ecosystem of the river, adjacent wetlands and floodplains, coldwater tributary streams, large expanses of wildlife and rare species habitat, and the steep, forested, western slopes of October Mountain State Forest. There are also historical and archaeological resources, farmland and open space, and scenic and recreational areas. The ACEC includes all nine of the inland resource features listed in the ACEC Regulations - including fisheries, wetlands and surface waters, water supply areas, floodplains and steep slopes, agricultural and forested areas, historical and archaeological resources, wildlife and rare species habitats, and public recreational and natural areas.
>
> The regionally significant biodiversity and wildlife habitat in the designated area is indicated by the exceptional number of rare species (32), Certified and Potential Vernal

> Pools (46), and the combined total of 11,405 acres or 93% of the area delineated as viable habitat by the Division of Fisheries and Wildlife's (DFW) Natural Heritage & Endangered Species Program (NHESP). Of this total, 7,869 acres (64%) of the ACEC is designated as BioMap Core Habitat and Supporting Natural Landscapes, 3,536 acres (29%) as Living Waters Core Habitat and Critical Supporting Watershed. Regulated areas of rare species Priority Habitats and Estimated Habitats total 3,130 acres or 25% of the ACEC, with the majority of these acres included in the BioMap and Living Waters areas. There are more than 21 river miles of Coldwater Fisheries, with breeding populations of native brook trout, and other fishery resources totaling approximately 30 fish species. Common wildlife in the region includes bobcat, coyote, deer, bear, and moose. The extensive wildlife habitats of the ACEC, including many rare and unique habitats, illustrate the close ecological interdependence of the various natural and cultural resource features of the ACEC. The area is important for fishing, tourism, recreation, forestry, and agriculture.

Upper Housatonic River ACEC Designation, March 30, 2009, p. 1.

The Primary Study Area (the "PSA") for the Rest of River remediation extends from the confluence of the East and West Branches of the Housatonic River in Pittsfield, to Woods Pond in Lenox. This stretch of Housatonic River in the PSA is a low-gradient, large river that is free to migrate across hundreds of acres of protected open space and sculpt the floodplain. The meandering river is constantly reshaping the landscape, creating an incredible diversity of habitats including oxbow wetlands, backwaters, sloughs, and vernal pools (Figures 7-9). The fertile soils, shifting banks and dynamic nature of the river are precisely what make the Housatonic River segments of the PSA an ecologically unique resource among all the major rivers in the Commonwealth. The PSA also supports an abundance of diverse and ecologically sensitive wildlife resources including 25 state-listed species (Table 1).

In addition, the Commonwealth's Division of Fisheries and Wildlife ("DFW"), a division of the Department of Fish & Game, owns one or both sides of approximately 85% of the land along the river's bank in the PSA, including the 818 acre George L. Darey Housatonic Valley Wildlife Management Area (the "Darey WMA"). The Darey WMA is spread across multiple parcels consisting of river-front and floodplain and is one of western Massachusetts' most heavily utilized wildlife management areas for all types of passive recreation, including hunting, fishing, trapping, hiking, canoeing, kayaking, bird watching, and wildlife viewing. Thus, in addition to its regulatory interests, the Commonwealth is a major landowner within the PSA, with stewardship responsibilities over a wildlife management area that is highly valued by recreational stakeholders.

<u>The PSA is a Critical Area for Biodiversity and State-listed Species</u>

The Housatonic River watershed supports one of the greatest concentrations of plant and animal species listed for protection under MESA in the Commonwealth. The Commonwealth has documented 25 state-listed species within the PSA alone, including 6 species that are listed as "Endangered" and 9 that are listed as "Threatened." The list of these 25 state-listed species is shown in Table 1.

The Commonwealth has divided the PSA into four sections as illustrated in Figure 1. It is striking that almost the entire PSA is mapped as priority habitat for one or more state-listed species by DFW's Natural Heritage & Endangered Species Program ("NHESP") pursuant to the MESA regulations (Figure 2). Figures 3, 4 and 5, in turn, depict the high degree of overlap between priority habitats of individual species, with some areas mapped for up to 15 state-listed species at any given point on the ground.

Moreover, there are high concentrations of state-listed species, including **core areas**[1] for subsets of species, throughout the PSA, as described in more detail below.

Section 1 of the PSA (from the confluence of the East and West Branches, south to the Pittsfield Sewage Treatment Plant) has a high concentration of state-listed species, including priority habitat for 18 of the 25 listed species in the PSA (Figure 4). It also contains core areas for the following 11 species: American Bittern (*Botaurus lentiginosus*), Common Moorhen (*Gallinula chloropus*), Wood Turtle (*Glyptemys insculpta*), Triangle Floater (*Alasmidonta undulata*), Riffle Snaketail (*Ophiogomphus carolus*), Ostrich Fern Borer (*Papaipema* sp. 2), Mustard White (*Pieris oleracea*), Tuckerman's Sedge (*Carex tuckermanii*), Hairy Wild Rye (*Elymus villosus*), Bristly Buttercup (*Ranunculus pensylvanicus*), and Wapato (*Sagittaria cuneata*).

Section 2 of the PSA (from the Pittsfield Sewage Treatment Plant, south to New Lenox Road in Lenox) has a high concentration of state-listed species, including priority habitat for 14 of the 25 listed species in the PSA (Figure 4). It also contains core areas for the following 5 species: Wood Turtle (*Glyptemys insculpta*), Rapids Clubtail (*Gomphus quadricolor*), Mustard White (*Pieris oleracea*), Narrow-leaved Spring Beauty (*Claytonia virginica*), and Wapato (*Sagittaria cuneata*).

Section 3 of the PSA (from New Lenox Road in Lenox, south to the north end of Woods Pond) has a high concentration of state-listed species, including priority habitat for 18 of the 25 listed species in the PSA (Figure 5). It also contains core areas for the following 8 species: American Bittern (*Botaurus lentiginosus*), Common Moorhen (*Gallinula chloropus*), Rapids Clubtail (*Gomphus quadricolor*), Mustard White (*Pieris oleracea*), Gray's Sedge (*Carex grayi*), Narrow-leaved Spring Beauty (*Claytonia virginica*), Bur Oak (*Quercus macrocarpa*), and Wapato (*Sagittaria cuneata*).

Section 4 of the PSA (Woods Pond, including the northern portion of the pond) includes priority habitat for 10 of the 25 listed species in the PSA. It also contains core areas for the following 4 species: American Bittern (*Botaurus lentiginosus*), Common Moorhen (*Gallinula chloropus*), Bur Oak (*Quercus macrocarpa*), and Wapato (*Sagittaria cuneata*).

As shown in Figure 6, the PSA contains core areas for 15 species, which covers a majority of the PSA. While all 25 of the state-listed species with habitat in the PSA may experience some level of negative impact due to remediation activities, the 15 species for which core areas have been designated are particularly sensitive to such impacts, and are listed in Table 2.

From a MESA standpoint, the Housatonic River watershed has long been recognized for its diversity of rare species, many of which are found nowhere else in the Commonwealth. Moreover, recent field surveys conducted by the NHESP have greatly improved our understanding of the distribution of state-listed species, vernal pool-breeding amphibians, and important natural communities. The results of these surveys are summarized in a 2010 NHESP report entitled, *Rare Species and Natural Community Surveys in the Housatonic River Watershed of Western Massachusetts*, contained in Appendix B.

The NHESP surveys targeted a total of 60 state-listed species including 31 plants, 3 butterflies and moths, 5 dragonflies and damselflies, 2 freshwater mussels, 4 fish, 2 salamanders, 3 turtles, and 10 marsh birds. The project also targeted 12 priority (S1-S3) natural community types. A total of 47 target species and 21 non-target state-listed species were encountered during these surveys. Among the newly documented species were 10 Endangered, 5 Threatened, and 6 Special Concern species. Moreover, all of the target

[1] A "core area" for any given state-listed species is defined by the NHESP as a portion of the priority habitat that is of particularly high quality or habitat that is critical to survival and reproduction of the local population, or both.

natural communities were found, plus an additional 4 priority natural community types were documented for the first time in the critical supporting watershed.

In short, these recent MESA-related surveys provide fresh documentation of the wide range of robust state-listed species and amphibian populations within the PSA that occur despite PCB contamination. These surveys underscore the critical importance of avoiding and minimizing impacts to these species and their habitats as a core consideration of the Rest of River remedy selection process, and counsel strongly against sacrificing an actual, existing rich ecology in the name of achieving a theoretical ecological benefit from PCB removal.

The Importance of Preserving the Meandering and Dynamic Character of the Housatonic River and Floodplain

Natural areas with a high degree of "ecosystem integrity" retain not only a full complement of native plants and animals, but also the natural *processes* that maintain those species in the long term. Low gradient rivers with intact, undeveloped floodplains will move, and it is this channel migration that maintains a diverse mosaic of wetlands and habitats that support species diversity over time. One of the most unique aspects of the Housatonic River and floodplain in the PSA is the degree of meandering of the river and the presence of backwaters, side channels, oxbows, and remnant oxbows that have developed into diverse wetlands. Indeed, it is extremely unusual to see this morphology in rivers of this size in Massachusetts or elsewhere in southern New England. To underscore this critical point, we have included a series of visual representations in Appendix A (Figures 7, 8 and 9) that illustrate the channel migration and wetlands formation process that characterize the Housatonic River system.

Figure 7 illustrates the great diversity of wetland types and habitat features created by the meandering Housatonic River within the PSA.

Figure 8 illustrates how these vital habitat features are formed by the meandering river. River segments that remain relatively stable allow for the establishment of streamside and aquatic vegetation, while fallen trunks and branches (snags) provide additional aquatic habitat. Gradual channel migration and sudden meander cut-offs greatly increase the variety of habitats available on the floodplain through continual creation of floodplain wetlands, which then undergo gradual vegetation succession.

As shown in Figure 8a, gradual erosion occurs on the outer bank of a meander while sediment deposition occurs on the inner bank. This process causes the river to migrate, thereby creating a deeper, more sinuous meander. Eventually, often during a major storm, the river channel cuts off to establish a straighter path, creating an oxbow lake (Figure 8b; Figure 7). Over time, the floodplain ponds reconnect to the river during flood events, leading to sediment deposition in the oxbows, as well as an exchange of organisms. As the oxbows gradually fill with sediment, the changes in vegetation ("succession") lead to the great diversity of wetland types found in the PSA, including oxbow lakes, vernal pools, sloughs, side channels, shrub swamps, marshes, wet meadows, and various types of floodplain forest (Figures 8c-d).

Figure 9 illustrates two recent examples of meander cutoff, oxbow and side channel formation from the 1970s to 1990s. Recent M.S. thesis research by Heather Pierce and Dr. Melinda Daniels of the University of Connecticut, confirms that the Housatonic has undergone considerable channel migration from the 1940s through 2001, with particularly dramatic changes during the 1970s. Among other findings, this research highlights that current geofluvial models do not adequately predict the amount of channel migration that was observed during the study period. Scientists are only beginning to understand complex riverine systems such as the Housatonic, so there is a great deal of uncertainty about the effects of any attempts by humans to manipulate

these systems. The implications of this uncertainty for the remediation selection process are discussed later in this letter.

In short, for these floodplain ecosystem processes to continue to maintain biological diversity, the stream banks must be deformable—that is, the river must be able to shape its floodplain and erode and deposit sediment. ***In the absence of channel migration, floodplain oxbows and wetlands will gradually fill with sediment over time, and the diverse mosaic of wetlands in different states of succession will be lost.***

Thus, it is important to consider carefully the uniqueness of the Housatonic River system, including the severity of such a loss on the ecology and biodiversity of the Commonwealth and Southern New England, when selecting a remedy for Rest of River. We cannot stress enough that there simply are no other rivers in Massachusetts (and few in New England) of the size of the Housatonic with the kind of floodplain dynamics illustrated in Figures 7 through 9. These defining characteristics of the Housatonic River, in turn, weigh heavily in the Commonwealth's development of its proposed remediation approach.

Reduction of Human Health Risks – A Commonwealth Priority

The Commonwealth strongly supports remedial alternatives that reduce the level of risk to human health from the PCBs in the system. The Human Health Risk Assessment (HHRA) report for the Rest of River (ROR) evaluated three primary exposure scenarios through which people may be exposed to PCBs, including direct contact with soil and sediment during recreational, residential, commercial and agricultural activities in the floodplain; consumption of fish and waterfowl taken from the river; and consumption of agricultural products produced in the floodplain such as milk, eggs and plants. The results of the HHRA demonstrated that remedial actions for the ROR are necessary to reduce human health risks.

The revised CMS presents an analysis of the ability to achieve certain human health risk standards through a combination of various sediment and floodplain alternatives. For consumption of agricultural products, all proposed alternatives will meet acceptable risk standards, including the Monitored Natural Recovery (MNR) option. For consumption of fish and waterfowl taken from the river, none of the proposed alternatives, including those that remove a large amount of material, will allow fish and waterfowl to be safely consumed within a reasonable time period. While we recognize some alternatives eventually achieve this goal faster than others, all the time periods are lengthy (e.g. within 50 to 100 years in some cases). In the short-term, these risks can be avoided by maintaining and further strengthening existing institutional controls.

For direct contact with soil and sediment, current conditions do not meet human health standards in many of the floodplain areas and in one sediment area (located within the banks of Woods Pond). Using highly protective assumptions about human health exposure frequencies, EPA has established a range of acceptable concentration limits to guide the remedy selection. The Commonwealth supports this range, and advocates remediation to meet the EPA's upper bound limit of ten minus four human health excess cancer risk, and further remediation to add a layer of protection when it can be done without causing significant environmental damage.

Preserving the Special Character of the Housatonic River Ecosystem – A Commonwealth Priority

Earlier in this letter the Commonwealth highlighted the uniqueness and importance of the Housatonic River ecosystem, underscoring its exemplary value from a MESA and biodiversity perspective and the dynamic nature of the meandering action of the river in creating habitats. Thus, our assessment of the acceptability of each remedial alternative in the revised CMS focused on the extent to which the alternative would result in short and long term adverse impacts on these defining ecological features.

General Conclusions

As a result of our review, the Commonwealth has reached the following general conclusions in regard to the expected impact of the range of remediation alternatives in the revised CMS (except for monitored natural recovery) on the Housatonic River ecosystem:

1. Extensive bank and river bottom stabilization associated with sediment remediation alternatives SED 3 – SED 10 (+/-14 linear miles) are proposed solely to address perceived ecological risks from PCB contamination; none of these proposals are needed to meet EPA's human health goals. Yet all of these alternatives will have a particularly severe and long-lasting impact on the integrity of the Housatonic River-floodplain ecosystem as well as on state-listed species and their habitats.

2. The short and long-term impacts of floodplain remediation on state-listed species and the Housatonic River-*floodplain* ecosystem, are in some cases substantial and should be avoided, but, are generally of less of a long term concern when compared to the scope and long lasting impact resulting from large scale bank and river bottom stabilization in the PSA.

   Consistent with EPA's own remediation guidance, the Commonwealth believes that the long and short term benefits of meeting certain Ecological Interim Media Protection Goals ("IMPGs") must be weighed against the environmental damage that would be incurred through the remediation actions necessary to achieve those IMPGs. (EPA 2005, *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*; see also NRC 2001, *A Risk Management Strategy for PCB-Contaminated Sediments*).

3. The Commonwealth believes that any potential benefits associated with remediation to achieve ecological IMPGs would be far outweighed by the short and long-term damage to the meandering character of the Housatonic River ecosystem and to the associated state-listed species and their habitats. Consequently, as discussed elsewhere in this letter, the selected ROR remedy should focus on eliminating public health hazards associated with direct contact exposure to PCBs.

Impacts on the integrity of the Housatonic River and Floodplain Ecosystem

As discussed in detail earlier in this letter, the natural riverine processes of meandering, erosion, and channel migration lead to creation of floodplain wetlands and landforms including levees, side channels, backwaters, sloughs, and oxbows. These wetlands and landforms develop and evolve on a time scale of tens to hundreds of years. The resulting floodplain comprises complex heterogeneous patches (i.e., "mosaics") of different successional stages, including herbs, grasses, deciduous trees, and conifers, creating high species diversity.

The effects of armoring and stabilizing the river banks on the floodplain wetlands created by the above natural processes are as follows:

- First and foremost, the armoring or stabilization of the banks will eliminate the meandering and channel migration of the river. The affected portions of the river would evolve into a single-thread channel without the complex mosaic of floodplain wetlands that currently exist.

- If the channel migration process is eliminated, the existing wetland habitats will eventually fill in with fine sediment, re-forest, and meld into one homogenous habitat, with lower species diversity.

- The species that rely on the mosaic of wetlands and plants for foraging, refugia, and/or rearing will also vanish.

- These habitats, functions, and values cannot be fully re-created or restored by human intervention, because the habitats result from interactions of complex processes operating over hundreds of years.

- "Soft" engineering methods for bank stabilization will have the same impact on floodplain wetlands as bank armoring. Both are designed to prevent erosion and channel migration. While soft engineering methods may look better aesthetically, they will not prevent or mitigate the above described impacts to floodplain wetlands.

- Additional functions and values that would be lost or degraded by armoring or stabilizing the river banks include:

    - Energy dissipation (slowing down the flood waters);
    - Surface and subsurface water storage and exchange (making water available to animals and underground aquifers);
    - Landscape hydrologic connections (connecting habitats together for wildlife and plants);
    - Trapping, retaining, and cycling of elements and compounds (e.g. nutrients)
    - Particulate detention (holding sand, silt, and clay in the floodplain);
    - Organic matter transport (moving organic matter around);
    - Detrital biomass (creating and storing decaying leaves and other organic debris);
    - Spatial structure of habitats (providing multiple places for wildlife and plants to live);
    - Connectivity of habitats and movement routes (providing a means of connecting different types of habitats together and allowing movement of animals).

In short, the impacts associated with the implementation of the SED 3–SED 10 remediation alternatives would have long-lasting and potentially irreversible adverse effects on the natural process of channel migration. This result would, in turn, fundamentally alter the integrity of a riverine system that supports and maintains the diversity of unique ecological features, species and habitats that are the hallmarks of the Housatonic River in the PSA.

In the floodplain, the impacts associated with excavation include alteration of soils, vegetation, and hydrology in certain wetland types such as marshes and vernal pools. This outcome will make successful restoration challenging, and the loss of mature floodplain forest will take many decades to regenerate. Moreover, excavation of the floodplain results in habitat fragmentation associated with road and staging area construction, causes impacts to state-listed species, and increases the risk of introducing invasive species. For these reasons, the Commonwealth's remedial approach prioritizes the excavation of floodplain areas for the protection of human health, and avoids intrusive work when performed solely for perceived ecological benefit.

Impacts to State-Listed Species protected by MESA

The revised CMS contains detailed analyses of the extent to which various remedial alternatives will impact state-listed species and their habitats, as well as an analysis of the feasibility of restoring various habitat types, post-remediation. Although the Commonwealth disagrees with some of the methods used[2], and some of the species-specific impact analyses, the Commonwealth agrees with the general conclusion that except for monitored natural recovery, all of the remedial alternatives identified in the revised CMS will result in the "take" of numerous state-listed species.

For example, in a preliminary analysis, we estimate that combined alternatives SED3/FP3 and SED10/FP9 may result in the take of 26 and 22 state-listed species, respectively. We further determined on a preliminary basis that SED3/FP3 and SED10/FP9 have the potential to result in a significant impact to the local populations of 9 and 6 state-listed species respectively. As discussed earlier in this letter, we are particularly concerned about the potential for moderate to severe long-term impacts to the 15 species found in "core areas" in the PSA (listed in Table 2), which, due to their distribution, life history characteristics, and/or challenges associated with restoration of their habitat, are particularly vulnerable to remediation activities.

Compliance with Location-Specific ARARS such as MESA is Crucial to Avoiding, Minimizing and Mitigating Impacts of the ROR Remedy on the Housatonic River System

During this CMS process, the Commonwealth has consistently commented to EPA and GE that the selected remedy's compliance with state applicable and relevant or appropriate standards (ARARs) is essential to ensuring that impacts resulting from the remedy are avoided, minimized and mitigated consistent with the substantive requirements of the Commonwealth's applicable and relevant statutes, regulations and requirements. One such ARAR is the Massachusetts Endangered Species Act (MESA). We have also made clear our position that GE has a legal obligation to comply with state ARARs, independent of the prior settlement of the Commonwealth's NRD claim.

The Commonwealth notes that in section 2.1.3 of the revised CMS (pp. 2-5 to 2-9) GE argues that only those federal and state laws and regulations that specifically address "hazardous substances that will remain on-site or the media containing such substances" constitute ARARs. GE's position is that federal or state laws or regulations that require avoidance or minimization of non-pollutant impacts of the remedy or that require the restoration of or compensatory mitigation for resources impacted by the contamination or the implementation of the ROR remedy are not ARARs. GE also argues that any resource impacts caused by the contamination or the implementation of the remedy were addressed by the settlement of the NRD claim.

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[2] In the revised CMS, GE states that, "For most species with Priority Habitat in Reaches 5 and/or 6, based on the location and extent of Priority Habitat and the foraging and dispersal characteristics of the species, it appears that the longitudinal extent of the local population is also fairly represented by the mapped Priority Habitat area(s) in those reaches." This would mean that, in many cases, the "local population" would be confined to one or more portions of the PSA. As acknowledged in the revised CMS, the NHESP determined that GE's approach to defining the local population may be "overly narrow" in some cases, and this remains the position of the NHESP. Nonetheless, the NHESP believes that the more narrow approach to determining "Impact on Significant Portion of the Local Population" applied by GE in the revised CMS is valid for the more narrow purpose of evaluating impacts of proposed remedial alternatives on those portions of the local population (i.e. subpopulations) located within Reaches 5 and 6 (and Reaches 7 and 8, as applicable). In summary, although the Commonwealth may disagree on the some of the species-specific conclusions regarding "significant impact" presented by GE in Appendix L, and would characterize them as analyses of significant impact on local *sub*populations, we believe that it is useful approach when weighing the severity of impacts to state-listed species against the potential benefits of meeting the ecological IMPGs.

Thus, in section 5.4 (p. 5-95) and in the introduction to Appendix L to the revised CMS (the MESA assessment of the remedy alternatives, p. IN-3), GE concludes that because MESA does not specifically address hazardous substances that will remain onsite or the media containing them, it is not an ARAR. Consequently, GE chose not to evaluate the potential application of MESA's long-term Net Benefit provisions associated with a take of a state-listed species to the remedy alternatives, notwithstanding EPA's express direction to GE to do so.

In setting out its ARAR analysis in section 2.1.3 (p. 2-5), GE states that it considered EPA's 1989 guidance document for identifying ARARs. This guidance includes a discussion of the federal Endangered Species Act ("ESA") as an ARAR, and states that substantive compliance with the ESA *"means that the lead agency must identify whether a threatened or endangered species, or its critical habitat, will be affected by a proposed response action. If so, the agency must avoid the action or take appropriate mitigation measures so that the action does not affect the species or its critical habitat."* See EPA's CERCLA Compliance with Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes and State Requirements (August, 1989), p. 4-12. EPA makes clear that not only is the federal ESA an ARAR that is applicable to a *response action* that will affect a federally-listed species or its habitat, but also that any potential or actual impacts caused by the response action must be avoided or mitigated. That same common sense analysis applies to other location-specific ARARs such as MESA.

Accordingly, the Commonwealth reiterates its position that (1) ARARs include requirements that address the resource areas, species and their habitats that are impacted by the implementation of the remedial action; and (2) GE has a legal obligation - independent from the resolution of the NRD claim - to fully restore and mitigate for all resources impacted by the contamination or the implementation of the ROR remedy, as required by the federal and state ARARs. We therefore request EPA to affirmatively reject GE's position on the record as part of its response to the revised CMS.

The Commonwealth Proposal

The Commonwealth proposes a multi-phased, long term remedy for the Rest of River that immediately addresses human health risks for direct exposure to sediment and floodplain areas; includes ongoing monitoring and the potential for continued remediation to ensure ongoing compliance with human health standards; and requires the ongoing evaluation and potential implementation of innovative remedial approaches and technologies. The remedial proposal is fully consistent with state and federal regulatory frameworks and consists of the following six significant components:

1. **Remediation of specific floodplain areas and one sediment exposure area identified in the CMS to address human health risks for direct exposure to sediment and floodplain soils.**

   The Commonwealth has identified approximately 57 acres in the floodplain to be remediated to meet human health risk goals. One of the proposed floodplain alternatives, (FP 4) also identifies 15 acres to achieve ecological cleanup goals for amphibians in vernal pools. The Commonwealth does not propose to remediate the amphibian areas, because this would cause more ecological harm than benefit. We believe that restoration of these vernal pools will not result in the actual replication of the vernal pools and associated amphibian communities that existed prior to the removal of the pools.

   Within the 57 acres identified in the floodplain to meet human health risk standards, the NHESP identified sensitive areas that house particularly vulnerable state-listed species, and other areas of extremely important ecological value. The Commonwealth proposes that no excavation be performed in these areas; rather, that risk standards be addressed in these core habitat areas through the implementation of institutional controls including, but not limited to, advisories, educational materials, notifications, boot washing stations, signage, hygiene and laundering

instructions, etc. The Commonwealth proposes that the remaining acres be remediated through a combination of soil removal techniques as well and/or the implementation of institutional controls, particularly where access to the areas may cause significant impact to the ecology of the system. However, we stress that these remaining acres also have ecological value, and that intrusive work within these areas should be judicious and approached as a last resort. The Commonwealth strongly urges EPA and GE to work closely with the state at the design phase of the project to help refine the remediation work and minimize ecological impacts in these areas, and to take maximum advantage of achieving acceptable average concentrations by performing more excavation in areas of high concentrations and/or low ecological value, and less excavation in areas of low concentrations and/or high ecological value. The Commonwealth is finalizing a map that shows these areas, and will submit it shortly as an addendum to these comments.

In addition to the floodplain areas, the Commonwealth's conceptual remedy provides for the remediation of one sediment area located on the banks of Woods Pond referred to as SA 3 in the CMS. This is the only sediment area that does not meet human health risk standards for direct contact with sediment, and this area can be remediated without significant environmental damage. SA 3 encompasses approximately 11 acres and extends approximately 6 meters from the shore of Woods Pond. The Commonwealth recommends that this area be remediated as proposed in the SED 10 remedy presented in the CMS.

Due to the ecological impacts resulting from remediation of the river and its banks as described above, no bank work for the Housatonic River is proposed for this phase of the cleanup as it is not needed to address immediate human health risks. However, the Commonwealth's proposal does recognize that future remediation of the river and banks may be necessary to maintain conditions protective of human health, based upon the results of future monitoring and assessment (See also Paragraph 4 below).

2. **Bulk source removal of the majority of contaminated media in Woods Pond to an average of 1 mg/kg (1 part-per-million, or 1 ppm).**

The Commonwealth believes that removal of PCBs in Woods Pond will not cause significant adverse effects to rare and endangered species and their habitats. This is because there are no state-listed rare species habitats within the pond or surrounding area, and the non-listed species would actually benefit from sediment removal by restoring open-water habitat and water quality such as dissolved oxygen. Given the absence of environmental harm, it is a priority for the Commonwealth that GE remove a significant source of PCB material in the pond. After careful review of the costs and benefits of various removal options, the Commonwealth believes that a removal to obtain a pond-wide average of 1 ppm with no area exceeding 6 ppm strikes the right balance. Removal action to achieve a lower concentration than that encounters significant diminishing returns. For example, we estimate that to achieve 1 ppm on average, removal of approximately 286,000 cubic yards is needed. But to achieve 1 ppm in all areas of the pond would require doubling that amount of excavation to dredge 575,000 cubic yards. Most of the contamination in the ROR system is located between the confluence of the East and West branches of the river and Woods Pond Dam. Some of the highest concentrations of PCBs in the ROR system are found within Woods Pond. Further, based on approximations of mass estimated during previous work[3], approximately 15 to 25% of the mass in the entire ROR system is in Woods Pond itself. Remediation to an average of 1 ppm level would result in the approximate removal of 92% of the PCBs in the pond. A significant dredge of sediment and PCB mass from the pond will also increase Woods Pond's PCB trapping efficiency, thereby improving and enhancing the natural ability of the pond to capture contaminated sediment eroding from the

[3] *Housatonic River – Rest of River RCRA Facility Investigation Report*, September 2003

upstream banks[4]. In addition, removing significant quantities of PCBs behind Woods Pond Dam will protect public health against downstream contamination if there were ever a dam failure. As an ancillary benefit, this dredge would deepen the pond from its current depth of 2.5-5.5 feet to a range of 4.7-9.8 feet, thereby greatly enhancing recreational opportunities.

3. **Ongoing evaluation of innovative remedial approaches and technologies.**

A significant problem with the proposed remedies is that there is no detailed mechanism for the on-going evaluation and application of innovative remedial approaches and technologies. The Commonwealth proposes that GE be required to evaluate on a regular basis the availability of innovative remedial approaches and technologies that can be utilized to reduce human health and ecological risks without unacceptable consequences to the ecosystem, and that GE implement, to the extent feasible, such approaches and technologies should they become available.

4. **Ongoing monitoring and remediation as needed to meet and maintain human health standards and to remove accumulated sediment behind Woods Pond Dam.**

The Commonwealth's conceptual remedy requires compliance with human health standards on an ongoing basis. Accordingly, this proposal requires GE to perform: a) ongoing monitoring and assessment of areas remediated under Paragraphs 1 and 2 above; b) additional remediation to the extent necessary to meet and maintain human health standards as determined by such monitoring and assessment; and c) removal of excessive amounts of contaminated sediment that accumulate behind Woods Pond dam to sustain an average of 1 ppm throughout the pond.

Continuing source control upstream of the Rest of River system as well as the work proposed as the first phase of this remedy (See also Paragraphs 1 and 2 above) will likely alter PCB levels, and re-assessment will allow for the collection of data that are representative of these new conditions and more applicable for subsequent remedial decisions.

Monitoring and assessment will be conducted to evaluate how successful/effective the preliminary measures have been to eliminate the human health risks and control the continuing sources. This could include qualitative evaluation of the institutional controls on consumption of fish from the river, quantitative assessment of potential recontamination of the floodplain, and a quantitative evaluation of the effectiveness of a Woods Pond sediment trap. Secondly, the assessment will evaluate the potential for implementing additional response actions to address the remaining contamination in the river and floodplain, considering new technologies and methodologies, as well as the success of similar restoration projects on the Housatonic River (e.g., cleanup and restoration of vernal pools) or on analogous river systems. Monitoring will include routine sampling and analysis of fish tissue, river sediment, Woods Pond sediment, and floodplain soil. Periodic evaluations of the ecosystem (i.e., fluctuations of threatened/endangered species and habitat changes) will also be necessary. The assessments will continue until the conditions in the river are documented to pose no significant risk to human health and the environment. It is a long-term commitment by the Commonwealth, EPA and GE.

5. **Implementation of more comprehensive institutional controls for consumption of fish and waterfowl taken from the river.**

Although there are institutional controls in the form of consumption advisories currently in place, the Commonwealth endorses the implementation of a more comprehensive program of institutional controls, including, but not limited to, implementation of extensive public

[4] The dredge of the pond consists of the entire 60 acres in area and depths throughout where PCBs are detected.

educational programs and providing incentives for those relying on fish and waterfowl for sustenance purposes. In general, we recommend improved signage, regular local newspaper advertisements and other informational literature and outreach programs.

Problems cited from the past measures have included vandalism of signage and fencing, inadequate signage, and fisherman ignoring biota consumption advisories. Also, many people were reportedly unaware of prohibitions or risks, indicating a need for added public outreach. In addition to signage we recommend regular inspections of these areas to ensure signs are present and in good condition, and in order to document areas where frequent activity is occurring. In these frequently visited areas, there needs to be better communication through outreach, public notice, best management practices, and other measures. Overall, there needs to be more frequent presence in these areas. As was done with the residential fill program, fact sheets should be made available at all access points and agency websites. Any institutional controls applied will need to be re-visited based on information gathered from regular inspections and public outreach.

To improve the existing array of institutional controls, we recommend that EPA require GE to submit for approval an institutional control program. Under such a program, GE should perform an ongoing review of the current uses, and any new specific recreational uses, of the various exposure areas to determine and implement notice, education and best management practices to minimize exposure to users and visitors to these properties. GE would further monitor (at a frequency to be proposed by GE and approved by the agencies) effectiveness of this program, report to the agencies and make adjustments to further reduce risk.

6. **Disposal of all removed material out of state to an existing approved facility utilizing rail transport.**

The Commonwealth ***vigorously*** opposes two disposal options outlined in the revised CMS that call for disposal of removed material to be sited within Berkshire County. These two options include a Confined Disposal Facility (CDF) to be built within a local waterbody and the installation of an Upland Disposal Facility constructed in an area near the River. The Commonwealth opposes the creation of new landfills, given that there are existing, off-site, permitted disposal facilities that are equipped to accept this material.

Woods Pond is a potential location for both the CDF and the Upland Disposal Facility[5]. However, as mentioned previously in this letter, the Upper Housatonic River Area has been designated by the Commonwealth to be an ACEC. The ACEC includes all nine inland resource features as designated by regulation, including fisheries, wetlands and surface waters, water supply areas, floodplains and steep slopes, agricultural and forested areas, historical and archaeological resources, wildlife and rare species habitats, and public recreational and natural areas. A disposal facility in or around Woods Pond is clearly not appropriate in this type of area, and the prohibition against siting a landfill in an ACEC has previously been identified as an ARAR by the Commonwealth. In addition, installation of a disposal facility would not meet the requirements of several of the Commonwealth's regulations including the Massachusetts Water Quality Certification regulations (314 CMR 9.06) and the Massachusetts Wetlands Protection Act regulations (310 CMR 10.00). The CDF would also reduce necessary flood compensatory storage area.

[5] There are also two additional upland disposal facility locations identified including Forest Street in Lee and near Rising Pond.

Installation of a disposal facility in Berkshire County would also have extremely negative impacts to the communities surrounding the facility including economic, aesthetic, recreational, and potential health impacts should the facility fail. Further, construction of yet another such facility just expands the number of locations that would be affected by PCB-contamination, requiring additional long-term monitoring, operation and management beyond what is already a long-term burden on the community, and which runs counter to the concept of the anti-degradation provisions incorporated into the Massachusetts site cleanup regulations. The costs (including the social costs) of such a facility must be weighed against the simplicity and finality of disposal of this material in a pre-existing facility. The Commonwealth therefore supports disposal at an existing, out of state disposal facility properly permitted to receive such materials, and believes that rail is a feasible alternative to transport the material.

The current freight rail system owned by Housatonic Railroad Company, Inc. runs adjacent to the portions of the Housatonic River subject to removal actions under our concept, including Woods Pond. GE evaluated the feasibility of utilizing rail transport in the CMS but determined to not consider it due to "logistical issues". The Commonwealth disagrees that logistical issues prohibit the use of rail for transport of media. In fact, the CMS presents the results of an evaluation examining the feasibility of using rail by a consultant hired by GE. That consultant concluded that rail transport of excavated materials would be technically feasible. Based on our experience on other projects, the Commonwealth believes that rail is a cost-effective and efficient way to transport contaminated media.

Conclusion

In conclusion, the Commonwealth Proposal is consistent with EPA's goal of Risk Management to achieve Overall Protection of Human Health and the Environment, and is superior to any of the various proposals made to date in balancing protection of public health and conservation of natural ecosystems. As acknowledged by EPA, a sound remediation approach involves complex balancing of competing interests and values. By taking a common sense, incremental approach to cleaning up the Housatonic River, we can protect the health of our citizens while preserving the integrity of this unique place for the benefit of future generations. We urge you to incorporate our Proposal into your final disposition of this matter, which is of vital importance to the Commonwealth.

We appreciate the opportunity to present our views on this important matter.

Sincerely,

Richard K. Sullivan, Jr.
Secretary, Executive Office of Energy
and Environmental Affairs

Kenneth L. Kimmell
Commissioner, Massachusetts
Department of Environmental Protection

Mary Griffin
Commissioner, Massachusetts
Department of Fish and Game[6]

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EPA –	Curt Spalding, Ira Leighton Richard Cavagnero, Tim Conway, Dean Tagliaferro, Holly Inglis
MassDEP –	Mike Gorski, Eva Tor, Jeff Mickelson, Paul Locke, John Ziegler
DFG/DFW –	Wayne F. MacCallum, Mark Tisa, Jon Regosin, Beth Lambert, Richard Lehan

Appendix A – Tables & Figures
Appendix B – NHESP 2010 Report entitled "Rare Species and Natural Community Surveys in the Housatonic River Watershed of Western Massachusetts"

[6] These comments include the input of a team of staff biologists at the Natural Heritage and Endangered Species Program within DFG, and engineers and risk assessment specialists at MassDEP. The Secretary and the Commissioners have relied upon their staffs' respective technical expertise in formulating this proposal.

Appendix A

Tables & Figures

Table 1. State-listed species occupying the PSA

Common Name	Scientific Name	Status
Foxtail Sedge	*Carex alopecoidea*	Threatened
Hairy Wild Rye	*Elymus villosus*	Endangered
Bald Eagle	*Haliaeetus leucocephalus*	Endangered
Tuckerman's Sedge	*Carex tuckermanii*	Endangered
Zebra Clubtail	*Stylurus scudderi*	Special Concern
Bur Oak	*Quercus macrocarpa*	Special Concern
Bristly Buttercup	*Ranunculus pensylvanicus*	Special Concern
Common Moorhen	*Gallinula chloropus*	Special Concern
Jefferson Salamander	*Ambystoma jeffersonianum*	Special Concern
Ostrich Fern Borer	*Papaipema sp. 2*	Special Concern
Rapids Clubtail	*Gomphus quadricolor*	Threatened
Arrow Clubtail	*Stylurus spiniceps*	Threatened
Gray's Sedge	*Carex grayi*	Threatened
American Bittern	*Botaurus lentiginosus*	Endangered
Crooked-stem Aster	*Symphyotrichum prenanthoides*	Threatened
Water Shrew	*Sorex palustris*	Special Concern
Spine-crowned Clubtail	*Gomphus abbreviatus*	Endangered
Narrow-leaved Spring Beauty	*Claytonia virginica*	Endangered
Triangle Floater	*Alasmidonta undulata*	Special Concern
Brook Snaketail	*Ophiogomphus aspersus*	Special Concern
Wood Turtle	*Glyptemys insculpta*	Special Concern
Mustard White	*Pieris oleracea*	Threatened
Wapato	*Sagittaria cuneata*	Threatened
Riffle Snaketail	*Ophiogomphus carolus*	Threatened
Intermediate Spike-seed	*Eleocharis intermedia*	Threatened

Table 2. State-listed species for which Core Areas were delineated.

Common Name	Scientific Name	Status
American Bittern	*Botaurus lentiginosus*	Endangered
Common Moorhen	*Gallinula chloropus*	Special Concern
Wood Turtle	*Glyptemys insculpta*	Special Concern
Triangle Floater	*Alasmidonta undulata*	Special Concern
Rapids Clubtail	*Gomphus quadricolor*	Threatened
Riffle Snaketail	*Ophiogomphus carolus*	Threatened
Ostrich Fern Borer	*Papaipema* sp. 2	Special Concern
Mustard White	*Pieris oleracea*	Threatened
Gray's Sedge	*Carex grayi*	Threatened
Tuckerman's Sedge	*Carex tuckermanii*	Endangered
Bur Oak	*Quercus macrocarpa*	Special Concern
Bristly Buttercup	*Ranunculus pensylvanicus*	Special Concern
Narrow-leaved Spring Beauty	*Claytonia virginica*	Endangered
Hairy Wild Rye	*Elymus villosus*	Endangered
Wapato	*Sagittaria cuneata*	Threatened

Figure 1. Housatonic "PSA" habitat sections.

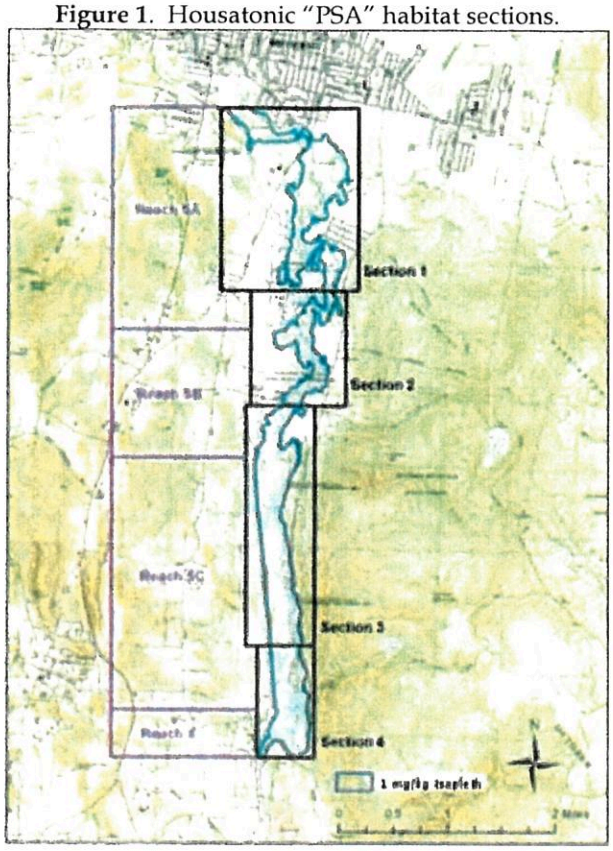


Figure 2. Regulatory habitat within the PSA.

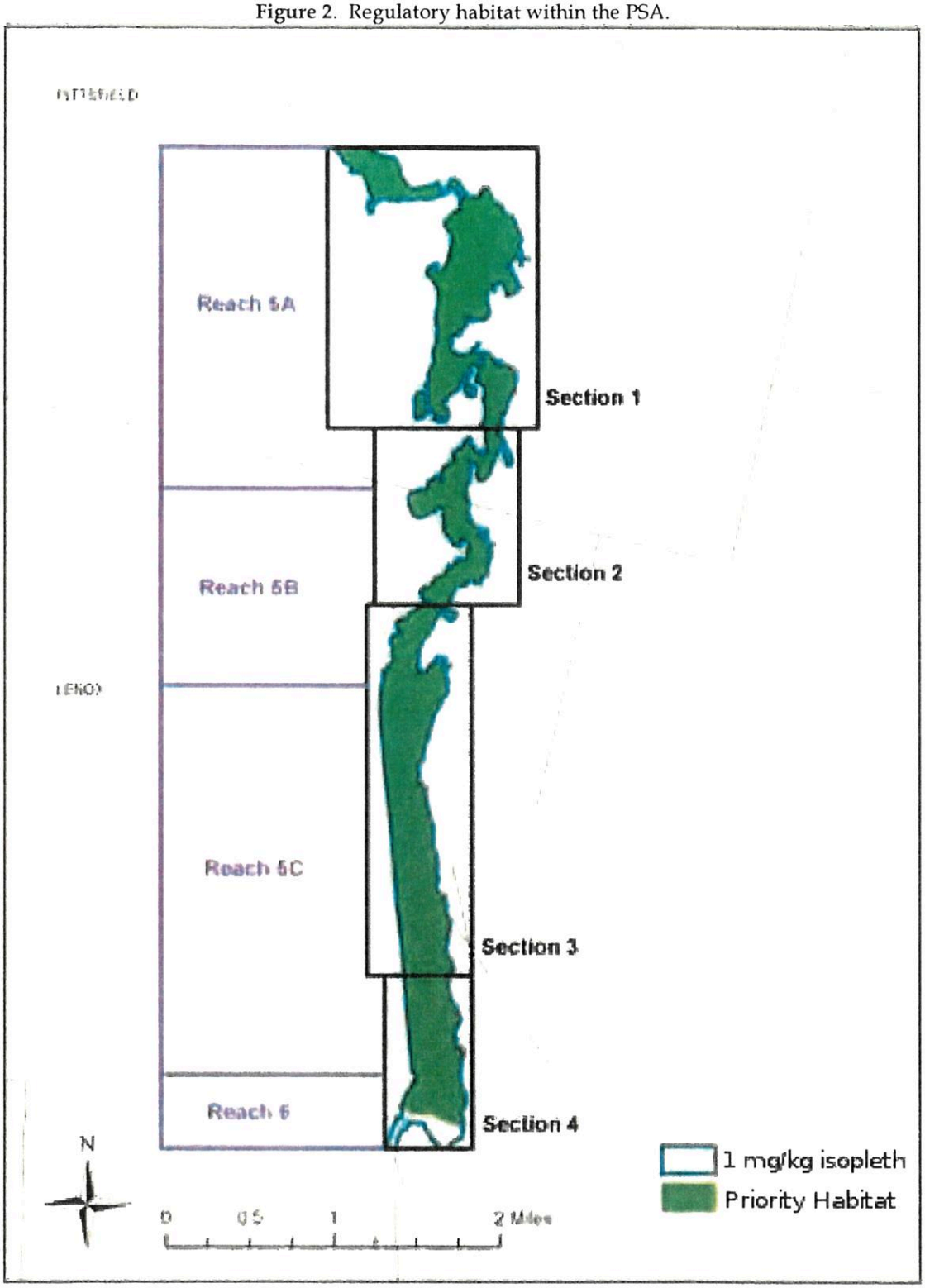


Figure 3. Overlap of Priority Habitats in the PSA.

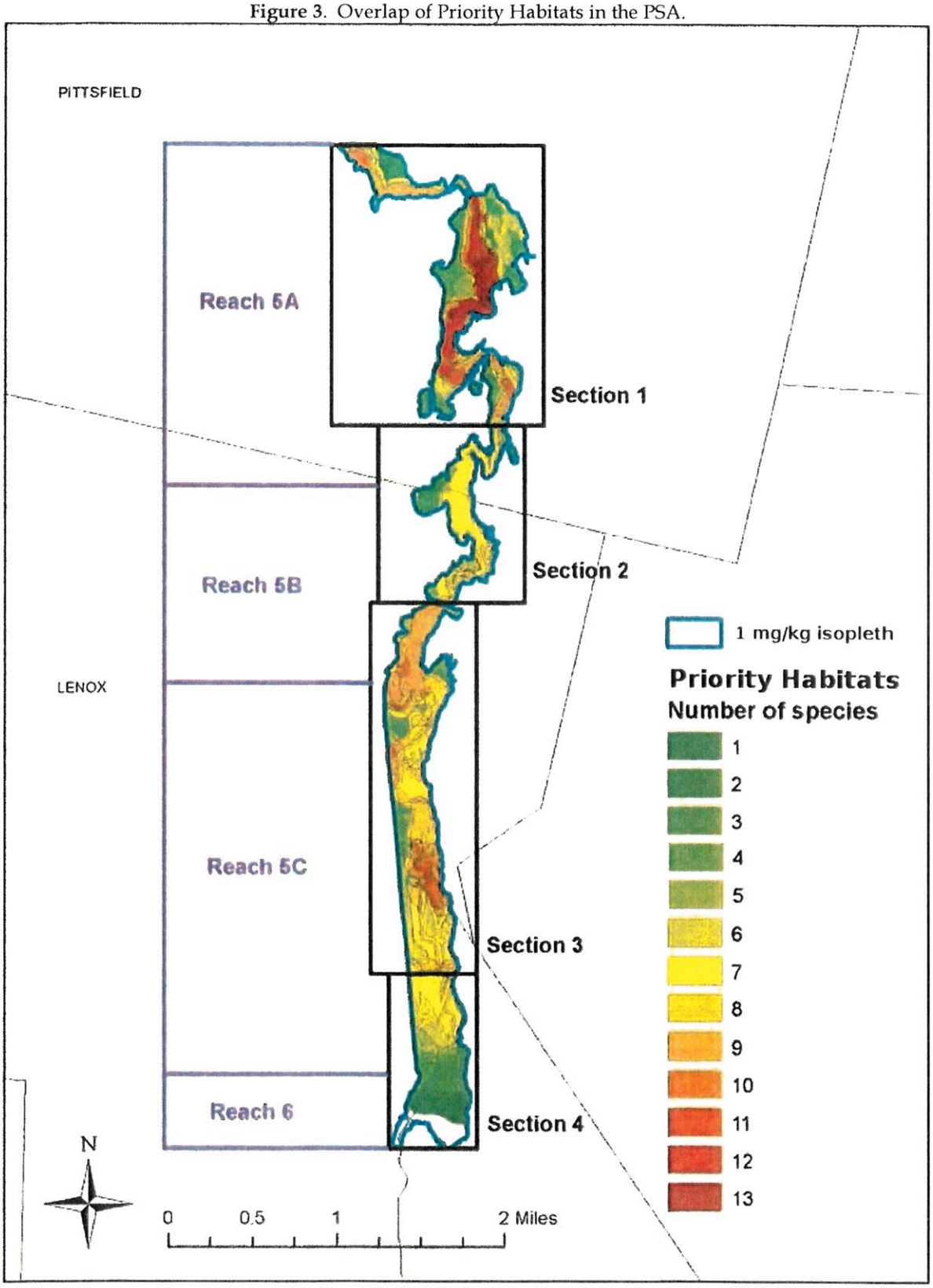


Figure 4. Overlap of Priority Habitats in habitat sections 1 and 2 of the PSA.

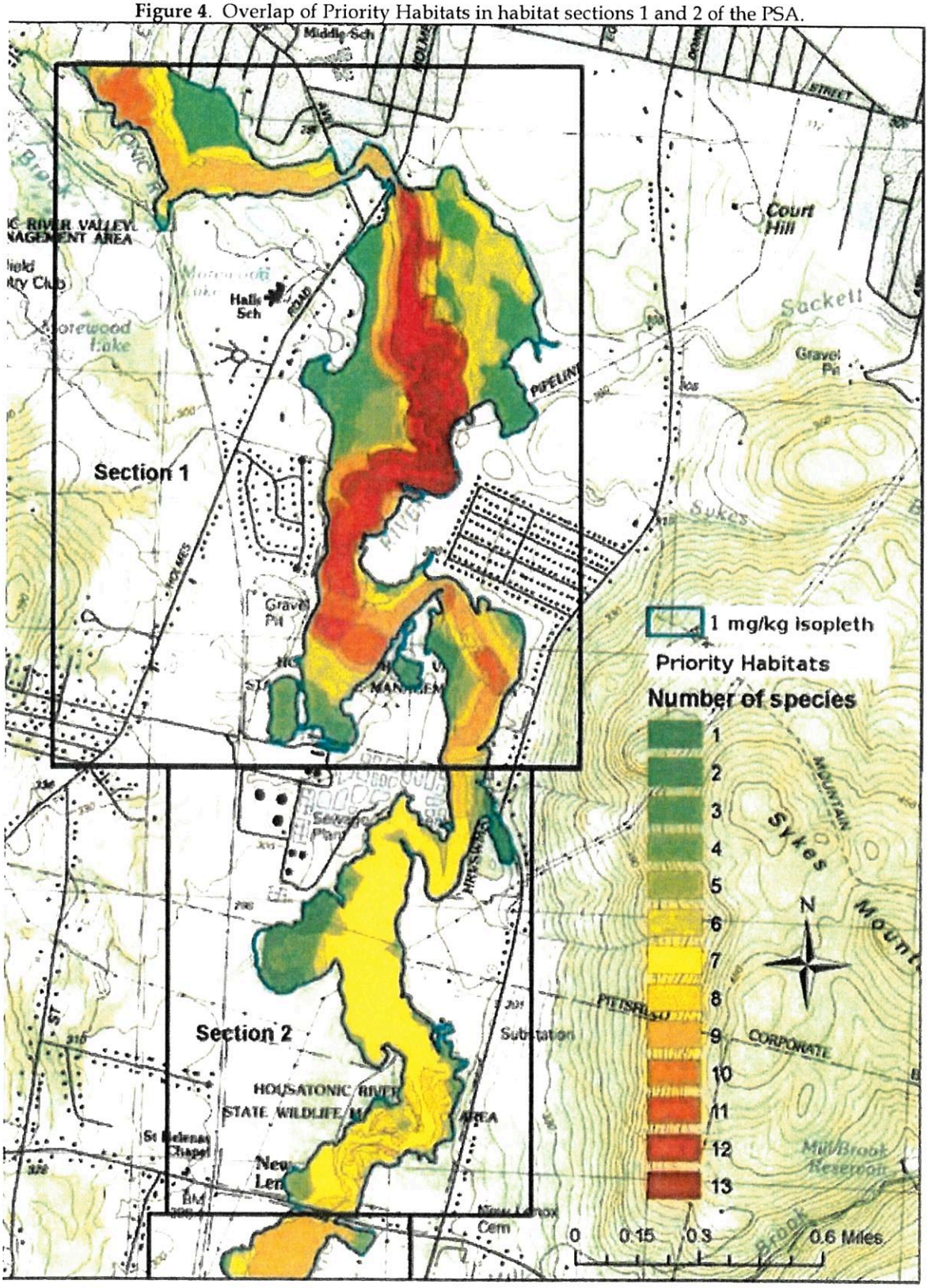


Figure 5. Overlap of Priority Habitats in habitat sections 3 and 4in the PSA.

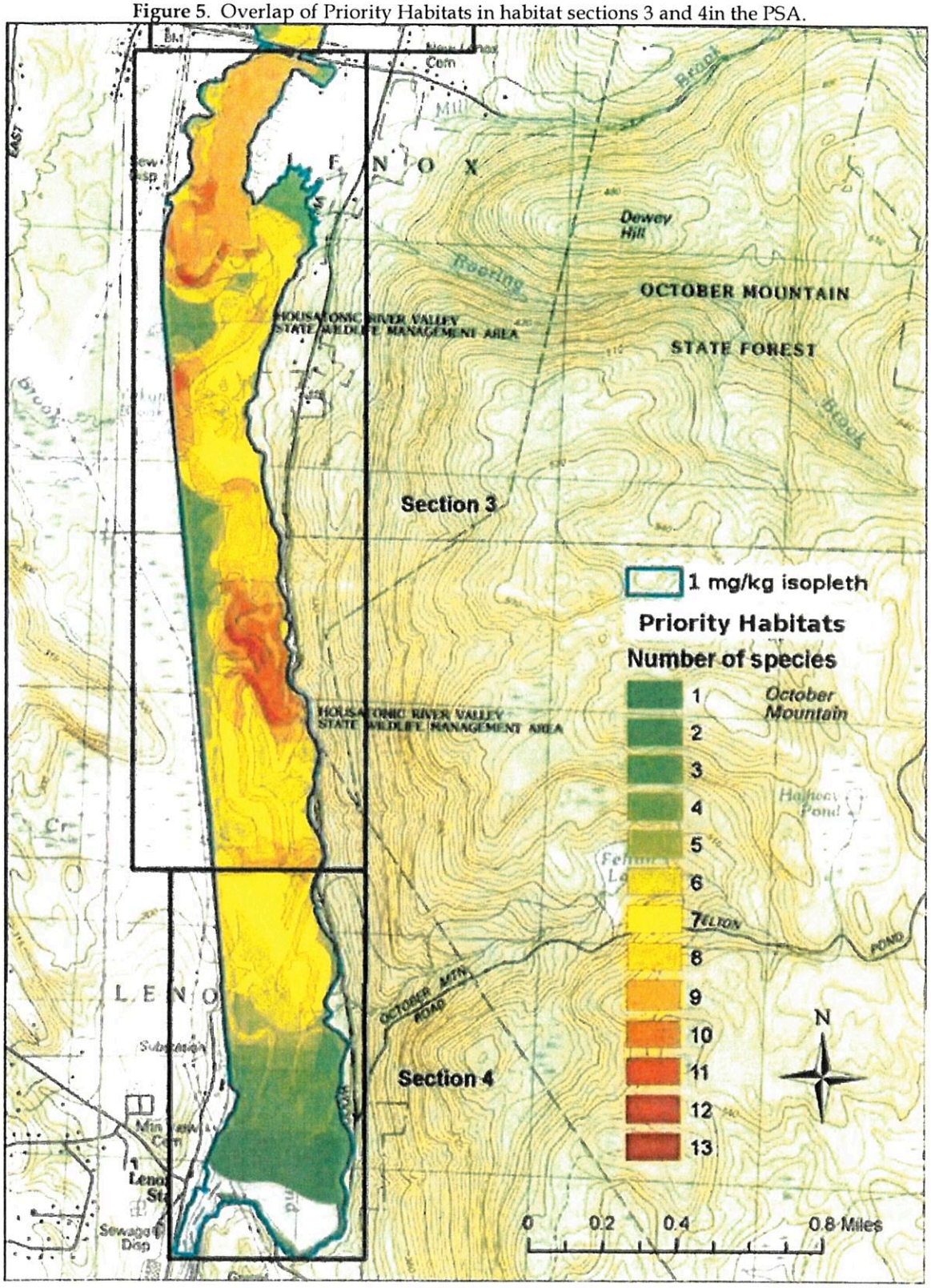


Figure 6. Core Areas for 13 species within the PSA.

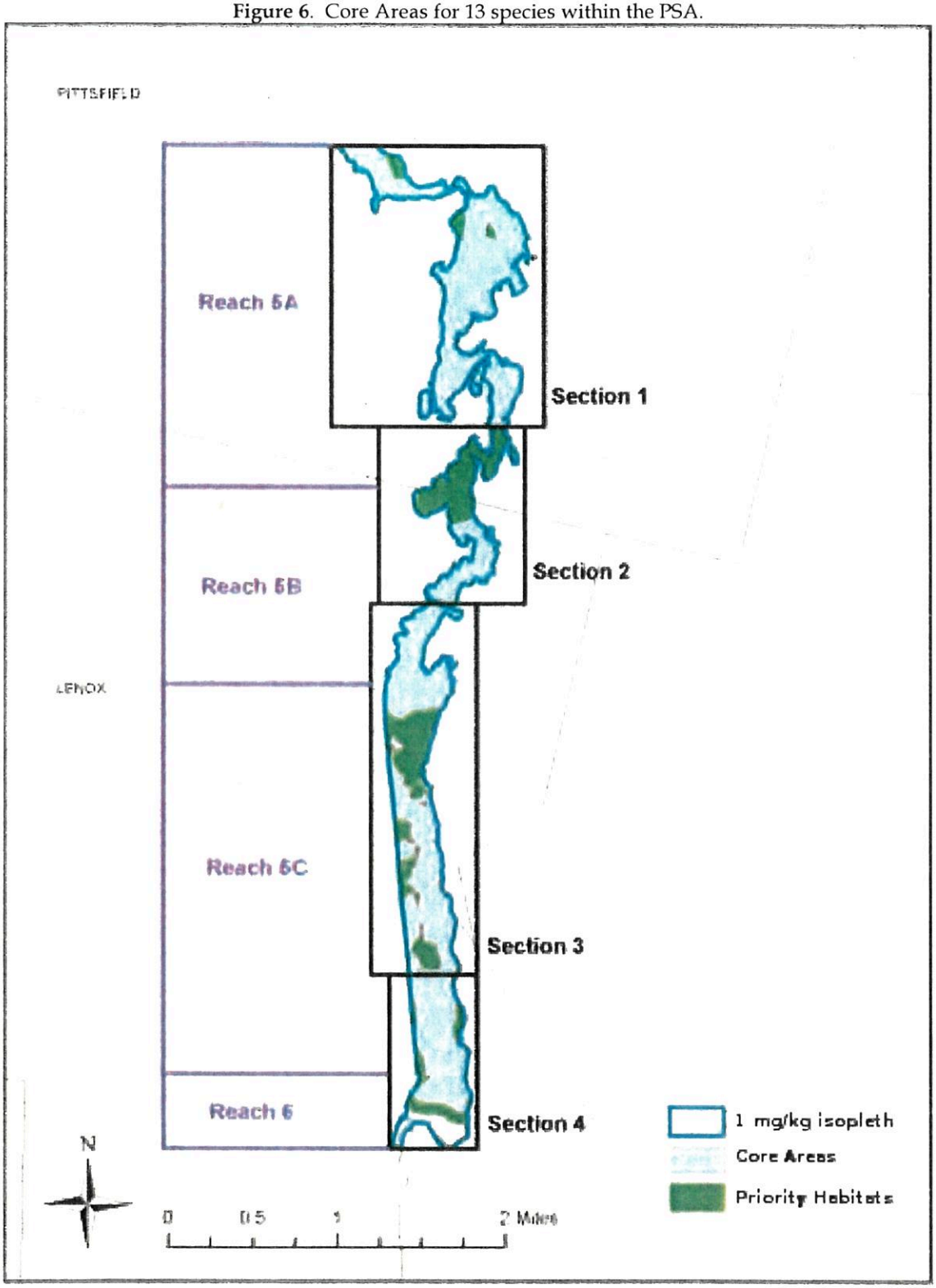


Figure 7. Meander, Oxbow, and Floodplain Processes

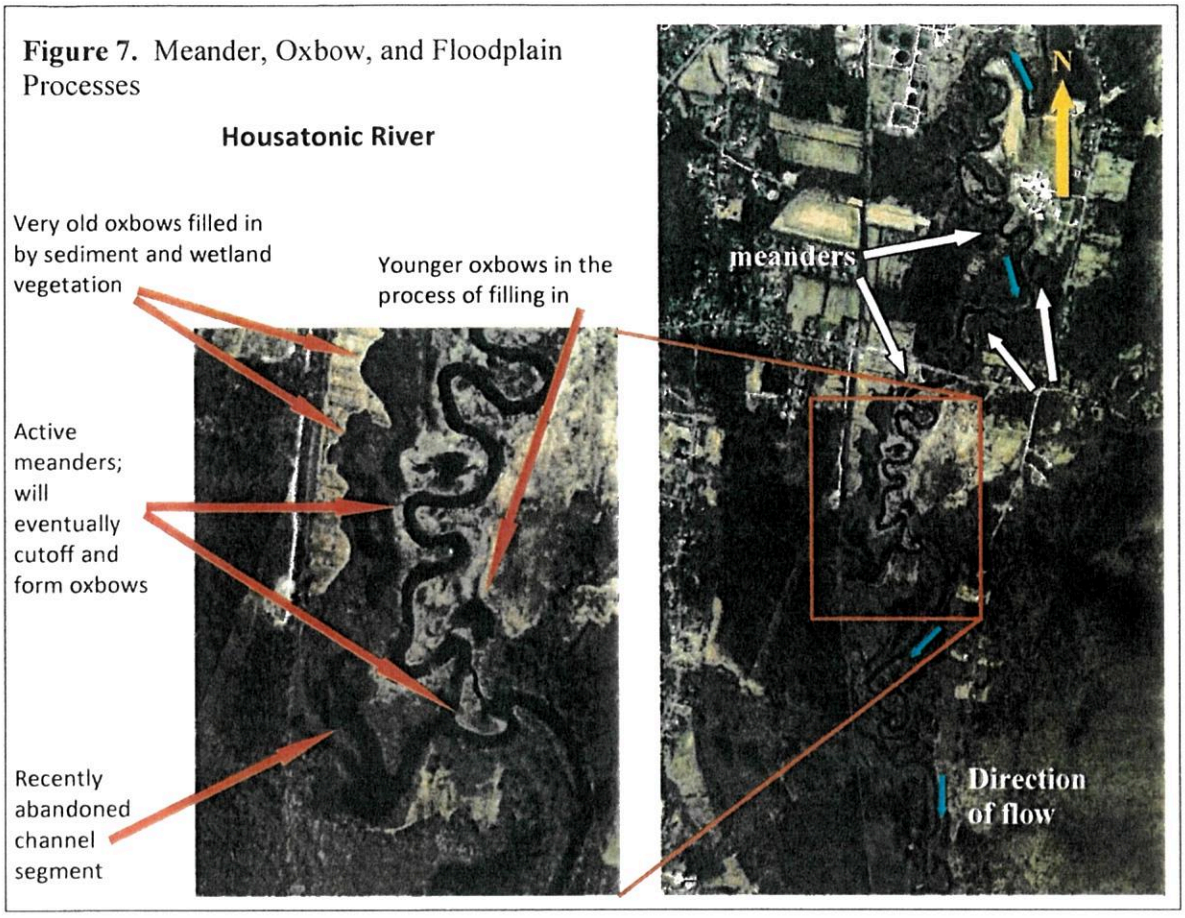
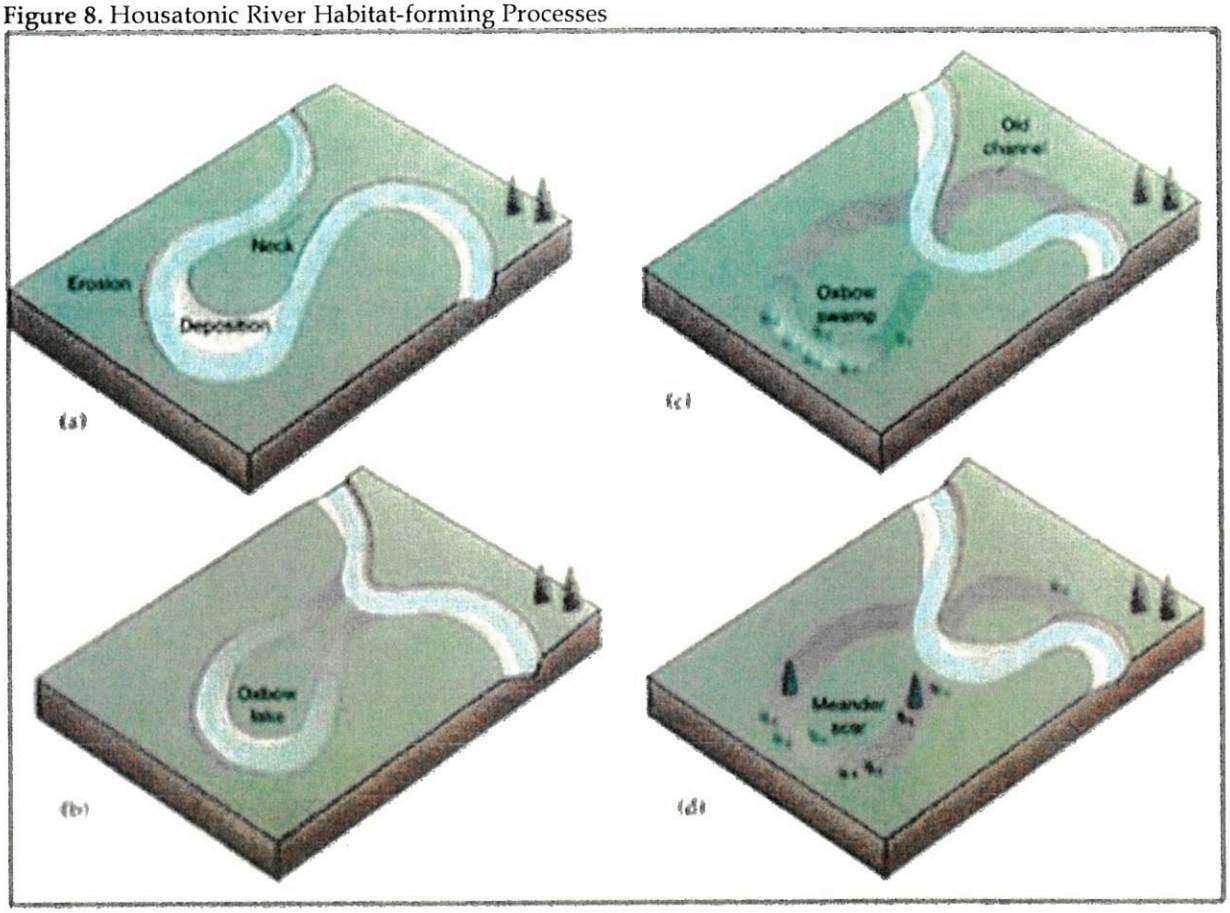
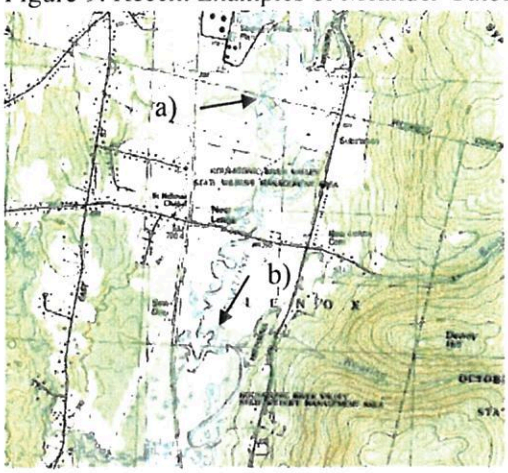


Figure 8. Housatonic River Habitat-forming Processes

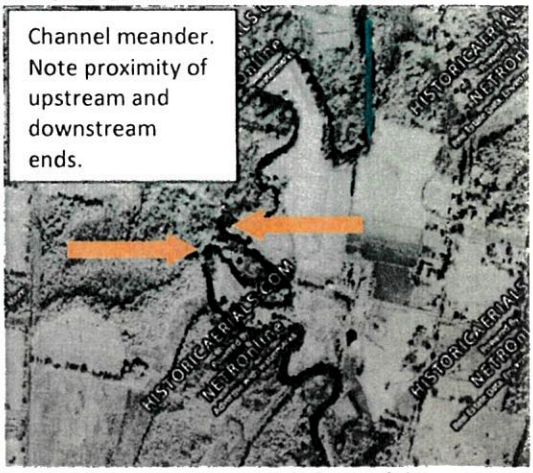


(Central Michigan University College of Science and Technology)

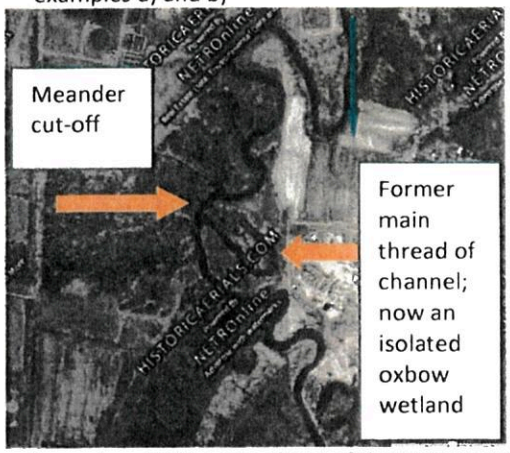
Figure 9. Recent Examples of Meander Cutoff and Side Channel Formation in the PSA



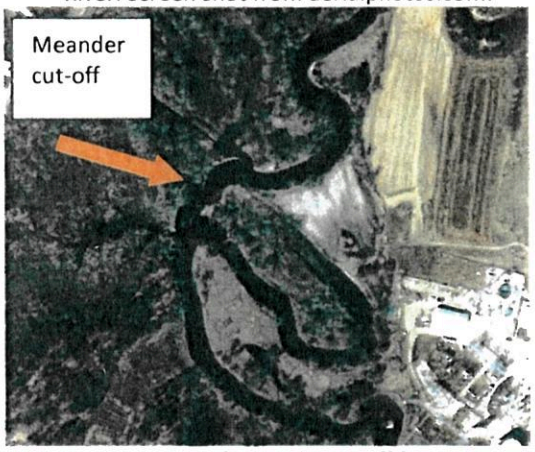
a. Locations of post-1971 channel change examples a) and b)



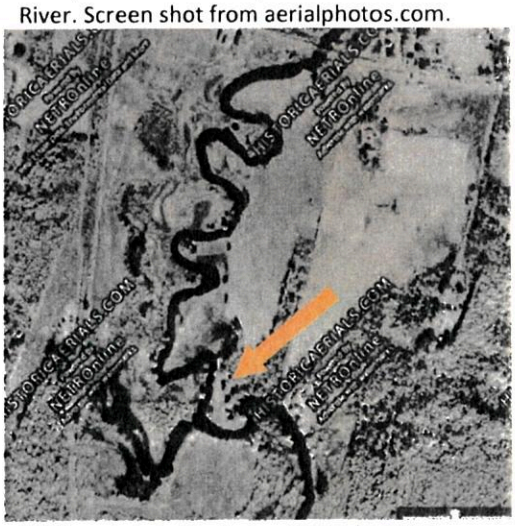
b. Example a. 1971 aerial photo of the Housatonic River. Screen shot from aerialphotos.com.



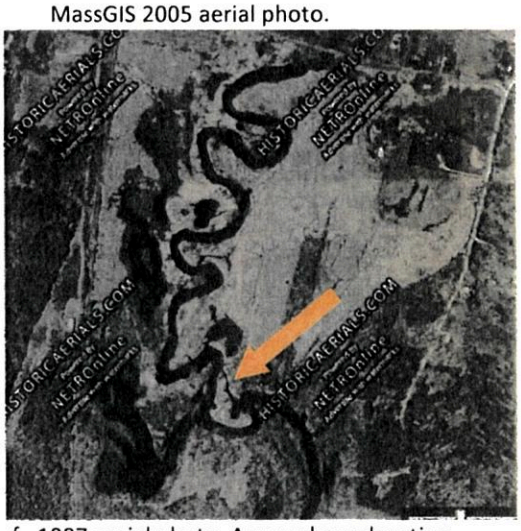
c. Example a. 1997 aerial photo of the Housatonic River. Screen shot from aerialphotos.com.



d. Detailed view of meander cutoff from MassGIS 2005 aerial photo.



e. 1971 aerial photo. Arrow shows location of 1997 side channel.



f. 1997 aerial photo. Arrow shows location of new side channel.

Rare Species and Natural Community Surveys in the Housatonic River Watershed of Western Massachusetts

Natural Heritage and Endangered Species Program
Massachusetts Division of Fisheries and Wildlife

July 2010

Rare Species and Natural Community Surveys in the Housatonic River Watershed of Western Massachusetts

Prepared for:

Trustee Sub-Council for Massachusetts
Natural Resource Trustees for the GE/Housatonic River NRDAR Case

Massachusetts Executive Office of Energy and Environmental Affairs
and
United States Fish and Wildlife Service

In partial completion of Proposal 18:
"Rare Species Recovery on the Housatonic River"

Prepared by:

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July 2010

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Rare Species and Natural Community Surveys in the Housatonic River Watershed of Western Massachusetts

EXECUTIVE SUMMARY

The Housatonic River watershed is critical to biological conservation in Massachusetts. The Western New England Marble Valleys ecoregion that spans the lowlands of the Housatonic watershed is characterized by calcium-rich conditions that support some of the rarest plants, animals, and natural communities in the state. The watershed currently contains 110 plant species and 51 animal species protected by the Massachusetts Endangered Species Act (MESA). As part of the legal settlement with the General Electric Company for releasing polychlorinated biphenyls (PCBs) into the Housatonic River and its floodplain, the Massachusetts Natural Heritage and Endangered Species Program (NHESP) was awarded funds via the Massachusetts Sub-Council of the Housatonic River Trustee Council under the auspices of the Massachusetts and Department of the Interior (DOI) Natural Resource Damage Assessment and Restoration (NRDAR) Programs. It used these funds to undertake the most intensive and comprehensive ecological field study in the Program's history. The study focused on protected species and priority natural communities known to occur in the critical supporting watershed of the Housatonic River. Nearly 50 people participated in field studies and conducted nearly 2,500 site visits, with survey effort including approximately 495 days and more than 9,000 person-hours for fieldwork alone. Studies targeted a total of 60 state-listed species including a variety of plants (31), butterflies and moths (three), dragonflies and damselflies (five), freshwater mussels (two), fish (four), salamanders (two), turtles (three), and marsh birds (ten). The project also targeted 12 priority (S1-S3) natural community types. A total of 47 target species and 21 non-target state-listed species were encountered during the studies. Among the newly documented species were ten Endangered, five Threatened, and six Special Concern species. All of the target types of natural communities were found and an additional four priority natural community types were documented for the first time in the critical supporting watershed. The survey results greatly enhance resource protection afforded under MESA and the Wetlands Protection Act and will also help establish conservation priorities for federal, state, and local governments as well as non-government conservation organizations. Field studies described in this technical report, combined with existing natural resource data for the study area, will form the basis for a biodiversity conservation plan that includes priorities and recommendations for habitat protection, restoration, and management in the critical supporting watershed of the Housatonic River. The plan will be disseminated to stakeholders in the form of reports to each of 19 towns in the critical supporting watershed and a non-technical summary that appeals to the public and helps raise public awareness for watershed conservation efforts.

Housatonic River near Canoe Meadows Wildlife Sanctuary, Pittsfield. Ethan Nedeau

INTRODUCTION

The Housatonic watershed of western New England spans approximately 1,950 square miles of strikingly varied landscape, from the glacially scoured Taconic Mountains and Berkshire Highlands south through the highlands of western Connecticut to the Atlantic coastal plain. The Housatonic River flows through the heart of its watershed, meandering through expansive pastoral lands and cutting sharply through steep rocky ravines along its 149-mile path to the Long Island Sound. The Housatonic River watershed spans 545 square miles of southwestern Massachusetts (Figure 1) and includes 54 miles of the upper Housatonic River. The entire Massachusetts length of the Housatonic River flows through the Western New England Marble Valleys ecoregion[1] (Figure 2), a relict of an ancient shallow marine sea that was lost when continents drifted toward each other to connect along a seam that separates what is now New York and the Lake Champlain basin from the rest of New England. The calcium-rich marine sediments of the ancient seafloor were transformed to marble during the Acadian Orogeny 350-400 million years ago (reviewed in Woodlot Alternatives 2002). Although the last glaciers—which left the Housatonic only 10,000-14,000 years ago—and the erosive forces of water shaped current landforms in the watershed, it is the underlying marble that makes the Housatonic watershed one of the most biologically distinctive areas in Massachusetts. The principal characteristics of the Western New England Marble Valleys ecoregion are extensive groundwater aquifers and calcium-rich soil and water, which provide

Figure 1. Location of the Housatonic River watershed in southwestern Massachusetts. Data source: MassGIS.

[1]Ecoregions (or ecological regions) are areas of relatively homogeneous ecological systems, including vegetation, soils, climate, geology, and patterns of human uses)

Calcareous natural community types, such as this calcareous rock outcrop at Renee's Cobble in Sheffield, contribute to the high biological diversity in the Housatonic River watershed. Michael Batcher.

hydrological and chemical conditions preferred by plants and animals found nowhere else in the Commonwealth (Barbour *et al.* 1998, NHESP 2001).

Two of the ecoregions that occur in the Massachusetts portion of the watershed—the Taconic Mountains and the Western New England Marble Valleys—are among the four ecoregions with the highest densities of state-listed species in Massachusetts (Barbour *et al.* 1998). Within these two ecoregions, most of the rare species occur within four broad groups of natural community types: rich mesic forests, calcareous wetlands, river and stream communities, and emergent marshes. In addition to the species whose presence results from unique habitat conditions, the watershed is at the edge of the range for several state-listed species such as the bog turtle (*Glyptemys muhlenbergii*) and bur oak (*Quercus macrocarpa*). The Housatonic watershed is currently known to support 110 species of plants and 51 species of animals that are protected by the Massachusetts Endangered Species Act (MESA) and its implementing regulations (321 CMR 10.00) (NHESP database). Only 15 percent of Berkshire County lands lower than 1,000 feet in elevation – home to 112 state-listed species – receive the benefits of state protection (Barbour *et al.* 1998). In contrast, high elevation areas of the county are inhabited by 25 state-listed species and are relatively well protected—61 percent of lands higher than 2,500 feet in elevation are protected. Lowlands of Berkshire County, especially the Housatonic River valley, are an urgent conservation priority in Massachusetts.

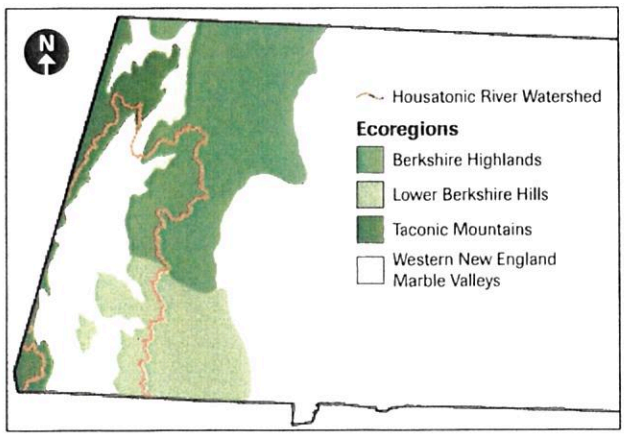


Figure 2. Ecoregions of western Massachusetts, showing the Western New England Marble Valleys through which the Housatonic River flows. Data source: MassGIS.

In 2005, the Natural Heritage and Endangered Species Program sought funds via the Massachusetts Sub-

The confluence of the East and West Branches of the Housatonic River in Pittsfield. Ethan Nedeau.

Council of the Housatonic River Trustee Council under the auspices of the Massachusetts and Department of the Interior (DOI) Natural Resource Damage Assessment and Restoration (NRDAR) Programs, as part of the legal settlement with the General Electric Company for releasing polychlorinated biphenyls (PCBs) into the Housatonic River and its floodplain. NHESP received these funds in 2007. Central to the proposal was the long-held conviction that the Housatonic watershed was critical to statewide biodiversity protection and the belief that state agencies, municipalities, private landowners, and corporate entities had a shared responsibility to protect and restore the watershed. The project had three main objectives regarding the identification, prioritization, and protection of critical natural resources:

- Conduct ecological and endangered species surveys of select habitats and taxonomic groups, especially those species most closely associated with the Housatonic River, its system, and tributaries, to define possible protection and restoration strategies.
- Identify and prioritize sites for habitat protection, restoration, and management.
- Provide conservation planning materials to the 19 municipalities within the primary study area.

This technical document primarily describes accomplishments toward the first objective. Site prioritization (Objective 2) is summarized in this document but is a collaborative effort that will evolve in 2010 and beyond. NHESP will provide conservation planning materials (Objective 3) to towns in the form of reports that are explicit about the rare species or exemplary natural communities that occur in each town and where protection, restoration, or management activities should be directed. The town reports will also incorporate new *BioMap* Core Habitats and are therefore expected to be completed soon after *BioMap 2* is completed late in 2010. In addition to the original objectives described above, NHESP will produce a non-technical summary of the work accomplished with NRD funds that will be engaging and appealing to general audiences and help build momentum for watershed conservation efforts.

STUDY AREA DESCRIPTION

Ecological and rare species studies were conducted within the Massachusetts portion of the Housatonic River watershed (Figure 3), specifically in areas closely tied to the Housatonic River. The study area was termed the **critical supporting watershed** and its boundaries (Figure 4) were determined using a grid-based watershed delineation model ("AQUALAND") developed at the University of Massachusetts (McGarigal *et al.* 2003). The critical supporting watershed included the Housatonic River and its floodplains, lower portions of major and minor tributaries, and nearby wetlands and terrestrial lands that may support aquatic and riparian species. Rare species and natural communities in higher elevations of the watershed, as well as most lakes, were excluded from the study.

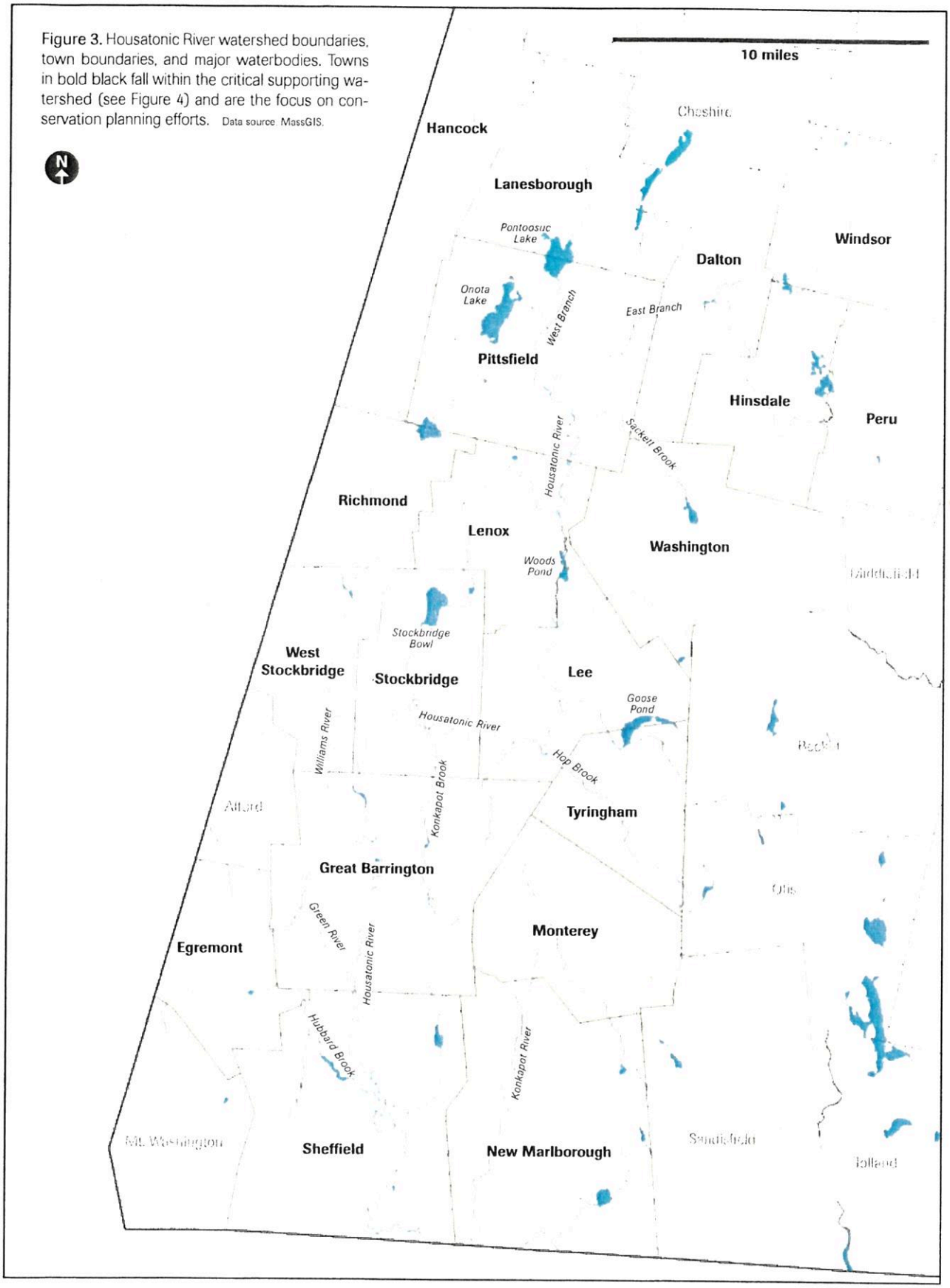


Figure 3. Housatonic River watershed boundaries, town boundaries, and major waterbodies. Towns in bold black fall within the critical supporting watershed (see Figure 4) and are the focus on conservation planning efforts. Data source: MassGIS.

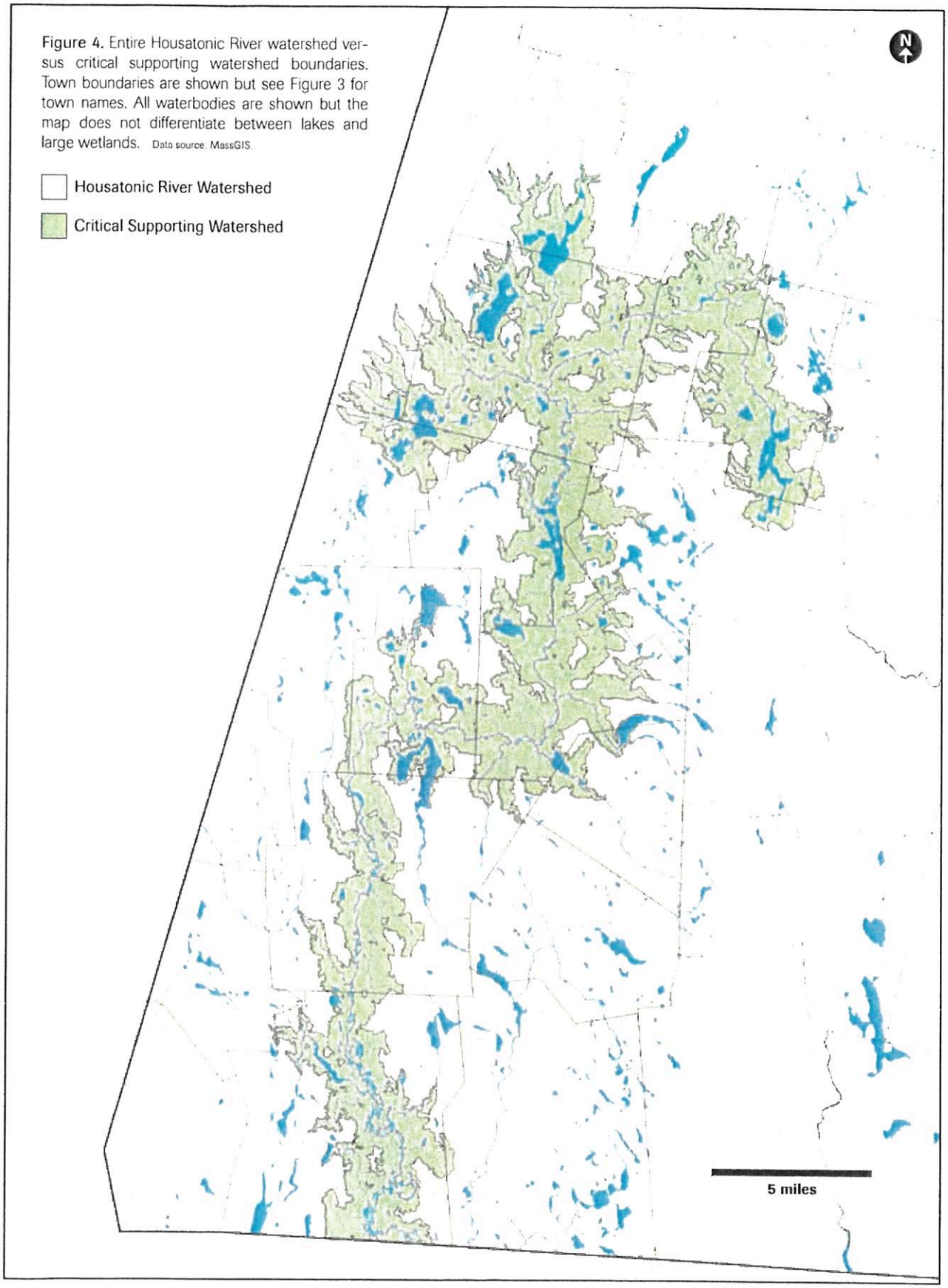


Figure 4. Entire Housatonic River watershed versus critical supporting watershed boundaries. Town boundaries are shown but see Figure 3 for town names. All waterbodies are shown but the map does not differentiate between lakes and large wetlands. Data source: MassGIS.

TARGET TAXA AND NATURAL COMMUNITIES

Surveys focused on state-listed plants and animals, priority natural communities (see Table 1 for ranking definitions), and vernal pools that were known, or suspected, to occur in the critical supporting watershed (Table 2). Existing **element occurrences** (EOs) are carefully tracked and updated by NHESP and helped direct the selection of survey targets and survey sites. EOs are defined as areas where a rare species population or natural community is (or was) present and which have practical conservation value for the species or community. In addition to EOs, NHESP also tracks some information on EO sources, including all the individual plants or animals that might constitute a single EO. In this report, EO sources are discussed specifically for the botanical surveys that targeted both EOs and EO sources. One of the primary reasons that this survey targeted existing or historic EOs (occurrences with the most recent record more than 25 years old are called historic) is that EOs only receive MESA protection for 25 years since the last observation. EOs with older records might or might not continue to support rare species, but without updates verifying the continued presence of rare species they receive no legal protection. Thus, there is a continual need to update EOs to maintain the legal protections provided to rare species and their habitats. Some of the more recent EOs in the NHESP database were not targeted for the NRD surveys because of the long time before they would expire and the need to focus efforts on older EOs.

The life history and dispersal ability of target taxonomic groups were considered when defining the geographic scope of studies; central goals were to locate source populations that might recolonize impacted areas and to protect dispersal routes to facilitate natural recovery. For example, dragonfly, wood turtle, fish, and marsh bird surveys were often conducted far up tributaries and in more remote areas because these mobile species may be able to replenish depleted populations nearer the Housatonic River or elsewhere in the critical supporting watershed. Targets are briefly described below.

Plants: A total of 83 state-listed or Watch List plant species were known from the critical supporting watershed prior to NRD surveys, with eight additional species considered to have been historically present. From among the pool of 91 rare plant species, surveys primarily targeted 31 species expected to occur in wetlands and forests in the floodplain of the Housatonic River (Table 2), whereas high-elevation species were not targeted. There were four objectives: (1) update EO records in the study area, (2) conduct searches for new rare plant species and occurrences in the study area, (3) assess the spatial extent and condition of habitat supporting EOs, and (4) assess threats to, and management needs of, rare plants and their habitats.

Table 1. Definition of regulatory (Massachusetts Endangered Species Act) and non-regulatory status ranks used for species and natural communities in this report.

Status Ranks	Definition
Regulatory (MESA)	
Endangered	Endangered (E) species are native species which are in danger of extinction throughout all or part of their range, or which are in danger of extirpation from Massachusetts, as documented by biological research and inventory.
Threatened	Threatened (T) species are native species which are likely to become endangered in the forseeable future, or which are declining or rare as determined by biological research and inventory.
Special Concern	Special concern (SC) species are native species which have been documented by biological research or inventory to have suffered a decline that could threaten the species if allowed to continue unchecked, or which occur in such small numbers or with such restricted distribution or specialized habitat requirements that they could easily become threatened within Massachusetts.
Non-Regulatory	
Watch List	The plant Watch List (WL) is an unofficial, non-regulatory list of plants of known or suspected conservation concern that NHESP is interested in tracking.
State Ranks (S rank)	The state rank (S) reflects the rarity and threat within Massachusetts. The non-regulatory ranks for communities: S1 is least common, S5 most common;
S1	Typically 5 or fewer occurrences, very few remaining individuals, acres, or miles of stream or especially vulnerable to extirpation in Massachusetts for other reasons.
S2	Typically 6 - 20 occurrences, few remaining individuals, acres, or miles of stream or very vulnerable to extirpation in Massachusetts for other reasons.
S3	Typically 21 - 100 occurrences, limited acreage, or miles of stream in Massachusetts.
S4	Apparently secure in Massachusetts.
S5	Demonstrably secure in Massachusetts

Moths and Butterflies: Two species of butterflies associated with wetland habitats were targeted for surveys: the Dion Skipper (*Euphyes dion*) and Mustard White (*Pieris oleracea*). Both species are listed as Threatened in Massachusetts. The Dion Skipper inhabits sedge wetlands, and it nectars in open wetlands and upland fields. Berkshire County contains eight of the nine known locations in Massachusetts; these records comprise the northeastern edge of the species' range. The Mustard White inhabits a variety of habitats, including riparian floodplains, margins of fens and marshes, wet meadows, fields, and pastures. The species has been found at only six locations in

Table 2. State-listed species and priority natural communities either specifically targeted or found during NRD surveys. Ranks: E = Endangered, T = Threatened, SC = Special Concern, EXT = Extirpated, NL = Not Listed, S-ranks (natural community types) described Table 1.

Common Name	Latin Name	Rank
Plants		
Black Maple	*Acer nigrum*	SC
Black Cohosh	*Actaea racemosa*	E
Climbing Fumitory	*Adlumia fungosa*	SC
Small-flowered Agrimony	*Agrimonia parviflora*	E
Green Dragon	*Arisaema dracontium*	T
Mountain Spleenwort	*Asplenium montanum*	E
Smooth Rock-cress	*Boechera laevigata*	T
Purple Cress	*Cardamine douglassii*	E
Foxtail Sedge	*Carex alopecoidea*	T
Davis's Sedge	*Carex davisii*	E
Gray's Sedge	*Carex grayi*	T
Hairy-fruited Sedge	*Carex trichocarpa*	T
Tuckerman's Sedge	*Carex tuckermanii*	E
Cat-tail Sedge	*Carex typhina*	T
Narrow-leaved Spring Beauty	*Claytonia virginica*	E
Hemlock Parsley	*Conioselinum chinense*	SC
Showy Lady's-slipper	*Cypripedium reginae*	SC
Wright's Spike-rush	*Eleocharis diandra*	E
Intermediate Spike-sedge	*Eleocharis intermedia*	T
Ovate Spike-rush	*Eleocharis ovata*	E
Hairy Wild Rye	*Elymus villosus*	E
Dwarf Scouring-rush	*Equisetum scirpoides*	SC
Frank's Lovegrass	*Eragrostis frankii*	SC
Andrews' Bottle Gentian	*Gentiana andrewsii*	E
Giant St. John's-wort	*Hypericum ascyron*	E
Great Blue Lobelia	*Lobelia siphilitica*	E
Hairy Honeysuckle	*Lonicera hirsuta*	E
Many-fruited False-loosestrife	*Ludwigia polycarpa*	E
Winged Monkeyflower	*Mimulus alatus*	E
Comb Water-milfoil	*Myriophyllum verticillatum*	E
Tiny Cow-lily	*Nuphar microphylla*	E
Drooping Speargrass	*Poa saltuensis ssp. languida*	E
Hill's Pondweed	*Potamogeton hillii*	SC
Ogden's Pondweed	*Potamogeton ogdenii*	E
Bur Oak	*Quercus macrocarpa*	SC
Yellow Oak	*Quercus muehlenbergii*	T
Bristly Buttercup	*Ranunculus pensylvanicus*	T
Swamp Dock	*Rumex verticillatus*	T
Wapato	*Sagittaria cuneata*	T
Long-styled Sanicle	*Sanicula odorata*	T
Wild Senna	*Senna hebecarpa*	E
Shining Wedgegrass	*Sphenopholis nitida*	T
Small Dropseed	*Sporobolus neglectus*	E
Crooked-stem Aster	*Symphyotrichum prenanthoides*	T
Culver's-root	*Veronicastrum virginicum*	T
Barren Strawberry	*Waldsteinia fragarioides*	SC
	Total Species	46
Butterflies and Moths		
Dion Skipper	*Euphyes dion*	T
Mustard White	*Pieris oleracea*	T
Ostrich Fern Borer	*Papaipema sp. 2 near pterisii*	SC
	Total Species	3
Dragonflies		
Arrow Clubtail	*Stylurus spiniceps*	T
Zebra Clubtail	*Stylurus scudderi*	SC
Brook Snaketail	*Ophiogomphus aspersus*	SC
Riffle Snaketail	*Ophiogomphus carolus*	T
Skillet Clubtail	*Gomphus ventricosus*	SC
Spine-crowned Clubtail	*Gomphus abbreviatus*	E
Rapids Clubtail	*Gomphus quadricolor*	T
Harpoon Clubtail	*Gomphus descriptus*	E
Ocellated Darner	*Boyeria grafiana*	SC
Stygian Shadowdragon	*Neurocordulia yamaskanensis*	SC
	Total Species	10
Freshwater Mussels		
Triangle Floater	*Alasmidonta undulata*	SC
Creeper	*Strophitus undulatus*	SC
	Total Species	2
Fish		
Burbot	*Lota lota*	SC
Trout Perch	*Percopsis omiscomaycus*	EXT
Bridle Shiner	*Notropis bifrenatus*	SC
Longnose Sucker	*Catostomus catostomus*	SC
	Total Species	4
Salamanders		
Four-toed Salamander	*Hemidactylium scutatum*	NL
Jefferson Salamander	*Ambystoma jeffersonianum*	SC
Marbled Salamander	*Ambystoma opacum*	T
	Total Species	3
Turtles		
Wood Turtle	*Glyptemys insculpta*	SC
Bog Turtle	*Glyptemys muhlenbergii*	E
Eastern Box Turtle	*Terrapene c. carolina*	SC
	Total Species	3
Marsh Birds		
Virginia Rail	*Rallus limicola*	NL
Sora	*Porzana carolina*	NL
American Bittern	*Botaurus lentiginosus*	E
Least Bittern	*Ixobrychus exilis*	E
King Rail	*Rallus elegans*	E
Common Moorhen	*Gallinula chloropus*	SC
Pied-billed Grebe	*Podilymbus podiceps*	E
Sedge Wren	*Cistothorus platensis*	E
Marsh Wren	*Cistothorus palustris*	NL
Green Heron	*Butorides virescens*	NL
	Total Species	10
Priority Palustrine Natural Community Types		
Acidic Graminoid Fen		S3
Alluvial Red Maple Swamp		S3
Black Ash Swamp		S2
Black Ash-Red Maple-Tamarack Calcareous Seepage Swamp		S2
Calcareous Basin Fen		S1
Calcareous Sloping Fen		S2
Level Bog		S3
Major-River Floodplain Forest		S2
Red Maple-Black Ash-Bur Oak Swamp		S2
Small-River Floodplain Forest		S2
Spruce-Fir Boreal Swamp		S3
Transitional Floodplain Forest		S2
Priority Terrestrial Natural Community Types		
Calcareous Forest Seep		S2
Calcareous Rock Cliff		S3
Calcareous Rocky Summit/Rock Outcrop		S2
High Terrace Floodplain Forest		S2
Rich Mesic Forest		S3
Ridgetop Pitch Pine-Scrub Oak		S2
Yellow Oak Dry Calcareous Forest		S2
	Total Natural Communities	19

Massachusetts, all in central Berkshire County, and these populations comprise the southernmost extent of the species' range in eastern North America. The Ostrich Fern Borer (*Papaipema* sp. 2 near *pterisii*), a Special Concern moth species, was also targeted for NRD surveys. Most of the known occurrences for this species in Massachusetts are in the Housatonic River floodplain, where it is associated with stands of ostrich fern (*Matteuccia struthiopteris*) in mature floodplain forests and wooded swamps.

Dragonflies and Damselflies: Prior to the NRD surveys, five state-listed dragonfly species and one state-listed

Four of the target state-listed species, including triangle floater (top left), Jefferson salamander (bottom left), wood turtle (top right) and Least Bittern (bottom right). In the order mentioned: Ethan Nedeau, Steve Johnson, Ethan Nedeau, Patricia Serrentino

damselfly species were known from the critical supporting watershed, but the whole region was undersurveyed and there was high potential for finding several more state-listed species. Thus, surveys targeted all riverine dragonflies in the mainstem Housatonic River and its tributaries rather than focusing on small areas or single species. Damselflies were not specifically targeted because they tend to be far less diverse in riverine environments and because the only state-listed damselfly previously known from the critical supporting watershed, the Tule Bluet (*Enallagma carunculatum*), prefers larger lakes. Primary targets were rare dragonfly species in the genera *Stylurus*, *Ophiogomphus*, *Gomphus*, and *Boyeria*. The life cycle of dragonflies includes an aquatic larval stage and aerial adult stage. From May through September (depending on the species), larvae emerge from the water when ready to metamorphose into adults; when they find an appropriate surface the adult form will shed their larval exoskeletons (called exuviae), unfurl and dry their wings, and then take flight. Surveys focused on larvae, exuviae, and adults.

Freshwater Mussels: Two state-listed freshwater mussel species were known from the Housatonic watershed prior to NRD surveys: the triangle floater (*Alasmidonta undulata*) and creeper (*Strophitus undulatus*). NHESP had only five site records for the triangle floater and four site records for the creeper, but thorough and systematic mussel surveys had never been conducted in the watershed. Both species occur in small to large streams and rivers throughout central and eastern Massachusetts and are also known from several sites in the Connecticut portion of the Housatonic watershed. For the NRD project, surveyors targeted all freshwater mussel species because of their importance to stream ecosystems and because they are indicators of the quality of water and habitat.

Fish: Three state-listed fish species and one species considered extirpated in Massachusetts have been reported in the Housatonic River watershed in Massachusetts. All four were targeted for the NRD surveys. Two species, the longnose sucker (*Catostomus catostomus*) and bridle shiner (*Notropis bifrenatus*)—both listed as Special Concern in Massachusetts—have been recently collected in the watershed. The longnose sucker occurs in cool rocky sections of streams and rivers in western Massachusetts, including the Deerfield, Housatonic, Hoosic, and

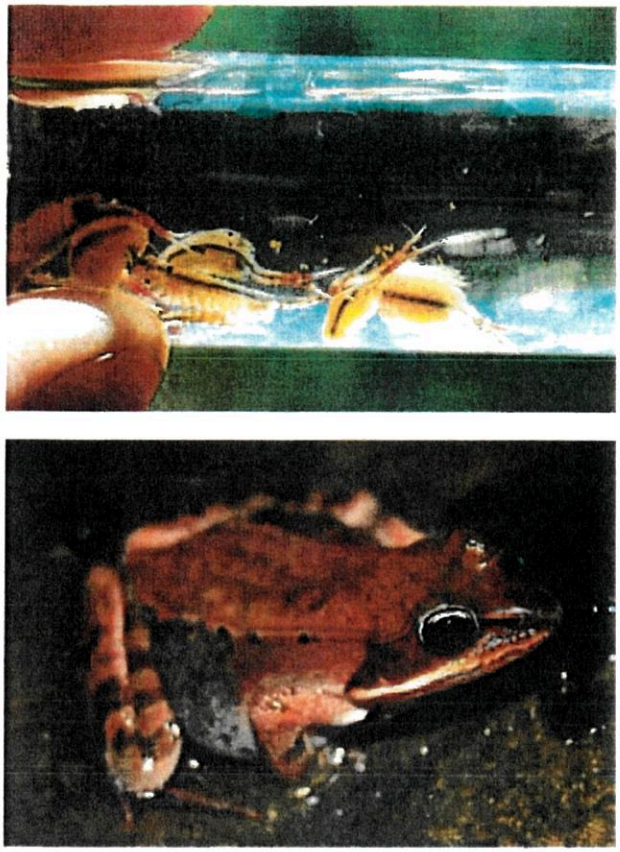
Plant and natural communities conducted in 2008 also noted presence of ostrich fern stands in floodplain forests, which were then targeted for Ostrich Fern Borer moth surveys in 2009. Michael Batcher.

Westfield watersheds. The bridle shiner occurs in slack areas of streams and rivers, as well as ponds and lakes, especially among submerged aquatic vegetation.

Two target fish species were historically reported from the watershed or occur in nearby Connecticut. The burbot (*Lota lota*), a species of Special Concern in Massachusetts, occurs in tributaries in the Connecticut portion of the Housatonic watershed. The trout perch (*Percopsis omiscomaycus*), a species more common west of New England, has not been seen in Massachusetts since 1942 when it was found near the mouth of the Green River and the species is now considered extirpated.

Salamanders: Only two state-listed salamander species were known from the study area prior to NRD surveys: the Jefferson salamander (*Ambystoma jeffersonianum*) and four-toed salamander (*Hemidactylium scutatum*). The Jefferson salamander is listed as Special Concern in Massachusetts and is thought to occur primarily in the western half of the state. They live in upland deciduous or mixed forests within one mile of their breeding wetlands. The four-toed salamander was removed from the MESA list in 2008 after NRD surveys had been initiated. They occur throughout Massachusetts in a variety of forested wetlands and boggy habitats and nest in *Sphagnum* mounds (sometimes tussock sedge mounds) over standing water. The marbled salamander (*Ambystoma opacum*), which is listed as Threatened in Massachusetts, was not targeted for NRD surveys because it had never been reported in the watershed. It occupies similar habitat as Jefferson salamanders but has a more central and eastern distribution in Massachusetts and a more southern distribution range-wide. As described in the results, this species was documented in the Massachusetts portion of the Housatonic watershed for the first time ever.

Turtles: Surveys targeted two state-listed turtle species that occur in the Housatonic watershed. These include the wood turtle (*Glyptemys insculpta*) and bog turtle (*Glyptemys muhlenbergii*). The wood turtle is listed as Special Concern in Massachusetts, and it is widespread but uncommon from the coastal plain to the Housatonic watershed. It prefers slow-moving mid-sized streams with sandy bottoms and vegetated riparian areas. The bog turtle is listed as Endangered in Massachusetts and is also federally listed as Threatened by the United States Fish and Wildlife Service. The bog turtle inhabits calcareous fen wetlands in the Housatonic watershed and known populations are extremely isolated. A third state-listed turtle species, the eastern box turtle (*Terrapene c. carolina*) has been reported in the lower Housatonic watershed in Massachusetts (including one old carapace) but natural



Though not rare, fairy shrimp (top) and wood frogs (bottom) are obligate vernal pool species and were targeted to confirm whether pools met biological criteria for certification. Steve Johnson

populations have never been detected and historic reports might be escaped pets. A modest survey was conducted in 2009 but a much more intensive effort would be needed to detect low-density populations (if they exist).

Marsh Birds: Ten marsh bird species were targeted for surveys (Table 2), including five that had been recently confirmed in the study area, one historic species, and four species for which little prior information was available. Only six of the ten species are state-listed in Massachusetts (four Endangered, one Threatened, one Special Concern). Marsh birds are the only taxonomic group for which non-MESA listed species were surveyed: the four non-listed species occur in habitats similar to those of the listed marsh birds, and are often surveyed with them. Two of the four (Sora and Green Heron) are included In the Massachusetts Wildlife Action Plan[2] (WAP), a project to support conservation efforts aimed at preventing wildlife from becoming endangered. Surveys targeted large open wetlands throughout the watershed containing variable amounts of cattail (*Typha* spp.), tussock sedge (*Carex stricta*) and other wetland sedges, low shrubs, reed canary grass (*Phalaris arundinacea*), and the non-native common reed (*Phragmites australis*).

Vernal Pools: Vernal pools are temporary bodies of freshwater that either fill in the fall and hold water until the following spring ("autumnal pools") or fill in the springtime by spring rains and snowmelt and dry later in the summer. Most dry annually (with some variation due to size and depth of the vernal pool and precipitation) and therefore do not support fish populations. Many vernal pools throughout Massachusetts are critical breeding habitats for rare species, especially mole salamanders (*Ambystoma* spp.) and might also be foraging areas for other important wildlife species. A total of 786 potential vernal pools (PVPs) had been identified in the Housatonic watershed based on analysis of aerial photography (NHESP 2001), but only 70 were certified prior to 2008. Certified vernal pools are protected by the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) as well as other state and local laws. NHESP administers the official vernal pool certification program in Massachusetts and protects state-listed species associated with these habitats. Therefore, NRD surveys targeted both vernal pools and the state-listed species that could potentially inhabit them.

Natural Communities: Natural communities are groups of plants and animals that are found in recurring patterns and can be classified and described by their dominant physical and biological features. Each type of natural community receives an element rank that reflects its rarity and threat within Massachusetts. Priority natural communities are generally ranked from S1 (highest) to S3; lower-ranked communities (S4 and S5) are more common and widespread in the state. Prior to the NRD surveys, there were nine types of priority freshwater communities and three types of priority terrestrial communities in the critical supporting watershed (Table 2). Among these were one S1 community (Calcareous Basin Fen, two occurrences), six S2 communities, and five S3 communities. These were the primary targets for the NRD surveys, although the survey had a second major objective of documenting new or additional priority types of natural communities in the critical supporting watershed.

METHODS

NHESP solicited proposals for ecological and state-protected species work and contracted with expert consultants, academic researchers, and graduate students

[2]Website: www.mass.gov/dfwele/dfw/habitat/cwcs/cwcs_background

Table 3. Contractors and NHESP staff that contributed to fieldwork and preparation of the technical report.

Contractors (Principal Investigator)	Affiliation (s)	Category/Project Focus	Year
James Gibbs and Angela Sirois	State University of New York, ESF	Bog Turtles	2008-2009
Tom Lautzenheiser	Massachusetts Audubon Society	Butterflies	2008-2009
John Baker	Clark University	Fish	2009
Kimberly Ogden	University of Massachusetts Amherst	Four-Toed Salamanders	2008
Ethan Nedeau	Biodrawversity	Freshwater Mussels	2008-2009
Noah Charney	University of Massachusetts Amherst	Jefferson Salamanders, Vernal Pools	2008-2009
Jennifer Strules	Independent Wildlife Biologist	Marsh Birds	2008
Patricia Serrentino	Independent Wildlife Biologist	Marsh Birds	2009
Michael Batcher	Independent Ecologist	Natural Communities	2008-2009
David Wagner, Alexander Meleg, Michael C. Thomas, and Greg Hanisek	University of Connecticut	Odonate Surveys	2008
Fred Morrison	A Natural Focus	Odonate Surveys - Northern tributaries	2009
Ethan Nedeau	Biodrawversity	Odonate Surveys - Southern tributaries	2009
Suzanne Fowle	Independent Wildlife Biologist	Turtles	2009
Marybeth Hanley	Independent Botanist	Vascular Plants	2008-2009
William Moorhead	Independent Botanist	Vascular Plants	2008-2009
Michael Jones	University of Massachusetts Amherst	Wood Turtle	2008
Ethan Nedeau	Biodrawversity	Data analysis, report coordination, and writing	2009-2010
NHESP Staff			
Chris Buelow	NHESP	Marsh Birds	2008-2009
Michael Nelson	NHESP	Ostrich Fern Borer Moth	2009

(Table 3). Specific objectives, survey locations, methods, and reporting expectations varied among the different projects. Contractors closely coordinated with one or more NHESP staff to ensure that reports and data were submitted in a manner that would ensure their inclusion in NHESP's rare species database and conservation planning efforts. This report briefly describes the methods used for each taxonomic group, vernal pools, and natural communities. Methods are usually described in greater detail in the full submissions from contractors.

I. Ecological and Endangered Species Surveys

Plants: Marybeth Hanley and William Moorhead (both independent contractors) completed the botanical studies. The project focused on rediscovering and updating existing EOs and EO sources. Surveys primarily targeted wetland and upland plant species within the floodplain in Sheffield, Great Barrington, Lenox, and Pittsfield. Approximately 308 sites or EOs were visited. Field forms were completed according to NHESP specifications. Fieldwork was performed in 2008 and 2009 (two botanists, 120 days).

Moths and Butterflies: Tom Lautzenheiser of the Massachusetts Audubon Extension Services led the butterfly surveys. Eight locations were surveyed for Mustard White, including five where it had been previously documented and three with potential habitat. Surveys were conducted on sunny days during the flight period in April and May of 2008. Seven sites were surveyed for Dion Skipper on sunny days during the July flight period in 2008. Michael Nelson of NHESP surveyed for the Ostrich Fern Borer at seven floodplain sites where large concentrations of ostrich fern had been noted during the first year of the NRD funded surveys; larval surveys were conducted in 67 acres of potential habitat in the summer of 2009. Ostrich Fern Borer larvae were collected and reared to the adult stage to confirm their identity. Presence of host plants and the approximate extent of suitable habitat were noted at each survey site where the target species were found.

Dragonflies and Damselflies: In 2008, Dr. David Wagner of the University of Connecticut led a team that surveyed for dragonflies along nearly 51 miles of the Housatonic River, including 72 "sites" of varying length for a total of 104 site visits. In 2009, the consulting firms Biodrawversity LLC and A Natural Focus completed dragonfly and damselfly surveys in tributaries, collectively surveying 51 sites in 31 tributaries for a combined 85 site visits. Surveys focused on aquatic larvae in wadeable areas, exuviae and tenerals (pre-flight adults) along riverbanks, and aerial adults along rivers and in adjacent uplands. Larval sampling was conducted in a representative range of habitats at each survey site. Sites with habitat that appeared promising for rare species were usually revisited during the peak emergence period to find exuviae and adults. Community composition and habitat descriptions were recorded to establish baseline conditions for the survey sites.

Freshwater Mussels: Ethan Nedeau of Biodrawversity LLC led a two-year freshwater mussel study in the Housatonic River (44 sites) and five tributaries (eight sites) between Pittsfield and the Massachusetts border. Two biologists spent a total of 13 days conducting

qualitative and quantitative surveys over a total distance of 8,765 meters (5.5 miles) for an average survey distance of 170 meters per site and a range from 25-800 meters. Surveys were primarily done by snorkeling or wading with clear-bottom buckets. Surveyors recorded data on mussel species composition, abundance, demographics, shell condition, habitat preference, and habitat conditions.

Fish: In 2009, Dr. John Baker of Clark University led a team that surveyed fish at 27 sites in six tributaries but not in the mainstem Housatonic River. Studies were conducted between June and August. Five collection methods were used, including (1) backpack electrofishing device, (2) bag seines, (3) aquatic dip nets, (4) minnow traps, and (5) visual observations. The team attempted to survey at least 100 meters of habitat at each survey site. Captured fish were counted, identified to species, and habitat data were collected.

Salamanders: Kimberly Ogden, a graduate student at the University of Massachusetts, conducted the four-toed salamander survey with fieldwork supplemented by NHESP staff. Using a computer model to predict potential habitat (primarily forested wetlands and to a lesser extent bogs), 32 survey sites were selected for field visits to locate nests and adult females in suitable nesting substrates. Noah Charney, also a graduate student at the University of Massachusetts, led the Jefferson salamander survey. He visited a total of 520 sites that were either selected from among the Massachusetts Potential Vernal Pool (PVP) GIS datalayer (NHESP 2001) or encountered en route to other sites. Presence of Jefferson salamanders was determined by visual surveys for egg masses, larvae, and adults during the April-May breeding period. Additional methods for the vernal pool studies are described below.

Turtles: Dr. Michael Jones, while a graduate student at the University of Massachusetts, conducted wood turtle surveys in 2008 and Suzanne Fowle continued the work in 2009. Contractors surveyed 40 sites, including eight sites in the Housatonic River and 32 sites in 15 tributaries, covering nearly 48 miles of potential aquatic and upland habitat. Turtles were captured by hand by searching shallow water, streambanks, and riparian clearings. All captured turtles were marked with a unique number, aged, and sexed. Radiotelemetry studies were conducted at five sites (21 animals) to monitor movement and assess the extent of suitable habitat. Suzanne Fowle also conducted eastern box turtle surveys in 2009 at four locations where the species had been historically reported but not verified.

Angelo Sirois and Dr. James Gibbs of the State University of New York (College of Environmental Science and Forestry) undertook bog turtle research in 2008 and 2009. Six sites were surveyed in the watershed between May and September of each year, including two where bog turtle populations were known to occur, one historic (1966) site, and three with promising habitat but no prior records. Radiotelemetry studies were conducted at two sites to investigate habitat use. Previously unmarked bog turtles were marked with a unique number, aged, and sexed. Females were palpated to determine presence of eggs and surveyors attempted to locate nests and monitor hatching success.

Marsh Birds: Marsh bird surveys were completed by Jennifer Strules (2008) and Patricia Serrentino (2009) (independent contractors) and by staff and technicians at NHESP (led by Chris Buelow). A total of 100 potential sites were originally selected, and preliminary site visits narrowed the list to 81 sites that had appropriate habitat characteristics for target species. All were open marsh habitats greater than two acres in size and comprised a total of 1,504 acres. A total of 50 sites were surveyed in 2008 and 31 were surveyed in 2009. Each site was typically surveyed three times within the survey window of May 1-July 10 of each year. Using standard protocols, marsh bird vocalizations were broadcast into marshes at 200-meter intervals and presence (audible or visual) of target species was noted. Three target species—Green Heron, Marsh Wren, and Sedge Wren—were surveyed primarily by listening or watching because vocalization broadcasts have proven ineffective for detecting them. The composition and spatial structure of marsh plant communities were recorded within a 100-meter radius of each broadcast point, and surveyors also noted water levels, presence of beavers, degree of beaver influence on water levels, and presence of invasive plant species.

Vernal Pools: Noah Charney, a graduate student at the University of Massachusetts, led a two-year vernal pool survey. He visited a total of 520 sites that were either selected from among the Massachusetts Potential Vernal Pool (PVP) GIS datalayer (NHESP 2001) or encountered en route to other sites. In 2009, only PVPs greater than 1,000 meters away from 2008 survey sites were visited to ensure adequate coverage of the watershed. Surveys were conducted primarily for vernal pool obligate species including spotted salamanders (*Ambystoma maculatum*), Jefferson salamanders, wood frogs (*Lithobates sylvaticus*), and fairy shrimp (*Eubranchipus* spp.). Surveys were completed in April and May during the peak amphibian breeding season and included visual or auditory surveys for spermatophores, egg masses, larvae, adult salamanders and wood frogs, and fairy shrimp. Obligate vernal pool

species were documented with photographs, and audio recordings were taken of vocalizing wood frogs.

Natural Communities: Michael Batcher completed the natural community surveys. A preliminary list of 48 survey sites was developed using existing field data, GIS data, and consultation with NHESP. The contractor visited 26 of these sites in 2008 and evaluated conditions using NHESP protocols. Field data were analyzed and subsequent site visits (21 more sites) targeted important data gaps. One site was posted and could not be visited because the owners could not be contacted. Final field forms, maps, and photographs were compiled and submitted according to NHESP standards. Fieldwork was completed over a total of 41 days in 2008 and 2009.

II. Data Synthesis and Reporting

The enormous amount of data gathered during this project, resulting from combined effort of NHESP staff and 17 contracted biologists (plus their technicians, students, or volunteers), required a high degree of organization and synthesis to produce a comprehensive report. NHESP staff overseeing the fieldwork of contracted biologists ensured that data submissions were complete and accurate. However, because not all contractors were required to write summary reports, submissions ranged from GIS files and datasheets to detailed technical reports. Data managers and GIS experts at NHESP collaborated with other staff and contractors to update the NHESP database and to modify existing—or draw new—rare species or priority natural community polygons based on fieldwork. NHESP hired a consultant to summarize results from all field studies, extract performance measures (e.g., units of effort, number of new EOs located, etc.), help with GIS analysis and site prioritization, and prepare a technical report. The same consultant will also help prepare conservation planning materials for towns and a non-technical summary report.

III. Establishing Priorities for Protection, Restoration, and Management

One of the primary goals of the project was to identify and prioritize sites for conservation of rare species and priority natural communities based on up-to-date rare species and natural community data. The prioritization process is an ongoing collaborative process, and final results are not presented in this report. NHESP will base prioritization primarily on two types of information:

1. **Species Element Ranks** (see Table 1 for definitions): These are MESA ranks assigned to all state-listed species, which for species include Endangered, Threatened, or Special Concern. There are also some rare plants on a "Watch List," because more information is needed to determine if MESA protection is warranted or because they were removed from the MESA list. Natural communities are ranked from S1 (critically imperiled) to S5 (common, widespread, and abundant). Priority natural communities in Massachusetts are those ranked as S1, S2, or S3.
2. **Species Occurrence Ranks (or Viability Ranks):** All species and natural community occurrences are assigned a rank on an A-D scale that indicates their probability of persisting over time. A-ranked occurrences have the highest probability of long-term persistence and D-ranked occurrences have the lowest. Ranking is based on size, condition, and landscape context for each species, species habitat, or natural community.

Land protection status and a variety of other considerations may also be part of the prioritization process, depending on the amount of information available for an EO and the best professional judgment of NHESP staff and other experts. The prioritization process will be adjusted for different objectives including habitat protection, restoration, or management.

RESULTS

I. Target Taxa and Natural Communities

Plants: A total of 308 "sites" were surveyed during the two-year study. Of these, 206 were prior EOs or EO sources within the critical supporting watershed. Surveys updated 67 prior EOs and documented thirty new EOs during the course of the study. A total of 46 state-listed plant species and 165 EOs (not including EO sources) are now documented within the critical supporting watershed, including 46 Endangered, 68 Threatened, and 51 Special Concern species EOs. Surveys increased the number of plant EOs within the critical supporting watershed by 20 but with a much higher increase in the number of EO sources. Figure 5 shows the current (as of spring 2010) distribution of all rare plant EOs in the Housatonic watershed.

Eleven of the original 31 target species had not previously been recorded within the critical supporting watershed; however, the survey did locate populations for four of these species: Smooth Rock Cress (*Boechera laevigata*) Purple Cress (*Cardamine douglassii*), Cattail Sedge (*Carex typhina*), and Barren Strawberry (*Waldsteinia*

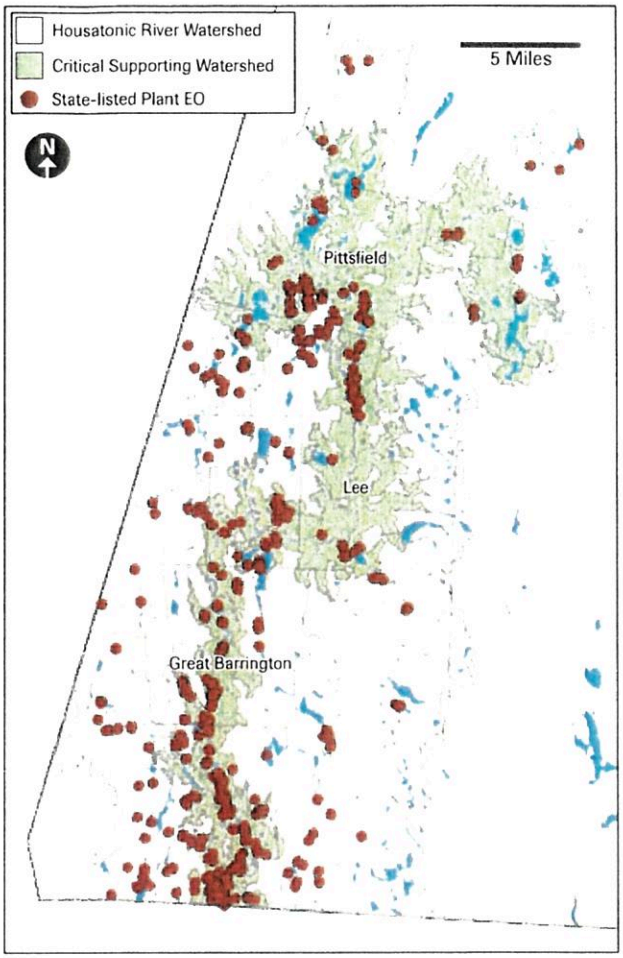


Figure 5. Current distribution of rare plant EOs in the Housatonic watershed and critical supporting watershed. Many of these were updated or newly documented during NRD surveys.

Data sources: MassGIS, NHESP database.

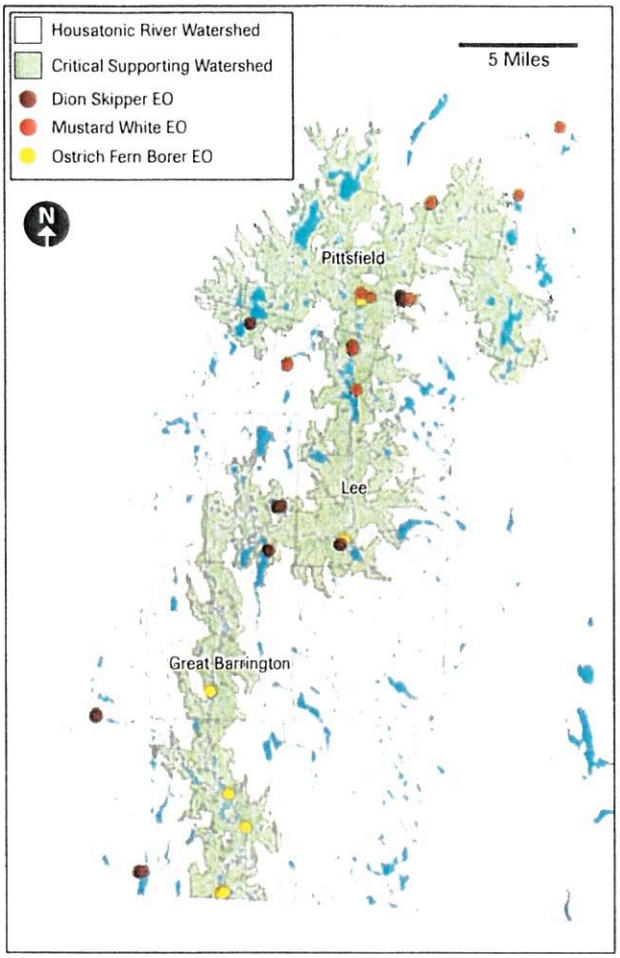


Figure 6. Current distribution of target butterfly and moth species EOs in the Housatonic watershed and critical supporting watershed. Many of these were updated or newly documented during NRD surveys.

Data sources: MassGIS, NHESP database.

fragarioides). The surveyors found populations of all 20 target species with prior EOs within the critical supporting watershed and found populations of 15 non-target state-listed species as well. The distribution of plant EOs within the Housatonic River watershed shows some distinct concentrations of rare plants. The greatest concentration of EOs occurs in southern Sheffield, with other concentrations occurring in northern Sheffield, southern Great Barrington, eastern Stockbridge, eastern Lenox, and southern Pittsfield.

Moths and Butterflies: Figure 6 shows the current (as of spring 2010) EO distribution of the three target species in the Housatonic watershed. The Mustard White was found at five of seven survey sites plus at an additional site where it was not the target species. Surveys updated a historic (>25 year old) record, reconfirmed the species at three sites, and located two new sites. All survey sites contained one or more host plants in the Mustard family (Brassicaceae) but these varied in abundance. Host species included Toothwort (*Dentaria* spp.), Cuckooflower (*Cardamine pratensis*), the non-native Garlic Mustard (*Alliaria petiolata*), and Watercress (*Rorippa nasturtium-aquaticum*).

The Dion Skipper was found at six of seven survey sites, including three of four sites where it had been previously documented plus three new sites. Five of the sites contained large areas of preferred sedge habitat, especially species such as lakeshore sedge (*Carex lacustris*). One of the newly discovered sites had expansive areas of suitable habitat and might be the best Dion Skipper site in Massachusetts. The survey site where Dion Skippers were not found lacked large areas of preferred sedge habitat.

The Ostrich Fern Borer was found at six of seven survey sites, with as many as ten larvae found at a single site. During these surveys, biologists documented

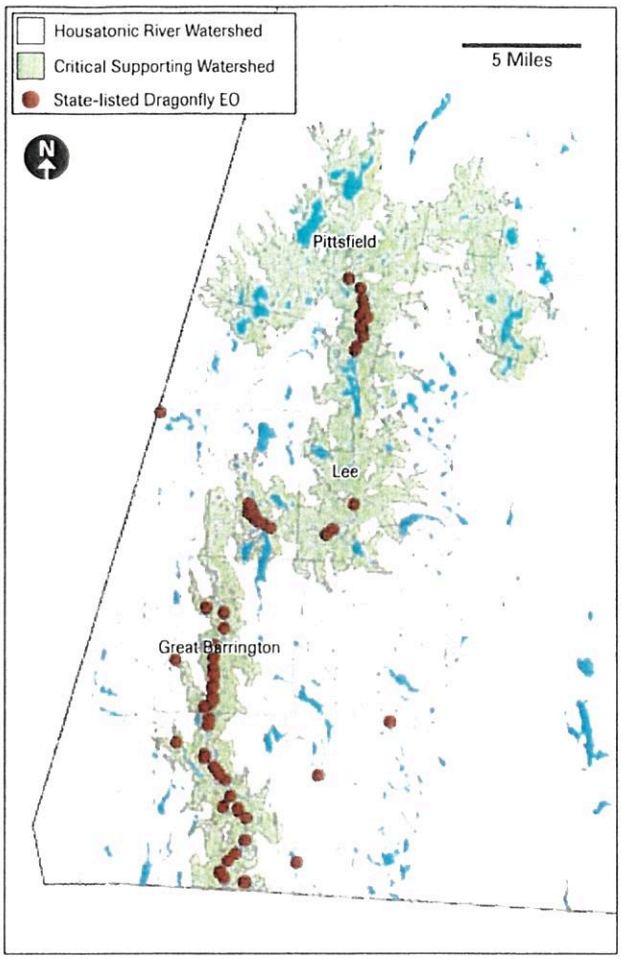


Figure 7. Current distribution of rare dragonfly EOs in the Housatonic watershed and critical supporting watershed. Many of these were updated or newly documented during NRD surveys.

Data sources: MassGIS, NHESP database.

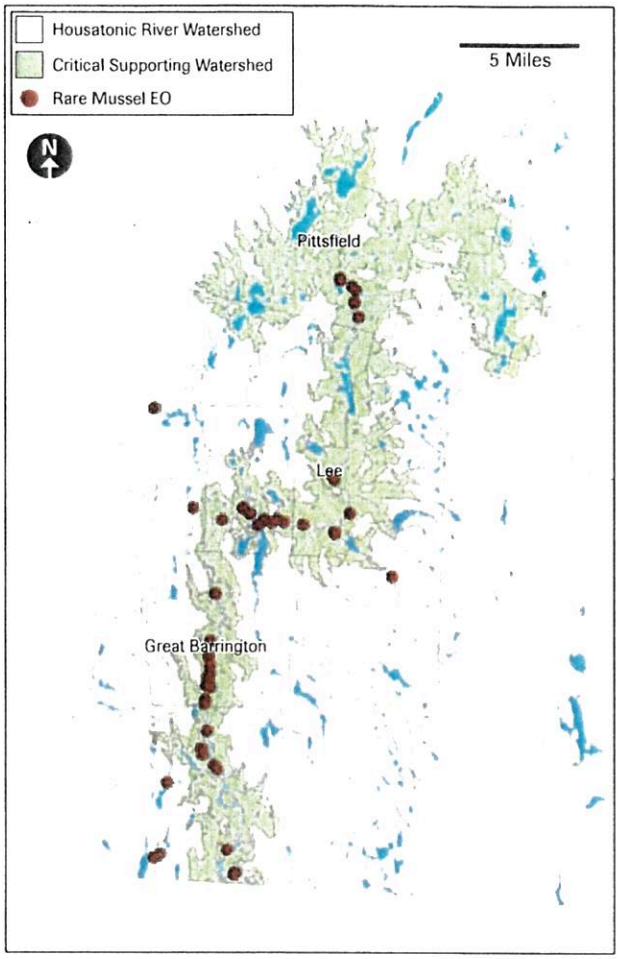


Figure 8. Current distribution of state-listed mussel EOs in the Housatonic watershed and critical supporting watershed. Most of these were newly documented during NRD surveys. The two species nearly always overlapped, therefore one symbol is used for both species.

Data sources: MassGIS, NHESP database.

another rare moth species that also feeds on ostrich fern called the Ghost Moth (*Sthenopis auratus*). This species is uncommon in Massachusetts and globally rare but not state-listed. It is only the third location in Massachusetts where the species has been found in recent decades.

Dragonflies and Damselflies: Forty-eight species representing all six New England families of dragonflies were recorded during the surveys. Damselflies were much less diverse than dragonflies and no state-listed damselfly species were encountered. The most species-rich families in the study area were the Gomphidae (19 species) and Libellulidae (14 species). The family Gomphidae contains 11 species that are state-listed in Massachusetts, and eight of these species were found during the two-year survey. Only three species in this species-rich family had been documented in the study area prior to the NRD surveys. Altogether, surveyors documented ten state-listed dragonfly species (Table 4), doubling the number of state-listed dragonflies known from the critical supporting watershed. Among the newly discovered species were two Endangered species, one Threatened species, and two Special Concern species. Surveys also resulted in a significantly greater number of EOs for state-listed species overall, from eight prior to NRD surveys to 29 afterward. Figure 7 shows the current (as of spring 2010) distribution of rare dragonfly EOs in the Housatonic watershed. It was evident from the surveys that nearly all of the mainstem Housatonic River from Pittsfield to Sheffield and many of its tributaries were priority habitat for one or more state-listed dragonfly species.

Freshwater Mussels: Five native freshwater mussel species were found during the survey, including the two target

state-listed species (triangle floater and creeper) and three others: eastern elliptio (*Elliptio complanata*), eastern floater (*Pyganodon cataracta*), and eastern lampmussel (*Lampsilis radiata*). The last was reported in the Massachusetts portion of the Housatonic watershed for the first time. The best freshwater mussel populations encountered occurred within physically or hydraulically stable river reaches, especially medium-gradient reaches with confined stable riverbanks, slow to moderate flow velocities, deep water, and sand and gravel substrates. Figure 8 shows the current (as of spring 2010) distribution of triangle floater and creeper EOs in the Housatonic watershed.

A total of 304 live triangle floaters were found at 23 mainstem locations and two tributary locations out of 54 total sites, for an average of 5.7 individuals/site (13.2 individuals/site among the sites where they were found), a catch-per-unit-effort (CPUE) of 5.1 individuals per hour, and a CPUE range from 0.0-70.0 individuals per hour. The survey greatly increased the number of triangle floater EOs in the critical supporting watershed from five to 30. Juvenile triangle floaters were only observed in two reaches—the upper Housatonic River in Pittsfield and between Hop Brook and Willow Mill Dam in Lee—and populations elsewhere exhibited highly skewed length distributions suggestive of geriatric (non-reproducing) populations. Triangle Floaters constituted 93 percent of all live mussels encountered in the upper 16 miles of the mainstem Housatonic River.

A total of 69 creepers were found at 17 locations, for an average of 1.3 individuals/site (4.0 individuals/site among the sites where they found), a catch-per-unit-effort (CPUE) of 0.8 individuals per hour, and a CPUE range from 0.0-12.7 individuals per hour. The survey greatly increased the number of creeper EOs in the watershed from four to 21. The average shell length of the creepers was 75.9 mm, which is larger than the maximum shell length of the species encountered in most other waterbodies in southern New England. This is the largest average shell length ever documented for a creeper population, and there is concern for the viability of a population with such a strongly skewed length/age distribution and apparent lack of recruitment.

Adult zebra mussels (*Dreissena polymorpha*) were detected in the Housatonic River in Lee for the first time ever while conducting the native freshwater mussel survey; these were located downstream of Laurel Brook in Lee, which connects to an established zebra mussel population in Laurel Lake.

Fish: Unusually high flows throughout the river in June-August of 2009 made it difficult to effectively sample fish using the techniques planned and equipment available;

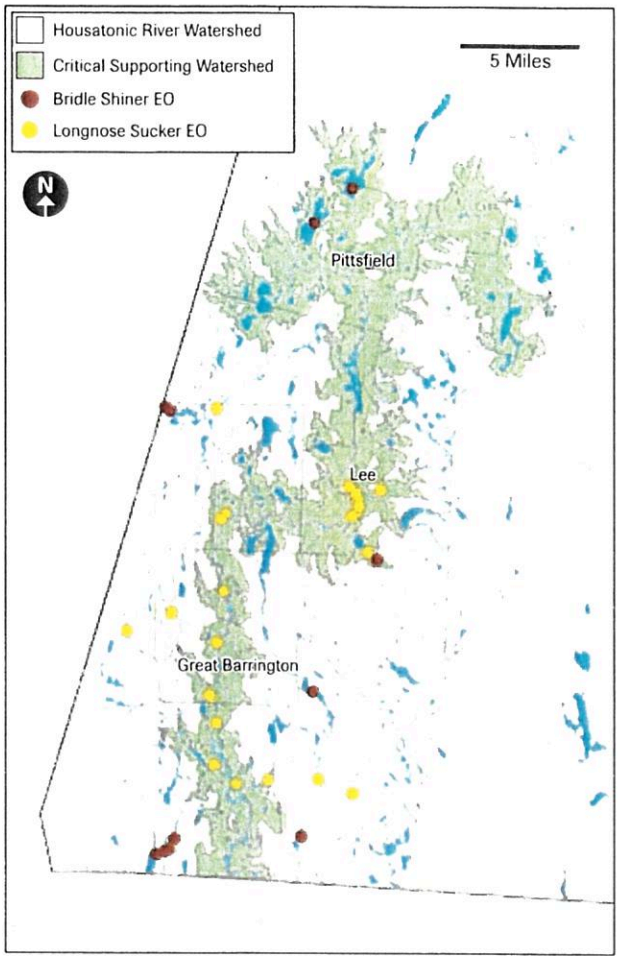


Figure 9. Current distribution of bridle shiner and longnose sucker EOs in the Housatonic watershed and critical supporting watershed.
Data sources: MassGIS, NHESP database.

however, surveyors captured 1,068 fish from 27 sites and documented 23 species altogether. The bridle shiner was the only target species captured during the survey. It was found at three sites in Hop Brook (22 individual fish) although unconfirmed visual observations were made at several other sites. The bridle shiner was known from seven other sites in the watershed prior to NRD surveys. Longnose suckers were known from eight locations prior to the NRD survey but none were found in 2009, likely because they prefer deeper water than what was able to be surveyed in 2009 due to equipment limitations. Neither the burbot nor the trout-perch was found in 2009 but these species had not been reported in the study area since 1970 and 1942, respectively. Figure 9 shows the current (as of spring 2010) distribution of bridle shiner and longnose sucker EOs in the Housatonic watershed.

Salamanders: Initially, four-toed salamanders were found in only seven of 32 target wetlands but follow-up surveys

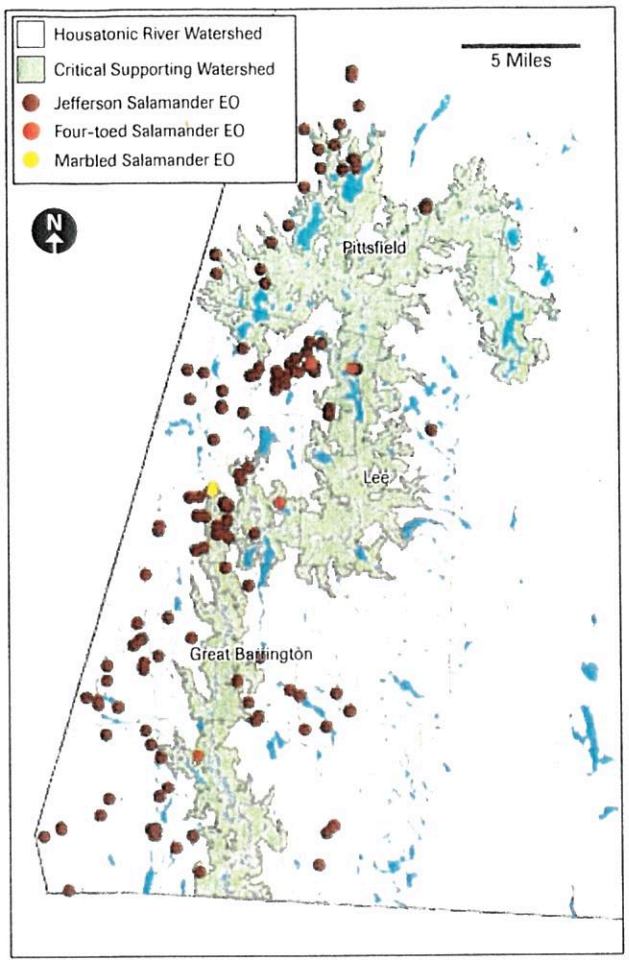


Figure 10. Current distribution of Jefferson, marbled, and four-toed salamanders in the Housatonic watershed and critical supporting watershed. Data sources: MassGIS, NHESP database.

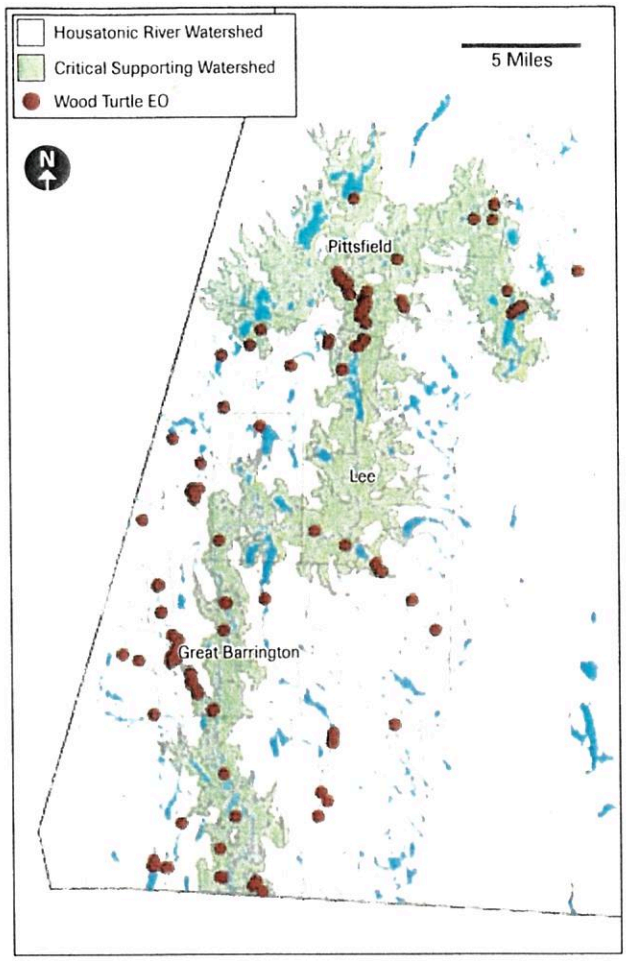


Figure 11. Current istribution of wood turtle EOs in the Housatonic watershed and critical supporting watershed. Several were newly documented during NRD surveys. Data sources: MassGIS, NHESP database.

were able to detect the species at some of the sites where it had not been found, underscoring the difficulty of finding this cryptic species. All nests were found in *Sphagnum* hummocks overhanging pools of water at least six inches deep, within forested wetlands or bogs. The species was removed from the MESA list in 2008 because it was widespread and locally common in Massachusetts and because its preferred habitat was considered stable.

Jefferson salamander egg masses were identified in 56 vernal pools and 21 additional pools need further investigation. This greatly increased the number of EOs for Jefferson salamanders in the critical supporting watershed (from seven prior to NRD surveys) and nearly doubled the number of Jefferson salamander records in Massachusetts. However, the study also noted a high incidence of nonviable eggs that may be related to hybridization between blue-spotted salamanders (*Ambystoma laterale*) and Jefferson salamanders.

The study documented three populations of the state-threatened marbled salamander, which also breed in vernal pools. These are the first records of marbled salamanders in Berkshire County and represent a significant westward range expansion from known populations in the Connecticut River watershed or perhaps a northward range expansion from known populations in northwest Connecticut. The current distribution of target salamander species is shown on Figure 10.

Turtles: Wood turtles were detected at 48 percent of the survey sites (19 of 40) located in the mainstem Housatonic River and at eight tributaries. Prior to the NRD surveys, wood turtles were known from 15 locations in the critical supporting watershed. Surveys confirmed suitable habitat at 11 locations where wood turtles had been previously documented and updated eight EOs. A total of 45 wood turtles were located, including 25 males, 15 females, and five unsexed juveniles. Captures of juvenile turtles and relatively high recruitment rates compared to

known populations in central Massachusetts and New Hampshire suggest high reproductive success; however, population densities were quite low compared to other regions. Investigators concluded that indeed wood turtles were widespread in the study area and that the observed low population densities might be related to high rates of adult mortality rather than low rates of reproductive success. At the three sites with the most captures, the percentage of individuals with tail or limb loss ranged from 23-78 percent and one road-killed juvenile wood turtle was found. Figure 11 shows the current distribution of wood turtle EOs in the Housatonic watershed.

Bog turtles were reconfirmed at the two sites where populations were known to occur but none were found at four other sites. Multiple nests, hatchlings, juveniles, and adults were found at each of the two primary sites, suggesting that these isolated populations are faring well and responding favorably to habitat restoration in the form of Phragmites removal. Radio-tagged males extensively used areas outside the area previously designated as core habitat. Lack of bog turtles at the four sites with suitable habitat underscores the rarity and isolation of bog turtle populations in Massachusetts.

No eastern box turtles were found during the survey. There have been several unconfirmed and anecdotal reports of individual box turtles in Berkshire County during the past 40 years, and a carapace was found at one site in 2009. These reports could be released pets or remnants of small, previously undocumented populations. Published distribution maps indicate that eastern box turtles are not present in Berkshire County, adjacent Taconic highlands of eastern New York, or northwestern Connecticut. The closest documented populations are in the Hudson Valley of New York and the southwest corner of Kent, Connecticut. There remains no conclusive evidence of an extant box turtle population in Berkshire County.

Marsh Birds: Surveys detected nine of ten target species, failing to find only the state-endangered Pied-Billed Grebe. The current distribution of marsh bird EOs (not separated by species) is shown on Figure 12. Surveys detected very low numbers of Least Bittern, King Rail, and Sedge Wren, all of which are Endangered in Massachusetts. Target species were observed in a variety of marsh communities, but cattail was the most important feature associated with presence of nearly all target species, especially Virginia Rail, Sora, Marsh Wren, Least Bittern, and Common Moorhen. Any potential disruption to cattail marshes, such as that from invasive Common Reed and Purple Loosestrife (*Lythrum salicaria*), represents a critical threat to marsh birds in the watershed. Common Reed and Purple Loosestrife was documented at 73 and 72 percent

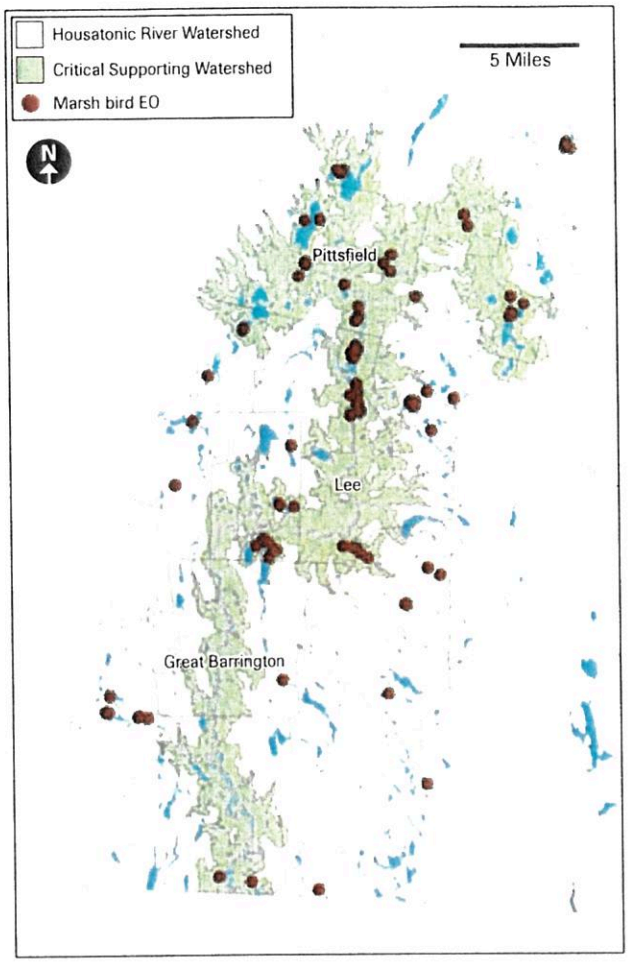


Figure 12. Current distribution of marsh bird EOs in the Housatonic watershed and critical supporting watershed.

Data sources: MassGIS, NHESP database.

of all survey sites, respectively, and occurred in remote and isolated wetlands. The beetle released to control purple loosestrife, *Galerucella*, was observed at 81 percent of the sites and appeared to be having a positive effect.

- **Virginia Rail:** Virginia Rails were observed at 62 percent of the survey sites and were the most commonly encountered of all target species. Most Virginia Rail territories were in cattail wetlands (63 percent), shrub marsh (17 percent), and Tussock Sedge marsh (10 percent). The Virginia Rail is not state-listed in Massachusetts; therefore, accurate records of sightings prior to NRD surveys are not available. It was included as a member of the marsh bird group.
- **Sora:** Sora were observed at six percent of the survey sites (five sites) and only one of these sites supported two Sora territories. Wetlands were typically associated with wide riparian basins and cattails were usually the dominant species. Survey results reinforce

Marsh habitats with abundant cattails (*Typha* spp.) and good structure of native vegetation were preferred by most target species of marsh birds. Patricia Serrentino.

a perception among ornithologists that Sora are declining throughout Massachusetts. The Sora was included in this study because it is in the marsh bird group and was included in the Massachusetts Wildlife Action Plan (MDFW 2006), but it is not state-listed in Massachusetts.

- **American Bittern:** American Bittern were observed at 16 locations (nearly 20 percent of all survey sites), including seven sites where American Bitterns had been observed before and nine sites that lacked prior records. They were not confirmed at five existing EOs. American Bittern were observed in a variety of conditions including wet meadows, palustrine cattail basin, riparian cattail wetland, and shrub marsh. Multiple territories and displaying males were observed within the 680-acre wetland at Hinsdale Flats Wildlife Management Area.
- **Least Bittern:** Least Bittern were observed at only two survey sites, representing only 2.5 percent of all survey sites. Three birds were observed: a lone vocalizing individual in a cattail marsh on October Mountain and a pair of foraging birds in a sedge/shrub marsh area in Hinsdale Flats Wildlife Management Area. Least Bittern appeared to be absent from seemingly suitable sites throughout the study area.
- **King Rail:** Only one King Rail was observed during the project. It responded to a broadcast call in the wet meadow near Hop Brook in Tyringham. The specific habitat included a wet meadow with tall lush sedges, some Reed Canary Grass, and shrubs such as alders and willow. The bird was never seen, and it was only heard twice on a single visit.
- **Common Moorhen:** The Common Moorhen was observed at four locations, all of which contained dense cattail beds adjacent to open water. Three sites confirmed existing records and the fourth represents a new location for the species. Although the species is rare in Massachusetts, highest densities are thought to occur in wetlands near the Housatonic River above Woods Pond, and it was surprising that more birds were not observed in 2008-2009. Sites where the species is consistently reported, such as coves of the Housatonic River and Woods Pond, yielded no sightings in 2008 or 2009.
- **Pied-Billed Grebe:** The Pied-Billed Grebe was not detected during the surveys, despite the presence of apparently suitable habitat. This is one of the rarest breeding birds in Massachusetts, with only three

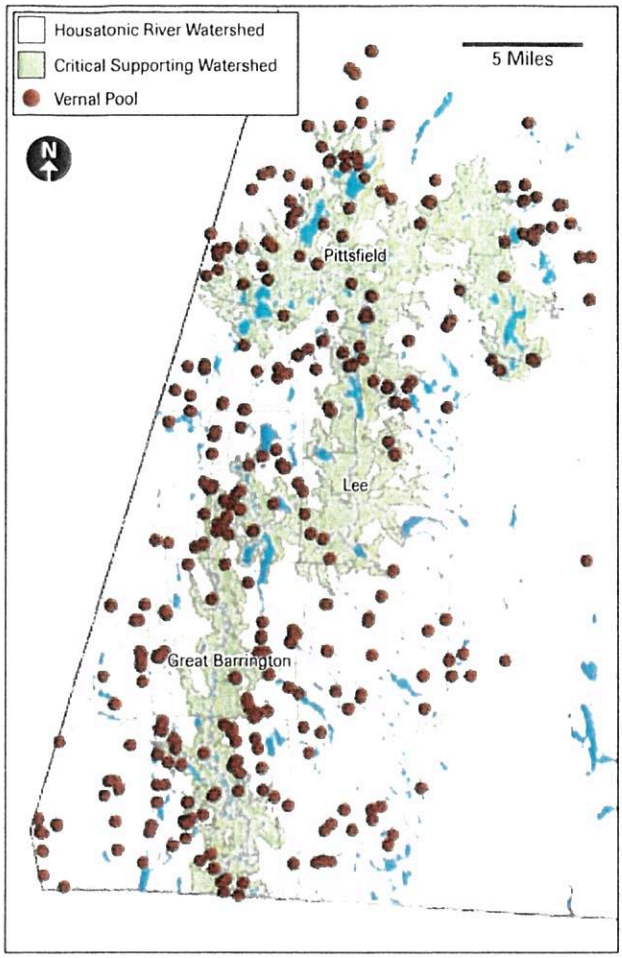


Figure 13. Current distribution of documented vernal pools in the Housatonic watershed and critical supporting watershed.
Data sources: MassGIS, NHESP database.

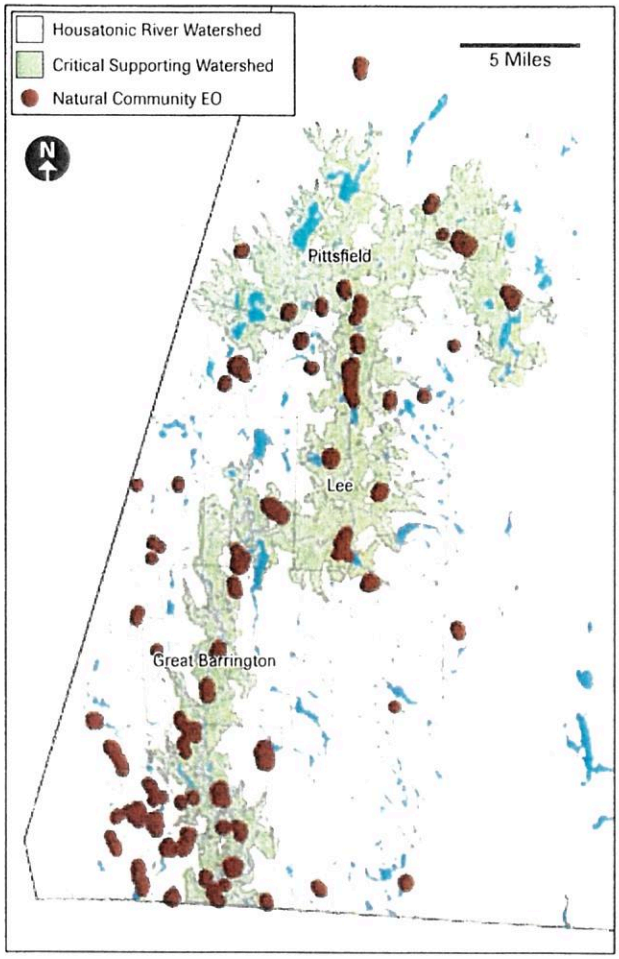


Figure 14. Current distribution of priority natural community EOs in the Housatonic watershed and critical supporting watershed.
Data sources: MassGIS, NHESP database.

breeding locations reported by Crowley (1994). The decline of this species between the mid-19th century and the present time is thought to be related to destruction of its preferred wetlands of aquatic bed vegetation adjacent to emergent cattail marsh.

- **Sedge Wren:** A single Sedge Wren was observed at one location during the survey, singing vigorously for the duration of the survey period. Sedge Wrens had been documented in the same wetland complex prior to NRD surveys. The Sedge Wren is very rare in Massachusetts, and the single bird was not surprising, although prime habitat was observed elsewhere (such as wet meadows along Hop Brook in Tyringham).
- **Marsh Wren:** Marsh Wrens were observed in 12 percent of the survey sites, mostly within riparian cattail beds in the Pittsfield, Richmond, and Lenox areas. A total of 46 Marsh Wren territories were observed; most sites supported multiple territories (up to 16 territories at one site) and numbers of pairs tended to increase as the season progressed. This species is not state-listed in Massachusetts.
- **Green Heron:** Green Herons were observed at 15 percent of the survey sites. This may not be a reliable indication of their distribution, because broadcasting calls does not increase detectability and observations were entirely visual and opportunistic. In addition, its preferred breeding habitat—wooded swamps and shrub swamps—were not targeted for surveys. The Green Heron was included in this study because it was included in the Massachusetts Wildlife Action Plan (MDFW 2006), but it is neither state-listed in Massachusetts nor is it considered a potential candidate for MESA protection.

Vernal Pools: During the two-year study, a total of 520 PVPs were surveyed, mostly within the critical supporting watershed. Of these, 361 wetlands met current vernal pool certification criteria based on presence of ambystomid

salamanders, wood frogs, or fairy shrimp in 48, 43, and six percent of the wetlands, respectively. Obligate vernal pool species appear to be thriving in the watershed. Only 70 vernal pools were certified in the critical supporting watershed prior to the NRD survey. The current distribution of vernal pools is shown on Figure 13.

Natural Communities: In 2008, 26 locations (13 prior EOs and 13 potential locations) were surveyed. The targeted community types were found at each site, thus producing 13 updated EOs and 13 new EOs. In 2009, 21 locations (seven prior EOs and 14 potential locations) were surveyed. Once again, surveys confirmed all prior EOs and also documented 14 new EOs. In total, 20 prior EOs were updated and 27 new EOs were discovered over the course of this study. The new EOs represented 16 different priority community types (Table 2). A total of 18 different community types were observed, including several communities not previously documented: alluvial red maple swamp, black ash swamp, calcareous rock summit, and high terrace floodplain forest. In addition, a new community type was documented: red maple-black ash-bur oak community. This new community type has not been assigned a rank but will likely receive S2. The current distribution of priority natural communities in the Housatonic watershed is shown on Figure 14.

II. Quantitative Performance Measures

To track accomplishments and to provide accountability for the surveys, NHESP attempted to compile information on level of effort for individual studies, the number of survey sites visited, reconfirmed EOs, and new EOs (Table 4). These summaries demonstrate an impressive amount of work completed for the NRD surveys, and, indeed, this is the most intensive and comprehensive survey effort ever undertaken by NHESP. There was some disparity in the tracking and reporting of the level of effort among different studies and therefore performance measures are not precise, but they reasonably represent the accomplishments of the project.

- **Personnel:** Fieldwork was completed by nearly 50 people including NHESP staff, 17 contracted experts and their technicians, students, or volunteer assistants.
- **Survey Sites:** Approximately 1,837 "sites" of varying size (from individual vernal pools to long river reaches [>2 miles]) were visited. Some of these were visited numerous times, including three visits for each of the 81 marsh bird sites and as many as 31 visits for individual wood turtle sites. Overall, nearly 2,500 site visits were completed.
- **Time:** The total time spent on fieldwork was approximately 495 days and represented more than 9,000 person-hours. Not included in these numbers are the unrecorded hours that NHESP staff and primary contractors put toward planning, travelling, laboratory work (especially dragonfly identification and moth rearing), data analysis, and submitting forms and reports to NHESP. Also not included is the time devoted toward data management, GIS, and data analysis required to assimilate data for the NHESP database and to prepare a technical report.
- **Species and Natural Communities:** Surveys targeted 31 state-listed plants, 29 state-listed animals, and 12 priority natural community types (see Table 2). Forty-seven of the target species (23 plants and 24 animals) were found, and an additional 15 state-listed plant species and six state-listed animal species were also found. Among the newly documented species were ten Endangered, five Threatened, and six Special Concern species. All of the target natural community types were found, and an additional four priority natural community types were documented in the critical supporting watershed for the first time.
- **Element Occurrences:** Surveys reconfirmed approximately 135 EOs and documented 170 new EOs (Table 4). Target groups or species with the greatest increase in the number of EOs in the watershed resulting from the survey included Jefferson salamanders, freshwater mussels, and dragonflies. Large increases in the number of EOs for these groups reflect the quality of the field studies and the limited survey efforts prior to 2008. Well-studied taxonomic groups such as plants, turtles, and marsh birds showed much more modest gains or even declines (as in the case of marsh birds).

DISCUSSION

I. Priority Areas

Core habitats for state-listed species and rare natural community types occur throughout the entire Housatonic watershed and its critical supporting watershed (Figure 15), including all towns in the primary study area. The distribution of core habitats is discontinuous, with higher concentrations in aquatic, wetland, floodplain, and rich mesic environments, especially in areas with the least amount of urban lands. Urban and agricultural lands and associated transportation infrastructure and dams have fragmented the landscape. Some critical habitats are embedded within developed areas and it is challenging to maintain both habitat quality in these areas and connectivity with other areas.

Table 4. Results of the NRD study in terms of reconfirmed and new EOs for each target plus non-target state-listed species and priority natural communities. Not all EOs, especially recent ones, known prior to the NRD study were survey targets. Data from NHESP database.

			Number of EOs			
Common Name	Latin Name	Rank	Pre-NRD Study	Reconfirmed	New	New Total
Plants						
Black Maple	*Acer nigrum*	SC	9	8	0	8
Black Cohosh	*Actaea racemosa*	E	1	1	0	1
Climbing Fumitory	*Adlumia fungosa*	SC	1	0	1	2
Small-flowered Agrimony	*Agrimonia parviflora*	E	2	2	0	2
Green Dragon	*Arisaema dracontium*	T	3	3	0	3
Mountain Spleenwort	*Asplenium montanum*	E	2	1	0	2
Smooth Rock-cress	*Boechera laevigata*	T	2	0	1	3
Purple Cress	*Cardamine douglassii*	E	2	0	2	2
Foxtail Sedge	*Carex alopecoidea*	T	5	2	2	7
Davis's Sedge	*Carex davisii*	E	1	1	3	4
Gray's Sedge	*Carex grayi*	T	5	3	2	6
Hairy-fruited Sedge	*Carex trichocarpa*	T	0	0	0	0
Tuckerman's Sedge	*Carex tuckermanii*	E	3	1	2	4
Cat-tail Sedge	*Carex typhina*	T	0	0	1	1
Narrow-leaved Spring Beauty	*Claytonia virginica*	E	2	1	2	4
Hemlock Parsley	*Conioselinum chinense*	SC	5	2	0	5
Showy Lady's-slipper	*Cypripedium reginae*	SC	6	1	0	5
Wright's Spike-rush	*Eleocharis diandra*	E	0	0	0	0
Intermediate Spike-sedge	*Eleocharis intermedia*	T	4	2	3	7
Ovate Spike-rush	*Eleocharis ovata*	E	0	0	0	0
Hairy Wild Rye	*Elymus villosus*	E	2	2	1	3
Dwarf Scouring-rush	*Equisetum scirpoides*	SC	4	1	0	4
Frank's Lovegrass	*Eragrostis frankii*	SC	5	4	1	6
Andrews' Bottle Gentian	*Gentiana andrewsii*	E	3	1	0	3
Giant St. John's-wort	*Hypericum ascyron*	E	1	1	2	3
Great Blue Lobelia	*Lobelia siphilitica*	E	8	2	0	8
Hairy Honeysuckle	*Lonicera hirsuta*	E	1	1	0	1
Many-fruited False-loosestrife	*Ludwigia polycarpa*	E	0	0	0	0
Winged Monkeyflower	*Mimulus alatus*	E	0	0	0	0
Comb Water-milfoil	*Myriophyllum verticillatum*	E	2	1	0	2
Tiny Cow-lily	*Nuphar microphylla*	E	1	0	0	1
Drooping Speargrass	*Poa saltuensis ssp. languida*	E	0	0	1	1
Hill's Pondweed	*Potamogeton hillii*	SC	7	1	0	5
Ogden's Pondweed	*Potamogeton ogdenii*	E	2	1	0	2
Bur Oak	*Quercus macrocarpa*	SC	9	5	3	11
Yellow Oak	*Quercus muehlenbergii*	T	4	2	0	4
Bristly Buttercup	*Ranunculus pensylvanicus*	T	5	2	0	5
Swamp Dock	*Rumex verticillatus*	T	0	0	0	0
Wapato	*Sagittaria cuneata*	T	11	8	0	11
Long-styled Sanicle	*Sanicula odorata*	T	7	3	0	7
Wild Senna	*Senna hebecarpa*	E	0	0	0	0
Shining Wedgegrass	*Sphenopholis nitida*	T	0	0	1	1
Small Dropseed	*Sporobolus neglectus*	E	2	1	2	3
Crooked-stem Aster	*Symphyotrichum prenanthoides*	T	9	1	0	9
Culver's-root	*Veronicastrum virginicum*	T	4	1	0	4
Barren Strawberry	*Waldsteinia fragarioides*	SC	5	1	0	5
Moths and Butterflies						
Dion Skipper	*Euphyes dion*	T	3	3	3	6
Mustard White	*Pieris oleracea*	T	1	4	2	6
Ostrich Fern Borer	*Papaipema sp. 2 near pterisii*	SC	0	0	6	6
Dragonflies						
Arrow Clubtail	*Stylurus spiniceps*	T	3	3	1	4
Zebra Clubtail	*Stylurus scudderi*	SC	2	1	3	4
Brook Snaketail	*Ophiogomphus aspersus*	SC	0	0	5	5
Riffle Snaketail	*Ophiogomphus carolus*	T	1	0	1	1
Skillet Clubtail	*Gomphus ventricosus*	SC	0	0	2	2
Spine-crowned Clubtail	*Gomphus abbreviatus*	E	0	0	2	2
Rapids Clubtail	*Gomphus quadricolor*	T	0	0	1	1
Harpoon Clubtail	*Gomphus descriptus*	E	0	0	3	3
Ocellated Darner	*Boyeria grafiana*	SC	1	0	4	5
Stygian Shadowdragon	*Neurocordulia yamaskanensis*	SC	1	1	1	2
Freshwater Mussels						
Triangle Floater	*Alasmidonta undulata*	SC	5	5	20	25
Creeper	*Strophitus undulatus*	SC	4	4	13	17
Fish						
Burbot	*Lota lota*	SC	0	0	0	0
Trout Perch	*Percopsis omiscomaycus*	EXT	0	0	0	0
Bridle Shiner	*Notropis bifrenatus*	SC	7	1	0	7
Longnose Sucker	*Catostomus catostomus*	SC	8	0	0	8
Salamanders						
Four-toed Salamander	*Hemidactylium scutatum*	NL	4	1	De-listed, no longer tracked	
Jefferson Salamander	*Ambystoma jeffersonianum*	SC	8	2	2	13
Marbled Salamander	*Ambystoma opacum*	T	0	0	3	3

Table 4. (continued).

Common Name	Latin Name	Rank	Number of EOs			
			Pre-NRD Study*	Reconfirmed	New	New Total**
Turtles						
Wood Turtle	*Glyptemys insculpta*	SC	15	8	4	18
Bog Turtle	*Glyptemys muhlenbergii*	E	2	2	0	2
Eastern Box Turtle	*Terrapene c. carolina*	SC	0	0	0	0
Marsh Birds						
Virginia Rail	*Rallus limicola*	NL	-	-	-	-
Sora	*Porzana carolina*	NL	-	-	-	-
American Bittern	*Botaurus lentiginosus*	E	12	7	9	12
Least Bittern	*Ixobrychus exilis*	E	1	0	2	2
King Rail	*Rallus elegans*	E	1	0	1	2
Common Moorhen	*Gallinula chloropus*	SC	9	3	1	10
Pied-billed Grebe	*Podilymbus podiceps*	E	4	0	0	4
Sedge Wren	*Cistothorus platensis*	E	2	1	0	2
Marsh Wren	*Cistothorus palustris*	NL	-	-	-	-
Green Heron	*Butorides virescens*	NL	-	-	-	-
Priority Freshwater Communities						
Acidic Graminoid Fen		S3	1	0	0	1
Alluvial Red Maple Swamp		S3	0	0	1	1
Black Ash Swamp		S2	0	0	1	1
Black Ash-Red Maple-Tamarack Calcareous Seepage Swamp		S2	6	1	0	6
Calcareous Basin Fen		S1	2	0	0	2
Calcareous Sloping Fen		S2	2	0	1	2
High Terrace Floodplain Forest		S2	0	0	3	3
Level Bog		S3	1	0	0	1
Major-River Floodplain Forest		S2	4	4	4	8
Red Maple-Black Ash-Bur Oak Swamp		S2	0	0	1	1
Small-River Floodplain Forest		S2	1	0	0	1
Spruce-Fir Boreal Swamp		S3	1	1	0	1
Transitional Floodplain Forest		S2	2	2	3	5
Priority Terrestrial Communities						
Calcareous Forest Seep		S2	1	1	?	1
Calcareous Rock Cliff		S3	2	1	0	2
Calcareous Rocky Summit/Rock Outcrop		S2	1	1	2	3
Rich Mesic Forest		S3	3	2	2	5
Ridgetop Pitch Pine-Scrub Oak		S2	1	0	0	1
Yellow Oak Dry Calcareous Forest		S2	1	0	0	1

* Some of the original occurrences were about to expire, so numbers may not sum in the total if they were not confirmed.
** Numbers may not add because the new total is for the critical supporting watershed and some of the survey findings were out of the critical supporting watershed.

Although the prioritization component of this project is not yet complete, Figure 15 highlights some areas of the critical supporting watershed that will likely emerge as high priorities for protection, restoration, or management (Areas 1-4). This is largely based on locations of clusters of Endangered or Threatened species and high priority (S1 or S2) natural community types. These four areas were subjectively outlined and described in this report to provide a brief illustration of the process and their selection was not meant to diminish the importance of other areas, but rather to explain the importance of a select few. Actual prioritization, which will occur after the completion of this report, will be a more quantitative process. A complete analysis of town-scale and regional-scale priorities will be provided in subsequent materials.

Area 1: This area includes the Housatonic River and its floodplains, nearby uplands, and tributaries from Woods Pond in Lenox to Pittsfield. It includes the lower part of the West Branch Housatonic River. Towns within this area include Lee, Lenox, Washington, and Pittsfield. Good examples of priority natural community types associated with streams and rivers, floodplains, and calcareous wetlands occur in this area. Thirty-four state-listed species have been observed within this area, including 19 plant species and 15 animal species. Wetlands are important for several species of rare marsh birds, including the Least Bittern, American Bittern, and Common Moorhen. Rare aquatic species include the wood turtle, triangle floater, and four dragonfly species. Much of this area falls within the Housatonic Valley Wildlife Management Area and October Mountain State Forest but additional conservation opportunities exist. The entire area falls within an area designated as the Upper Housatonic River Area of Critical Environmental Concern (ACEC) by the Massachusetts Executive Office of Environmental Affairs in 2009.

Area 2: This area includes much of the Hop Brook subwatershed in Lee and Tyringham and a two-mile reach of the Housatonic River in Lee. The conspicuously higher concentration of priority habitat in this small narrow valley appears as an island within a large area that otherwise lacks priority habitat, including Beartown State Forest, with its predominantly upland forest habitat, to the south and west. Route 102, the Massachusetts Turnpike, a railroad

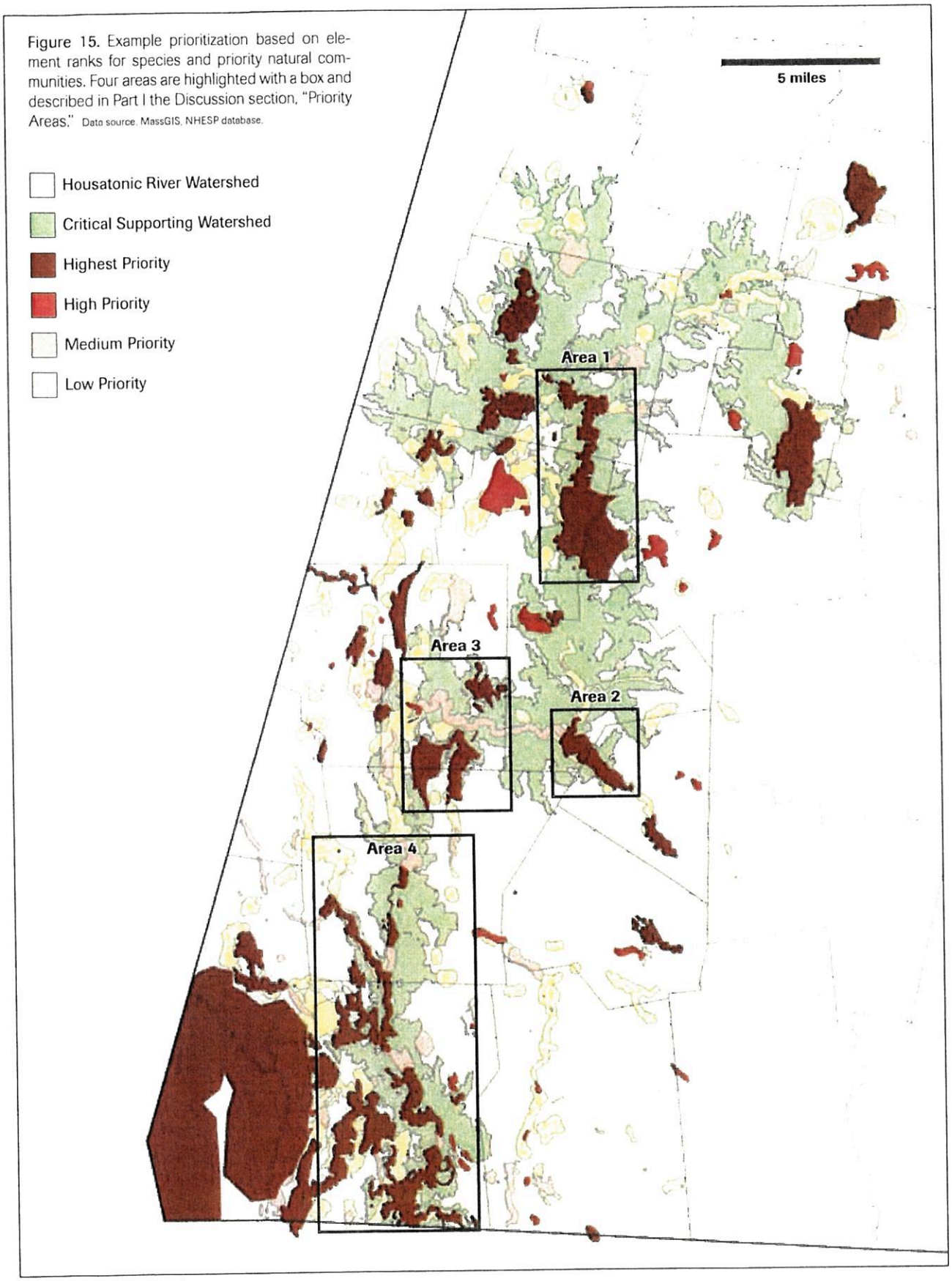


Figure 15. Example prioritization based on element ranks for species and priority natural communities. Four areas are highlighted with a box and described in Part I the Discussion section, "Priority Areas." Data source. MassGIS, NHESP database.

Calcareous sloping fen near Spurr Lake in Sheffield. Michael Batcher.

line, and urban and industrial lands of Lee disconnect this area from high priority habitats to the north. Although this is a relatively small area of riverine and associated wetland habitats, three priority natural community types, eight state-listed plant species, and ten state-listed animal species occur in this area. This was the only stream where state-listed fish (the bridle shiner) were found in 2009 and also supports wood turtles and triangle floaters. The results of the freshwater mussel survey demonstrated that populations of three mussel species, including two state-listed species, increased dramatically in the Housatonic River starting at the confluence of Hop Brook compared to population densities in nearly ten miles of the Housatonic River upstream of the confluence. Hop Brook contains one of the largest eastern elliptio populations documented in the two-year study.

Area 3: This general area spans much of southern Stockbridge and northern Great Barrington and includes the areas along the Housatonic River, small tributaries and their associated wetlands, and terrestrial habitats on the slopes of Monument Mountain. Forty-eight state-listed species and four priority natural community types—including a critically imperiled calcareous basin fen (S1)—have been observed in this area. The area also contains the State's best example of a Black Ash-Red Maple-Tamarack Calcareous Seepage Swamp (S2) at Kampoosa Bog and Fen. A total of 32 rare plant species and 16 rare animal species occur in the area, most closely connected with the river. Among the rare animals are five dragonfly species, three marsh bird species, two freshwater mussel species, two fish species, two reptile species, and one rare amphibian species. The area is particularly important for wood turtles. Some of the most important priority habitats and natural community occurrences are not protected as conservation land.

Area 4: This portion of the watershed spans most of Sheffield and southern Great Barrington. This is one of the most biologically rich areas in Massachusetts, and it has a very high concentration of priority habitats. The town of Sheffield has the third highest number of EOs among all towns in Massachusetts and is the only town in the top ten that does not occur in the southeastern coastal plain or Cape Cod. A total of 84 state-listed species (64 plants and 20 animals) have been observed in this area, as well as 21 natural community types. Among the plants are 32 Endangered species and 16 Threatened species, many of

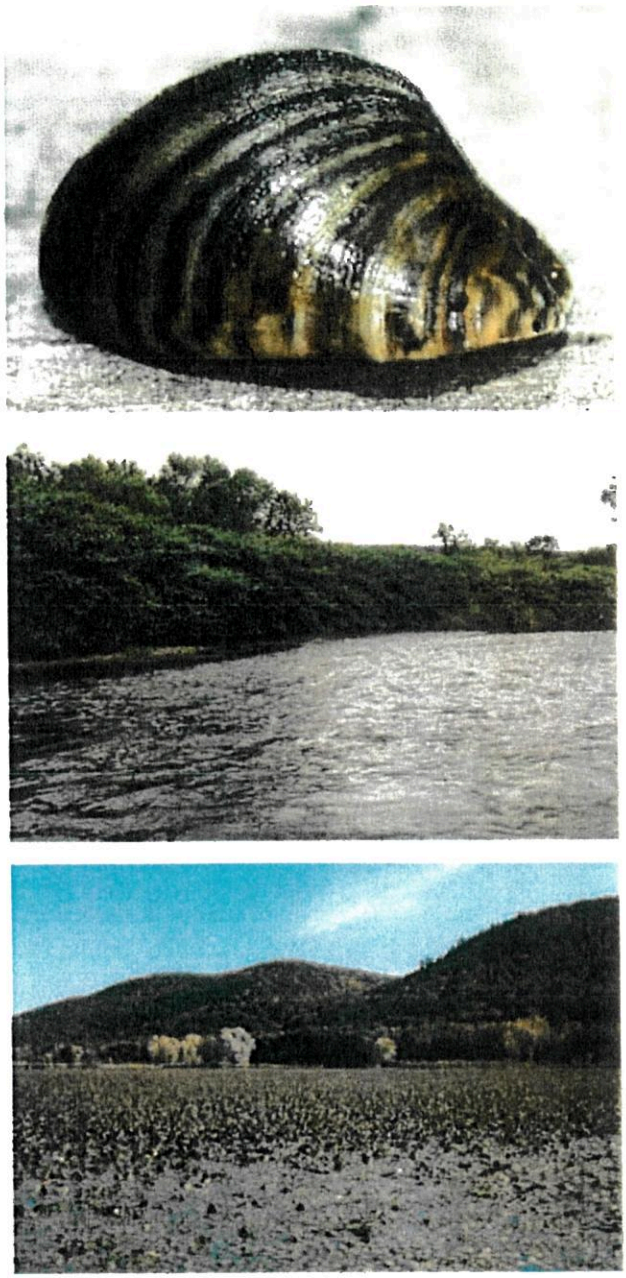
which inhabit rich mesic forests and calcareous wetlands. State-listed animals include butterflies, dragonflies, freshwater mussels, amphipods, turtles, snakes, fish, birds, and salamanders. Although some of the most valuable sites in this region are protected (such as Bartholomews Cobble and areas along Schenob Brook), additional protection is needed for many large critical parcels. In this region, agriculture and grazing are prevalent in the floodplain, and much of the valuable floodplain forest has been lost. The river is actively migrating across unforested and therefore more easily erodible, floodplain soils and causing sedimentation problems throughout this reach.

II. Threats

There are numerous threats to biodiversity in the Housatonic watershed, and it is beyond the scope of this technical document to identify and describe them all. During the course of field studies, contractors and NHESP staff most frequently noted two primary classes of threats: (1) non-native invasive species and (2) channel and floodplain alteration. Pollution was noted as a concern for the Housatonic River because of PCBs, point source discharges (industries and wastewater treatment plants), and urban runoff.

Non-native Invasive Species: Nearly all studies mentioned one or more non-native invasive species with strong potential to change fundamental ecosystem processes and functions, and, ultimately, the native species assemblages that make the Housatonic watershed such a special place. Strategies to control the spread of invasive species and encourage native species will be some of the most important elements of a comprehensive watershed biodiversity protection plan. Some of the most damaging invasive species in North America, such as zebra mussels, common reed, purple loosestrife, water chestnut (*Trapa natans*), and Eurasian water-milfoil (*Myriophyllum spicatum*), are firmly established in aquatic and wetland habitats in the Housatonic watershed. A remarkable number of non-native and invasive upland plants are proliferating in abandoned farmlands and other disturbed areas of the watershed. From these sources, they are encroaching on intact forests; species such as garlic mustard, Morrow's honeysuckle (*Lonicera morrowii*), Japanese barberry (*Berberis thunbergii*), Oriental bittersweet (*Celastrus orbiculatus*), European buckthorn (*Rhamnus frangula*), Japanese knotweed (*Fallopia japonica*), and multiflora rose (*Rosa multiflora*) are leading this charge. The following are specific examples most relevant to the NRD surveys:

- Bog turtle habitats are threatened by the presence of common reed, purple loosestrife, and reed canary grass. These species outcompete native vegetation and form a monoculture that may eliminate important microhabitats that turtles may need for nesting, basking, or feeding. In one of the bog turtle sites, scientists documented bog turtles' increasing use of marsh habitat after common reed was removed.
- Marsh bird surveyors noted a high incidence of common reed and purple loosestrife infestations



Three highly invasive species that are firmly established in the Housatonic wastershed. **Top**: zebra mussel from the Housatonic River. **Middle**: Monoculture of Japanese knotweed on the banks of the Housatonic River. **Bottom**: Dense growth of water chestnut covering the surface of Woods Pond. Ethan Nedeau

in study sites (73 and 72 percent of all survey sites, respectively, including some remote and isolated wetlands). Both of these species threaten native marsh vegetation that is critical to marsh birds, especially cattails and several species of sedges. The beetle released to control purple loosestrife, *Galerucella*, was observed at 81 percent of the sites and did appear to be having a positive effect.

- Zebra mussels were discovered in Laurel Lake and in the Housatonic River in the towns of Lee, Lenox, and Stockbridge during surveys in 2009. Water chemistry in these waterbodies is ideal for zebra mussels, although physical habitat in the Massachusetts portion of the Housatonic River appears to be mostly confined to impoundments. Zebra mussels have the potential to greatly alter ecosystem processes in the Housatonic River and have adverse effects on benthic invertebrates and some fish species. A second concern is the potential effect zebra mussels may have on uptake and bioaccumulation of toxins, such as PCBs, because they are benthic filter feeders that have been shown to efficiently uptake toxins and are eaten by a variety of fish, mammals, and waterbirds.
- Invasive aquatic plants are present in lakes, ponds, and suitable river habitats throughout the watershed. Woods Pond is almost completely infested with water chestnut and represents a source population for other suitable areas in the watershed. A high percentage of lakes have Eurasian water-milfoil, variable water-milfoil (*Myriophyllum heterophyllum*), lesser naiad (*Najas minor*), coontail (*Ceratophyllum demersum*), and curly pondweed (*Potamogeton crispus*). These species affect native plant and animal species to varying degrees, and efforts to control them by physical or chemical means often have important non-target adverse affects.
- Japanese knotweed is prolific on recently disturbed sites and is one of the most abundant plant species on riverbanks and gravel bars along much of the Housatonic River. It provides very little shade or other values to wildlife and is a poor substitute for preferred native riparian vegetation such as silver maple (*Acer saccharinum*).

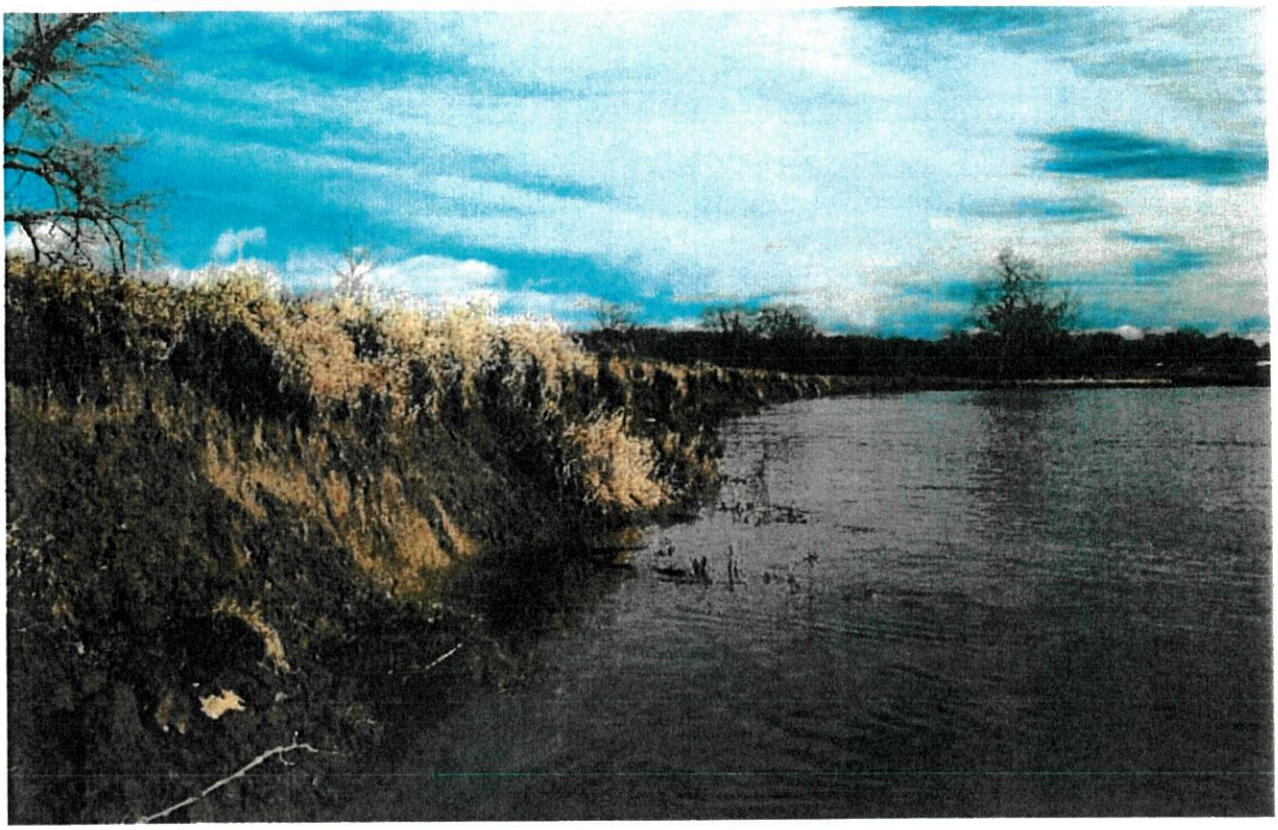
Channel and Floodplain Alteration: The complex set of problems associated with the floodplain and channel processes in the Housatonic River is rooted in the long history of landscape alteration, settlement patterns, and structural control of the river (e.g., dams, channelization, bank armoring). Humans sculpted the river and its floodplain to meet the myriad needs of a growing population: road and rail infrastructure, agriculture,

Long reaches of the Housatonic River, including this area near Great Barrington, have a homogenous stream channel of unstable sandy sediments that provide poor habitat for invertebrates. Ethan Nedeau.

industrial and municipal demands for water and wastewater treatment, waste disposal, urban development, and generation of electricity. The major results of this activity were the loss or degradation of floodplain forests and wetlands, loss of natural flood storage capacity, altered natural flow regimes (in the river and its major tributaries), destabilization of instream habitats and riverbanks, and degraded water quality.

Some of the most visible symptoms of these problems are deeply incised channels and severely eroding riverbanks, especially in unconfined reaches where the river is actively migrating across easily erodible floodplain soils as it tries to reestablish equilibrium. Narrow strips of riparian trees, such as silver maple, willow (*Salix* spp.) and boxelder (*Acer negundo*), are being lost with no forest behind them to provide stability and cover after the river claims those few. More expansive riparian forests are needed. Opportunistic and aggressive plant species such as Japanese knotweed are colonizing disturbed streambanks. Cutoff oxbows, other former river channels, and wet depressions are quickly filled by common reed and purple loosestrife rather than more desirable native species. Because of the tremendous amount of sediment exported to the river, vast areas of the Housatonic River have a homogenous and unstable sand substrate that provides poor habitat for aquatic invertebrates and fish. This situation is not likely to improve in the near term.

The currently employed methods of dealing with unstable and eroding banks, such as riprap, exacerbate the problems associated with an unstable river environment, fail to provide a long-term solution to these problems, and ultimately contribute to a more homogenous river environment (Kline *et al.* 2006). The river needs to be given access to its floodplain so that it can heal itself and redevelop the habitat complexity that can support



Severe bank erosion along a long section of riverbank in Sheffield that lacks any riparian vegetation aside from grass. Ethan Nedeau

a full suite of native species. A minimum 200-foot buffer should be established along the river, but broader floodplain protection areas should be established where the river needs greater room, where the floodplain can capture and store floodwaters, and where exemplary natural communities exist and can maintain themselves over time. Undersized culverts should be replaced by culverts or bridges of an appropriate size to restore hydrologic regimes and continuity for migratory animals (Massachusetts Riverways Program 2005), especially where roads and railways cross small tributaries in the Housatonic River floodplain. This report strongly urges resource managers to invest in a clearer understanding of the dynamic nature of the upper Housatonic River and to seek ways to restore a more natural river environment.

Pollution: Numerous current and historic point sources of pollution exist along the Housatonic River, mainly from industries and wastewater treatment plants. There are well documented PCB levels in the Housatonic River and portions of its floodplain, especially between Pittsfield and Woods Pond. However, it is beyond the scope of this technical report to address this pollution source. Information on PCB contamination in the Housatonic River is available on EPA's GE/Housatonic website, www.epa.gov/ne/ge/index. Surface runoff from urban areas and golf courses near Pittsfield, Lee, and Great Barrington carries high levels of nitrogen, phosphorus, road salt, sediment, oils, metals, pesticides, bacterial pathogens, and other toxic materials. All of these pollutants will influence aquatic species such as freshwater mussels, other aquatic invertebrates (including dragonflies), fish, and the high-level predators that consume them such as river otter and birds.

III. Next Steps

Prioritization: One of the primary goals of the project was to identify and prioritize sites for conservation of rare species and exemplary natural communities based on updated survey data. Three broad classes of conservation strategies may include protection (e.g., land acquisition or conservation easements), restoration (e.g., dam removal or reestablishing natural conditions), and management (e.g., invasive species control, prescribed burns, or mowing). The prioritization process is an ongoing collaborative process, and final results are not presented in this report. Final prioritization is expected to be part of a biodiversity protection plan that will be presented in town reports and a non-technical summary report. The prioritization

Early morning on a marsh in Great Barrington. Patricia Serrentino.

process will benefit from analyses being undertaken by NHESP for its *BioMap 2* project due in late 2010.

Town Reports: NHESP will provide conservation planning materials to 19 towns included in the critical supporting watershed. The materials will be a blueprint for conserving rare species and natural communities. Materials will be based on data acquired during the NRD study but will also include other rare species information that NHESP has for each town. Reports will be explicit about what is in each town and will also provide specific recommendations for protection, restoration, or management, which will distinguish these town reports from the more general overviews provided by *BioMap* (NHESP 2001) and Living Waters (NHESP 2003). The timeframe for the completion of town reports was extended to late 2010 to allow *BioMap 2* to be completed so that new information can be integrated into town reports. Town reports and details of specific conservation needs will be useful in prioritizing projects and evaluating proposals in subsequent rounds of NRD restoration funding.

Public Report: Although not included in the original proposal to NRD, NHESP felt it was necessary to provide a non-technical summary of survey results to state agencies, conservation groups, municipalities, and citizens. This will provide an opportunity to generally discuss the need for biodiversity protection in the watershed and outline NHESP's commitment to that process. The public report will discuss biodiversity, introduce town reports, and discuss priorities for protection, restoration, and management. Photographs, maps, and illustrations will help make this publication more engaging and appealing to a general audience. NHESP hopes that this document will help increase broad support for biodiversity protection in the watershed. The timeframe for completion is late 2010.

For a long time, conservationists have recognized the importance of the Housatonic River watershed to the biodiversity of Massachusetts and this survey strengthened that conviction. The project saw the updating of records and the discovery of many new occurrences of rare species and priority natural communities that were recently or historically known from the watershed, and also included

the identification of several rare species never before documented in the watershed. There does not appear to have been a significant decline in the number of species or priority natural community types despite the long history of human influence in the watershed, although some have declined in abundance and distribution (population or occurrence quality). Native habitats are changing due to the combined effects of habitat degradation, non-native invasive species, and natural succession. However, surveys demonstrate that it may not be not too late to reverse trends and preserve biodiversity if the most severe problems are addressed, including the threats of non-native species, channel and floodplain alteration, and pollution. Accomplishing this will require the collective and coordinated efforts of state and federal agencies, local governments, conservation groups, and citizens.

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