

**Focus Areas for Wildlife  
Habitat Protection in the  
Nashua River Watershed**

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By the

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**Jeffrey Collins, Coordinator**

## **Table of Contents**

<b>Executive Summary .....</b>	<b>i</b>
<b>Introduction.....</b>	<b>1</b>
The Nashua.....	2
Theory of Conservation Planning .....	2
Reserve Design.....	4
Landscape Scale Conservation Planning.....	6
<b>Methods.....</b>	<b>9</b>
<b>Results .....</b>	<b>11</b>
Large Focus Areas .....	11
Medium-sized Focus Areas .....	15
Small Focus Areas & Connectors .....	18
Riparian Corridors.....	23
Priority Natural Communities .....	25
<b>Conclusion .....</b>	<b>25</b>
<b>Literature Cited .....</b>	<b>27</b>
<b>Appendix A.....</b>	<b>A - 1</b>

This report implies no endorsement by Massachusetts Audubon Society of positions or actions arising from the use of this information. Any opinions stated or conclusions drawn do not necessarily reflect the official position of MAS.

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## Executive Summary

In the past fifty years, the Nashua River Watershed, like much of New England, has recovered from the extensive agricultural land uses of the 19<sup>th</sup> century. Yet today suburban development has replaced agriculture as the voracious human land use pattern that replaces natural vegetation, fragments forested areas, and leads to an overall degradation of wildlife habitat; and development is a less reversible conversion than agriculture. The energies of the many dedicated people working over the past century and longer to protect land within the watershed have often focused more on human values such as drinking water resource protection and recreational needs than on wildlife habitat value. Preservation of long term habitat viability requires a systematic approach to the identification and acquisition of valuable habitat to meet the needs of large and wide-ranging wildlife species and plant and animals which require specific natural communities as habitat. This report, funded by the Massachusetts Executive Office of Environmental Affairs, is intended to identify the most important areas for wildlife habitat protection in the watershed. The maps propose habitat protection focus areas, and it is hoped that towns, land trusts and state and federal agencies will be able to make use of the findings as a first iteration in a multi-step process of identifying priorities for land acquisition.

Reserve design theory is based on the core-corridor-buffer model which states that biodiversity at multiple levels will best be maintained in a system of large, undisturbed core areas, surrounded by buffer zones of limited disturbance, and connected by functional corridors for wildlife dispersal. Large, roadless core areas perform many functions: they provide habitat for species that are extremely sensitive to human disturbance; they serve as “biological fortresses” against invasion of exotic species; and they can serve as control sites for ecosystem research in a landscape where human alteration is nearly all-pervasive. Smaller core areas serve as secondary habitat and as stepping stones for movement of individuals and populations. Buffers are areas of limited human presence surrounding core areas. Such a reserve network is designed to: represent in protected areas all kinds of ecosystems across their natural range of variation; maintain viable populations of all native species in natural patterns of distribution and abundance; sustain ecological and evolutionary processes; and maintain a conservation network that is resilient to environmental change.

Conservation practitioners have developed a three-prong approach to identifying specific areas that go into a reserve design to meet those goals:

- protection of special elements, such as rare species hotspots, old-growth forests, and critical watersheds for aquatic biota;
- representation of all habitats and vegetation types within a network of reserves; and
- meeting the needs of particular focal species, especially those that are area-dependent or sensitive to human activities.

Given the limited timeline of this project we were not able to fully pursue all of these steps. We spoke with dozens of professional and amateur wildlife biologists and naturalists to identify focal species and the landscape elements they require. We relied on MassGIS roads, land use, topography, wetlands, and other datalayers, topographic maps, and aerial photographs to identify large areas of potential habitat. And we used Mass. Natural Heritage & Endangered Species Program data to locate habitat for rare, threatened, and endangered plants and animals. Combining this information, we generated *Focus Areas* to include large undisturbed areas as habitat cores, with smaller focus areas as stepping stones and corridors to allow wildlife movement across the landscape. Based on this approach, we nominate the Focus Areas shown in Map 1 as high priorities for habitat protection efforts in the Nashua River Watershed. The focus areas themselves are, of course, important for their habitat qualities; but in combination the areas form a habitat network that could provide for the landscape level requirements of species, populations, and ecosystems.

The network of areas identified in this report as priorities for habitat protection is a first cut. We hope that people discuss the assumptions, the methods, and the results, and continue to work on refining the focus areas. Wildlife habitat inventories carried out at the town or subwatershed level can build on this report by focusing at a finer scale. If we protect large core areas, buffers around them, and corridors between them, the wild will remain with us in the Nashua.

## Introduction

*I spend a considerable portion of my time observing the habits of the wild animals ... [b]ut when I consider that the nobler animals have been exterminated here, the cougar, panther, lynx, wolverine, wolf, bear, moose, deer, the beaver, the turkey, etc., etc., I cannot but feel as if I lived in a tamed, and, as it were, emasculated country... Is it not a maimed and imperfect nature that I am conversant with?*

Henry David Thoreau  
Journal entry, March 22, 1856

In this journal entry from another era, Thoreau wrote of the Sudbury-Assabet-Concord watershed, but the situation he described was little different in the Nashua. By the middle of the nineteenth century, two hundred years of agriculture had cleared much of the forests from the land, leaving little habitat for the “nobler animals.” However, only five years after this journal entry, the Civil War would call young men from their fields, and afterwards the opening of the Ohio River Valley and points west, the tallgrass prairie of deep, rich soils, would attract settlers tired of battling the glacial till of New England. The forest regenerated, there was a spate of logging as trees matured in the first half of this century, and then, aside from sporadic cutting, the forests have been left since that time to grow to what we see today. And with the return of “bear, moose, deer, the beaver, the turkey,” we actually look out upon a less maimed, more complete nature than did Thoreau.

Now there is a new threat to ecological integrity in the watershed. Suburban development has replaced agriculture as the voracious human land use pattern that replaces natural vegetation, fragments forested areas, and leads to an overall degradation of wildlife habitat; and development is a less reversible conversion than agriculture. The black bear, fisher, and bobcat have returned to the Nashua River Watershed since the days of Thoreau, but unless development and land protection in the watershed are planned so that essential habitats remain, they may again be chased out.

Many dedicated, energetic people have worked over the past century and longer to protect land within the watershed, however land protection efforts often focus on human values such as drinking water resource protection and recreational needs more than habitat value, and the spatial distribution of this protected land in the watershed has never been analyzed from an ecological perspective. Preservation of long term habitat viability requires a systematic approach to the identification and acquisition of valuable habitat to meet the needs of large and wide-ranging wildlife species and plant and animals which require specific natural communities as habitat. Through such a process the Nashua River watershed will continue to develop as a functioning landscape on the edge of major metropolitan areas.

This report is intended to identify the most important areas for wildlife habitat protection in the watershed. The maps propose habitat protection focus areas and it is hoped that

towns, land trusts and state and federal agencies will be able to make use of the findings as a first iteration in a multi-step process of identifying priorities for land acquisition.

We have been asked to identify areas important for their value as wildlife habitat within the 538 square mile Nashua River Watershed in a relatively short project timeline of three months. The task of answering a generalized question for a large area of land in a short period of time required that we apply methods that would produce a sound, but gross answer to the question being posed. We have relied on data produced by the MassGIS program and the input of many naturalists and biologists familiar with the watershed as well as town Open Space Plans and other reports. The results presented here should be seen as a first step in an iterative process of identifying important wildlife habitat in the watershed. Future work will be required to verify and refine the large areas proposed here.

## **The Nashua**

As seen in Map 1, the Nashua River drains an area of 538 square miles in central Massachusetts and southern New Hampshire, including parts of 31 towns in three counties. The watershed lies on the boundary between the Worcester Plateau and Southern New England Coastal Plains and Hills ecoregions. The major tributary rivers in the watershed – the Nissitissit, Squannacook, North Nashua, Stillwater, and Quinapoxet – generally flow from northwest to southeast, spilling off of the Worcester Plateau on the long slopes characteristic of Townsend, Fitchburg, and Princeton, to the lower, flatter land in Pepperell, Groton, Shirley, and Lancaster. Here waters meet the mainstem of the Nashua River which flows north toward the watershed outlet into the Merrimack River in Nashua, New Hampshire.

## **Theory of Conservation Planning**

Historically, land conservation efforts have neglected landscape scale planning for habitat protection. Conservation areas, reflecting human values more than habitat values, are often set aside for recreational uses, as drinking water supply buffers, or simply because the land is of little economic value. When biodiversity is considered, acquisition is still frequently driven by threat or opportunity (Prendergast et al. 1997). In the absence of an overall strategy, acquisition of properties for multiple use, with the hope that they will provide functional wildlife habitat, can actually do more harm than good to the long range goal of representing biodiversity. Such uncoordinated efforts are problematic in that they usually do not represent the diversity of natural communities in a region, and, in the end, they increase the cost of establishing a representative system of protected lands (Pressey 1994).

This report is a first attempt at identifying conservation targets in the Nashua River Watershed that will contribute specifically to the representation and maintenance of biodiversity and designing a network of conservation lands that will allow for maintenance of ecosystem integrity in the long term. Targeting lands for habitat protection is an iterative process, and further analyses, at finer scales, will be required to refine the recommendations made here.

Before constructing a habitat protection plan with the goal of representing biodiversity, it is important to understand the four components of biodiversity: genetic, population-species, community-ecosystem, and landscape or regional (Noss 1990). Genetic diversity is the variability of the genetic code in a given species caused by propagation of random mutations. A species that is limited in range, in which the entire population mixes freely, may have very low genetic diversity since there is constant genetic mixing. For another species, one in which populations are largely separated by a mountain range, an ocean, or a highway for instance, genetic diversity may be high as mutations present in one population are rarely introduced into another population by interbreeding.

Population-species diversity is the level most people consider when they think of *biodiversity*. This level involves the number of plant and animal species present in an area *and* their arrangement across the landscape. Ecologists have defined three types of species diversity: alpha-, beta-, and gamma-diversity. Alpha-diversity is simply the number of species present in a single habitat type, the species *richness*; a habitat type with high alpha diversity, such as a rich, mesic forest, would be a conservation priority. Beta-diversity is the rate of change in species composition between two habitat types within the same general area, and gamma diversity refers to the rate of change in species composition over larger spatial scales such as ecoregions. High beta- or gamma-diversity would indicate that species face barriers to movement between adjacent communities or ecoregions and indicates the need for many wildlife reserve areas as opposed to one large area that might not capture the full diversity of a region. (*Scott et al. 1999*).

In order to maintain species level biodiversity, it is essential that a habitat conservation plan capture the full diversity of communities-ecosystems native to an area. A natural community is generally defined as an assemblage of plant species that tend to occur together given similar environmental conditions. A community is frequently named for the dominant canopy species and/or a landscape feature that controls its occurrence, e.g.: Pitch Pine-Oak Forest, Hemlock Ravine, or Acidic Rocky Summit. If across the landscape of the watershed we found low community diversity, such as second growth White Pine-Oak forests, homogenized by fragmentation and the introduction of exotic plant species, we would expect to find lower species diversity. Thus it is crucial to protect the full variety of natural communities found in the watershed. While conservation efforts often focus on examples of uncommon natural communities, such as Spruce-Tamarack Bogs, it is also important to locate and protect the finest examples of our more common natural communities. Likewise, areas of high community diversity, such as a large, undisturbed core areas with extensive and varied wetlands adjacent to a floodplain forest and a steep rocky slope, should be conservation priorities.

Landscape or regional biodiversity refers to spatial scales that begin to lose relevance to this analysis. In a conservation plan for all of Massachusetts, we would want to balance protection of the coastal landscape with that of marble valleys in the western part of the state. Focusing on the Nashua watershed, we do not face such landscape diversity; however the basin does lie on the boundary of the Worcester Plateau and Southern New England Coastal Plains and Hills ecoregions (Griffith et al. 1994). Thus, conservation efforts must balance protection of the cooler, high elevation northwestern corner of the watershed and the relatively warmer, lower southern and eastern portion.

A well-planned network of protected, undeveloped land, a *reserve system*, should aim to allow for maintenance of biodiversity at each of the four levels of biodiversity: genetic, species, community, and landscape. Higher diversity at each level increases redundancy in ecosystem functions which leads to greater resilience to disturbance.

## **Reserve Design**

Current reserve design theory is based on the core-corridor-buffer model which states that biodiversity at multiple levels will best be maintained in a system of large, undisturbed core areas, surrounded by buffer zones of limited disturbance, and connected by functional corridors for wildlife dispersal (Forman 1995). There are five basic principles of reserve design:

- Large blocks of habitat, containing large populations, are better than small blocks with small populations.
- Blocks of habitat close together are better than blocks far apart.
- Habitat in contiguous blocks is better than fragmented habitat.
- Interconnected blocks of habitat are better than isolated blocks.
- Blocks of habitat that are roadless or otherwise inaccessible to humans are better than roaded and accessible blocks. (Noss et al. 1999)

Large, roadless core areas perform many functions: they provide habitat for species that are extremely sensitive to human disturbance; they serve as “biological fortresses” against invasion of exotic species; and they can serve as control sites for ecosystem research in a landscape where human alteration is nearly all-pervasive (Noss et al. 1999). Smaller core areas serve as secondary habitat and as stepping stones for movement of individuals and populations. Buffers are areas of limited human presence surrounding core areas. Areas of compromise between conservation and human use, such buffers could include farms, orchards, athletic fields, and low-density residential zones.

Placing pressure on the goals of maintaining contiguity are the many land uses that encourage fragmentation. Massachusetts Audubon Society and others have identified habitat fragmentation as one of the state’s most significant threats to wildlife habitat integrity. Fragmentation, the process of dividing natural lands into smaller and smaller units, is destructive in many ways; it:

- limits foraging area of animals;
- decreases area of interior habitat;
- disturbs natural migration routes;
- limits genetic interaction;
- inhibits dispersal and recolonization after local extinction; and
- restricts scale of natural disturbance regimes.

Depending on the mobility and sensitivity of a given animal species, an insurmountable barrier could be a highway such as Route 2 or a smaller town road, a strip development of buildings and parking lots, a residential cul-de-sac, or a corn field. Plant response to ecological barriers depends largely on habitat requirements and dispersal mechanisms of individual species, but impacts on animals such as pollinators indirectly affect plants. Fragmentation favors habitat generalists and tends to reduce the populations of larger predators. Overabundances of some species can have far reaching impacts on the landscape, as in the case of white tailed deer: their browsing directly impacts diversity and structure of the shrub layer in many of our forests, degrading shrub habitat to the point that heavily browsed areas host fewer shrub-nesting bird species (McShea and Rappole 2000). Increased fragmentation also leads to decreased populations of large carnivores. The removal of top predators can cause the population boom of smaller carnivores no longer competing with or hunted by top carnivores, a process called meso-predator release. Increased populations of mesopredators, such as raccoons and skunks, can negatively impact small mammals, amphibians, birds and their eggs.

Another major threat to wildlife habitat in Massachusetts is the invasion of exotic plant and animal species. “Invasives” are invasive due to dispersal and growth habits (and lack of pathogens and browsers) that allow them to outcompete native plants, thus depressing populations of native plants, and creating a homogenized natural community which is of reduced habitat value to native animals. Seeds of invasive plants disperse along roads and pathways, carried by wind or with vehicle and foot traffic. One small road through an otherwise contiguous forest can serve as a conduit for the introduction of invasive plants. Thus habitat fragmentation contributes directly to the spread of invasive plants.

*Edge habitat*, or the boundary area between two distinct vegetation types, such as forest and grassland, is often touted as a contributor to biodiversity since many different species make use of such transition zones between cool, shady, tall canopy forest and warm, sunlit openings. In truth these are ecologically important and diverse areas for plants and invertebrates and edges are heavily used by animals taking advantage of the openings for food and the forest for cover. This information is often used as support for logging or other land clearing operations with the reasoning that if edge is diverse, and diversity is good, more edge must be better. Unfortunately, edge is a common characteristic of suburban development, and more edge only means larger populations of the same species that currently make use of the watershed’s already abundant edge habitat.

Interior is not exclusive to forests. Grassland, a rapidly declining habitat type in the northeast, is unique breeding habitat for many bird species that require not just a small grassy opening, but large expanses of treeless meadow. Any increase in edge comes at the expense of interior – of any community type including forest, grassland, water body, etc. – and impacts negatively on the species that specialize in making use of that interior habitat. Scarlet tanagers populations have been shown to decrease in more fragmented landscapes, where there is a concurrent increase in avian and mammalian nest predators and cowbirds, a nest parasite (Rosenberg et al. 1998).

Thoughtful reserve design will allow for the long-term integrity of landscapes and ecosystems by maintaining functional relationships at all levels of biological

organization, allowing individual organisms to obtain nutrients, shelter, security, and protection from pathogens, parasites, and pollutants; populations sufficient area to maintain genetic variability, and connectivity to allow for recolonization after local extinctions; communities functional relationships between associated species such as predator/prey, parasite/host, and plants/pollinators-seed dispersers; and regions maintenance of landscape level processes such as floods, weathering, and migration (Scott et al. 1999).

## **Landscape Scale Conservation Planning**

Perhaps the leading proponent of landscape-scale planning for the restoration and protection of naturally functioning ecosystems in North America is the Wildlands Project. The Nature Conservancy, with their Ecoregional Planning process, is also working on identifying important areas for land protection on the regional scale. These two groups often work with much larger land areas than we are analyzing in the Nashua, such as the Wildlands Project's effort to identify and protect grizzly bear habitat from Yellowstone National Park to the Yukon Territory in Canada. However the techniques developed through their large-area planning efforts, and the lessons learned can be borrowed and adapted for this analysis. In an ecoregional reserve design completed in Oregon and California, Noss et al. (1999) state four goals to be met by a reserve system; to:

- represent all kinds of ecosystems, across their natural range of variation, in protected areas;
- maintain viable populations of all native species in natural patterns of distribution and abundance;
- sustain ecological and evolutionary processes; and
- maintain a conservation network that is resilient to environmental change.

Noss and others have developed a three-prong approach to identifying specific areas that go into a reserve design to meet those goals:

- protection of special elements, such as rare species hotspots, old-growth forests, and critical watersheds for aquatic biota;
- representation of all habitats and vegetation types within a network of reserves; and
- meeting the needs of particular focal species, especially those that are area-dependent or sensitive to human activities.

## **Special Elements**

Rare, threatened, and endangered plants and animals; uncommon landforms such as ledges, caves, and eskers; and rare and exemplary natural communities are all special elements that any reserve design should take into consideration. Rare natural communities and habitat for rare species is not always the most species diverse habitat, so targeting these locations for protection while neglecting other areas is not a sound approach to overall habitat protection. Locating *hotspots* where many special elements

occur together one way of maximizing protection effort. A balanced reserve design must aim to protect special features where possible, while remaining focused on the coarser scale need for landscape connectivity.

## **Representation**

In an ideal reserve design, all native natural communities would be represented within protected areas; but realistically, one must decide which communities are more important for the protection of biodiversity, and then how many examples of each community to include in a conservation network. In *Guidelines for Representing Ecological Communities in Ecoregional Conservation Plans*, The Nature Conservancy presents a framework for considering these questions and developing answers. They recommend setting conservation targets by considering Heritage Program information on the rarity and diversity of natural communities with expert input by those familiar with the study area. For deciding how much of a given community type is enough to protect, they consider three factors. First is the geographic scale and spatial pattern of the community in the conservation planning unit -- is it a *matrix* community, such as white pine-oak in the Nashua that needs protection over wide areas, or is the target red maple swamps that are local in extent. Second, the proportion of the community's total distribution contained within the planning unit -- is the community common all over the Northeast or are all known examples found only within our study area. Finally, the resolution of the vegetation classification and the ecological variability of each community -- is the classification so specific that a few examples of each captures variability, or is it a broad classification in which many examples of each community type should be protected to guarantee representation of several varieties (Groves and Valutis 1999).

## **Focal species**

Even with unlimited time to study an ecosystem, it would still be impossible to know all the needs of every species and all of the myriad interactions between species. As a substitute for designing reserves with hundreds of species in mind, ecologists use a small number of representative species to plan for the protection of many species. By managing for the protection of these *focal species*, a successful reserve design will maintain ecosystem conditions upon which many other species rely, thus contributing to their protection (Miller et al 1999; Lambeck 1997). Generally, there are six types of focal species as described by Foreman et al. (2000):

- **umbrella** —species that generally cover large and ecologically diverse areas in their daily or seasonal movements; protection of enough of their habitat to assure a viable population of these organisms would provide habitat and resources to many other species more restricted in range.
- **keystone** — species that enrich ecosystem function in a unique and significant manner through their activities, and the effect is disproportionate to their numerical abundance. The extirpation of keystone species often triggers other extirpations and significant changes or loss of habitats. Large carnivores are often keystone species. The beaver, through its modification of the landscape is another keystone species (Mills et al 1993)

- **flagship** — charismatic animals, like wolves and eagles, which build popular support for the protected area.
- **habitat quality indicator** — species that require natural habitat of high ecological integrity and that provide an early warning system because they are sensitive to ecological changes.
- **wilderness quality indicator** — species that are sensitive or vulnerable to human disturbance and thus require remote, wilderness habitat.
- **prey** — key prey species for focal predators in the above categories.

Having identified focal species from a number of taxa, the next step is to consider the primary habitat requirements of those species. These required landscape elements, be they large waterbodies, ledge slopes, or red maple swamps, then become the basic units of a reserve network.

This introduction provides a brief overview of the theory and practice of reserve design. Excellent references include *Continental Conservation: Scientific Foundations of Regional Reserve Networks* by Soule and Terbourgh, *The Science of Conservation Planning* by Noss, O’Connell, and Murphy, and *Land Mosaics: The Ecology of Landscapes and Regions* by Richard Forman. Given the limited timeline of this project, we were not able to fully pursue every step outlined above. The process is presented as a framework for conservation planning with the hope that land protection efforts in the Nashua watershed will build on the results of this report to identify and protect a network of habitat that functions to maintain biodiversity at multiple levels.

## Methods

Our first task was to determine what it is we are trying to identify. Would habitat protection in the Nashua be best served by identification of small, uncommon natural communities, or certain types of waterbody or landscape feature, or food source, or migration route, or landscape process, etc. To approach an answer, we used the focal species method to identify umbrella species, habitat disturbance indicators, and habitat quality indicators. Among other amateur and professional naturalists and biologists, we spoke with the following wildlife experts:

- Mammals – Paul Rezendez, Dave Kay, John McCarter (independent trackers);
- Birds – Wayne Peterson, Simon Perkins, Andrea Jones, (Mass. Audubon), Ron Lockwood (bird surveys);
- Reptiles & Amphibians – Betsy Colburn, Joan Milam, Ron Wolanin (Mass. Audubon);
- Fish – Lee McGlaughlin (DFWELE)
- Lepidoptera & Odonata – Chris Leahy, Jackie Sones (Mass. Audubon)

Through these conversations we nominated focal species, concentrating on birds, mammal, reptiles, and amphibians. We then asked the experts to identify habitat requirements of these species and worked with those requirements to locate important areas for wildlife habitat in the watershed.

### Special elements

For identification of special elements, we relied on data from the Massachusetts Natural Heritage and Endangered Species Program and input from dozens of professional biologists, amateur naturalists, conservation commission and land trust members and other individuals familiar with parts of the watershed. We were able to conduct field work in some areas of the watershed, but our ability to gather new field information was severely limited by the project timeline.

We used ArcView 3.2 GIS software to analyze landuse and open space patterns in the watershed and to locate areas of significant wildlife habitat. We first combined MassGIS roads (Massachusetts Highway Department Roads) and land use datalayers to identify large, undeveloped areas in the watershed. In the land use polygon attribute table, each land use unit is assigned one of 21 land use types. We used these categories to code each polygon as low-quality, marginal, or potential high-quality habitat according to Table 1.

For most of the watershed, the latest land use data available was completed from interpretation of 1985 aerial photographs. To correct for changes since then, we used the most up-to-date aerial photography available to visually check the outlines of our habitat focus areas; for various parts of the watershed the latest aerial photography was flown in either 1992, 1995, or 1997. Using GIS to display roads and low-quality habitat in black,

**Table 1: Habitat codes for land use types in MassGIS land use datalayer.**

Low quality	Marginal	Potential high quality
Spectator recreation	Cropland	Forest
Water-based recreation	Pasture	Wetland
Residential	Mining	Open land
Commercial	Participation recreation	Water
Industrial	Woody perennial (orchards, etc.)	
Urban open		
Transportation		
Waste disposal		

and marginal habitat in gray, we identified large areas of low development that could serve as habitat cores and corridors, and buffer areas. These areas were labeled “Draft Focus Areas.”

We then concentrated on identifying riparian and ridge corridors as connectors of the large habitat areas identified in the above steps. We used MANHESP Priority Habitat polygons and the FEMA Q3 Flood zone datalayer available from MassGIS to identify the riparian corridor. Ridgelines were identified by mammal experts as important corridors for wide-ranging animals. We used the 3D Analyst capability of ArcView to locate prominent ridgelines in the watershed and the “Create buffers...” function to generate a 100 meter buffer on either side of the ridgelines.

We reviewed the most recent Open Space Plan of each Massachusetts town in the watershed for conservation priorities and sought input from Conservation Agents, members of conservation commissions and land trust, and Land Protection Directors from the Nashua River Watershed Association and Beaver Brook Association. In addition, we incorporated information from Mass. Audubon and Heritage Program botanists, ecologists, and land protection specialists on specific areas of high quality habitat and habitat protection priorities. Finally, we added the Massachusetts Natural Heritage & Endangered Species Program (MANHESP) Priority Habitat datalayer to identify known habitat for listed species.

Information from interviews was combined to create “habitat highlight” polygons in the GIS analysis. These polygons were overlaid with the Draft Focus Areas to make final adjustments. Thus the Focus Areas represent large, lightly-developed areas of potential high-quality habitat, containing habitat for rare, threatened, and endangered species and distinct landscape features, and distributed across the watershed in a network that contributes to maintenance of landscape level processes.

### **Priority Communities**

We attempted to identify the priority natural communities for protection in the Nashua watershed. We worked with MANHESP staff to assign a Watershed Rank to natural communities that occur in the Nashua. Ranks have been assigned at the global, national, and state level, but not at the watershed level in Massachusetts. Communities are ranked on a scale of 1 to 5, the lower number indicating increasing rarity or threat of extirpation.

We combined these watershed ranks with state rank, Natural Heritage information on the number of listed species known to use each community as habitat, distribution throughout the state, and commonness in the watershed to arrive at a priority value for each community.

## **Results**

When we asked wildlife experts to identify focal species within their area of expertise and to list habitat characteristics for those species that would be central to protection, again and again we heard three things: large areas, undisturbed, roadless. There are particular needs for each of the groups we investigated, for instance various birds require particular forest structure – shrubbiness, dead standing trees, openings, etc. – for nesting habitat; trout require cool, well-oxygenated streams while smallmouth bass prefer warmer waters; and the myriad invertebrates have their own specialized habitat requirements. However the one thing that nearly every commenter came back to is low human disturbance as the number one promoter of high quality habitat.

In interviews with those working in the watershed it became abundantly clear that the Squannacook and Nissitissit River corridors are of central importance both as aquatic and wetland habitat and as riparian corridors. Based on those central principals, we nominate the Focus Areas shown in Map 1 as high priorities for habitat protection efforts in the Nashua River Watershed. The focus areas themselves are, of course, important for their habitat qualities; but in combination the areas form a habitat network that could provide for the landscape level requirements of species, populations, and ecosystems.

### **Large Focus Areas**

These large areas, each over 7000 acres in size and with a large amount of little-disturbed interior, are the cornerstones of a habitat reserve design for the Nashua River Watershed. Each area is large enough to host animal species that are sensitive to human disturbance, and include a variety of natural communities that provide diverse habitat for plants. Many of them are based on large protected areas such as state forests, parks, or wildlife management areas (WMAs). Since most of these areas do have small roads running through them, further protection should emphasize acquisition of interior parcels, especially those adjacent to already protected land.

#### **Mt. Wachusett/Hubbardston WMA (Map 11; 18816 acres)**

Located in Princeton, Westminster, and Hubbardston, this extremely large area of little-developed land sits on the southeastern corner of the Worcester Plateau ecoregion. Although it lies mostly outside the Nashua watershed, its position at the southern end of a mountain chain extending north into New Hampshire, its elevation and topography, and its importance to natural communities typically found to the north make it one of the most important habitat cores in this analysis. Uncommon and high-quality natural communities include Spruce-Fir-Northern Hardwood Forest and Acidic Rocky Summit/Rock Outcrop (although this example is impacted by parking lot and foot traffic).

At least 32% of the area is permanently protected, with an additional 14%, in the areas around Wachusett Lake, Meetinghouse Pond, And Mare Meadow Reservoir, listed by MassGIS as open space with unknown protection. The major conservation properties are the DEM Wachusett Mountain State Reservation, DFWELE's Hubbardston WMA, and Mass. Audubon's Wachusett Meadows Wildlife Sanctuary. Priority Habitat areas are almost completely contained within these protected lands. Conservation opportunities include the Church Rock ridge to the west of West Princeton Road, which connects Mt. Wachusett to Meetinghouse Pond; Noyes Pond which connects Mt. Wachusett to Mare Meadow Reservoir to the west; and the area south of Wachusett Lake comprising a ridge which connects to the Crow Hill area of Leominster State Forest. The Midstate Trail runs along this ridge. Recent building along New Westminster Road in Hubbardston has reduced the amount of interior habitat.

### **Badger Hill/Spaulding Brook (Map 19; 12200 acres)**

This area in Mason, Brookline, Wilton, and Milford, New Hampshire features diverse topography with Spaulding Brook, Mitchell Brook and smaller streams cutting through a series of steep-sided valleys between Boynton, Burns, Badger, Hutchington, and Pale Hills. These steep slopes could include ledges with talus fields below, which often host uncommon natural communities. The uplands adjacent to the brooks are crucial to the maintenance of these feeders to the Nissitissit as clean, cold-running habitat for aquatic invertebrates and native fish populations. The north-facing slopes of these hills likely harbor natural communities, such as Spruce-Fir-Northern Hardwood Forest, more common to the north and found in few other places in the Nashua watershed. Badger Hill/Spaulding Brook serves as a habitat core, and together with the Townsend State Forest focus area, offers a wide corridor for wildlife moving north to open areas in southern New Hampshire.

The focus area appears to be relatively undeveloped, yet only 5% is permanently protected according to New Hampshire GRANIT data. The steep valleys and limited lowland adjacent to streams means that there are few wide marshes or swampy areas, but the many saddles and areas of gentle slope may be sites of vernal pools.

### **Leominster State Forest (Map 12; 11301 acres)**

The largest area of contiguous undeveloped land located wholly in the watershed, the landscape centered on Leominster State Forest is an absolutely crucial piece of any effort to maintain core wildlife habitat in the watershed. With a tremendous diversity of large waterbodies, such as Notown and Fall Brook Reservoirs, and Hy-Crest Pond, several medium and small open ponds, extensive wetlands at Bartlett Swamp and south of Notown Reservoir, and the topography of Ball and Crow Hills in the west and the Monoosnuoc Hills in the east, this focus area should be one of the highest priorities for concerted land protection in the watershed. The waterbodies are of particularly high value for their undeveloped perimeters; such areas may serve as nesting habitat for Common loon, a species of special concern. Three prominent ridges – Snow Hill-Crow Hills, Palmer Hill-Ball Hill-Wolfden Hill, and Monoosnoc Hills-Bayberry Hill – reach off of the Worcester Plateau providing an upland connection in the southwest to the Mt.

Wachusett focus area and the Wekepeke River area to the south. The Monoosnoc Hills may include potential habitat for small whorled pogonia, a federally threatened plant species. Perhaps the best example of an acidic talus slope in watershed is found at base of cliffs on the eastern slope of Crow Hills.

Leominster State Forest itself accounts for 32% of this focus area in permanent protection. The Town of Leominster and others own an additional 12% of the area with level of protection listed as limited or unknown by MassGIS. Protection priorities should be the west and southwestern slopes of Crow Hills, North and South Monoosnoc Hills, the Haynes Reservoir area, and the Flag Brook area north of the state forest (which includes a large cleared area on the aerial photograph; development of this site would severely impact the interior forest character of this section).

### **Mt. Watatic (10692 acres)**

Mt. Watatic is identified as a focus area on the watershed scale map, but is not pictured in a fine scale map. Although the focus area lies entirely outside of the Nashua River Watershed, it is mentioned as a priority of the Ashburnham Conservation Commission. This large area is a natural extension of the string of habitat running north from Savage Hill in Rutland and should be recalled when thinking of the value of Mt. Hunger/Russell Hill and Upper Naukeag/Lincoln Pond as connectors of large habitat areas.

### **Wachusett Reservoir (Map 18; 10339 acres)**

Clearly an important habitat resource as the largest body of open water in the watershed, Wachusett Reservoir is nonetheless a focus area of a different variety. MDC holds 36% of the land within this focus area *in addition to* the surface of the reservoir itself. The reservoir is important habitat for lake-nesting and -feeding birds. The entire water surface with adjacent upland connects with the Stillwater River in one large MANHESP Priority Habitat area. Habitat conservation priorities should include protection of the South Meadow Brook area north of the reservoir and Reubens and Rattlesnake Hills. These two hills actually lie in the SuAsCo watershed, but should be a point of cooperation with groups working in that watershed as the area provides a corridor to protected land across the watershed divide.

### **Savage Hill WMA/Quinapoxet Reservoir (Map 15; 9124 acres)**

This long, narrow focus area stretches along the Princeton-Rutland line into Holden, from Savage Hill in the northwest to the Quinapoxet Reservoir and Maple Spring Pond in the southeast. Mushcopauge Brook, especially at Holbrook Swamp is a protection priority, as are the extensive wetlands with adjacent uplands on either side of Glenwood Road south of Davis Hill. This focus area is a connector between the expansive open space of Mt. Wachusett to the north, the Pine Hill Reservoir focus area to the south, and the Poutwater Pond focus area to the east. Savage Hill WMA, Metropolitan District Commission, and Worcester Water Department lands combine with APR lands to total 42% of this area in some form of protection.

### **Townsend State Forest (Map 2; 8698 acres)**

This focus area straddles the state line in the north-central section of the watershed with parts in Townsend, Mason, and Brookline. While the Massachusetts portion is almost 100% permanently protected as Townsend State Forest, it appears that very little land on the New Hampshire side is protected in any way. The area abuts the Badger Hill/Spaulding Brook area in the north, and these two well-connected core areas allow wildlife movement well into the watershed from the less developed areas further north in New Hampshire. Barker Hill and uplands to the east form a ridge dropping off of the Worcester Plateau which may be another important wildlife corridor. Uplands include rocky outcrops that provide high quality habitat for snakes, and support headwater streams of the Nissitissit and Squannacook Rivers.

### **Oxbow/Intervale/Bolton Flats (Map 14; 8476 acres)**

Like Leominster State Forest to the west, this large focus area, together with McGovern Brook and Ballard Hill focus areas, is a wildlife habitat anchor in the east-central section of the watershed. Located in Lancaster, Harvard, and Bolton, the protected and largely trail-less Oxbow NWR and Bolton Flats WMA, and restricted-public-access Devens South Post create what could be the largest, least human-impacted habitat in the watershed. Even with military training in the South Post, the lack of buildings, low traffic, and periodic nature of human presence on the property mean that animals move relatively unmolested across this landscape. Tracks of bobcat, black bear, and moose have been recorded within this focus area. Bobcat are particularly sensitive to human disturbance and their presence in an area is a very strong indicator of high quality habitat. The “drop zone,” a large grassland maintained through mowing and occasionally used for parachute training, and the “impact zone” used for mortar training are two very important, uncommon habitat types. The maintained grasslands of the drop zone are utilized by upland sandpipers (endangered in Massachusetts), vesper and grasshopper sparrows (threatened in Massachusetts), and savannah sparrows, a species of special concern. Pitch pine woodlands and adjacent openings host one of the largest whip-poor-will populations in the state, and the frequently-burned scrubby cover of the impact zone is habitat for brown thrashers, another species in statewide decline. These are the largest, highest quality grassland habitat and pitch pine woodland habitat in the watershed. Nineteen listed species have been identified in a MANHESP Priority Habitat polygon that is almost entirely enclosed within this focus area. Uncommon plant communities include Pitch Pine/Scrub Oak Barrens around impact zone, an Alluvial red maple swamp, small river floodplains, and bogs.

The clear protection priority in this focus area is the continued and long-term management of Devens South Post in ways that are conducive to maintaining wildlife habitat.

### **Lake Wompanoag (Map 5; 7265 acres)**

The area in the vicinity of Lake Wompanoag in Ashburnham, Gardner, and Winchendon is one of the largest pieces of contiguous open space in the watershed; and the lake itself, along with Notown Reservoir in Leominster and Pine Hill Reservoir in Paxton, is one of the largest relatively undeveloped waterbodies in the watershed. More than half of the

area we have highlighted as important habitat lies outside the Nashua Watershed, but this entire undeveloped expanse is important for its size, its large amount of interior, and its location on the western edge of the watershed, lying in the Worcester Plateau ecoregion. Due to its higher elevation than most of the watershed, this area hosts natural communities, such as Spruce-Tamarack Bogs, that have northern affinities and are found here in the southern part of their range. It should be considered another cornerstone of a reserve design for the Nashua River Watershed.

Though there is low-density residential development to the southwest of Lake Wompanoag, and there are camps and a small lakefront community on the west side of the lake, the area is largely undeveloped. The entire lake is identified as Priority Habitat by the MANHESP. Part-time resident Elizabeth Bagdonas has conducted extensive biological inventory of the area focusing on the high-quality bog at the northern end of the lake. To the north is Cheshire Pond and another extensive boggy wetland, also identified as Priority Habitat. This wetland system, though not connected hydrologically, likely serves as an ecological link for animals requiring wetland habitat. Populations of bog-loving plants also benefit from this large system of acidic wetlands. The area is criss-crossed by a discontinued road and an old railroad bed as well as a power line right-of-way, all of which serve as feeding habitat and movement corridors for larger mammals, invertebrates, and birds. They are also used by all-terrain vehicles and motorcycles, with potential impacts on wildlife.

A significant portion of the area – 26% -- is permanently protected, primarily under ownership of Mass. Audubon Society, Monadnock Trust, DEM, and the Town of Gardner. Important targets for habitat protection include all of the Priority Habitat areas, especially undeveloped shoreline on Lake Wompanoag, and parcels along the Old County Road which could possibly allow access for development in the long term.

### **Medium-sized Focus Areas**

These areas enclose less interior habitat and landscape diversity than the large focus areas, but still provide home range for a large number of species in a variety of natural communities.

#### **Birch Hill/Rocky Pond (Map 19; 6866 acres)**

Like Badger Hill/Spaulding Brook, this focus area is important for its topography, position at the northern end of the watershed, connections to other large areas and the Nissitissit River corridor, and protection of steep, first order streams such as East, Stonehouse, and Rocky Pond Brooks. Again, typical of the abruptly rising hillsides in this northern part of the watershed, there are few large wetlands; however the north-facing slopes should be investigated for uncommon natural communities. Much of Rocky Pond Brook is protected by the Beaver Brook Association. Protection priorities would include increasing the area protected in the southern end of this focus area and expanding open space ownership on Birch Hill while working to limit further development on Milford and Rocky Pond Roads.

### **East Wachusett & Wekepeke Brooks (Map 13; 6439 acres)**

Difficult to label, this oddly shaped focus area ties together extensive lands with limited protection along East Wachusett Brook in its western end, unprotected habitat in its center, and additional protected lands around Fitch, Lynde, and Spring Basins adjacent to Wekepeke Brook. Keyes Brook, a tributary to the Stillwater running northwest from West Sterling, is part of the MANHESP Priority Habitat area that connects down the Stillwater all the way to Wachusett Reservoir and is habitat for numerous listed turtle species. The area is not without some development, yet it is an important connector between the extensive habitat of the Leominster State Forest and Poutwater Pond focus areas. Protection priorities should focus on the central portion of this area, south of Justice Hill Road, and the unprotected lands adjacent to Wekepeke Brook.

### **Pine Hill Reservoir (Map 16; 5714 acres)**

Exceptional for the extent of undeveloped hillside directly adjacent to large bodies of water, this focus area in Rutland, Holden, and Paxton forms the southern extent of a string of open areas stretching north to Mt. Watatic and beyond. The area around the reservoirs is known to provide excellent snake habitat, and the wetland to the west of Bond Hill is a MANHESP Priority Habitat. Twelve percent of the area is listed as permanently protected by MassGIS with another 39% in unknown protection. Protection priorities include Bond Hill and the wetland to the west and unprotected interior parcels such as the area around Worcester Brook north of Pine Hill Reservoir, and Streeter Pond to the south.

### **Poutwater Pond (Map 17; 5700 acres)**

This focus area in Princeton, Holden, Sterling, and West Boylston is centered on property owned by MDC, DFWELE, WOLCS, and the Nimrod League of Holden. It is an important corridor between the Savage Hill and Wekepeke Brook focus areas and is the nearest large area of limited development to the west of Wachusett Reservoir. Poutwater Pond and the adjacent, large Spruce-Tamarack Bog are MANHESP Priority Habitat and the wetland/upland combination on the east side of Flagg Hill and west of Mason Road are likely important reptile and amphibian breeding habitat. One third of the focus area is identified as having permanent or limited protection. Priorities are Flagg and Hog Hills and Poutwater Pond itself.

### **High Ridge WMA (Map 5; 3954 acres)**

This focus area is centered on High Ridge WMA which includes extensive (>80 acres) open meadows managed for hay. Bobolinks were present during a July field visit, however repeated mowing throughout the summer may deter nesting by more disturbance-sensitive grassland nesting birds. Portions of the meadows could be managed expressly for success of grassland nesters by delaying the first cut until after August 1<sup>st</sup>. Wetlands within this area provide habitat for state-endangered American bitterns, a strong indicator of low human disturbance. Together with the Lake Womponoag focus area, these open lands of the Worcester Plateau provide undisturbed

habitat for large mammals ranging south from the Mt. Watatic area. DFWELE staff report moose and bear activity in the area.

Over half (54%) of the area is permanently protected as the WMA and Westminster State Forest. Protection of the wetlands east and west of Overlook Road at the southern end of this focus area, and the lands west of Murray Road at the northern end are the conservation priorities.

#### **Horse Hill/Baddacook Pond (Map 8; 3809 acres)**

This area on the watershed boundary in Groton and Dunstable includes almost 500 acres of the Wharton Plantation owned by the New England Forestry Foundation. Other conservation owners include the Town of Groton Conservation Commission and Water Department, as well as the Groton Conservation Trust. Together those organizations and departments hold 33% of the land in some form of protection, though only 7% is listed by MassGIS as permanently protected. MANHESP recognizes four Priority Habitats within or intersecting this focus area: one along the Unkety Brook at the north end, one along the power line right-of-way east of Kemp Street, and two others located on the north and east sides of Chestnut Hills. Protection efforts here should focus on those areas.

#### **Willard Brook State Forest (Map 7; 3732 acres)**

This large area in Ashby, Townsend, and Lunenburg is 62% permanently protected as DEM's Willard Brook State Forest. Important conservation opportunities include Rattlesnake Hill which is largely unprotected and several Chapter 61 properties at the southern end of the area which are important for maintaining continuity between the core of Willard Brook SF and the Pearl Hill Brook area to the south.

#### **Whitney Hill/Coweas Hill/Muddy Pond (Map 5; 3665 acres)**

Straddling the Ashburnham-Westminster town line, this area contains a prominent north-south ridge that connects large open areas to the north and south. Small roads dissect the area, and some land is used for agriculture. This area may not be one of the habitat cores of an overall reserve design, but is a crucial stepping stone between others in the constellation of open areas found in the northwestern corner of the watershed. Only 1% of the area is permanently protected, by DEM as part of Westminster State Forest. MassGIS open space coverage shows another 14% as open space with unknown protection, grouped in three large parcels in the southeast of the site. Forested wetlands to the west of Willard and Bragg Hill Roads could include vernal pools. Protection of this section should be a priority.

#### **Mt. Hunger/Russell Hill (Map 6; 1896 acres)**

This section of Ashburnham is another focus area to be considered more for its value as a habitat connector than a large, undisturbed core. The area contains two ridges leading off of the Worcester Plateau including uncommonly steep terrain on the east side of Mt. Hunger. None of the land is listed as protected open space by MassGIS. Priorities include Mt. Hunger and the Russell Hill ridge.

### **Wright Ponds (Map 6; 3589 acres)**

The focus area centered on Wright Ponds in Ashby and Fitchburg, together with the Falulah Brook focus area, connects Willard Brook State Forest to the large open areas of the Worcester Plateau on the watershed's western boundary. The steep, cool streams are feeders of the Squannacook, and the wet meadows below Lower Wright Pond are high quality habitat. A ridge running through the southwestern quadrant of this area could be part of a wildlife corridor toward Mt. Watatic. Only 18% of this area is protected, some as part of Willard Brook SF, but most with ownership and level of protection listed as unknown by MassGIS. Protection of the wet meadows below Wright Ponds and the uplands adjacent to streams would be priorities here.

### **Small Focus Areas & Connectors**

These smaller areas provide habitat for smaller animals, and act as stepping stones for larger animals moving across the landscape and for the slower movement of populations.

### **Hound Meadow Hill/Hawk Swamp (Map 4; 3100 acres)**

Though crossed by small roads and including farmland and two gravel pits, this lightly developed northwestern corner of Dunstable is important for its 2.5 miles of undeveloped riverbank along the Nashua River and its role as buffer for the Unkety Brook and associated wetlands and their adjacent wooded uplands. Hollis Street in Dunstable runs along the ridge dividing this area into a western and eastern half, and separating the Nashua and Merrimack watersheds. The Nashua River at this point is a Priority Habitat with five listed species associated with it. Hawk Swamp, a Spruce-Fir Boreal Swamp, is an example of a natural community type near the southern end of its range. The Unkety Brook has been identified as exceptional habitat for aquatic wildlife. Eight percent of this focus area is listed as permanently protected land, with another 13% with limited protection. Priorities include the large parcel running south from Drake Hill which is listed by MassGIS as in Chapter 61a and owned by H&G Realty. Development of this area would bisect the entire area, severely degrading its value as wildlife habitat. The low land adjacent to Unkety Brook, east of River Street is another priority, for protection of riparian corridor habitat.

### **Squannacook Hill/Groton Town Forest (Map 9; 2820 acres)**

Featuring the confluence of the Squannacook and Nashua Rivers, this focus area is important for its floodplain forest habitat, extensive wetlands with adjacent uplands, and as a buffer to the riparian corridor along the Squannacook and Nashua, and Mulpus Brook. Development along Longley, Lawton, and Kittredge Roads limits the area of interior forest habitat here, and precludes this parcel from acting as a habitat core, but it is well-located as a stepping stone for wildlife movement north from the Oxbow NWR.

Between the Squannacook River WMA and the Ayer State Game Farm, 8% of the area is protected permanently; another 21% is under limited protection as the Groton Town Forest, and 7% is owned by the Shirley Rod & Gun Club. Priorities are appropriate

management of the game farm and town forest, protection along the east bank of the Nashua River, and protection of the southern slopes of Squannacook and Brattle Hill above Mulpus Brook in the western section.

### **Upper Naukeag/Lincoln Pond (Map 20; 2686 acres)**

Another site on the border of the watershed in Ashburnham, this medium sized core is an important stepping stone between the large Mt. Watatic and Lake Wompanoag sites. Upper Naukeag Lake (outside the watershed) is listed as MANHESP Priority Habitat, and beside Lincoln Pond is another fine example of a Spruce-Tamarack Bog approximately 40 acres in size.

DEM owns or holds conservation restriction over 46% of this site. Remaining conservation opportunities include the eastern shore of Lincoln Pond, where a planned residential development was abandoned some years ago.

### **Snake Hill/Long Pond (Map 10; 2471 acres)**

Straddling the Ayer-Groton border, this area contains a diverse combination of uplands adjacent to extensive wetlands. Powerline and gas rights-of-way provide movement corridors and the network of swamps and marshy areas are likely important undisturbed breeding habitat for multiple species. The network also provides dispersal routes between the large ponds in the area – Flannagan and Sandy Ponds to the southwest, Spectacle Pond to the southeast, and Knops Pond and Lost Lake to the northeast. Very little of the area is protected land – the Groton Conservation Commission owns a small parcel at Half Moon Swamp, and 8% is in limited protection, partly as the Rod & Gun Club. Priorities are Snake Hill itself as well as the wetlands to the north.

### **Townsend Hill (Map 3; 2300 acres)**

This almost entirely unprotected, yet undeveloped area in northeast Townsend is important as a connector between Townsend State Forest to the west, Gulf Brook to the east, and the Nissitissit River to the north. Gulf Brook is known to be habitat for black bear and bobcat, and the prominent ridge of Townsend Hill, with its steep eastern shoulder, is likely utilized as well by both species. A cluster of vernal pools has been certified along Wheeler Street to the east of Townsend Hill, and that area is listed as Priority Habitat. Some of the numerous small waterbodies on Townsend Hill itself are probably vernal pools; the area should be investigated in the Spring for vernal pool fauna. The entire area should be a protection priority to prevent further incursions such as that caused by Warner Road.

### **McGovern Brook (Map 14; 2283 acres)**

The McGovern Brook focus area, including White Pond and a stretch of the North Nashua River, is high quality habitat in its own right, but is of utmost importance as a buffer between downtown Leominster and the Oxbow/Intervale/Bolton Flats focus area. The combination of wetlands and gravel pits could provide ideal habitat for turtles looking for sandy deposits for their eggs. Abandoned or partially active gravel pits can

be well managed as habitat for bank nesting birds as well. The north bank of the North Nashua includes low lying land that could develop as flood plain forest, an uncommon natural community type in the watershed. Twenty percent of the area is already permanently protected as Chapman-Goodale, Chickering, and Cook Conservation Areas and Lancaster State Forest. Priorities are to ensure that abandoned gravel pits are not converted to another intensive use, and land on the south bank of the North Nashua River.

#### **Ballard Hill (Map 14; 2244 acres)**

Like McGovern Brook, Ballard Hill in Lancaster and Sterling is important as a buffer for Oxbow/Intervale/Bolton Flats, yet the west side of Ballard Hill and the section south of Flanagan Hill Road contain numerous certified vernal pools, and the vicinity of unnamed stream draining north, crossing at the intersection of Flanagan Hill, Hilltop, and Brockelman Roads, is a MANHESP Priority Habitat area. Lancaster Town Forest and New England Forestry Foundation lands protect 17% of the area permanently. The Priority Habitat section should be a protection priority as well as the northeastern corner of the focus area, along Route 117.

#### **Falulah Brook (Map 6; 2224 acres)**

A narrow focus area without abundant interior habitat, this site in Ashby and Fitchburg is nonetheless important buffer for Falulah Brook and Fitchburg reservoir, and a connector in the chain of habitat stretching from Lake Wompanoag to Townsend State Forest and beyond. Fitchburg Reservoir is important bird habitat and a Heritage Priority Habitat site. There is at least one certified vernal pool on the Mass. Audubon property east of Flat Rock Road. Between Audubon and other owners, 49% of the land is protected, although MassGIS lists level of protection as unknown for all of it. Protection priorities include the entire unprotected section south of Fitchburg Reservoir which includes the headwaters of the Falulah and narrow wetlands with adjacent uplands.

#### **The Throne (Map 8; 1916 acres)**

The Throne, located in Groton and Pepperell, is special for the extent of undeveloped upland in West Groton, and the number of vernal pools it harbors on its upper slopes. The Throne itself has been identified as a conservation priority by the Nashua River Watershed Association and the Town of Groton and we have extended the focus area east across Pepperell Road to include lowlands adjacent to the Nashua River. Groton Conservation Commission, Groton Conservation Trust, and New England Forestry Foundation own 19% of the land. The Throne is a central part of the set of focus areas that provide functional habitat in the northeastern corner of the watershed. It is an important link between the Squannacook River corridor and the J. Harry Rich State Forest and Squannacook Hill focus areas.

#### **Hunting Hills/Mulpus Brook (Map 7; 1876 acres)**

This area is 43% permanently protected as Hunting Hills WMA and the Cowdrey Nature Center, as well as lands of unknown ownership listed by MassGIS as permanently

protected. Four large Chapter 61 properties add 13% of the area in temporary protection. This area is an important connector between Witch Brook to the northwest and Mulpus Brook to the southeast. Mulpus Brook in turn leads to the Squannacook Hill focus area and the Nashua mainstem. These are crucial stepping stones for wildlife movement towards the large Oxbow/Intervale/Bolton Flats core area. The marsh just below the outlet from Hickory Hills Lake, is a MANHESP Priority Habitat, as is the wetland at the north end of the focus area.

### **Gulf Brook (Map 3; 1849 acres)**

Gulf Brook is one of the small treasures of the watershed. Though this focus area is long and narrow, without tremendous amounts of interior, its geology and location at the southern end of the expansive Birch Hill/Rocky Pond focus area makes it truly unique in the watershed, and topography creates a more isolated environment than the focus area outlines would suggest. The Heald Pond section, and the gorge to the north of the pond are known habitat for black bear and bobcat, and endangered invertebrates. Other uncommon species, such as various bats make use of the blocky bedrock outcropping in the gorge. The gorge and the Gulf Brook are natural corridors for wildlife movement south from New Hampshire. More than half of the land enjoys some level of protection, with Belmont Springs Bottling Company and the Town of Pepperell being the largest landowners. Protection priorities include the west side of the gorge north of Heald Pond, and the section south of Bemis Road.

### **Bixby Reservoir (Map 7; 1609 acres)**

This focus area is important for its location as a connector between Pearl Hill Brook and Willard Brook SF focus areas, and Bixby Brook and the Lower Squannacook River. This set of focus areas in the north-central section of the watershed provide an east-west link from the Worcester Plateau highlands and the large focus areas of Lake Wompanoag and Mt. Watatic to the Nashua mainstem lowlands in Shirley and Groton. About 18% of the area is permanently protected as Lunenburg Town Forest and another 14% is in Chapter 61b.

This medium sized area has been split in two by residential development along Tyler Road, however the density of house lots may be sufficiently low that ecological contiguity is maintained. Conservation priorities include permanent protection of the Chapter 61 lands and the remainder of the area's southern end around Mulpus Brook, and the hills surrounding Bixby Reservoir.

### **Unionville Pond/Quinapoxet River (Map 16; 1531 acres)**

Consisting of a large amount of MDC-owned land in Holden, this focus area is important as a connector between the Savage Hill focus area and the Stillwater River which leads to the Wachusett Reservoir as well as a buffer between the Poutwater Pond focus area and the center of Holden. The Quinapoxet and its tributaries here are identified by Heritage Program as Priority Habitat. More than half of the land is currently protected; however,

the hill north of River Street appears to be unprotected, and any development here would divide and degrade the value of this focus area as a stepping stone and buffer.

### **J Harry Rich State Forest/Shepherd Hill (Map 8; 1524 acres)**

The Nashua River as it passes through this focus area has been identified by Nashua River Watershed Association aquatic experts as important habitat for birds, fish, and turtles. The slow, meandering nature of the river here, with many oxbows and backwaters offers a rich combination of warm, sluggish water, a few marshy areas, and wide, sandy lowlands that provide shelter, feeding, and breeding habitat for a variety of wildlife. The state forest is the centerpiece of this focus area, with 41% of the land permanently protected. Protection efforts should focus on the west bank of the Nashua River along the length of this focus area.

### **Pearl Hill Brook (Map 7; 1303 acres)**

An important buffer between Willard Brook State Forest and the urban development of Fitchburg, this area is largely owned by [golf club] according to MassGIS data. The eastern quarter drains into Mulpus Brook and provides upland adjacent to the brook that may function as a corridor to the Bixby Reservoir focus area. The area straddles a ridge that runs north into the Willard Brook SF which may be another important wildlife corridor. The conservation priority is to work with the country club on permanent protection of their undeveloped property.

### **Parker Hill (Map 5; 1169 acres)**

Parker Hill is the southern terminus of a ridge running south from Mt. Hunger in Ashburnham. Though a small focus area, it contains the lower section of MANHESP Priority Habitat centered on Phillips Brook, and provides important buffer to the dense development of West Fitchburg. Only 5% of the area is protected in any way, and MassGIS lists level of protection as unknown. The protection priority here is the section surrounding a tributary stream to Phillips Brook in the northern end of the focus area.

### **Bixby Brook (Map 7; 1163 acres)**

This focus area is another important connector between the Squannacook River and large open areas to the west. DEM owns 33% of the area, permanently protected as part of Townsend State Forest. Another 22% is owned by the Townsend Rod & Gun Club. The state forest section includes a large riverside marsh and meanders of the Squannacook. The northeast section of this marsh is unprotected.. Priorities include protecting this section of the marsh and Harbor Pond.

### **Trapfall Brook (Map 2; 1102 acres)**

This small area is another stepping stone for animals ranging south into Ashby and east-west from Mt. Watatic to Townsend State Forest. The ~50 acre wetland on Trapfall Brook, south of the Mason Road-Foster Road intersection is a MANHESP Priority

Habitat and likely provides habitat for a large number of reptiles, amphibians, birds, and invertebrates. This wetland and the adjacent uplands should be a protection priority.

### **Long Swamp/Catacoonamug Brook (Map 9; 837 acres)**

An intricate network of eskers in Long Swamp as well as the extent of wetland (~100 acres) in Long Swamp and along Catacoonamug Brook make this focus area a standout. The wetlands are likely turtle habitat and eskers are often associated with uncommon plant communities. Fifteen percent of the area is permanently protected under municipal ownership, and another 25% is in Chapter 61. The priorities here are protection of Long Swamp and maintenance of the southern end of the focus area in conservation land.

### **Riparian Corridors**

Crucial for aquatic and riparian habitat and as corridors between focus areas, these areas are smaller in acreage. With their linear character they lack the interior of the large and medium focus areas; nonetheless, they are central to a reserve network in the watershed.

### **Squannacook River (Map 2 & Map 7)**

The Squannacook River is listed by several people familiar with the watershed as a central component of wildlife habitat quality. Its headwaters drain an area that is some of the most forested, least developed in the watershed, leaving the main Squannacook a cold, clean stream that is frequently cited as prime habitat for native brook trout, and listed species of dragonflies, mussels, reptiles, and amphibians. The boundaries of the Upper and Lower Squannacook River focus areas were taken directly from MANHESP Priority Habitat polygons; additional land adjacent to the river and its floodplain may also be priorities for protection.

Much of the Lower Squannacook focus area (29%) is protected by the Squannacook River WMA. The Fitchburg Rod & Gun Club property makes up another 4% of the area as land in limited protection. The protection priority for this area should be expansion of the WMA along Witch Brook.

A small proportion of the Upper Squannacook River focus area (7%) is protected by the Squannacook River WMA and Townsend State Forest. The Ash Swamp should be a clear priority for land protection in this area, as well as the wetlands adjacent to the Squannacook at the eastern end of the focus area.

### **Nashua River/Mulpus Brook (Map 9)**

This stretch of the Nashua mainstem is perhaps the most important corridor in the watershed. Its main function is to connect the expanse of high quality habitat in the Oxbow focus area with the smaller areas to the north that are stepping stones to the large open space of north Lunenburg and Townsend. The bridge carrying Route 2 over the Nashua River is one of the few locations for wildlife to cross the barrier created by the highway. A second, possibly more important passage is by the railroad underpass just east of the Nashua River bridge, at the northeast corner of the Oxbow/Intervale/Bolton

Flats focus area. The area south of Sheridan Road on the Devens North Post, and the uplands adjacent to the Nashua near the Devens exits from Route 2 should be carefully managed for wildlife movement to and from the Oxbow focus area.

The uplands adjacent to the Nashua at the southern end of this corridor include an ash swamp, floodplain forest, and a mesic terrace, all uncommon natural communities. Catacoonamug Brook offers a riparian corridor toward the Long Swamp/Spruce Swamp focus area, though it does pass through the center of Shirley; it is certainly valuable as aquatic habitat. Further north the Nashua River corridor widens to include marshy wetlands on low ground adjacent to the river, then connects to the Squannacook Hill focus area. Moore Airfield may offer habitat for grassland nesting birds and small prey species, and the wide, low area southwest of the airfield is a Heritage Priority Habitat for four listed species. The Mulpus Brook corridor extends northwest, through the southern section of the Squannacook Hill focus area, to the Hunting Hills focus area. Twenty-two percent of the corridor is protected; priorities include Mulpus Brook south of Brattle Hill and the areas around the river and railroad underpasses underneath Route 2.

### **Stillwater River Corridor (Map 17)**

The boundaries of this corridor are taken directly from a MANHESP Priority Habitat polygon. The polygon extends to include all of Wachusett Reservoir, and is identified as habitat for ten listed species. The corridor connects Wachusett Reservoir with Unionville Pond focus area which is a stepping stone to the large Poutwater Pond and Savage Hill/Quinapoxet Reservoir focus areas, and the Wekepeke River focus area which leads to Leominster State Forest. As the river corridor that stretches between three of the largest focus areas in the watershed, and as fine aquatic habitat with important floodplain forests adjacent, the Stillwater River is another area crucial for protection of landscape level processes. Fortunately, nearly the entire area is already protected, primarily by the MDC. Remaining priorities include protection of the Waushacum Brook area, and management of the Route 190 underpasses for wildlife movement.

### **Nissitissit River (Map 3)**

The Nissitissit, like the Squannacook River, is identified by aquatic biologists, anglers, entomologists, and land protection professionals as one of the highest quality stretches of aquatic habitat in the watershed. As a wildlife corridor, it connects the Hound Meadow Hill/Hawk Swamp focus area with Gulf Brook and the large focus areas of Townsend and southern New Hampshire, as well as the large protected lands along Beaver Brook. Largely because the tributary streams in Brookline and Mason flow through the undeveloped land identified as Badger Hill/Spaulding Brook and Townsend State Forest focus areas, the Nissitissit is a clean, cold, well-oxygenated stream important to invertebrates and native trout. The entire length of the Nissitissit in Massachusetts is identified as Natural Heritage Priority Habitat for five listed species. Thirteen percent of the corridor area is permanently protected as the Nissitissit River WMA. Protection priorities include the upper area of the corridor between Brookline center and South Brookline, and the lowlands adjacent to the river between North Pepperell and Four Corners.

## Priority Natural Communities

Table 2 presents our top twenty priority natural communities grouped as Highest Priority and High Priority. This is a proposed classification, to be discussed, as the Focus Areas presented above, and updated as new information is gathered in the watershed.

MANHESP lists 47 natural communities occurring in the watershed. Many of these can be split into finer definitions of what a natural community is, but we have used these 47 as the basis for this analysis. A description of each of the communities listed in Table 2 can be found in Appendix A.

**Table 2: Priority natural communities for protection in the Nashua River Watershed.**

<b>Highest Priority</b>	<b>High Priority</b>
Alluvial Atlantic White Cedar Swamp	Acidic Graminoid Fen
Atlantic White Cedar Bog	Alluvial Red Maple Swamp
Black Ash Swamp	Black Oak - Scarlet Oak Forest / Woodland
Black Gum Swamp	Dry Riverside Bluff
Northern Atlantic White Cedar Swamp	Dry, Rich Acidic Oak Forest
Pitch Pine-Scrub Oak Community	High-Terrace Floodplain Forest
Rich, Mesic Forest	Kettlehole Wet Meadow
Sandplain Grassland	Spruce-Fir Boreal Swamp
Small-river Floodplain Forest	Spruce-Tamarack Bog
Spruce-Fir-Northern Hardwood Forest	Wet Meadow

## Conclusion

The network of areas identified in this report as priorities for habitat protection is a first cut. We hope that people discuss the assumptions, the methods, and the results, and continue to work on refining the focus areas. Towns, land trusts, and other conservation organizations and agencies should look at the focus areas identified in their area of interest and, if generally satisfied with their outlines, take a closer look at what lies inside. Ecological inventories should be carried out to identify the natural communities present and the species making use of each area. Wildlife habitat inventories carried out at the town or subwatershed level can build on this report by focusing at a finer scale.

Management of protected areas should be reviewed to ensure that habitat maintenance is a high priority alongside recreation and drinking water protection. Additional biological information, especially the outcome of the Natural Heritage Program BioMap effort, should be integrated with this report to support or alter the results. Professional and amateur naturalists should be on the lookout for examples of the high priority natural communities listed in Table 2.

With additional work, large parts of the focus areas identified here will be permanently protected from conversion to low-quality habitat. The Nashua River Watershed will continue to function as the home range of the full spectrum of wildlife we now enjoy, and possibly other species that have not yet reclaimed ground lost in the days of Thoreau. If we protect large core areas, buffers around them, and corridors between them, the wild will remain with us in the Nashua.

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## Appendix A: Natural Community Descriptions

“Natural community” is a term used to describe an association of plant species that tend to occur together in similar environmental settings. The concept of natural communities is fundamentally artificial, a human construct, thus it is difficult to define a natural community or to decide when to separate one type into two or vice-versa. Accepting these difficulties, communities are still a useful unit for conservation. If all community types in a study area could be located and described, it would be possible to decide which are most in need of protection, and conservation efforts could be directed accordingly. In the results section of our study, we present twenty natural communities that should be priorities for protection in the Nashua River Watershed, due to their relative rarity, their distribution, and their role as habitat for listed and unlisted plant and animal species. This appendix presents descriptions of those twenty priority natural communities.

These descriptions are based directly on the Massachusetts Natural Heritage & Endangered Species Program’s *Draft Classification of the Natural Communities of Massachusetts* (Swain & Kearsley 2000); however the descriptions in that document contain more detail on each listing. The following Page Guide explains the information found in the descriptions in this appendix.

<b>Community Name:</b>	Name used to describe the community in Massachusetts.
<b>SRANK:</b>	Community state rank (SRANK) that reflects the community’s rarity and threat within Massachusetts, with regard to its regional rarity and threat. The SRank system was developed for Natural Heritage programs by The Nature Conservancy. The SRANKs are as follows: <b>S1=</b> Typically 5 or fewer occurrences, very few remaining acres or miles of stream, or especially vulnerable to extirpation in Massachusetts for other reasons. <b>S2=</b> Typically 6-20 occurrences, few remaining acres or miles of stream, or very vulnerable to extirpation in Massachusetts for other reasons. <b>S3=</b> Typically 21-100 occurrences, limited acreage or miles of stream in Massachusetts. <b>S4=</b> Apparently secure in Massachusetts. <b>S5=</b> Demonstrably secure in Massachusetts. <b>SU=</b> Status unknown in Massachusetts.
<b>Concept:</b>	Brief general description or word-picture of the community.

<b>Environmental setting:</b>	Detailed description of the landscape setting, soils, water chemistry, and other physical characteristics of the community.												
<b>Vegetation Description:</b>	Detailed description of the vegetation structure and characteristic plant species of the community.												
<b>Habitat values for: Associated Fauna</b>	Description of the habitat that the community provides for animals, including birds, small mammals, amphibians, invertebrates, etc.												
<b>Associated rare plants:</b>	A list of rare plants that are known to occur in the community type. Rare plants include those that are state-protected under the Massachusetts Endangered Species Act and those that are on the state watch list. Plants on the watch list are not legally protected, but they are believed to be uncommon or rare. They are species for which information is lacking on number of sites and severity of population decline, or species that have been delisted.												
Plant Latin name	<table border="0" style="margin-left: 40px;"> <tr> <td style="padding-right: 20px;">Plant common name</td> <td>Plant state status</td> </tr> <tr> <td></td> <td>E= State Endangered</td> </tr> <tr> <td></td> <td>T= State Threatened</td> </tr> <tr> <td></td> <td>SC= State Special Concern</td> </tr> <tr> <td></td> <td>WL= State Watch List</td> </tr> <tr> <td></td> <td>H= State Historic</td> </tr> </table>	Plant common name	Plant state status		E= State Endangered		T= State Threatened		SC= State Special Concern		WL= State Watch List		H= State Historic
Plant common name	Plant state status												
	E= State Endangered												
	T= State Threatened												
	SC= State Special Concern												
	WL= State Watch List												
	H= State Historic												
<b>Associated rare animals:</b>	A list of rare animals that are known to occur in the community type. Rare animals include those that are state-protected under the Massachusetts Endangered Species Act (birds on the bird watch list are also included). Format and abbreviations follow those used for Associated rare plants (see above).												
<b>Examples: OR Examples with Public Access:</b>	List of representative examples of the community in areas with public access. For particularly sensitive communities, specific examples are not listed.												
<b>Threats:</b>	A description of known threats to the community.												
<b>Management needs:</b>	A description of management activities that may be necessary to maintain community occurrences and the quality of those occurrences.												

Priority natural communities for protection in the Nashua River Watershed:

**Highest Priority**

Alluvial Atlantic White Cedar Swamp..... A - 4  
Atlantic White Cedar Bog ..... A - 5  
Black Ash Swamp..... A - 6  
Black Gum Swamp ..... A - 7  
Northern Atlantic White Cedar Swamp ..... A - 8  
Pitch Pine-Scrub Oak Community ..... A - 9  
Rich, Mesic Forest ..... A - 11  
Sandplain Grassland..... A - 13  
Small-river Floodplain Forest..... A - 15  
Spruce-Fir-Northern Hardwood Forest ..... A - 17

**High Priority**

Acidic Graminoid Fen..... A - 18  
Alluvial Red Maple Swamp ..... A - 20  
Black Oak - Scarlet Oak Forest / Woodland ..... A - 22  
Dry Riverside Bluff..... A - 23  
Dry, Rich Acidic Oak Forest ..... A - 24  
High-Terrace Floodplain Forest..... A - 25  
Kettlehole Wet Meadow..... A - 27  
Spruce-Fir Boreal Swamp ..... A - 29  
Spruce-Tamarack Bog..... A - 30  
Wet Meadow..... A - 31

**Community Name:** ALLUVIAL ATLANTIC WHITE CEDAR SWAMP

**SRANK:** S2

**Concept:** Forested swamps occurring along low-gradient rivers where Atlantic white cedar is co-dominant with red maple in the overstory.

**Environmental setting:** Alluvial AWC swamps differ from other AWC wetlands in that they occur within the floodplain of rivers and streams or at the fringes of open marshy areas along ponds. They receive annual or semi-annual overbank flooding making them more mineral-rich than other AWC wetlands. As with all AWC swamps, water-saturated peat, generally about 1 m thick in alluvial examples, overlies the mineral sediments, and standing water generally occurs for half of the growing season or longer.

**Vegetation Description:** Alluvial AWC swamps are highly variable in their composition. Atlantic white-cedar (*Chamaecyparis thyoides*) and red maple (*Acer rubrum*) dominate the tree layer, and high-bush blueberry (*Vaccinium corymbosum*) and sweet pepperbush (*Clethra alnifolia*) occur in the shrub layer along with silky dogwood (*Cornus amomum*). The herb layer is comprised of species common to very wet, open or enriched sites, including sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda regalis*), bugleweed (*Lycopus* spp.), marsh fern (*Thelypteris palustris*), and marsh St. John's-wort (*Hypericum virginicum*).

**Habitat values for Associated Fauna:** Alluvial AWC swamps can function as vernal pool habitat if water remains standing for 2-3 months and they lack fish; these areas provide important amphibian breeding habitat.

**Associated rare plants:**

LYCOPUS RUBELLUS	GYPSYWORT	E
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**Associated rare animals:**

AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	SC
CLEMMYS GUTTATA	SPOTTED TURTLE	SC
CLEMMYS INSCULPTA	WOOD TURTLE	SC
CRANGONYX ABERRANS	MYSTIC VALLEY AMPHIPOD	SC
HEMIDACTYLIUM SCUTATUM	FOUR-TOED SALAMANDER	SC
MITOURA HESSELI	HESSEL'S HAIRSTREAK	SC

**Examples:** Known examples on the Canoe, Bungay, and Shingle Island Rivers.

**Community Name:** ATLANTIC WHITE CEDAR BOG

**SRANK:** S2

**Concept:** Acidic forested peatlands with a nearly continuous heath shrub layer and an open canopy in which Atlantic white cedar is the characteristic tree species.

**Environmental setting:** Semi-forested level bogs with sphagnum mats. More information is needed on the physical characteristics of Atlantic white cedar forested bog communities.

**Vegetation Description:** Total canopy coverage is low, but Atlantic white cedar (AWC; *Chamaecyparis thyoides*) is dominant with scattered red maple (*Acer rubrum*). Other occasional associates are white pine (*Pinus strobus*), grey birch (*Betula populifolia*), pitch pine (*Pinus rigida*), and black spruce (*Picea mariana*). A low shrub layer is dominated by leatherleaf (*Chamaedaphne calyculata*) and sheep laurel (*Kalmia angustifolia*) mixed with clumps of tall shrubs including high-bush blueberry (*Vaccinium corymbosum*) and swamp azalea (*Rhododendron viscosum*). Other associated shrub species are (*Gaylussacia baccata*), rhodora (*Rhododendron canadense*), (*G. dumosa*), and bog rosemary (*Andromeda glaucophylla*). There is typically a well-formed Sphagnum moss layer below the shrubs, and large and small cranberry (*Vaccinium macrocarpon* and *V. oxycoccus*), sundews (*Drosera* spp.) and pitcher plants (*Sarracenia purpurea*) occur throughout.

**Habitat values for Associated Fauna:** The moats of AWC bogs can function as vernal pool habitat if water remains standing for 2-3 months and they lack fish; these areas provide important amphibian breeding habitat.

**Associated rare plants:**

NONE KNOWN

**Associated rare animals:**

AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	SC
MITOURA HESSELI	HESSEL'S HAIRSTREAK	SC
PAPAPEMA APPASSIONATA	PITCHER PLANT BORER MOTH	SC

**Examples:** Mashpee pine barrens, Mashpee.

**Community Name:** BLACK ASH SWAMP

**SRANK:** S2

**Concept:** A variant of red maple swamps in which black ash (*Fraxinus nigra*) is co-dominant in the canopy. Black ash swamps are associated with circumneutral groundwater seepage.

**Environmental setting:** Black ash swamps typically occur in areas with circumneutral groundwater seepage. They can occur at the edge of river floodplains adjacent to the upland slope where seepage input occurs, as small seepy pockets within a larger matrix of red maple swamp, or at the headwaters of streams, which may be the typical location in northern and western parts of the state. The pH of black ash swamps in Essex Co. ranges between 7.0 and 7.4 [MacDougall, pers. comm.]. More information is needed on the physical characteristics of black ash seepage swamps.

**Vegetation Description:** Black ash (*Fraxinus nigra*) is co-dominant with red maple (*Acer rubrum*) in the overstory. There are lesser amounts of sugar maple (*Acer saccharum*), Eastern hemlock (*Tsuga canadensis*), yellow birch (*Betula alleghaniensis*), and white pine (*Pinus strobus*). Ironwood (*Carpinus caroliniana*) is common in the sub-canopy, but it does not always occur. Common shrubs are spicebush (*Lindera benzoin*), winterberry (*Ilex verticillata*), highbush blueberry (*Vaccinium corymbosum*), mountain holly (*Nemopanthus mucronata*), northern arrow-wood (*Viburnum dentatum* var. *lucidum*), and occasional witch hazel (*Hamamelis virginiana*). Skunk cabbage (*Symplocarpus foetidus*) and cinnamon fern (*Osmunda cinnamomea*) are common herb species. Other herbaceous associates include sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda regalis*), lady fern (*Athyrium filix-femina*), jack-in-the-pulpit (*Arisaema triphyllum*), tussock sedge (*Carex stricta*), swamp-saxifrage (*Saxifraga pennsylvanica*), and jewelweed (*Impatiens capensis*). The micro-topography is hummock and hollow with abundant Sphagnum spp. moss, particularly on the hummocks. Black ash swamps occurring in Berkshire Co. or the Connecticut Valley that have species-rich herbaceous layers, with more than 40 species, and calcareous indicator species including delicate sedge (*Carex leptalea*), brome-like sedge (*Carex bromoides*), long-stalked sedge (*Carex pedunculata*), rough-leaved goldenrod (*Solidago patula*), and golden ragwort (*Senecio aureus*) are classified separately as "black ash-red maple-tamarack calcareous seepage swamps."

**Habitat values for Associated Fauna:** Black ash swamps can function as vernal pool habitat if water remains standing for 2-3 months and they lack fish; these areas provide important amphibian breeding habitat.

**Associated rare plants:**

NONE KNOWN

**Associated rare animals:**

CLEMMYS GUTTATA	SPOTTED TURTLE	SC
CLEMMYS INSCULPTA	WOOD TURTLE	SC
EMYDOIDEA BLAND INGII	BLAND ING'S TURTLE	T
PAPAPEMA SP 2	OSTRICH FERN BORER MOTH	SC

**Examples:** Cedar Swamp, Reading; Satan's Kingdom WMA, Northfield.

**Threats:** Known threats include alteration of natural seepage and logging. More information is needed to determine the greatest threats to black ash seepage swamps.

**Community Name:** **BLACK GUM SWAMP**

**SRANK:** S2

**Concept:** Forested acidic basin swamps with accumulations of peat. Black gum is the dominant canopy tree.

**Environmental setting:** Black gum swamps are forested hummocky peatlands that occur in poorly-drained basins. There can be small areas of seepage, usually at the edges of the basin, where seepage indicator plants such as black ash and bugleweed, occur. pH is strongly acidic and ranges from 3-5. More information is needed.

**Vegetation Description:** Black gum swamps have pronounced hummock-hollow topography, and woody vegetation is confined to the hummocks. The canopy is open, often in the 25-50% cover range. Black gum (*Nyssa sylvatica*) dominates the canopy, but red maple (*Acer rubrum*) and Eastern hemlock (*Tsuga canadensis*) are also abundant. Yellow birch (*Betula alleghaniensis*), white pine (*Pinus strobus*), red spruce (*Picea rubens*), and black ash (*Fraxinus nigra*) may also be common. The shrub layer is well-developed; typical species include common winterberry (*Ilex verticillata*), smooth winterberry (*Ilex laevigata*), mountain-laurel (*Kalmia latifolia*), common mountain-holly (*Nemopanthus mucronatus*), highbush blueberry (*Vaccinium corymbosum*), and wild raisin (*Viburnum nudum* var. *cassinoides*). Herbaceous species occur on the hummocks and include cinnamon fern (*Osmunda cinnamomea*), beggar-ticks (*Bidens frondosa*), goldthread (*Coptis trifolia* ssp. *groenlandica*), northern water-horehound (*Lycopus uniflorus*), swamp-dewberry (*Rubus hispidus*), marsh St. John's-wort (*Triadenum virginicum*), and Massachusetts fern (*Thelypteris simulata*). Wet hollows are typically lined with sedges including silvery bog-sedge (*Carex canescens* ssp. *arctiformis*), bladder-sedge (*Carex intumescens*), tussock-sedge (*Carex stricta*), and three-seeded bog sedge (*Carex trisperma*).

**Habitat values for Associated Fauna:** Black gum swamps can function as vernal pool habitat if water remains standing for 2-3 months and they lack fish; these areas provide important amphibian breeding habitat.

**Associated rare animals:**

CLEMMYS GUTTATA

SPOTTED TURTLE

SC

**Examples:** Satan's Kingdom WMA, Northfield.

**Threats:** Hydrologic alterations threaten black gum swamps. Selective logging of trees other than black gum may have allowed the relative abundance of black gum to increase. More information is needed.

**Community Name:** NORTHERN ATLANTIC WHITE CEDAR SWAMP

**SRANK:** S2

**Concept:** A variant of spruce-fir boreal swamps in which Atlantic white cedar is an associate in the tree canopy.

**Environmental setting:** Northern AWC swamps are restricted to basins at high elevations; the one described occurrence in Massachusetts occurs at an elevation of 1,110 feet and is currently the highest known elevation for Atlantic White-Cedar in the state. As with all AWC swamps, water-saturated peat overlies the mineral sediments, and standing water generally occurs for half of the growing season or longer. The water and soil are nutrient-poor, and particularly low in nitrogen and phosphorus. There is a high iron content in the soil; the iron, called "bog iron," was mined in the early days of manufacturing. Soil pH is acidic (3.1-5.5) and leaf litter decomposition is slow.

**Vegetation Description:** Northern conifers, such as black and red spruce (*Picea mariana* and *P. rubens*), and balsam fir (*Abies balsamea*) dominate the overstory, and Atlantic White-Cedar (*Chamaecyparis thyoides*) occurs as an associate. Shrubs and herbs are similar to those found in high-elevation Inland AWC swamps, especially mountain holly (*Nemopanthus mucronatus*), creeping snowberry (*Gaultheria procumbens*), and bunchberry (*Cornus canadensis*). Labrador tea (*Ledum groenlandicum*) and rhodora (*Rhododendron canadense*) are also common.

**Habitat values for Associated Fauna:** Northern AWC swamps can function as vernal pool habitat if water remains standing for 2-3 months and they lack fish; these areas provide important amphibian breeding habitat.

**Associated rare animals:**

AMBYSTOMA JEFFERSONIANUM	JEFFERSON SALAMAND ER	SC
HEMIDACTYLUM SCUTATUM	FOUR-TOED SALAMAND ER	SC

**Examples:** a site in Westminster.

**Community Name: PITCH PINE - SCRUB OAK COMMUNITY**

**SRANK:** S2

**Concept:** Shrub dominated communities with scattered to dense trees and scattered openings. Shrubs are often very dense.

**Environmental Setting:** Pitch pine/scrub oak communities develop on droughty, low nutrient soils - usually deep, coarse, well-drained sands derived from glacial outwash -- in the coastal plain, the Connecticut River Valley, and other scattered areas throughout the northeast. Pitch pine/scrub oak communities are a fire maintained and fire dependent community; most species in the community recover well from fire. The openings grade into heathland and grassland communities, which are larger. The community grades into Pitch pine - oak - heath forests which have tree oak species and much less scrub oak, and usually occur in less dry environments.

**Vegetation Description:** Pitch pines form an open canopy above a shrub layer dominated by shrub oaks, scrub oak (*Quercus ilicifolia*) and sometimes dwarf chinquapin oak (*Q. prinoides*). Older oaks may form a nearly impenetrable understory 3-4 m (10-15 feet) tall, or it may be more open and shorter. Huckleberries (*Gaylussacia baccata*) occur between the oak clones or under more open plants. Scattered openings of variable size support patches of heathland or grassland vegetation -- more or less sparse lowbush blueberry (*Vaccinium angustifolium*), bearberry (*Arctostaphylos uva-ursi*), lichen patches, little bluestem grass (*Schizachyrium scoparium*), sedges (primarily *Carex pensylvanica* and *C. rugosperma*), and beach heather (*Hudsonia tomentosa*). Cow wheat (*Melampyrum lineare*) and mayflower (*Epigaea repens*) are typically found on edges within the community.

**Habitat Values for Associated Fauna:** A large number of species of lepidopterans are restricted to the pitch pine/scrub oak community, and its openings. The bird fauna is generally that of oak woodlands: Rufous-sided Towhee (*Pipilo erythrophthalmus*), Pine Warbler (*Dendroica pinus*), and ruffed grouse (*Bonasa umbellus*) are common. Whip-poor-will (*Caprimulgus vociferus*) and Common Nighthawk (*Chordeiles minor*) are now increasingly restricted to sandy openings of pitch pine / scrub oak communities. American woodcock (*Philohela minor*) also use the openings.

**Associated Rare Plants:**

COREMA CONRADII	BROOM CROWBERRY	SC
LUPINUS PERENNIS	WILD LUPINE	- WL

**Associated Rare Animals:**

ABAGROTIS CRUMBI BENJAMINI	COASTAL HEATHLAND CUTWORM	SC
ACRONICTA ALBARUFA	BARRENS DAGGERMOTH	T
ANISOTA STIGMA	SPINY OAKWORM	SC
APHARETRA PURPUREA	BLUEBERRY SALLOW	SC
CATOCALA HERODIAS GERHARDI	GERHARD'S UNDERWING MOTH	T
CICINNUS MELSHEIMERI	MELSHEIMER'S SACK BEARER	T
CINGILIA CATENARIA	CHAIN DOT GEOMETER	SC
EACLES IMPERIALIS	IMPERIAL MOTH	SC
HEMILEUCA MAIA	COASTAL BARRENS BUCKMOTH	T
ITAME SP 1	PINE BARRENS ITAME	SC
LYCIA YPSILON	PINE BARRENS LYCIA	T

METARRANTHIS APICIARIA	BARRENS METARRANTHIS MOTH	E
ZALE SP 1	PINE BARRENS ZALE	SC
ZANCLOGNATHA MARTHA	PINE BARRENS ZANCLOGNATHA	T

**Examples with Public Access:** Southern Myles Standish SF (and Camps Cachalot and Squanto areas), Plymouth; Mashpee Pine Barrens, Mashpee; Manuel F. Correllus State Forest, Martha's Vineyard; Montague WMA, Montague.

**Threats:** Development, fragmentation, and erosion from heavy trail use. Fire suppression and severe wildfires.

**Management Needs:** Reintroduction of fire according to fire management plans. Many areas that have not burned for more than 20 years may need to have fuels mechanically reduced (*brush cut*) before prescribed fires are attempted.

**Community Name:** RICH, MESIC FOREST COMMUNITY

**SRANK:** S3

**Concept:** A variant of the northern hardwood forest where sugar maple is usually dominant and there is a diverse herbaceous layer with abundant spring ephemerals in a moist, nutrient rich environment.

**Environmental Setting:** Rich, mesic forests are usually found on slopes or talus below calcareous bedrock or on level areas where calcareous or circumneutral bedrock is near the surface [areas of enrichment can also occur where bedrock or till are not particularly base rich, but near the location where downslope enrichment takes place]. In Massachusetts, they are restricted to low to moderate elevations below 2,400 ft. (about 650 m), and usually on north or east-facing, concave, middle to lower slopes that experience downslope movement of nutrients and organic matter. Rich refers to rich in nutrients, although they are also rich in species; and mesic is the moderate moisture regime. Soils are usually deep, with rapid decomposition of leaves and other plant litter quickly incorporated into the soil, so that there is rarely more than one year's accumulation of leaves on the forest floor.

**Vegetation Description:** Rich mesic forests are dominated by sugar maple (*Acer saccharum*), with white ash (*Fraxinus americana*), bitternut hickory (*Carya cordiformis*), elm species (*Ulmus* spp.), and basswood (*Tilia americana*) being other characteristic trees. Bitternut (*Juglans cinerea*) usually grows in rich mesic forests but is infrequent. Hophornbeam (*Ostrya americana*) is common as a subcanopy tree. Although the shrub layer is usually sparse, alternate-leaved dogwood (*Cornus alternifolia*), witch-hazel (*Hamamelis virginiana*), leatherwood (*Dirca palustris*), or red-berried elderberry (*Sambucus racemosa* ssp. *pubens*) might be present. Typically spring ephemerals are abundant. Combinations of any several of the following species usually indicate a rich mesic community: bloodroot (*Sanguinaria canadensis*), maidenhair fern (*Adiantum pedatum*), blue cohosh (*Caulophyllum thalictroides*), sweet cicely (*Osmorhiza claytonii*), Dutchman's breeches (*Dicentra cucullaria*), squirrel corn (*Dicentra canadensis*), toothwort (*Dentaria diphylla*), wild leeks (*Allium tricoccum*), wild ginger (*Asarum canadense*), white baneberry (*Actea pachypoda*), Goldie's fern (*Dryopteris goldiana*), and zigzag goldenrod (*Solidago flexicaulis*) as well as the state-listed species listed below. Two semi-evergreen, fairly distinct sedges (*Carex plantaginea* and *C. platyphylla*) are good indicators of the community that are visible throughout the year.

**Habitat Values for Associated Fauna:** Most animals of rich, mesic forests are generalized deciduous forest species. Birds that often breed in rich, mesic forests include Wood Thrush (*Hylocichla mustelina*), Veery (*Catharus fuscescens*), Black-and-white Warbler (*Mniotilta varia*), Ovenbird (*Seiurus aurocapillus*), Louisiana Woodthrush (*S. motacilla*), Scarlet Tanager (*Piranga rubra*), and Barred Owls (*Strix varia*). Vernal pools in these forests may be breeding sites for blue spotted salamanders (*Ambystoma jeffersonianum*) and other mole salamanders (*Ambystoma* spp.), and spotted turtles (*Clemmys guttata*). Most small mammals of forests occur in rich mesic forests, including Southern flying squirrels (*Glaucomys volans*), grey squirrels (*Sciurus carolinensis*), woodland jumping mouse (*Napaeozapus insignis*), masked shrew (*Sorex cinereus*), and red-backed vole (*Clethrionomys gapperi*). Larger mammals include rich mesic forests as parts of their habitat.

**Associated Rare Plants:**

ACER NIGRUM	BLACK MAPLE	SC
APLECTRUM HYEMALE	PUTTY-ROOT	E
CIMICIFUGA RACEMOSA	BLACK COHOSH	E
CORALLORRHIZA ODONTORHIZA	AUTUMN CORALROOT	SC
DIPLAZIUM PYCNOCARPON	GLADE FERN	- WL
MILIUM EFFUSUM	WOODLAND MILLET	T
RIBES LACUSTRE	BRISTLY BLACK CURRANT	SC

SANICULA CANADENSIS	CANADIAN SANICLE	T
SANICULA ODORATA	LONG-STYLED SANICLE	T
<b>Associated Rare Animals:</b>		
AMBYSTOMA JEFFERSONIANUM	JEFFERSON SALAMANDER	SC
AMBYSTOMA MACULATUM	SPOTTED SALAMANDER	- WL
CLEMMYS GUTTATA	SPOTTED TURTLE	SC
CLEMMYS INSCULPTA	WOOD TURTLE	SC
ELAPHE OBSOLETA	BLACK RAT SNAKE	E
HEMIDACTYLIUM SCUTATUM	FOUR-TOED SALAMANDER	SC
PIERIS NAPI OLERACEA	MUSTARD WHITE	SC

**Examples with Public Access:** Green River Forest, Greenfield; Maple Hill WMA, West Stockbridge; South Mountain, Pittsfield; Mt. Toby, Sunderland and Leverett; The Hopper - Mt. Greylock State Reservation, Williamstown.

**Threats:** Invasive exotics do very well in the nutrient rich, mesic conditions associated with these forests. Fragmentation and isolation can be problems for the species of the community.

**Management Needs:** Control of exotics in exemplary sites.

**Community Name: SANDPLAIN GRASSLAND**

**SRANK:** S1

**Concept:** An open community visually dominated by grasses, although forbs and shrubs are important components of the community.

**Environmental Setting:** A grassland community on flat outwash plains with droughty, low nutrient soils. Most occurrences are near the ocean and within the influence of winds and salt spray of storms, although sandplains throughout the state support small occurrences of this grassland community. The community grades into sandplain heathlands, shrublands, dunes, or forest. It is maintained by fire, salt spray, and, now, mowing. It often occurs as small openings within Pitch pine / Scrub oak communities.

**Vegetation Description:** Grasslands are dominated by graminoids, usually little blue stem grass (*Schizachyrium scoparium*), Pennsylvania sedge (*Carex pensylvanica*), and poverty grass (*Danthonia spicata*), with bearberry (*Arctostaphylos uva-ursi*), scrub oak (*Quercus ilicifolia*), stiff aster (*Ionactis linariifolius*, formerly *Aster linariifolius*), bayberry (*Myrica pensylvanica*), lowbush blueberry (*Vaccinium angustifolium*), and black huckleberry (*Gaylussacia baccata*). Shrub clones often form patches. There is great species overlap with sandplain heathlands, but sandplain grasslands are much richer in vascular species. As a group, Goat's rue (*Tephrosia virginiana*), yellow wild indigo (*Baptisia tinctoria*), butterfly weed (*Asclepias tuberosa*), and bird's foot violet (*Viola pedata*) are good indicators of the community.

**Associations:** Dunwiddie et al. (1996) recognized five grassland associations: Hairgrass Grasslands were divisible into a Beach Grassland subtype and a Heathy Grassland subtype and Little Bluestem Grasslands divided into Pennsylvania Sedge Grasslands, High Diversity Native Sandplain Grasslands, and Weedy Grasslands.

**Habitat Values for Associated Fauna:** Animal species that are adapted to open areas include birds such as Grasshopper Sparrow (*Ammodramus savannarum*) which is particularly adapted to areas with open ground between grass tussocks and Eastern Meadowlarks (*Sturnella magna*) which uses areas with continuous short grass. Small mammals include meadow vole (*Microtus pennsylvanicus*), meadow jumping mouse (*Zapus hudsonius*), and short-tailed shrew (*Blarina brevicauda*). Grasslands provide hunting territory for hawks and owls. Black racers (*Coluber constrictor*) are common snakes that also live and hunt in open grasslands.

**Associated Rare Plants:**

AGALINIS ACUTA	SANDPLAIN GERARDIA	E
AMELANCHIER NANTUCKETENSIS	NANTUCKET SHADBUSH	SC
ARISTIDA PURPURASCENS	PURPLE NEEDLEGRASS	T
ASCLEPIAS PURPURASCENS	PURPLE MILKWEED	T
ASCLEPIAS TUBEROSA	BUTTERFLY-WEED	- WL
ASTER CONCOLOR	EASTERN SILVERY ASTER	E
CIRSIUM HORRIDULUM	YELLOW THISTLE	- WL
DICHANTHELIUM COMMONSIANUM	COMMONS' PANIC-GRASS	SC
GAMOCHAETA PURPUREA	PURPLE CUDWEED	E
HELIANTHEMUM DUMOSUM	BUSHY ROCKROSE	SC
LACTUCA HIRSUTA VAR SANGUINEA	HAIRY WILD LETTUCE	- WL
LECHEA MINOR	THYME-LEAF PINWEED	- WL
LIATRIS SCARIOVA VAR NOVAE-ANGLIAE	NEW ENGLAND BLAZING STAR	SC
LINUM INTERCURSUM	SANDPLAIN FLAX	SC
LUPINUS PERENNIS	WILD LUPINE	- WL
POLYGALA NUTTALLII	NUTTALL'S MILKWORT	- WL
QUERCUS STELLATA	POST OAK	- WL

SCLERIA PAUCIFLORA VAR CAROLINIANA	PAPILLOSE NUT-SEDGE	E
SETARIA GENICULATA	BRISTLY FOXTAIL	SC
SISYRINCHIUM ARENICOLA	SANDPLAIN BLUE-EYED GRASS	SC
SPIRANTHES VERNALIS	GRASS-LEAVED LADIES'-TRESSES	SC

**Associated Rare Animals:**

AMMODRAMUS SAVANNARUM	GRASSHOPPER SPARROW	T
ASIO FLAMMEUS	SHORT-EARED OWL	E
BARTRAMIA LONGICAUDA	UPLAND SANDPIPER	E
CINGILIA CATENARIA	CHAIN DOT GEOMETER	SC
CIRCUS CYANEUS	NORTHERN HARRIER	T
CYCNIA INOPINATUS	UNEXPECTED CYCNIA	SC
GRAMMIA OITHONA	OITHONA TIGER MOTH	E
GRAMMIA PHYLLIRA	PHYLLIRA TIGER MOTH	E
METARRANTHIS PILOSARIA	COASTAL SWAMP METARRANTHIS	SC
SEMIOTHISA EREMIATA	THREE-LINED ANGLE MOTH	SC
SPEYERIA IDALIA	REGAL FRITILLARY	X

**Examples with Public Access:**

Katama Plains, Edgartown; Francis Crane WMA, Falmouth.

**Threats:**

Exotics - Scotch Broom (*Cytisus scoparius*), Japanese knotweed (*Polygonum cuspidatum*), Cypress spurge (*Euphorbia cyparissias*), and cool season grasses such as sheep fescue (*Festuca ovina*), sweet vernal grass (*Anthoxanthum odorata*), velvet-grass (*Holcus lanatus*), and bluegrass (*Poa pratensis*). Mats formed by cool season grasses change the character of the community.

**Management Needs:**

Fire management plans should be produced and implemented to introduce prescribed fire to the best examples. Reduce exotics where possible.

**Community Name: SMALL-RIVER FLOODPLAIN FOREST**

**SRANK:** S2

**Concept:** Silver maple/green ash-dominated forests occurring on alluvial soils of small rivers and streams.

**Environmental setting:** Small-river floodplain forests are known to occur on third-order or smaller tributaries of the Connecticut and Nashua Rivers, on small rivers of eastern Massachusetts where banks are low and overbank flooding occurs, such as the Ipswich, Assabet, Concord, Shawsheen, and Three Mile Rivers, and on edges of riverine islands of the Merrimack River. Annual flooding occurs, but the water volume and degree of scour are much less than in major-river floodplain forests. Soils are hydric silt loams and fine sandy loams with soil mottling within the top 60 cm [2 ft.] and sometimes with a surface organic layer.

**Vegetation Description:** As in major-river and transitional floodplain forest types, silver maple (*Acer saccharinum*) is dominant in the overstory of small-river floodplain forests, but the understory more closely resembles that of red maple-alluvial swamp forests. Cottonwood (*Populus deltoides*) and red maple (*Acer rubrum*) are both typically absent in the canopy of small-river floodplain forest communities. Pin oak (*Quercus palustris*) is a common canopy associate in the Connecticut River basin, and river birch (*Betula nigra*) in the Merrimack River basin. Small-river floodplain forests have a more substantial shrub layer than both major-river and transitional types, but less than alluvial swamp forests. The shrub layer consists mainly of silky dogwood (*Cornus amomum*) and buttonbush (*Cephalanthus occidentalis*). There is greater herbaceous plant diversity in small-river floodplain forests than in major-river and transitional types. Sensitive fern (*Onoclea sensibilis*) and false nettle (*Boehmeria cylindrica*) are most common, and associates include the moisture-loving plants, water hemlock (*Cicuta maculata*), swamp candles (*Lysimachia terrestris*), and water parsnip (*Sium suave*).

**Habitat values for Associated Fauna:** Small-river floodplain forests often contain meander scars or backwater sloughs that function as vernal pools and provide important amphibian breeding habitat.

**Associated rare plants:**

ARISAEMA DRACONTIUM	GREEN DRAGON	T
BETULA NIGRA	RIVER BIRCH	- WL
CAREX GRAYI	GRAY'S SEDGE	T
CAREX TYPHINA	CAT-TAIL SEDGE	T
CLAYTONIA VIRGINICA	NARROW-LEAVED SPRING BEAUTY	T
MENISPERMUM CANADENSE	MOONSEED	- WL
MIMULUS ALATUS	WINGED MONKEY-FLOWER	E
RUMEX VERTICILLATUS	SWAMP DOCK	T

**Associated rare animals:**

AMBYSTOMA JEFFERSONIANUM	JEFFERSON SALAMANDER	SC
AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	SC
CINCINNATIA WINKLEYI	NEW ENGLAND SILTSNAIL	SC
CLEMMYS GUTTATA	SPOTTED TURTLE	SC
CLEMMYS INSCULPTA	WOOD TURTLE	SC
EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	T
GOMPHUS FRATERNUS	MIDLAND CLUBTAIL	E
GOMPHUS VASTUS	COBRA CLUBTAIL	SC
GOMPHUS VENTRICOSUS	SKILLET CLUBTAIL	SC

HEMIDACTYLIUM SCUTATUM	FOUR-TOED SALAMANDER	SC
NEUROCORDULIA OBSOLETA	UMBER SHADOWDRAGON	SC
OPHIOGOMPHUS ASPERSUS	BROOK SNAKETAILED	SC
OPHIOGOMPHUS CAROLUS	RIFFLE SNAKETAILED	T
SOMATOCHLORA CINGULATA	LAKE EMERALD	SC
SOMATOCHLORA ELONGATA	SKI-TAILED EMERALD	SC
SOMATOCHLORA GEORGIANA	COPPERY EMERALD	E
SOMATOCHLORA GEORGIANA	COPPERY EMERALD	E
SOMATOCHLORA KENNEDYI	KENNEDY'S EMERALD	E
SOMATOCHLORA LINEARIS	MOCHA EMERALD	SC
STYLURUS AMNICOLA	RIVERINE CLUBTAIL	E
STYLURUS SCUDDERI	ZEBRA CLUBTAIL	E
STYLURUS SPINICEPS	A CLUBTAIL DRAGONFLY	T

**Examples:** small tributaries of the Connecticut River, South Hadley.

**Threats:** The non-native plant species, moneywort (*Lysimachia nummularia*), forget-me-not (*Myosotis scorpioides*), and glossy buckthorn (*Rhamnus frangula*), are most prevalent in small-river and transitional floodplain forest types, especially in disturbed areas.

**Management needs:** Removal of non-native plants is needed, especially in areas where they are competing with state-protected rare species.

**Community Name:** **SPRUCE - FIR - NORTHERN HARDWOODS FOREST**

**SRANK:** S4

**Concept:** A northern and higher elevation mixed red spruce - northern hardwood forest.

**Environmental Setting:** Tends to be in cool, and typically rocky soils, nutrient poor, somewhat dry, and acidic. Grades into northern hardwoods - hemlock - white pine forests on moister, warmer slopes.

**Vegetation Description:** A community of variable dominance: red spruce may be dominant, or co-dominant with sugar maple and beech (or these may be dominant), with abundant yellow birch and smaller amounts of red spruce and/ or balsam fir. Hemlock (*Tsuga canadensis*) can be abundant or scattered. Heart-leaf paper birch (*Betula cordifolia*) and paper birch (*Betula papyrifera*) usually occur as scattered individuals. Characteristic shrubs include mountain maple (*Acer spicatum*), red-berried elder (*Sambucus racemosa* var. *pubens*), northern mountain ash (*Sorbus americana*), and hobblebush (*Viburnum lantanoides*). A low shrub layer has bunchberry (*Cornus canadensis*), creeping snowberry (*Gaultheria hispidula*), and occasionally, twinflower (*Linnaea borealis*). The herbaceous layer tends to be sparse, especially when spruce is abundant; plants include intermediate fern (*Dryopteris intermedia*), mountain wood fern (*Dryopteris campyloptera*), blue-bead lily (*Clintonia borealis*), painted trillium (*Trillium undulatum*), and wood sorrel (*Oxalis acetosella*).

**Habitat Values for Associated Fauna:** Animals of this community tend to be northern species that are more typical of forests of Vermont and New Hampshire. Birds include Golden-crowned Kinglet (*Regulus satrapa*), Blue-headed Vireo (*Vireo solitarius*), and species of big warblers including Blackburnian (*Dendroica fusca*), Yellow-rumped (*D. dominica*), and Magnolia Warbler (*D. Magnolia*). Mammals include fisher (*Martes pennanti*), as a classic example, and northern species such as red squirrels (*Tamiasciurus hudsonicus*), snowshoe hare (*Lepus americanus*), in the open areas, northern flying squirrels (*Glaucomys sabrinus*), and Pygmy shrews (*Sorex hoyi*). Amphibians would include the ubiquitous redbacked salamanders (*Plethodon cinereus*), wood frogs (*Rana sylvatica*), and red efts, the juvenile stage of red-spotted newt (*Notophthalmus v. viridescens*).

**Associated Rare Plants:**

AMELANCHIER BARTRAMIANA	BARTRAM'S SHADBUSH	T
DRYOPTERIS CAMPYLOPTERA	MOUNTAIN WOOD-FERN	- WL
HUPERZIA APPALACHIANA	APPALACHIAN CLUBMOSS	E
HUPERZIA SELAGO	MOUNTAIN FIRMOSS	E
LINNAEA BOREALIS	TWINFLOWER	- WL
MILIUM EFFUSUM	WOODLAND MILLET	T
RIBES TRISTE	SWAMP RED CURRANT	- WL
SORBUS DECORA	NORTHERN MOUNTAIN-ASH	E
STREPTOPUS AMPLEXIFOLIUS VAR	WHITE MANDARIN	- WL AMERICANUS

**Associated Rare Animals:**

NONE KNOWN

**Examples with Public Access:** Mohawk Trail State Forest, Charlemont; Savoy State Forest, Savoy; Monroe State Forest, Monroe; Mt. Greylock State Reservation, Lanesboro.

**Community Name:** ACIDIC GRAMINOID FEN

**SRANK:** S3

**Concept:** Mixed graminoid/herbaceous acidic peatlands that experience some groundwater and /or surface water flow but no calcareous seepage. Shrubs occur in clumps but are not dominant throughout.

**Environmental setting:** Acidic graminoid fens are sedge-/sphagnum-dominated peatlands that are weakly minerotrophic [mineral-rich]. Acidic graminoid fens typically have some surface water inflow and some groundwater connectivity. Inlets and outlets are usually present, and standing water is present throughout much of the growing season. Peat mats are quaking and often unstable. More information is needed on peat characteristics and hydrology.

**Vegetation Description:** Acidic graminoid fens are differentiated from acidic shrub fens by their abundance of graminoid species and lack of extensive leatherleaf (*Chamaedaphne calyculata*) and water-willow (*Decodon verticillatus*). Beaked sedge (*Carex utriculata*) and slender woolly-fruited sedge (*Carex lasiocarpa* var. *americana*) are often dominant. Other good indicator species are white beak-sedge (*Rhynchospora alba*), twig-sedge (*Cladium mariscoides*), and pondshore-rush (*Juncus pelocarpus*). Characteristic herbaceous species include arrow-arum (*Peltandra virginica*) and rose pogonia (*Pogonia ophioglossoides*). Large cranberry (*Vaccinium macrocarpon*) can be abundant. There is patchy tree and shrub cover, including swamp azalea (*Rhododendron viscosum*), sweet pepper-bush (*Clethra alnifolia*), poison sumac (*Toxicodendron vernix*), red maple (*Acer rubrum*), and Atlantic white cedar (*Chamaecyparis thyoides*). Coastal sites also have bayberry (*Myrica pennsylvanica*).

**Habitat values for Associated Fauna:** Acidic graminoid fens can function as vernal pool habitat in sections that have two to three months of ponding and lack fish; these sections provide important amphibian breeding habitat.

**Associated rare plants:**

ARETHUSA BULBOSA	ARETHUSA	T
CAREX LIMOSA	MUD-SEDGE	- WL
SCIRPUS LONGII	LONG'S BULRUSH	E
XYRIS MONTANA	NORTHERN YELLOW-EYED GRASS	- WL

**Associated rare animals:**

CISTOTHORUS PALUSTRIS	MARSH WREN	- WL
CLEMMYS GUTTATA	SPOTTED TURTLE	SC
DESMOCERUS PALLIATUS	ELDERBERRY LONG-HORNED BEETLE	SC
EMYDOIDEA BLAND INGII	BLAND ING'S TURTLE	T
PAPAIPEMA APPASSIONATA	PITCHER PLANT BORER MOTH	SC
PAPAIPEMA STENOCELIS	CHAIN FERN BORER MOTH	SC
SYNAPTOMYS COOPERI	SOUTHERN BOG LEMMING	SC
VERTIGO PERRYI	OLIVE VERTIGO	SC
WILLIAMSONIA LINTNERI	RINGED BOGHAUNTER	E

**Examples:** Grassy Pond, Acton.

**Threats:** Nutrient enrichment from runoff from roads, lawns, septic systems, and agricultural fields. Other threats are alterations to the natural hydrology and trampling.

**Management needs:** Cattails appear to proliferate in areas that experience road and /or lawn runoff. Efforts should be made to minimize runoff into these communities.

**Community Name:** ALLUVIAL RED MAPLE SWAMP

**SRANK:** S3

**Concept:** A richer variant of red maple swamp that occurs in low areas along rivers and streams that experience overbank flooding.

**Environmental setting:** Alluvial red maple swamp forests occur along mainstem sections of smaller rivers in eastern Massachusetts (*Nashua Assabet, Shawsheen, Concord, and Three Mile*). They experience overbank flooding, but they appear to be more poorly drained than true floodplain forests. Soils are typically silt loams with pronounced soil mottling and a surface organic layer.

**Vegetation Description:** The overstory of alluvial red maple swamps is characterized by a mixture of red maple (*A. rubrum*) and silver maple (*Acer saccharinum*; particularly along riverbanks) with lesser amounts of green ash (*Fraxinus pennsylvanica*) and /or swamp white oak (*Quercus bicolor*). Red oak (*Q. rubra*), white pine (*Pinus strobus*), and black cherry (*Prunus serotina*) occur in elevated sections. Unlike true floodplain forests, alluvial swamp forests have well-developed shrub layers composed of northern arrow-wood (*Viburnum dentatum* var. *lucidum*), silky dogwood (*Cornus amomum*), and the non-native plant European buckthorn (*Rhamnus frangula*). The herbaceous layer is often dominated by sensitive fern (*Onoclea sensibilis*) and false nettle (*Boehmeria cylindrica*) mixed with a rich assemblage of herbaceous species that commonly includes royal fern (*Osmunda regalis*), awned sedge (*Carex crinita*), and bugleweeds (*Lycopus* spp.).

**Habitat values for Associated Fauna:** Alluvial red maple swamps, especially at the upland fringe or in old meander scars and oxbows, can function as vernal pool habitat if water remains standing for 2-3 months and they lack fish; these areas provide important amphibian breeding habitat. Riverine odonates use adjacent alluvial red maple swamps for shelter.

**Associated rare plants:**

BETULA NIGRA	RIVER BIRCH	- WL
CAREX TYPHINA	CAT-TAIL SEDGE	T

**Associated rare animals:**

CLEMMYS GUTTATA	SPOTTED TURTLE	SC
CLEMMYS INSCULPTA	WOOD TURTLE	SC
EMYDOIDEA BLAND INGHII	BLAND ING'S TURTLE	T
GOMPHUS VASTUS	COBRA CLUBTAIL	SC
GOMPHUS VENTRICOSUS	SKILLET CLUBTAIL	SC
NEUROCORDULIA OBSOLETA	UMBER SHADOWDRAGON	SC
OPHIOGOMPHUS ASPERSUS	BROOK SNAKETAILE	SC
OPHIOGOMPHUS CAROLUS	RIFFLE SNAKETAILE	T
SOMATOCHLORA CINGULATA	LAKE EMERALD	SC
SOMATOCHLORA ELONGATA	SKI-TAILED EMERALD	SC
SOMATOCHLORA GEORGIANA	COPPERY EMERALD	E
SOMATOCHLORA KENNEDYI	KENNEDY'S EMERALD	E
SOMATOCHLORA LINEARIS	MOCHA EMERALD	SC

**Examples:** parts of Fort Devens, Nashua River; sections of the Blackstone and Concord Rivers.

**Threats:** Invasion of non-native plant species, including moneywort (*Lysimachia nummularia*) and European buckthorn (*Rhamnus frangula*).

**Management needs:** Removal of non-native plant species.

**Author:** J. Kearsley

**Date:** 7/21/99

**Community Name:** **BLACK OAK - SCARLET OAK FOREST / WOODLAND**

**SRANK:** S3S4

**Concept:** A fairly open oak / heath community maintained by regular light fire.

**Environmental Setting:** A community of dry, sandy or rocky slopes, but also on other xeric sites. Grades into mixed oak and pine-oak forests, and more open communities. Except on the driest sites, without regular fire the community tends to change to include more white oak, chestnut oak, red oak, and hickories. Without fire, there tends to be deep oak leaf litter with slow decomposition.

**Vegetation Description:** Black oak (*Quercus velutina*) is the dominant canopy species. White oak (*Q. alba*) and red maple (*Acer rubrum*) are common associates. A sparse subcanopy may have species of recent disturbance such as grey birch (*Betula populifolia*), black cherry (*Prunus serotina*), and sassafras (*Sassafras albidum*), as well as species less tolerant of fire such as flowering dogwood (*Cornus florida*) or shadbush (*Amelanchier arborea*). Lowbush blueberries, (*Vaccinium angustifolium* and *V. pallidum*), huckleberry (*Gaylussacia baccata*), and scrub oak (*Quercus ilicifolia*) form a fairly dense, but clumped low shrub layer, with scattered maple-leaved viburnum (*Viburnum acerifolium*) and American hazelnut (*Corylus americana*). Sedges (such as *Carex pensylvanica*), bracken fern (*Pteridium aquilinum*), and pink lady's slipper (*Cypripedium acaule*) are often scattered in the open herbaceous layer. On Martha's Vineyard, black oak grows with white oak (*Q. alba*) and post oak (*Q. stellata*) in open, savanna-like woodlands with dense heath understories, in mosaics with grasslands, heathlands, and scrub oak communities.

**Habitat Values for Associated Fauna:** Black oak acorns are important food for white-tailed deer (*Odocoileus virginianus*), black bear (*Ursus americanus*), grey squirrels (*Sciurus carolinensis*), other small rodents, and Wild Turkeys (*Meleagris gallopavo*) and other birds. The understory of blueberries and huckleberries is used by many of these same species in areas with sufficiently large forests to provide all the habitat needs. Passerine birds of oak forests include Red-eyed Vireo (*Vireo olivaceus*), White-breasted Nuthatch (*Sitta carolinensis*), Ovenbird (*Seiurus aurocapillus*), Black-and-white Warbler (*Mniotilta varia*), Scarlet Tanager (*Piranga olivacea*), Great Crested Flycatcher (*Miarchus crinitus*), and Downy Woodpecker (*Picoides pubescens*). [Listing proposed 2000, (*Rhodoecia aurantiago*) Orange Sallow Moth T]

**Associated Rare Plants:**

NONE KNOWN

**Associated Rare Animals:**

APODREPANULATRIX LIBERARIA

NEW JERSEY TEA INCHWORM

T

**Examples with** Green Hill Park, Worcester; Broad Meadow Brook Wildlife Sanctuary, Worcester;

**Public Access:** Quabog WMA, Brookfield; Manuel F. Correllus State Forest, Martha's Vineyard.

**Threats:** fire suppression, severe wildfire, and exotics.

**Management Needs:** Prescribed fire, exotic removal.

**Community Name:** DRY RIVERSIDE BLUFF

**SRANK:** S2

**Concept:** An erosional gravel/sandy cliff face next to rivers or river floodplains supporting species of dry habitats in predominantly open conditions.

**Environmental Setting:** High, 20-40 feet, bluffs of gravel next to river floodplains. Fire has been important in at least some situations, especially on drier south and southwest facing slopes. In areas of oak - pine forests, bluff tops and surroundings may support black oak savannas or dry to mesic oak - pine forests or woodlands. Wetter areas between slopes support shrub thickets or forests.

**Vegetation Description:** Scattered individuals or thickets of scrub oak (*Quercus ilicifolia*), American hazelnut (*Corylus americana*), gray birch (*Betula populifolia*), and trembling aspen (*Populus tremuloides*), with little blue stem (*Schizachyrium scoparium*), lowbush blueberries (*Vaccinium angustifolium* and *V. pallidum*), sweet fern (*Comptonia peregrina*), goat's rue (*Tephrosia virginiana*), stiff aster (*Ionactis linariifolius*), woodland sunflower (*Helianthus divaricatus*), and lupine (*Lupinus perennis*) between patches. Bare ground maintained by erosion, amount varies with location and recent disturbances. This community - type may be subdivided into Acidic and Calcareous variants with further inventory.

**Habitat Values for Associated Fauna:** Harsh, dry conditions limit the number of species expected of all types. Bank Swallows (*Riparia riparia*) and Belted Kingfisher (*Ceryle alcyon*) nest in sandy banks, especially of large rivers. Less common Northern Rough-winged Swallows also use sand and clay banks. Turtles nest in sand that collects at the bottom of such bluffs and tiger beetles breed at the bases and hunt in flatter near by areas.

**Associated Rare Plants:**

LUPINUS PERENNIS

WILD LUPINE

- WL

**Associated Rare Animals:**

NONE KNOWN

**Examples with Public Access:** Clinton River Bluff, Clinton.

**Threats:** Gravel mining removes the community. The substrate is easily disrupted and eroded, but bank stabilization interferes with the natural changes in the community..

**Community Name:** DRY, RICH ACIDIC OAK FOREST

**SRANK:** S4

**Concept:** Deciduous, predominantly oak forest with a rich understory of herbaceous plants and graminoids. The shrub layer has fewer ericaceous plants than other oak forests.

**Environmental Setting:** Often steep slopes with warm, southwest exposure. Soil is enriched due to overwash and downslope movement of nutrients. Best developed on less acidic rocks.

**Vegetation Description:** Mesic to dry oak forest of slightly acid, often rocky soils of intermediate fertility, occurring on well-drained loams on mid-slopes and coves. Tree canopy is dominated by a mixture of oaks (*Quercus rubra*, *Q. velutina*, and *Q. alba*), sugar and red maple (*Acer saccharum* and *A. rubrum*), white ash (*Fraxinus americana*), and shagbark and other hickories (*Carya ovata*, *C. glabra*, and *C. ovalis*). Flowering dogwood (*Cornus florida*) and hop-hornbeam (*Ostrya americana*) form an open subcanopy. A fairly sparse shrub layer includes saplings of canopy tree species and maple-leaved viburnum (*Viburnum acerifolium*). A rich herbaceous flora includes perfoliate bellwort (*Uvularia perfoliata*), four-leaved milkweed (*Asclepias quadrifolia*), early meadow-rue (*Thalictrum dioicum*), false foxgloves (*Aureolaria flava*, *A. pedicularia*, and *A. virginica*), wild coffee (*Triosteum aurantiacum*), bush clovers (including *Lespedeza procumbens*), tick-trefoils (*Desmodium rotundifolium* and others), and sedges such as *Carex retroflexa*.

**Habitat Values for Associated Fauna:** Dry oak forests support a smaller mix of animal species than are found in moister communities. There are no species known to be restricted to the Dry, Rich Acidic Oak Forest community. Common species of dry sites include short-tailed shrew (*Blarina brevicauda*), red-backed vole (*Clethrionomys gapperi*), white footed mouse (*Peromyscus leucopus*), and chipmunks (*Tamias striatus*). Snakes of dry forest sites include garter snakes (*Thamnophis s. sirtalis*) and redbelly snakes (*Storeria o. occipitamaculata*). Birds that nest in dry oak forests include Eastern Wood-Pewee (*Contopus virens*), Red-eyed Vireo (*Vireo olivaceus*), Scarlet Tanager (*Piranga olivacea*), and Ovenbird (*Seiurus aurocapillus*).

**Associated Rare Plants:**

RANUNCULUS MICRANTHUS	TINY-FLOWERED BUTTERCUP	T
SPHENOPHOLIS NITIDA	SHINING WEDGEGRASS	T

**Associated Rare Animals:**

NONE KNOWN

**Examples with Public Access:** None identified on public lands.

**Threats:** Exotics, barberry (*Berberis thunbergii*) is reported from several sites.

**Management Needs:** Removal of exotics in exemplary cases.

**Community Name:** HIGH-TERRACE FLOODPLAIN FOREST

**SRANK:** S2

**Concept:** Mesic, deciduous hardwood forests of high alluvial terraces above the zone of annual flooding. This community type also occurs along riverbanks of high-gradient, northern rivers.

**Environmental setting:** High-terrace floodplain forests occur on raised banks adjacent to rivers and streams, on steep banks bordering high-gradient rivers in the western parts of the state, on high alluvial terraces, and on raised areas within major-river and small-river floodplain forests. They are river-influenced and mesic, but they typically are not flooded annually as indicated by the presence of a distinct surface, soil organic layer. Soils are typically silt loams.

**Vegetation Description:** The canopy is a mixture of floodplain taxa, such as red and silver maple (*Acer rubrum* and *A. saccharinum*), and mesic, deciduous hardwoods including sugar maple (*A. saccharum*), shagbark hickory (*Carya ovata*), black cherry (*Prunus serotina*), American elm (*Ulmus americana*), and basswood (*Tilia americana*). Ironwood (*Carpinus caroliniana*) typically forms an open subcanopy and is a good indicator species of this community type. The shrub layer varies from sparse to well-developed with arrowwood (*Viburnum dentatum*), nannyberry (*Viburnum lentago*), and winterberry (*Ilex verticillata*) most common mixed with variable amounts of non-native shrubs, including Japanese barberry (*Berberis thunbergii*) and buckthorn (*Rhamnus frangula*, *R. cathartica*). The herbaceous layer is a mixture of the characteristic floodplain forest ferns--sensitive fern (*Onoclea sensibilis*) and ostrich fern (*Matteuccia struthiopteris*)--and rich upland herbs, such as Canada mayflower (*Maianthemum canadense*), lady fern (*Athyrium filix-femina*), zigzag goldenrod (*Solidago flexicaulis*), white snakeroot (*Eupatorium rugosum*), jack-in-the-pulpit (*Arisaema triphyllum*) and bellwort (*Uvularia sessilifolia*). Other characteristic herbaceous taxa include honewort (*Cryptotaenia canadensis*), bottlebrush grass (*Hystrix patula*), floodplain avens (*Geum laciniatum*), jumpseed (*Tovara virginianum*), Wiegand 's wild rye (*Elymus wiegandii*), trilliums (*Trillium* spp.), trout-lily (*Erythronium americanum*), and enchanter's nightshade (*Circaea lutetiana* ssp. *canadensis*). Virginia creeper (*Parthenocissus quinquefolia*) and poison ivy (*Toxicodendron radicans*) can also be abundant.

**Habitat values for Associated Fauna:** High-terrace floodplain forests can contain low wet depressions that function as vernal pools and provide important amphibian breeding habitat.

**Associated rare plants:**

ACER NIGRUM	BLACK MAPLE	SC
CLAYTONIA VIRGINICA	NARROW-LEAVED SPRING BEAUTY	T
WALDSTEINIA FRAGARIOIDES	BARREN STRAWBERRY	SC

**Associated rare animals:**

AMBYSTOMA JEFFERSONIANUM	JEFFERSON SALAMAND ER	SC
AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMAND ER	SC
CLEMMYS GUTTATA	SPOTTED TURTLE	SC
CLEMMYS INSCULPTA	WOOD TURTLE	SC
EMYDOIDEA BLAND INGII	BLAND ING'S TURTLE	T
HEMIDACTYLIUM SCUTATUM	FOUR-TOED SALAMAND ER	SC

**Examples:** Mill River, Northampton.

**Threats:** Most high terraces have been converted to agriculture. Remaining examples are typically small and disturbed by selective logging and trail clearing. The lack of natural vegetated

buffers make these communities highly susceptible to non-native plant invasions. Most known examples have non-native plant species comprising a substantial percentage of overall plant cover. Because these communities fall outside of wetland boundaries, they are not subject to wetland regulations making them targets for selective logging and clearing for agriculture.

**Management needs:** Removal of non-native species.

**Community Name:** **KETTLEHOLE WET MEADOW**

**SRANK:** S3

**Concept:** Graminoid/emergent herbaceous or mixed shrub/herbaceous communities that are restricted to small, usually less than five acres, seasonally inundated, kettle depressions in sandy glacial outwash.

**Environmental setting:** Kettlehole wet meadows are a variant of wet meadows that are restricted to glacial kettleholes in sandy outwash soils that have seasonal water level fluctuations. They are seasonally inundated by local runoff and ground water fluctuations, and they typically have no inlet or outlet. For most of the summer, they look like shallow ponds, but by late summer they are covered by emergent vegetation. Soils are typically shallow, mucky peats. Deep peat does not develop due to the seasonal drawdown of water. The hydrology of kettlehole wet meadows is similar to coastal plain ponds. Both are characterized by a series of plant associations occurring along a gradient from the higher, drier margins to the lower, wetter centers.

**Vegetation Description:** Sedges and rushes are dominant, and characteristic species include Canada rush (*Juncus canadensis*), pondshore rush (*Juncus pelocarpus*), bayonet rush (*Juncus militaris*), needle spike sedge (*Eleocharis acicularis*), Small's spike sedge (*Eleocharis smallii*), Torrey's bullsedge (*Scirpus torreyi*) and various sedge (*Carex*) species. Shorter plants, like pipewort (*Eriocaulon aquaticum*), are found growing beneath the cover of sedges and rushes. Grasses, such as creeping bent grass (*Agrostis stolonifera*), and some broad-leaved emergents, including arrowhead (*Sagittaria engelmanniana*), nodding bur-marigold (*Bidens cernua*), beggar's ticks (*Bidens tripartita*) and common St. John's wort (*Hypericum perforatum*), also occur. The wettest, muckiest areas have floating-leaved aquatic plants, including white water lily (*Nymphaea odorata*) and mermaid-weed (*Proserpinaca palustris*). When water levels are high, manna grass (*Glyceria pallida* and *G. acutifolia*) is common, with yellow pond-lily (*Nuphar variegata*) and pickerel-weed (*Pontederia cordata*) occurring in deeper water. Kettlehole wet meadows are typically fringed with shrubs, such as leatherleaf (*Chamaedaphne calyculata*), high-bush blueberry (*Vaccinium corymbosum*), buttonbush (*Cephalanthus occidentalis*) and water willow (*Decodon verticillatus*), and with trees such as tupelo (*Nyssa sylvatica*) and red maple (*Acer rubrum*). Common meadow-beauty (*Rhexia virginica*) and various species of sphagnum moss (*Sphagnum sp.*) also grow along the edges. Kettlehole wet meadows are best visited in the late-summer when water levels are down, and the basin is covered by a dense growth of narrow-leaved emergents.

**Habitat values for Associated Fauna:** Kettlehole wet meadows can function as vernal pool habitat if water remains standing for 2-3 months; these areas provide important amphibian breeding habitat. The sedges, bulrushes and grasses of kettlehole wet meadows provide a food resource for waterfowl and other marsh birds.

**Associated rare plants:**

SCIRPUS TORREYI	TORREY'S BULLSEEDGE	- WL
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**Associated rare animals:**

AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER	SC
AMBYSTOMA OPACUM	MARbled SALAMANDER	T
DESMOCERUS PALLIATUS	ELDERBERRY LONG-HORNED BEETLE	SC
HEMIDACTYLIUM SCUTATUM	FOUR-TOED SALAMANDER	SC
SCAPHIOPUS HOLBROOKII	EASTERN SPADEFOOT	T
SYNAPTOMYS COOPERI	SOUTHERN BOG LEMMING	SC

- Examples:** There are currently three tracked sites, one in Douglas State Forest in Douglas and two in Minuteman National Park in Concord. More sites undoubtedly exist.
- Threats:** Alterations to natural water-level fluctuations. The sites for which we have vegetation data have surprisingly few non-native plant species, and exotics may not currently threaten these communities.
- Management needs:** More information is needed on the physical and hydrological processes associated with Kettlehole wet meadows in order to make educated management recommendations. It is known that seasonal water level fluctuations play an important role in the occurrence of the community. Spring high-water levels prevent encroachment of woody shrubs and trees, and late-summer low-water levels allow characteristic narrow-leaved emergents to appear. Any alteration in natural water level fluctuations, such as groundwater withdrawal, would negatively affect the community. Inland Basin Marshes may be prone to burning during low water periods, but the role of fire in community dynamics is not known.

**Community Name: SPRUCE-FIR BOREAL SWAMP**

**SRANK:** S3

**Concept:** Forested wetlands of western and north-central Massachusetts dominated by red spruce and balsam fir.

**Environmental setting:** Spruce-fir swamps are typically found at stream headwaters or in poorly drained basins in the mountainous, northwestern part of the state. They develop in cold, poorly drained areas, typically on acidic glacial till. Elevation ranges from 1500-2000 ft. in the Berkshire Highlands [Weatherbee 1996]. Peat accumulation appears to be minimal at most known sites. More work is needed to describe the physical setting and soil profiles of boreal swamps.

**Vegetation Description:** Red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*) are dominant in the overstory. Other canopy associates are white pine (*Pinus strobus*), black cherry (*Prunus serotina*), tamarack (*Larix laricina*), black spruce (*Picea mariana*), paper birch (*Betula papyrifera*), hemlock (*Tsuga canadensis*), yellow birch (*Betula alleghaniensis*), and red maple (*Acer rubrum*). Unlike spruce-tamarack forested bogs, spruce-fir boreal swamps have red spruce rather than black spruce co-dominant in the canopy, and they typically lack bog indicator species like Labrador tea (*Ledum groenlandicum*) and bog laurel (*Kalmia polifolia*). The following three shrubs almost always occur in boreal swamps: mountain holly (*Nemopanthus mucronatus*), sheep laurel (*Kalmia angustifolia*), and wild raisin (*Viburnum nudum* var. *cassinoides*). Other shrubs include American mountain-ash (*Sorbus americana*), hobble-bush (*Viburnum lantanoides*), and mountain maple (*Acer spicatum*). Typical herbaceous species are northern awned sedge (*Carex gynandra*), New England sedge (*Carex novae-angliae*), goldthread (*Coptis trifolia* ssp. *groenlandica*), creeping snowberry (*Gaultheria hispidula*), bluebead-lily (*Clintonia borealis*), one-sided pyrola (*Orthilia secunda*), bishop's cap (*Mitella diphylla*), lesser mitrewort (*Mitella nuda*), mountain wood-sorrel (*Oxalis montana*), royal fern (*Osmunda regalis*), and pale St. John's-wort (*Hypericum ellipticum*). The ground is often a carpet of mosses; more information is needed on the characteristic moss species. Richer variants of the community can occur in areas of calcareous groundwater seepage, but more information is needed.

**Habitat values for Associated Fauna:** Spruce-fir boreal swamps can function as vernal pool habitat if water remains standing for 2-3 months and they lack fish; these areas provide important amphibian breeding habitat.

**Associated rare plants:**

AMELANCHIER BARTRAMIANA	BARTRAM'S SHADBUSH	T
ARCEUTHOBIMUM PUSILLUM	DWARF MISTLETOE	SC
RIBES TRISTE	SWAMP RED CURRANT	- WL

**Associated rare animals:**

PIERIS NAPI OLERACEA	MUSTARD WHITE	SC
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**Examples:** several spruce-fir swamps bordering Peru WMA, Peru.

**Threats:** More information is needed to identify the threats to boreal swamps.

**Management needs:** More information is needed to assess the management needs for boreal swamps.

**Community Name:** **SPRUCE-TAMARACK BOG**

**SRANK:** S2

**Concept:** Acidic forested peatlands with an overstory of black spruce and tamarack and an understory of heath shrubs on sphagnum moss.

**Environmental setting:** Forested bogs occur in a variety of physical settings, primarily in the north-central and western parts of the state. They occur in kettlehole depressions, watershed divides, and along pond margins. Forested bogs are late-successional peatlands that typically occur on thick peat deposits.

**Vegetation Description:** Black spruce (*Picea mariana*) and tamarack (*Larix laricina*) are dominant in the overstory. Red spruce (*Picea rubens*) can occur in place of black spruce. The trunks and branches are often covered and draped in lichens, especially *Usnea* spp. Other trees that occur in lesser amounts are white pine (*Pinus strobus*), pitch pine (*Pinus rigida*), and red maple (*Acer rubrum*), but red spruce (*Picea rubens*) can also occur. A mixture of tall shrubs and short, ericaceous shrubs provide nearly continuous cover in the understory. Labrador tea (*Ledum groenlandicum*) and bog-laurel (*Kalmia polifolia*) are good indicators of the community, but they do not always occur. Other common shrubs are mountain-holly (*Nemopanthus mucronatus*), wild raisin (*Viburnum nudum* var. *cassinoides*), and sheep-laurel (*Kalmia angustifolia*). The ground is covered in Sphagnum spp. moss with three-seeded bog sedge (*Carex trisperma*), three-leaved Solomon's seal (*Maianthemum trifolium*), bluebead-lily (*Clintonia borealis*), goldthread (*Coptis trifolia* ssp. *groenlandica*), and creeping snowberry (*Gaultheria hispidula*).

**Habitat values for Associated Fauna:** The moats of forested bogs can function as vernal pool habitat if water remains standing for 2-3 months and they lack fish; these areas provide important amphibian breeding habitat.

**Associated rare plants:**

ARCEUTHOBIUM PUSILLUM

DWARF MISTLETOE

SC

**Associated rare animals:**

NONE KNOWN

**Examples:** Poutwater Pond, MDC, Sterling.

**Threats:** More work is needed to identify threats to black spruce-tamarack forested bogs.

**Management needs:** More work is needed to assess the management needs of black spruce-tamarack forested bogs.

**Community Name:** WET MEADOW

**SRANK:** S4

**Concept:** Graminoid/emergent herbaceous communities that are similar to deep and shallow emergent marshes except that they are temporarily rather than seasonally flooded. The soil is saturated during the growing season but not generally inundated. Repeated disturbance, usually from grazing or mowing, keeps these communities open.

**Environmental setting:** Wet meadows occur in lake basins, wet depressions, along streams, and in sloughs and other backwater areas with impeded drainage along rivers. The mucky mineral soils are permanently saturated and flood occasionally; standing water is not present throughout the growing season as in deep and shallow emergent marshes. As these communities flood only temporarily, continued disturbance is necessary to prevent encroachment by woody plants. More information is needed on the physical and biological characteristics of wet meadow and marsh communities.

**Vegetation Description:** Tussock-forming sedges, such as tussock-sedge (*Carex stricta*) or marsh-sedge (*Carex lacustris*), are often dominant, with over 50% of the cover, with variable proportions of other graminoids and herbaceous species. Canada bluejoint (*Calamagrostis canadensis* var. *canadensis*), wool-grass (*Scirpus cyperinus*), slender woolly-fruited sedge (*Carex lasiocarpa* var. *americana*), slender spike-sedge (*Eleocharis tenuis*), stalked wool-grass (*Scirpus pedicellatus*), rice cut-grass (*Leersia oryzoides*), and brown beak-sedge (*Rhynchospora capitellata*) are typical of wet meadows. Characteristic herbaceous associates include erect water smartweed (*Polygonum amphibium* var. *emersum*), pickereel-weed (*Pontederia cordata* var. *cordata*), river-horsetail (*Equisetum fluviatile*), nodding bur-marigold (*Bidens cernua*), spotted joe-pye-weed (*Eupatorium maculatum*), northern blue flag (*Iris versicolor*), and sweet flag (*Acorus calamus*). Calcareous wet meadows have calciphilic species, including red-footed spike-sedge (*Eleocharis erythropoda*), delicate sedge (*Carex leptalea*), fen-sedge (*Carex tetanica*), and beaked-sedge (*Carex utriculata*). More information is also needed on calcareous wet meadows in order to clarify their relationship to calcareous sloping fens and calcareous seepage marshes [both of which are described in the calcareous peatlands section due to their accumulation of peat]. Wet meadows are very closely related to shallow emergent marshes, but typically have more uniform vegetation, i.e. often a single sedge species dominates. Wet meadows are called "sedge meadows" in many other states, but "wet meadow" is used in Massachusetts because of known occurrences of meadows dominated by rice cut-grass and other non-sedge species.

**Habitat values for Associated Fauna:** Wet meadows can function as vernal pool habitat if water remains standing for 2-3 months; these areas provide important amphibian breeding habitat.

**Associated rare plants:**

CAREX ALOPECOIDEA	FOXTAIL SEDGE	T
CAREX BUSHII	BUSH'S SEDGE	E
CAREX BUXBAUMII	BUXBAUM'S SEDGE	- WL
CAREX EXILIS	BOG-SEDEGE	- WL
CAREX HAYDENII	HAYDEN'S SEDGE	- WL
CAREX SCHWEINITZII	SCHWEINITZ'S SEDGE	E
CAREX TRICHOCARPA	HAIRY-FRUITED SEDGE	T
ELEOCHARIS OBTUSA VAR OVATA	OVATE SPIKE-SEDEGE	E
ELEOCHARIS ERYTHROPODA	RED-FOOTED SPIKE-SEDEGE	-WL
GENTIANA CRINITA	FRINGED GENTIAN	- WL
OPHIOGLOSSUM PUSILLUM	ADDER'S-TONGUE FERN	T
PEDICULARIS LANCEOLATA	SWAMP LOUSEWORT	E
PLATANThERA FLAVA VAR HERBIOLA	PALE GREEN ORCHIS	T

SCIRPUS LONGII	LONG'S BULRUSH	E
SCIRPUS PENDULUS	PENDULOUS BULRUSH	- WL
<b>Associated rare animals:</b>		
AMBYSTOMA JEFFERSONIANUM	JEFFERSON SALAMAND ER	SC
AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMAND ER	SC
AMBYSTOMA OPACUM	MARBLED SALAMAND ER	T
AMMODRAMUS HENSLOWII	HENSLOW'S SPARROW	E
BARTRAMIA LONGICAUDA	UPLAND SAND PIPER	E
BOTAURUS LENTIGINOSUS	AMERICAN BITTERN	E
CIRCUS CYANEUS	NORTHERN HARRIER	T
DESMOCERUS PALLIATUS	ELDERBERRY LONG-HORNED BEETLE	SC
EULIMNADIA AGASSIZII	AGASSIZ'S CLAM SHRIMP	E
HEMIDACTYLIUM SCUTATUM	FOUR-TOED SALAMAND ER	SC
LIMNADIA LENTICULARIS	AMERICAN CLAM SHRIMP	SC
SCAPHIOPUS HOLBROOKII	EASTERN SPADEFOOT	T
SYNAPTOMYS COOPERI	SOUTHERN BOG LEMMING	SC

**Examples:** White Brook; Russell Cove, Hadley.

**Threats:** Wet meadows are threatened by filling and dredging, and by nutrient inputs from adjacent roads, fields, or septic systems. The invasion and spread of purple loosestrife (*Lythrum salicaria*) alters community structure and composition.

**Management needs:** Efforts are needed to control the spread of purple loosestrife. Continue activity that has kept the community open, e.g. fall mowing.