U.S. Environmental Protection Agency

New England Region
Boston, Massachusetts

Ecological Characterization

Of The

Housatonic River

September 2002

Environmental Remediation Contract

General Electric (GE)/Housatonic River Project

Pittsfield, Massachusetts

Contract No. DACW33-94-D-0009/032

WOODLOT ALTERNATIVES, INC.
ENVIRONMENTAL CONSULTANTS

www.woodlotalt.com

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Of The
Housatonic River

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Prepared by

Woodlot Alternatives, Inc.

Topsham, Maine 04086

Prepared under

EPA Contract No. DACW33-94-D-0009/032

with Weston Solutions, Inc.

Prepared for

U.S. Environmental Protection Agency

Region 1

Boston, Massachusetts

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SECTION I INTRODUCTION

1.0 Introduction

The United States Environmental Protection Agency (USEPA) and Army Corps of Engineers (ACOE) are characterizing the natural resources and contaminants found in and adjacent to the Housatonic River in portions of Pittsfield, Lenox, and Lee, Massachusetts. The river section being investigated for this report is approximately 12 miles (19 km) long and extends from Fred Garner Park in Pittsfield downstream to Woods Pond Dam in Lee (Map I-1). This area, with the associated floodplains, is referred to as the primary study area (PSA) in this report. The PSA includes riverine habitat, adjacent floodplain wetlands, and uplands associated with the main stem of the river. Elevated levels of polychlorinated biphenyls (PCBs), which originated from the General Electric facility in Pittsfield, have been found in this area (Blasland, Bouck & Lee, Inc. 1996).

This report contains a characterization of the ecosystems found in the PSA, including descriptions of methods used to perform the characterization and results of the survey efforts.

1.1 Purpose of Report

The objective of this study was to characterize the ecosystems occurring within the PSA, including both plant and animal communities. Information in this report is intended to complement and update material found in a preliminary characterization of the PSA (TechLaw, Inc. 1999). The wetlands in the PSA were also characterized using a functions and values assessment (FVA) prior to the studies reported in 1999 (TechLaw, Inc. 1998). These and other related investigations are reviewed in Section 3.0, *Relationship to Previous and Ongoing Studies*, below.

The ecological characterization was one of a series of biological investigations designed to support baseline human health and ecological risk assessments and modeling efforts (Roy F. Weston, Inc. 2000). These biological investigations included:

- Investigations to support fate and transport modeling

- Investigations to support ecological characterization
- Investigations to support ecological risk assessment

The ecological characterization investigations were defined in a series of eight work plans that included study objectives, methods, and quality assurance/quality control protocols (Roy F. Weston, Inc. 2000). The eight study plans addressed:

- Rare Plants and Natural Communities
- Dragonflies
- Freshwater Mussels
- Reptiles and Amphibians
- Raptors and Waterfowl
- Forest Birds and Marsh and Wading Birds
- Small Mammals
- River Otter, Mink, and Bats

The purpose of this document is to report on the results of these investigations within the context of an overall ecological characterization.

2.0 Report Organization

The report is organized into three sections:

- Section I Introduction
- Section II Study Area Description
- Section III Ecological Characterization

Section I introduces the purpose of the report, describes the report organization, and explains the relationship between the ecological characterization and previous and ongoing studies of a similar nature. A broad description of the PSA is provided in

Section II and includes discussions of land use patterns, the biophysical setting of the PSA, and descriptions of four reference areas used for previous and ongoing investigations.

The bulk of the report is contained in Section III, the Ecological Characterization. This section is further divided into six chapters describing:

- Chapter 1 Natural Communities and Rare Plants
- Chapter 2 Macroinvertebrates
- Chapter 3 Fish
- Chapter 4 Reptiles and Amphibians
- Chapter 5 Birds
- Chapter 6 Mammals

Each chapter is intended to stand alone as a reference to users working on other aspects of the Housatonic River investigation. For this reason, each chapter includes an introduction to the taxonomic group, a description of the methods used to characterize the resource, a characterization of the specific plant or animal community, and a listing of any rare, threatened, or endangered species that were found in the PSA.

The report includes several attachments that provide important background or species- and community-specific information, such as profiles of natural communities found in the PSA and selected communities from the reference areas, profiles of animal species that are the focus of related Risk Assessment work, and a species:habitat matrix of vertebrate wildlife species expected to occur in the PSA. Other attachments include field data forms for some of the investigations conducted from 1998 to 2000.

The electronic version of this document is formatted for convenient use in a digital environment, enabling the reader to use Adobe Acrobat Reader software to view the files and attachments. The main document includes links between the various sections and chapters of the report as well as between the body of the report and relevant attachments.

In reviewing natural communities in the PSA (Section III, Chapter 1, *Natural Communities and Rare Plants*), for example, users can link to the natural community profiles and the species-habitat matrix. Navigation through the document is achieved by clicking on various text and photo links, or by using navigation arrows in Acrobat Reader.

Specific data quality objectives and quality assurance/quality control protocols were provided in the eight separate study plans that comprised the technical directive for the ecological characterization effort. An amendment to Section 5, Field Investigation Tasks, of the Supplemental Investigation Work Plan is provided in Attachment D.

3.0 Relationship to Previous and Ongoing Studies

The ecological characterization reported in this document follows several previous ecological investigations and is a compilation of data collected during approximately three and a half years of study. It is also related to an ongoing study of amphibian reproduction in vernal pools of the PSA by the same investigators (Woodlot Alternatives, Inc. *in prep*). Staff members involved with the ecological characterization have also served in support roles for investigators conducting the risk assessments. For these reasons, and for the sake of clarity, the relationship of the ecological characterization to previous and ongoing studies is explained below.

3.1 Previous Ecological Investigations

3.1.1 Preliminary Wetland Characterization and FVA

A preliminary characterization of the wetlands in the PSA was developed using information from available maps and aerial photographs as well as several site visits in early 1998 (TechLaw, Inc. 1998). A four-phase approach was used to estimate wetland boundaries. The first phase consisted of collecting and reviewing existing information on wetlands in the PSA. The second phase involved reviewing stereo-pairs of color infra-red aerial photographs to identify areas with a wetland signature, which were used for the third phase of work, field verification. The purpose of the field verification task was to confirm and adjust the photo-interpretation, as needed, and to characterize representative

wetland community types. Wetland communities were primarily classified according to the system of Cowardin *et al.* (1979). Once the field verification was completed, the final task of creating a digital map commenced. Wetland-upland boundaries and wetland community boundaries (e.g., the boundary between forest and shrubland communities) were digitized as distinct layers on a digital base map provided by the USEPA.

The wetland maps produced as a result of the 1998 surveys were used as base maps for the ecological characterization studies reported in this document.

3.1.2 Preliminary Ecological Characterization

Following the wetland mapping and functions and values assesssment, an initial characterization of the ecological communities occurring within the PSA was conducted. This work was divided into six complementary studies based on species groups or communities for which initial baseline information was needed. They included reptiles and amphibians; mammals; birds; freshwater mussels; rare plants and natural communities; and rare animals.

A literature review was first conducted to identify the potential wildlife communities and the species present in each habitat type in the vicinity of the PSA. A list of potential species was created based on known habitat requirements of each species and available habitats in or near the PSA. Field surveys were then conducted to verify the occurrence of individual wildlife species, species groups, or required habitats. The methods used were reconnaissance-level, habitat-based assessment surveys.

These methods allowed for the development of general statements on the relative abundance of certain species and the habitats they used in the PSA. Additional, more detailed survey techniques were used to document species use of the PSA using established field methodologies. More specific habitat information was also collected and mapped wetland habitats, as well as uplands adjacent to the river, were more accurately classified using natural community classification systems available at the time (Weatherbee and Crow 1992).

The current studies were designed to complement and update the information reported in the preliminary ecological characterization.

3.2 Risk Assessment Support

Investigators involved with conducting the ecological characterization reported in this document also participated in several studies designed to support the risk assessment. In some cases, data collected to support the risk assessment were also used to complete the ecological characterization. The general nature of these investigations and the data that were used in the ecological characterization are briefly discussed below.

3.2.1 Amphibian Reproductive Study

A study of amphibian reproductive success within vernal pools in the PSA began with field studies in 1999. Field methodologies for the study are described in the Supplemental Investigation Work Plan (Roy F. Weston, Inc. 2000).

Documenting amphibian reproductive success within vernal pools was conducted because these animals may be influenced by PCBs in contaminated sediments. They may also bioaccumulate PCBs, which can then be passed on to other animals in the food chain. In addition, several herps that could occur in the PSA are of conservation concern and are listed as State-Endangered, Threatened, Special Concern, or Watch List Species (MNHESP 1997). These include the Jefferson salamander, spotted salamander, marbled salamander, spring salamander, and four-toed salamander.

Field work for the amphibian reproductive study was completed in 1999. This study documented two species of conservation concern (Jefferson salamander and four-toed salamander) in the PSA (Woodlot Alternatives, Inc. *in prep*) and was used, in part, to update amphibian and vernal pool community characterization data originally presented in the Final Preliminary Ecological Characterization report (TechLaw, Inc. 1999).

3.2.2 Wood Frog and Leopard Frog Collections

The Stover Group investigated the potential impact of PCB exposure on larval frog development, with a focus on leopard frogs and wood frogs. Ecological characterization

investigators have participated in these studies by collecting adult frogs and egg masses from the PSA in 1999 and 2000. These collections were also useful in documenting courtship, breeding, and egg laying dates for frogs in the PSA.

3.2.3 Aquatic Macrophyte Sampling

Sampling and analysis of macrophytes, periphyton, plankton/detritus, and filamentous algae, which make up the base of the food chain in aquatic systems, were conducted to provide information for the fate and transport model (Roy F. Weston, Inc. 2000). Ecological characterization investigators assisted with the collection of samples for these investigations. Characterizing the species composition and spatial distribution of the aquatic macrophyte community was of particular use in characterizing the aquatic habitats in the PSA.

3.2.4 Fish Tissue and Biomass Sampling

Fish have been collected to determine the PCB and other organic contaminant concentrations in tissues for use in both human health and ecological risk assessments, to evaluate congener patterns by species for use in fish and mink reproduction studies, and in the PCB fate and effects model. Fish have also been collected to estimate biomass for use in the fate and transport model (Roy F. Weston, Inc. 2000). These efforts provided information on species composition of the fish community in the various river reaches being modeled. They also provided size class distribution and length and weight data for use in the ecological characterization.

3.2.5 Waterfowl Collection and Tissue Sampling

Waterfowl, including mallards and wood ducks, have been observed using Woods Pond and upstream floodplain wetlands for breeding, brood rearing, and feeding, and waterfowl hunting is a common activity in this portion of the PSA. For these reasons, these areas were chosen as collection sites to evaluate the potential for risk, to the waterfowl directly and to humans consuming waterfowl, due to PCB accumulation in the tissue. Wood ducks and mallards were collected from both the PSA, and a reference area located at Threemile Pond State Wildlife Management Area (SWMA) in Sheffield,

Massachusetts. These investigations provided information on waterfowl habitat use for brood rearing and feeding that was used in the ecological characterizations.

3.2.6 Soil Invertebrate Sampling

The primary objective of this study was to collect representative samples of soil-dwelling invertebrates for the analysis of PCBs, dioxins/furans, and organochlorine pesticide concentrations in tissue. Results were intended to be used in the ecological risk assessment to model exposure through the food chain of higher trophic level consumers. In addition, results of tissue analysis and co-located soil samples were intended to be used to determine the relationship between earthworm tissue concentrations and corresponding soil concentrations (Roy F. Weston, Inc. 2000).

Soil invertebrates were divided into two groups based on their availability to receptors and their degree of exposure to contaminated soils: (1) invertebrates living in the soil, represented by earthworms; and (2) invertebrates living primarily on the soil surface in the leaf litter, as represented by snails, slugs, beetles, and other arthropods (i.e., litter invertebrates). The information collected from this study was used to characterize the soil macroinvertebrate community within portions of the PSA.

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SECTION II STUDY AREA DESCRIPTION

1.0 Introduction

In this section, land use patterns and population trends, climate, geology, and soils are described as they relate to the overall ecological characterization. Information on hydrology and plant communities is also presented for both the PSA and reference areas.

2.0 Land Use Patterns and Population Trends

2.1 Historical Land Use Patterns and Population Trends

Native American peoples were present in Berkshire County prior to European settlement. Two small groups of Mahican Native Americans were known to subsist along the Housatonic River in the early 1700s and as recently as 1735 (Weatherbee 1996). They primarily used the alluvial plain for hunting and agriculture. Because cutting of trees was primarily done for heating purposes, and crops (such as corn, beans, and squash) were often planted in abandoned beaver impoundments, it is believed that the impact of the Native Americans on the natural communities was minimal (Weatherbee 1996). The Native American population at this time had been reduced by European diseases, most notably smallpox. All the resident Native Americans of the Great Barrington area were moved in 1736 to a mission established in Stockbridge (Southern Berkshire Chamber of Commerce 2001). It was near and shortly after that time that several local towns (e.g., Pittsfield, Great Barrington, Sheffield) became incorporated and European settlers began to exert significant influences on the landscape (see Section 2.1).

Settlement of the Central Valley[1] of Berkshire County progressed in the late 1700s and early 1800s. Both the forest products industry and summer vacationing brought people to the Central Valley towns in the 1800s (Southern Berkshire Chamber of Commerce 2001, Weatherbee 1996). Great Barrington was reported to have grown from a rural community of 961 people in 1776 to become a manufacturing center of 2,264 people in 1830 (Southern Berkshire Chamber of Commerce 2001). Paper mills, blast furnaces, wool factories, and grist mills were important industries in the mid to late 1800s, all of

[1] The geographic region of Berkshire County in which the PSA is located.

which relied on timber or river resources for material stock and power. The influx of summer people into Berkshire County, primarily after the Civil War, led to swelling seasonal populations and home construction to accommodate the temporary residents.

European settlement brought rapid land clearing to Berkshire County (Dwight 1822, Brooks 1953). In some parts of the County, as much as 77 percent of the forests had been cleared for agriculture by 1800 (Brooks 1953), and wood shortages were reported from the region (Federal Writer's Project 1938). Sargent (1884) reported one-third to one-half of Berkshire County was forested. Most of the broad-leaved and eastern hemlock forests had been replaced by second- or third-growth eastern white pine stands. At that time, only the spruce forests of the high hillsides and ridgelines were still intact. In addition to clearing land for crop space, local industries began to affect the surrounding forests in the 19th century. Sawmills, tanneries, railroads and their engines, iron furnaces, and lime kilns all required trees for everyday operation (Weatherbee 1996). In 1867, the first paper mill in the area was established in Lee. Local timber supplies were eventually exhausted and raw materials were transported from increasingly more distant sources (Federal Writer's Project 1938).

By the end of the 19th century, two factors caused a reduction in the use of the forest products in the area. The first factor was the development of Midwestern farms and the creation of the Erie Canal, which allowed farm products to be transported to the east. The second factor was the exhaustion of marketable timber from the surrounding forests (Fisher 1933). Farm abandonment and reforestation, in the form of both natural and planted trees, began to shape the landscape of Berkshire County in the early part of the 20th century.

Berkshire County population grew steadily over the first half of the 1900s. From 1900 to 1960, it experienced a 48 percent increase in population, starting from 95,667 and ending with 142,135 people over that time period (United States Census Bureau 2001a). Neighboring counties in western Massachusetts, while also experiencing overall growth, did so at differing rates compared to Berkshire County over the same time period (e.g., Franklin County grew at 33 percent, Hampden County grew at 144 percent) (United States Census Bureau 2001a).

As a result of this historical population growth and development in the region, considerable disturbances and modifications to the Housatonic River in the vicinity of the study area have occurred. These modifications take the form of river channelization and impoundment.

Channelization has taken place largely within the limits of urban Pittsfield. Much of the river, from above Newell Street to Holmes Road, has been highly modified by realignments and the introduction of artificial banks and substrates such as rip-rap of large boulders, concrete, and even asphalt.

Impoundment has occurred upstream of the PSA in association with paper making facilities, and the downstream limit of the PSA is a storage dam. Impoundment of riverine systems changes shoreline configuration, traps fine sediments above dams, and scours riverbeds below dams. In addition, impoundment typically changes the natural flow regimes of a river system.

Municipal, agricultural, and industrial uses of the river and its riparian systems have also occurred. Industrial and municipal discharges to the Housatonic River contribute significantly to the flow quantities of the river. Approximately 1.3 cubic meters per second (cms) is added to the flow of the river from several industrial facilities and seven municipal facilities in Massachusetts, including the Pittsfield Wastewater Treatment Facility (WWTF), which discharges into the river within the study area (Blasland, Bouck, & Lee, Inc. 1996a; Harrington Engineering and Construction, Inc. 1996). Clearing of riparian areas for development purposes has occurred throughout the study area as well. This includes urban development in the upper 3.1 miles (5 km) of the PSA. Agricultural fields, including corn and hay fields, are a predominant land use within the PSA, and have affected the size of the natural riparian habitats in the middle section of the PSA and downstream sections near New Lenox Road.

From 1937 to 1977, GE used PCBs as insulating liquids for certain transformer applications (Blasland and Bouck Engineers, P.C. 1991). These materials came to be located in the sediments of the Housatonic River and associated floodplain by direct discharge from the facility, discharge from Silver Lake, erosion and runoff of

contaminated soil, discharge of contaminated groundwater, and inadvertent discharge due to spills and other events (Roy F. Weston, Inc. 1998a). Elevated levels of PCBs (1 ppm) appear to be largely confined to the ten-year-flood zone (Blasland and Bouck Engineers, P.C. 1991, 1992, 1993; Blasland, Bouck, & Lee, Inc. 1994a). During the channelization of the Housatonic River, a number of oxbows were filled (MADEP 1995). Some of the fill material was contaminated by PCBs (Blasland, Bouck, & Lee, Inc. 1996b). The total extent of PCBs in the sediments has been under investigation.

2.2 Current Land Use Patterns and Population Trends

In contrast to the earlier portion of the century, Berkshire County has experienced population decline since 1970. From the period of 1970 to 1990, the county has lost 2,783 residents amounting to a population decline of one percent (United States Census Bureau 2001a). More recently, Berkshire County was reported to have a population of 132,218 people in 1999. This represents a 5.1 percent decline in population since 1990 (United States Census Bureau 2001b). Farm abandonment, industrial factory closure and downsizing, and general migration to other population centers are reasons that may have contributed to the observed population decline.

Land use patterns have changed during this recent period as well. Most of the PSA is contained in the Housatonic River Valley State Wildlife Management Area. This management area extends over 5.6 miles (9 km) from the confluence of the East and West Branches of the Housatonic River to Woods Pond. This area is primarily used by outdoor recreation enthusiasts; hunting, fishing, and paddling are primary activities observed in the wildlife management area. Horseback riding, running, and birding also take place. A smaller wildlife sanctuary is located at Canoe Meadows, a Massachusetts Audubon property below Holmes Road.

Much of the upper two-thirds of the PSA appears to have been cleared for agriculture at one time. Active cropland, however, is relatively uncommon and generally restricted to a few locations upstream of the Pittsfield WWTF outfall, where corn, squash, and pumpkin are grown. Fallow fields are found more often, with the majority of this land located south of New Lenox Road.

The current use of the Housatonic River in Pittsfield, Lenox, and Lee is primarily as a natural area. Though several bridges, a railroad, former agricultural fields, buried sewer lines, and abutting residences influence the character of the riparian communities, most of the PSA is managed as a wildlife area and is largely free of development and forest clearing activities. Non-native flora, altered local hydrology, and open rights-of-way and fields are some of the more observable ecosystem impacts that human habitation and transportation system development have had on the Housatonic River floodplain communities.

The railroad line along the west edge of the lower PSA is a berm of crushed stone that is elevated above the ten-year-flood line. The substrate is coarse (over 1 cm in diameter), and therefore is well drained. This xeric habitat contains unique flora relative to other portions of the PSA. Wild thyme, love grass, common mullein, and tower mustard are species capable of growing on the xeric, crushed stone substrate. These weedy, colonizing species do not invade the neighboring communities because the soil moisture regimes are very different between the dry, railroad berm and the hydric, wetland soils. The significant impacts of the railroad include bisection of rare natural communities and altered hydrology. The cleared railroad line has been placed through and adjacent to a black ash–red maple–tamarack calcareous seepage swamp, a community of state conservation concern. Furthermore, ditching for the railroad has created linear, ponded areas in regions that were formally closed canopy forest with pit-and-mound topography.

3.0 Biophysical Setting

The study area is located in central Berkshire County, Massachusetts (Map I-1). Berkshire County is on the western edge of the state and is bordered by Connecticut (south), New York (west), and Vermont (north). This part of Massachusetts contains the most topographical relief, as well as the highest point in the state (Mount Greylock - 1064 meters). Though sometimes referred to by different names, Berkshire County is usually divided into three geographic sections: (1) the Berkshire Plateau; (2) the Taconic Range; and (3) the Central Valley region (New England River Basins Commission 1980, Veit and Petersen 1993, Weatherbee 1996). The Berkshire Plateau, a southern extension of

Vermont's Green Mountains, forms a ridge that runs along the eastern edge of the county. The Taconic Range, extending from Vermont to New York, forms the western edge of the county. The Central Valley region lies between these two mountain ranges, and is where the PSA is located.

3.1 Climate

Berkshire County is considered to have a continental climate, similar to the rest of interior New England, characterized by cold winters and hot summers (Soil Conservation Service 1988). Average annual temperature, average daily July temperature, and average daily January temperature for Lanesboro (immediately north of Pittsfield) have been 6, 19, and –8 degrees Celsius, respectively, for the time period between 1981 to1987. The number of frost-free days (i.e., the growing season) ranges from 103 – 144 days. Growing season for native vegetation begins in March (e.g., willows, evergreen trees, skunk cabbage) and ends in October with the last frost-tolerant herbs (e.g., asters, gentians) (Weatherbee 1996). Moisture supply usually exceeds evaporation, except during periods of drought. Average total rainfall is 109 cm and is evenly distributed throughout the year (i.e., 55 percent of the annual precipitation occurs between April and September). Average total snowfall is 181 cm (Weatherbee 1996).

3.2 Geology

The geologic features of the Berkshire County region and the PSA have been summarized in previous engineering and characterization reports (e.g., Blasland, Bouck & Lee 1994b; Roy F. Weston, Inc. 1998b; TechLaw, Inc. 1999; Roy F. Weston, Inc. 2000). This section provides an overview of those aspects relevant to the ecological characterization, as derived from a review of engineering reports and pertinent scientific literature.

3.2.1 Regional Geological Setting

The Housatonic River lies within the New England Physiographic Province, more specifically within the Taconic geologic region of western Massachusetts. The river occupies a broad, sediment-filled valley (i.e., the Central Valley) that separates two major

geologic: the Taconic Hills to the west, and the Berkshire Plateau (also referred to as the New England Uplands) to the east. The geomorphology of the region is typified by rounded hills and mountains draped with glacial deposits, and relatively narrow, steep-sided valleys cut into the hills by streams and rivers. Due to extensive continental glaciation and the thick deposits of glacial materials left behind, bedrock formations are generally exposed only in the hills and mountains.

3.2.2 Bedrock Geology

The Taconic region has been subjected to a series of depositional and tectonic events over the past 600 million years, related to repeated openings and closings of the Iapetus ocean basin (precursor to the Atlantic) and resultant continental collisions. From the late Cambrian to the early Ordovician period (from about 450 – 500 million years ago) the Pittsfield region was on the edge of a stable, warm-water continental shelf, located near the equator. Shallow water marine sediments, dominated by carbonates such as magnesium-rich dolomite and calcium-rich limestone (mapped as the Stockbridge formation), and quartz-rich sands (the Cheshire formation), were deposited in the Pittsfield area at this time, while deeper-water deposits such as mud and silt were deposited in an ocean basin that lay further to the east.

In the late Ordovician period (about 410 – 440 million years ago) the closing of the Iapetus ocean basin represented the onset of the Taconic Orogeny (mountain building activity), a tectonic event that compressed and buried the offshore deep-water sediment pile, metamorphosing the mud and silt into a series of slates and pelitic schists mapped as the Nassau, Everett, and Woolumsac Formations and the Greylock Schist (Zen 1983). Continued compression eventually pushed these basin deposits up and over the shelf carbonate rocks, forming a series of stacked, fault-bounded thrust sheets that today form the Taconic Hills west of the Housatonic River. As the ocean basin closed completely, a series of older, highly metamorphosed schists and gneisses (representing either the leading edge of the colliding continent or more deeply buried sediments on the western side of the basin) was also pushed upward and westward to form the Berkshire Plateau, which lies east of the study area.

During the Devonian period (350 – 400 million years ago) another tectonic event (the Acadian Orogeny) further compressed and heated the rocks in the region, producing an overprinted series of geologic faults, folds, and fractures and completing the transformation of Stockbridge Formation dolomite and limestone into the marble that underlies the Housatonic valley today. Subsequent dissolution of this marble along fractures and joints has established a network of interconnected fractures and openings, producing a significant groundwater aquifer in the region (Olcott 1995). These marble formations are also important not only because they are the largest economic marble deposits in the State of Massachusetts, but because their character significantly impacts the hydrology, groundwater chemistry, soil composition, and resultant natural communities in the study area.

3.2.3 Glacial Geology

The most recent chapter in the area's geologic history involved extensive glaciation and Quaternary sediment deposition over the past 14,000 years. As in most of New England, continental glaciers advanced and retreated over the study area several times during the last 100,000 years, scouring bedrock and leaving behind discontinuous deposits of sand, silt, clay, and a series of poorly sorted gravels generally referred to as glacial till. Following the last glacial retreat in Wisconsinan time (10,000 – 14,000 years ago) glacial till and sands filled the Housatonic valley locally to depths of 30 m or more.

Within the study area, till is reported to overlie marble bedrock directly under the Housatonic River, with till thickness ranging from 0.6 m to more than 15 m (Blasland, Bouck & Lee 1994b; Roy F. Weston, Inc. 2000). Cobbles of reworked marble within glacial tills suggest that the Stockbridge formation marble was exposed and scoured by the glaciers, contributing significant amounts of carbonate material to the sediments. Subsequent erosion and reworking of these deposits by streams has produced a complex set of surficial deposits that serve as aquifers and exert control over the hydrologic features of the region.

3.2.4 Soils

Six major soil associations are present in the Housatonic River basin (New England River Basins Commission 1980). Three of the associations, Paxton-Woodbridge, Charlton-Hollis, and Lyman-Peru-Marlow-Berkshire, are derived from glacial till and schist. These soils are characterized by shallow depth to bedrock, hardpan, stoniness, or steep slope. Two of the soil associations are derived from limestone and schist. These are called Copake-Groton, found in the Central Valley region, and Stockbridge-Farmington-Amenia-Pittsfield, located in the Taconic Range. They are characterized by deep, well-drained soils. The final soil association is called the Hinckley-Merrimac. This association is located along the valley edges on glacial outwash terraces. It is characterized by deep, sandy, well-drained, acidic soils.

The most common soils in the PSA are sandy loams, silt loams, and organic-rich mucks. At least 17 soil series are represented within the project boundary. Within the PSA, the soils are comparable to the Copake-Groton soil association, which are typically deep, well-drained loamy soils derived from glacial outwash. Housatonic River floodplain soils are derived directly from bedrock (marble or schist), from glacial outwash, or from calcareous glacial till (United States Department of Agriculture 1988). Overwash of silt and fine sand into the floodplain is apparent in much of the low floodplain. Heavier soil particles, such as medium to coarse sands, remain within the channel and are the dominant soils of the riverbanks and bars (Bent 1996).

The regional juxtaposition of more acidic source material (e.g., schists) with more neutral carbonate-rich bedrock (e.g., marble) has created a diverse series of soils that contribute to the richness of the natural communities. Though this contributes to diversity and species richness, it likely does not contribute to rare plants as all known rare plant occurences (except one) occur on calcareous bedrock regions.

PCBs have come to be located in the sediments of the Housatonic River and adjacent riparian areas. It is estimated that the amount of sediment containing PCB concentrations greater than 1 part per million (ppm) between the GE facility and Woods Pond is 600,636 cubic meters (Blasland, Bouck, & Lee, Inc. 1996a). For the same section of river, the estimated volume of sediments containing PCB concentrations higher than 10 ppm and 50 ppm is 374,919 m^3 and 198,171 m^3, respectively (Blasland, Bouck, & Lee, Inc.

1996a). Use of cesium-137 for geochronological dating indicates that peak PCB levels and transport occurred in the early 1960s (Blasland, Bouck, & Lee, Inc. 1996a).

3.3 Hydrology

3.3.1 Ground Water

The calcareous bedrock in the Housatonic Valley is the principal aquifer for the region, and its composition also influences the ground water quality. Ground water from this aquifer generally contains high concentrations of calcium and magnesium compared to water in other rock types, resulting in moderately hard to very hard water (i.e., a neutral pH and relatively high concentration of dissolved solids) (Olcott 1995). Ground water moving through the aquifer may also come in contact with calcareous glacial tills, which can maintain or increase the pH and mineral content of the water.

Regional groundwater in the Housatonic basin originates in upland areas, which consist dominantly of schist, quartzite and marble bedrock locally overlain by thin glacial deposits. Groundwater recharge presumably includes precipitation percolating through the glacial overburden or directly into the carbonate aquifer, and ground water movement is assumed to follow the carbonate bedrock surface down gradient toward the Housatonic River. Ground water entering the study area thus retains its neutral pH and high nutrient content, enhancing the rich soil conditions present along the river and floodplain areas.

3.3.2 Surface Waters

The water resources for the PSA include lacustrine, riverine, and palustrine wetlands. Woods Pond is an impoundment section of the Housatonic River and functions as a lacustrine community.

Berkshire County possesses seven major river systems that drain into three watersheds. The Hoosic River, along with Bash Bish and Kinderhook Brooks, drain into the Hudson River. The Deerfield and Westfield Rivers empty into the Connecticut River. The Housatonic River, which eventually collects waters from the Farmington River, flows into Long Island Sound. Approximately 197 lakes are located in Berkshire County

(McCann and Daly undated). Forty-five percent of these are artificial ponds and reservoirs. A number of the remaining water bodies have been altered or enlarged in some fashion, usually for recreation or water-power purposes.

Because of the varied topography of Berkshire County, there are an abundance of ponds, peatlands, and marshes. An estimated three percent of the county is considered to be occupied by palustrine communities (i.e., wetlands not associated with rivers, lakes, or tidal waterbodies) (Technical Planning Associates 1959). The Housatonic River basin is noted to contain the majority of wetlands in the county.

The PSA includes the Housatonic River, the Woods Pond impoundment, and the downstream portions of Yokum Brook and Willow Creek. Several small brooks, which drain from the west side of October Mountain, enter the Housatonic River south of New Lenox Road. Because of the topographical relief, however, only short sections of these brooks, primarily near their confluence with the Housatonic River, occur within the ten-year-flood zone of the PSA. South of New Lenox Road, the PSA is primarily bounded on the west by the Springfield Terminal railroad line (except where the ten-year-floodplain extends further west at Yokum Brook and Willow Creek) and on the east by October Mountain.

The Housatonic River is the major water feature in the PSA. It is formed by the confluence of the East Branch and West Branch Housatonic River in Pittsfield. The East Branch begins in Dalton and Hinsdale from headwater tributaries. The West Branch starts at Onota and Pontoosuc Lakes in Pittsfield and Lanesborro and is augmented by flows from the Southwest Branch. The Housatonic River ranges in elevation in the PSA from 295 m above mean sea level (msl) near the confluence of the East and West Branch to 292 m above msl at the Woods Pond impoundment. This equates to approximately 15 cm of drop per kilometer of river. Most of this elevation loss occurs in the upstream half of the PSA, particularly between the confluence and the outfall of the Pittsfield WWTF. Average flow rates are 4.0 cubic meters per second (cms) in the upper portion (confluence to New Lenox Road), and 6.3 cms in the downstream portion (New Lenox Road to Woods Pond) (Canonie Environmental 1995). Based on measurements collected from late May to late September 1993, temperature in the Housatonic River ranged from

11 – 32 degrees Celsius, dissolved oxygen ranged from 6.2 – 9.4 mg/L, and pH ranged from 7.9 – 8.3.

Woods Pond is an approximately 24-ha impoundment created in 1890. Most of the pond is less than 2 m deep, with the maximum depth at 4.8 m. In 1989, a new dam for Woods Pond was constructed approximately 55 m downstream of the historic dam (Canonie Environmental 1995). Based on measurements collected from late May to late September 1993, temperature in Woods Pond ranged from 12 – 33 degrees Celsius and dissolved oxygen ranged from 3.2 – 11.2 mg/L (Chadwick & Associates 1994).

Yokum Brook originates in Pleasant Valley, on the east side of Lenox Mountain, in Lenox. Its east and west branches have numerous small ponds and wetland areas along its course. Just before entering the Housatonic River, south of New Lenox Road and west of the Springfield Terminal railroad line, Yokum Brook expands into a large wetland system that is within the ten-year-flood zone of the PSA. This wetland system includes low-gradient stream, deep emergent marsh, shrub swamp, and red maple swamp communities.

Willow Creek is a small stream, approximately 4.2 km long, that originates between two ridges just north of Lenox Village. While most of the stream is narrow and quick-flowing, its final kilometer, before the confluence with the Housatonic River, slows and broadens into an expansive wetland system of deep emergent marshes and shrub swamps.

The volume of the water resources in the PSA is affected by industrial and municipal discharges that contribute significant flow quantities to the Housatonic River. Municipal treatment plants located in Massachusetts add 0.6 cms of wastewater flow to the river, while industrial plants contribute an additional 0.7 cms (Frink *et al*. 1982). The Pittsfield WWTF, which discharges its effluent near the midpoint of the PSA, contributes an average flow of 0.5 cms to the Housatonic River (Harrington Engineering and Construction, Inc. 1996). These discharges represent approximately 20, 24, and 17 percent of the local flow of the river, respectively.

3.4 Natural Communities

Eighteen natural communities occur within the PSA: one is a lacustrine community; ten are palustrine communities primarily associated with the Housatonic River floodplain and shoreline; three are riverine communities either within the channel itself or draining into it; and four are upland communities included within the 10-year flood zone. Full descriptions of the natural communities are provided in Attachment A. Though organic soils do occur in the PSA (primarily as shallow surface layers), all the palustrine communities are considered to be mineral soil systems (i.e., there are no peatlands in the PSA).

Within the PSA, the structure of the palustrine communities are heavily influenced by wetland hydrology and river flooding. Most of the existing landscape is forested, except where disturbance (i.e., forest clearing) or permanent flooding (i.e., river channel and backwater slough) prohibit tree growth. The forests can generally be categorized as one of two types—those areas that receive groundwater discharge and those that do not. Most of the PSA forests do not receive groundwater discharge and are largely classified as transitional floodplain forests. These forests are within the riparian corridor of the Housatonic River and are subject to inundation during spring flooding and other high water events. Vernal pools are common throughout this community and are found in most depressions. At a few locations, the floodplain forests are situated on elevated berms and are referred to as high–terrace floodplain forests. This community does not experience the same frequency of flooding as other floodplain communities, and has floristic similarity to rich, hardwood slopes. In the lower portion of the PSA, the floodplain forests give way to black ash–red maple–tamarack calcareous seepage swamps. These forested communities are low-lying wetlands that are enriched by high-pH groundwater discharge. These discharge areas can be recognized by the occurrence of standing water in depressions and a calciphilic (i.e., calcium-loving) flora. Red maple swamps, another type of forested wetland in the PSA, are primarily found in the transition between the floodplain forests and calcareous seepage swamps.

Portions of the PSA have been cleared for various purposes, primarily agriculture, residences, and various right of ways (e.g., roads, railroads, power lines). Agricultural

disturbances are the major source of forest clearing within the riparian zone of the upper Housatonic River. Several large wet meadows can be found in the PSA in which the species composition is influenced by past farming practices. Shrub swamps are common along pool and river channel borders, but they are especially frequent as an intermediate successional stage in areas where pasture is reverting to forested floodplain. Some transitional floodplain forest areas were farmed in the past century as evidenced by the subcanopy species present (i.e., dotted hawthorn routinely colonizes regenerating pasture land and survives in the subcanopy of floodplain forests for some time after the tree stratum has returned to the site).

Significant portions of the PSA are open palustrine wetlands and riverine systems dominated by submersed, floating-leaved, and emergent herbaceous vegetation. With the exception of Woods Pont, most of the Housatonic River in Pittsfield, Lenox, and Lee is classified as a low-gradient stream. This natural community is characterized by slow-moving water, often with abundant submersed vegetation. Woods Pond and some of the larger backwater areas to the immediate North are considered to be a moderately alkaline lake/pond. This relatively shallow impoundment has a similar flora as the downstream portions of the Housatonic River in the PSA. A short section of the upper PSA and sections of the river downstream of the Woods Pond impoundment are considered medium-gradient streams. High-gradient streams flow off the west slope of October Mountain and enter the ten-year-flood zone as they cross the Woodland Road. This riverine habitat is characterized as having moderately fast flowing water with some riffles and runs, and sparse aquatic vegetation.

Riverine point bar and beaches occur occasionally along the Housatonic River, primarily near bends in the channel. Mud flats of limited size begin to appear later in the season as the water levels decline and expose previously flooded substrate. Deep emergent marshes, which are usually inundated through the growing season and vegetated by robust herbs, are frequent along the river channel and backwater edges. Shallow emergent marshes, which are areas with saturated soil or shallow water and lower herbs, are less frequent in the study area and most commonly observed within the more permanent vernal pools.

Very little terrestrial or upland habitat is found in the PSA. Red oak–sugar maple transition forests are located in a few widely scattered locations. Cultural grasslands, which are open, upland habitats periodically disturbed by mowing or grazing, do occur in near New Lenox Road. A few upland inclusions of northern hardwoods–hemlock–white pine forest also occur north of Yokum Brook. Most of the upland habitats occur adjacent to the PSA as cultural grassland, northern hardwoods–hemlock–white pine forest, and rich mesic forest.

4.0 Reference Areas

Four separate reference areas were utilized during the biological surveys. Reference areas were chosen based on similarity to the PSA in natural communities, area, and land use. Necessary features of the reference areas included emergent, shrub, and forested wetland communities, considerable area occupied by or adjacent to forest land, and lack of extensive residential use. Reference areas could contain some housing and agricultural land, as these features were present in the PSA. The four reference areas included (1) Hinsdale Flats SWMA; (2) October Mountain State Forest; (3) Ashley Lake; and (4) Threemile Pond SWMA.

4.1 Hinsdale Flats State Wildlife Management Area

This reference area occurs in three parcels of property totaling 586 ha (1,454 acres) primarily in the town of Hinsdale (Map II-1). It encompasses a large section of the upper East Branch Housatonic River and borders the north end of Muddy Pond, the primary surveyed feature. This moderately alkaline lake/pond community is found at 440 meters elevation, higher than many other examples of this community in the Central Valley region of Berkshire County (most fall between 221 and 391 m). Muddy Pond covers an approximate area of 13 ha (32 acres) and is the headwater pond for the East Branch Housatonic River. It is a shallow (mostly less than 3.0 m deep), soft-bottomed lake that harbors rare plant species. On the northwest shore of the pond is a calcareous seepage marsh, a rare community in Massachusetts that contains plants of state conservation concern. This emergent, herbaceous-dominated community is supplied by high pH groundwater discharge that supports calciphilic plants. A railroad line passes along the

west shore of Muddy Pond and serves as the primary access way. Though the wildlife management area contains uplands dominated by hardwood and mixed conifer-hardwood stands, substantial portions of the area are wetlands. Shallow emergent marshes, shrub swamps, and red maple swamps are dominant.

4.2 October Mountain State Forest

This state forest is the largest in Massachusetts, covering an area of about 6,451 ha (15,940 acres). It is located primarily in the town of Washington and includes terrain from 294 – 605 m (964 – 1,984 feet) in elevation (Map II-2). October Mountain State Forest includes several lakes and reservoirs, including Washington Mountain Lake, the primary surveyed feature. This reservoir is an acidic brownwater lake/pond community reduced greatly in size from its past impoundment area of approximately 77 ha. The lake basin is now largely filled with shrub swamp and emergent marsh habitat. Several beaver flowages, averaging 1 – 3 ha in size, represent the only ponded conditions presently available. The basin overlies acidic bedrock (gneiss and quartzite) and has darkly stained water from the input of organic acids provided by adjoining peatlands. The state forest contains a diversity of natural communities, including rich mesic forests, northern hardwoods–hemlock–white pine forests, spruce–fir–northern hardwood forests, high–gradient streams, cultural grasslands, woodland vernal pools, and deep emergent marshes that border open water. It also contains a section of the Appalachian National Scenic Trail. A number of rare and uncommon plant species were seen in mature stands of sugar maple, white ash, and basswood (rich mesic forest community) (Attachment A). Woodland vernal pools here were found to be used extensively by wood frogs for breeding.

4.3 Ashley Lake

Ashley Lake is a 38 ha impoundment that serves as a water reservoir for the city of Pittsfield. It is located in the town of Washington in a rural, forested area adjacent to October Mountain State Forest (Map II-3). Ashley Lake is a clear softwater lake/pond community, characterized by clear, acidic water. The lake overlies granite and quartzite bedrock. Aquatic vegetation is generally sparse compared to other lakes in the Central

Valley region. Though a deep emergent marsh is located adjacent to the lake in a cove on the western shore, the majority of the shoreline is gravel or rock, or abruptly rises to the neighboring uplands. Red oak–sugar maple transition forests dominated by American beech and spruce–fir–northern hardwood forests surround the lake. The Ashley Lake area is used by a large number of wildlife species, including larger mammals such as mink, fish, river otter, coyote, and white-tail deer.

4.4 Threemile Pond State Wildlife Management Area

This wildlife management area contains 241 ha of land primarily in the town of Sheffield (Map II-4). It includes upland and wetland habitats in two separate parcels. Most of the shoreline of Threemile Pond, the primary survey feature, is contained in the management area. This impounded, moderately-alkaline pond community lies at 275 m elevation and covers an area of 32 ha. It is a shallow pond that contains dense colonies of submersed and floating-leaved aquatic plants, including a high proportion of non-native and invasive species. To the north of Threemile Pond is a large wetland complex containing deep emergent marshes, shallow emergent marshes, shrub swamps, red maple swamps, and wet meadows. The latter community is unusual in that is possess a number of rare or uncommon calciphilic plants. Much of the uplands surrounding Threemile Pond are hardwood and mixed conifer-hardwood forests, including mature sugar maple stands. The pond is used extensively by waterfowl during open water periods and several species of mustelids, including river otter, were documented during tracking surveys.

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SECTION III ECOLOGICAL CHARACTERIZATION

Chapter 1 Natural Communities and Rare Plants

1.0 Introduction

Surveys for natural communities and rare plants were conducted in the PSA. Natural communities provide detailed landscape descriptions and a framework to discuss animal-habitat associations. Rare species provide a measure of landscape uniqueness, as they occur more frequently in regions with unusual physical aspects (e.g., high elevation, high-pH bedrock) or in transition zones between ecoregions. Furthermore, rare plants are protected from taking by the Massachusetts Endangered Species Act (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00).

A natural community is an assemblage of interacting plants and animals and their common environment, recurring across the landscape, in which the effects of recent human intervention are minimal (Gawler 2000). Natural communities, therefore, include the biota and the physical substrate, and are repeatable units identified by their unique combination of plants and animals. They serve, therefore, as convenient categories for landscape discussion. Some communities are populated by common species with general habitat requirements, while other communities are inhabited by rare species with very specific substrate requirements and habitat.

Rare plants are those species that are considered by the State of Massachusetts to be of conservation concern (MNHESP 1999). Rare species, including plants, are commonly classified according to their rarity. Factors that influence a given species' rarity include number of state occurrences, number of global occurrences, vulnerability to disturbances, rarity of the associated natural community, fecundity, and other aspects of its biology. Definitions of rarity (e.g., endangered, threatened) can be found in Table 1-1.

Table 1-1 State status and ranking definitions.

Term	Definition
Endangered	Native species which are in danger of extinction throughout all or part of their range or which are in danger of extirpation from Massachusetts, as documented by biological research and inventory.
Threatened	Native species which are likely to become endangered in the foreseeable future, or which are declining or rare as determined by biological research and inventory.
Special Concern	Native species which have been documented by biological research or inventory to have suffered a decline that could threaten the species if allowed to continue unchecked, or which occur in such small numbers or with such restricted distribution or specialized habitat requirements that they could easily become threatened within Massachusetts.
Watch List	Rare or uncommon species in Massachusetts that are not formally protected by legislation but are monitored by the MNHESP. This category contains species that may have been dropped from the official rare plant list, are candidate species for listing, may have questions as to taxonomic identity or native range, or have had insufficient collection effort to ascertain rarity in Massachusetts.
S1	Critically imperiled in Massachusetts because of extreme rarity (five or fewer or very few remaining individuals or hectares) or because some aspect of its biology makes it especially vulnerable to extirpation from the State of Massachusetts
S2	Imperiled in Massachusetts because of rarity (6 – 20 occurrences or few remaining individuals or hectares) or because of other factors making it vulnerable to further decline.
S3	Rare in Massachusetts (on the order of 20 –100 occurrences).
S4	Apparently secure, but with cause for long-term concern.
S5	Demonstrably secure.
SH	Occurred historically in Massachusetts, and could be rediscovered; not known to have been extirpated.
SX	Apparently extirpated in Massachusetts (historically occurring species for which habitat no longer exists in Massachusetts).
SU	Possibly in peril in Massachusetts but status uncertain; need more information.
S?	Probably rare or historic in Massachusetts, based on status elsewhere in New England, but not yet reviewed or documented by MNHESP.
Global ranks (“G” instead of “S”)	Follow the criteria for state ranks, but refer to the entire range of a species, rather than just its statewide distribution.

2.0 Methods

2.1 Background

Plants and natural communities of conservation concern are those that are rare from a global or state perspective. Species and communities listed as rare follow Maine Natural Heritage and Endangered Species Program (MNHESP) (1999) and Swain and Kearsley (2000). Rare plants and natural communities are defined as those with a state "rank" of S1, S2, S3, SU, S?, SH, or SX, or those with a state "status" of endangered, threatened, special concern, or watch list. These terms follow MNHESP (1999) definitions and are described in Table 1-1.

Plant species and communities are also provided ranks based on the quality of the occurrence. The element occurrence (EO) rank is an average of four individual ranks: EO quality (size/productivity); EO condition (pristineness/ability to recover from impacts); EO viability (long-term existence prospects); and EO defensibility (how protectable the occurrence is). The EO rank is a relative rating system based on range-wide observations. It primarily utilizes four classes of ranks: A (excellent); B (good); C (marginal); and D (poor). A ranking of E is sometimes provided for EOs that are extant but for which information was inadequate to provide a qualitative score.

Landscape analysis, a multi-step process involving information collation, interpretation, and summarization (Lortie *et al.* 1992), was performed to provide a macroscopic view of the PSA's history and ecology. The landscape analysis process identified habitats in the PSA that had moderate to high potential for containing a targeted feature (e.g., rare plants, animals, or natural communities). It involved using available natural resource information such as United States Geological Survey (USGS) 7.5 minute topographic maps, surficial and bedrock geology maps, aerial photographs, soils maps, wetlands maps, land use history information (e.g., fire, cutting, herbicide spraying), and species descriptions to develop a search image of the targeted feature (e.g., a rare plant) or its associated natural community. The PSA was then assessed to determine if areas occurred that could harbor the target feature. Identified areas were field surveyed at the

appropriate time to determine if the rare species and natural communities occurred in the study area.

2.2 Literature review

Available information on rare plants and natural communities was collected from published and unpublished sources. The MNHESP was contacted for rare plant and community information. The locations of known rare features were plotted on PSA base maps. MNHESP botanists and natural community scientists were also consulted regarding the availability of reports on plants and communities for the PSA. Information on rare plant species taxonomy and biology was collected from botanical texts (e.g., Flora of North America Editorial Committee 1993, 1997 and 2000, Gleason and Cronquist 1991, Fernald 1950, Haines and Vining 1998) and herbarium vouchers. Available information on rare plants and communities in and near the PSA was reviewed to predict whether additional rare plant or community sites might occur in the PSA based on species ranges and habitat types.

Taxonomy of vascular plants follows Haines and Vining (1998) and Flora of North America Editorial Committee (1993, 1997, and 2000). Natural community classification largely follows Swain and Kearsley (2000), which represents the most current and comprehensive system for Massachusetts. Many river and lake ecosystems, however, are not described. Classification of these latter communities follows Weatherbee (1996) and Weatherbee and Crow (1992). Gawler (2000) and Swain (pers. comm., A. Haines of Woodlot Alternatives with P. Swain of the MNHESP, several contacts in 1999 and 2000) were referenced for community characterizations.

2.3 Aerial Photograph Interpretation

Color infra-red aerial photographs (1:12000 scale) were used to review the types and locations of natural communities in the PSA. Wetland maps previously prepared by the USEPA (TechLaw, Inc. 1998) were also reviewed to identify the location of riparian forest communities. Natural communities in the PSA that appear to be in a natural state (i.e., not altered by agricultural activities, development, human-induced flooding, or other

factors) were identified on maps and aerial photographs. In addition, based on information collected during the literature review, potential sites to field survey were located on aerial photographs and project maps.

2.4 Field Surveys

Field surveys to verify the existence of rare species or communities were conducted by experienced botanists trained in plant taxonomy. Using the list of rare plant species and natural communities that are known or suspected to occur in the PSA (prepared during landscape analysis), and aerial photographs and base maps showing potential survey sites, field botanists surveyed areas for rare occurrences. Survey efforts focused on areas identified during landscape analysis as having a moderate to high potential for containing a targeted rare plant or natural community. Surveyed sites were carefully examined to identify potential micro-habitats containing the occurrences of interest.

Most of the remainder of the PSA was also surveyed in a less intense manner during other field exercises to determine if potential habitats were missed during landscape analysis. When potential rare plant or natural community habitats were identified during these efforts, they were also carefully surveyed. Surveys were performed during periods when individual species could be positively identified (e.g., in flower or with mature fruit). Multiple site visits were used, as necessary, to ensure plants were observed in an appropriate stage for accurate identification. Taxonomic keys and herbarium specimens were used to verify species identification.

At each extant rare plant or natural community site, information on population size, evidence of reproduction, likely persistence, location, and existing threats (e.g., on an all-terrain vehicle trail), was collected in field notebooks. Photographs were taken of rare plants and their habitats when possible. Areal cover was estimated through use of figures (comparison charts showing various proportions) contained in Color Communications, Inc. (1997). Voucher specimens were collected for many species when sufficient numbers existed such that collection would not harm the population (the number dependent of the species' biology). Locations of rare plant populations were surveyed using Global Positioning System (GPS) equipment. Trimble Pro-XR GPS survey

equipment was used that, depending on conditions, captured locations with 1 – 2 m accuracy. MNHESP Rare Plant Observation Forms were completed for all rare plants observed in the PSA.

3.0 Natural Community Descriptions

Eighteen natural communities occur in the PSA. An additional seven communities located in reference areas were surveyed and described due to their importance in various biological studies. A listing of each community with summary information, including description, example locations, synonyms, and extent in the PSA, can be found in Table 1-2. Detailed narratives of the communities can be found in Attachment A. Map 1-1 provides natural community type and location for the entire PSA. Community data forms are provided in Attachment E. Scientific names for plants referenced in this document are listed in Attachement F.

Beginning from the confluence of the East Branch and West Branch Housatonic River, the floodplain is relatively narrow (ca. 100 – 250 m) and less structurally diverse compared to downstream portions of the PSA. Where the natural communities are intact, the upstream region is primarily vegetated by riparian forests that receive over bank flow during high-water events. Herb- and shrub-dominated, seasonally flooded depressions occured in this area and were found to be utilized by breeding amphibians. The main stem of the Housatonic River in this section has moderately fast water with pool, riffle, and run habitat. The channel walls are vertically cut and bottom substrate is often gravel and sand. Impacts to the floodplain communities are largely residential in nature and include housing lots, manicured lawns, and open rights-of-way for power lines and sewage systems. Non-native and invasive plant species are prevalent in this area. A representative cross-section is provided in Figure 1-1.

Table 1-2 Natural communities in the PSA and reference areas.

Community Name	Brief Description	Example Location	Area in PSA (ha)	State Rank	Synonyms	
					Cowardin *et al.* (1979)	Weatherbee[1]
Lacustrine Communities[2]						
Acidic brownwater lake/pond	Ponds found on the Berkshire Plateau that have stained water resulting from organic inputs from adjacent peatlands.	Washington Mountain Lake.	Not present in PSA	NA	LUB	Acidic brownwater lake/pond
Clear softwater lake/pond	Ponds found on the Berkshire Plateau that are relatively oligotrophic and do not have adjoining peatlands.	Ashley Lake.	Not present in PSA	NA	LOW	Clear softwater lake/pond
Moderately alkaline lake/pond	Ponds located in the central valley region with calcareous bedrock underneath.	Threemile Pond, Woods Pond.	9.2	NA	LAB	Moderately alkaline lake/pond
Riverine Communities[2]						
High-gradient stream	Small streams with swift-flowing sections generally devoid of vegetation except at edges of quiet pools.	Roaring Brook.	0.04	NA	ROW	High-gradient stream
Low-gradient stream	Slow-moving water that may have abundant submersed aquatic plants.	Housatonic River south of Holmes Road.	106.4	NA	RAB	Low-gradient stream
Medium-gradient stream	Streams with moderate flows and some riffles. Vascular vegetation is sparse.	East Branch Housatonic River.	6.7	NA	RUB	Medium-gradient stream
Spring	Occur where groundwater discharge creates small water bodies and rivulets. Often colonized by golden saxifrage.	Pool WML-2.	Not present in PSA	NA	NA	Spring
Palustrine Communities						
Black ash-red maple-tamarack calcareous seepage swamp	Hydric forests dominated by red maple, black ash, and bur oak. Occur in high pH groundwater discharge areas.	Most swamps on west side of Housatonic River south of Yokum Brook confluence.	47.4	S3	PFO	Circumneutral hardwood swamp (in part)

Community Name	Brief Description	Example Location	Area in PSA (ha)	State Rank	Synonyms	
					Cowardin *et al.* (1979)	Weatherbee[1]
Calcareous seepage marsh	Emergent marshes that experience high pH groundwater discharge. Calciphilic indicator plants are present.	Northwest end of Muddy Pond.	Not present in PSA	S2	PEM	Robust emergent marsh (in part).
Deep emergent marsh	Herb dominated wetland community that often remains inundated with water through the growing season. Dominated by robust graminoids grass-like plants or aquatic, broad-leaved herbs.	Many vegetated backwater areas upstream of Woods Pond.	21.5	S4	PEM	Robust emergent marsh (in part)
High-terrace floodplain forest	Riparian forests with a mixture of trees from wetter sites (e.g., silver maple, American elm) and trees from rich, upland sites (e.g., sugar maple, white ash, basswood). Herb layer with characteristic species of high-nutrient forests.	Floodplain forest upstream of WWTF outfall and to some extent around 8-VP-1.	4.4	S2	PFO	Floodplain forest (in part)
Mud flat	Sparsely vegetated, saturated mucky soils that become exposed in the summer as the water level recedes. Occur at the edges of vernal pools and river channels.	Many vernal pools transform to this community when the water completely recedes.	Present in PSA, but seasonal in occurrence	S4	PEM	Not specifically addressed
Red maple swamp	Hydric forests dominated by red maple.	South of New Lenox Road in vicinity of vernal pool 46-VP-1.	61.2	S5	PFO	Circumneutral hardwood swamp (in part)
Riverine point bar and beach	Open sand and mucky sand bars along the edge of river channels.	Accretion bars along Housatonic River.	0.4	S3	RUS	Low gradient stream (in part)
Shallow emergent marsh	Herb dominated wetland community with saturated soils or inundated at some locations. Vegetation diverse, but lacking robust, grass-like herbs characteristic of deep emergent marshes.	Vernal Pool 38-VP-2.	30.3	S4	PEM	Circumneutral graminoid marsh (in part) and robust emergent marsh (in part)

Community Name	Brief Description	Example Location	Area in PSA (ha)	State Rank	Synonyms	
					Cowardin *et al.* (1979)	Weatherbee[1]
Shrub swamp	Hydric shrublands lacking a closed canopy.	Vernal Pool 46-VP-1.	103.8	S5	PSS	Circumneutral shrub swamp
Transitional floodplain forest	Riparian forests dominated by silver maple, box-elder, and American elm.	Most floodplain forests adjacent to river channel north of Yokum Brook confluence.	84.1	S2	PFO	Floodplain forest (in part)
Wet meadow	Shallow emergent mashes that are periodically disturbed by mowing or grazing.	Hydric fields south of New Lenox Road.	18.4	S4	PEM	Graminoid marsh (in part); sloping graminoid fen (in part)
Woodland vernal pool	Small, vernally flooded depressions in upland settings.	October Mountain State Forest.	Not present in PSA	S3	PAB	Not specifically addressed
Terrestrial Communities						
Cultural grassland	Open uplands dominated by grass-like herbs that are periodically disturbed by mowing, grazing, or fire.	Upland fields near New Lenox Road.	22.0	NA	NA	Old field
Northern hardwoods-hemlock-white pine forest	Upland forests dominated by sugar maple, eastern hemlock, red oak, and eastern white pine.	Some forests along east side of Woodland Road.	24.3	S5	NA	Mesic northern hardwood forest (in part)
Red oak-sugar maple transition forest	Mesic upland forest dominated by red oak, and sugar maple, white ash. Flora of this community lacks extreme indicators of northern and southern forests.	Upland forest near Lenox Station on east side of Springfield Terminal rail line.	6.6	S4	NA	Mesic northern hardwood forest (in part)
Rich mesic forest	Mesic upland forest dominated by sugar maple, white ash, and basswood with a characteristic herb flora of high-nutrient sites.	Some forests along east side of Woodland Road.	2.0	S3	NA	Rich mesic forest

Community Name	Brief Description	Example Location	Area in PSA (ha)	State Rank	Synonyms	
					Cowardin *et al.* (1979)	Weatherbee[1]
Spruce-fir-northern hardwood forest	Moderate to high elevation forest dominated by trees adapted to cooler microclimates, such as red spruce, balsam fir, red maple, paper birch, and mountain ash.	Forest surrounding pool WML-3.	Not present in PSA	S4	NA	Mesic northern conifer forest
Successional northern hardwoods	Young forests growing on sites with a recent history of canopy disturbance. Dominant trees include quaking aspen, paper birch, and eastern white pine.	Forests around pools 23b-VP-1 and 23b-VP-2.	2.2	S5	NA	Mesic northern hardwood forest (in part)

1 Weatherbee (1996) and Weatherbee and Crow (1992) are both sources for previous community classification.

2 Lacustrine and riverine communities are not yet classified by Swain and Kearsley (2000); therefore, classification follows Weatherbee (1996) and Weatherbee and Crow (1992).

Moving downstream, the river slows and widens somewhat. Though the stream banks are generally vertically cut, a number of small sand beaches were found. The floodplain varies in width and ranges from ca. 50 – 400 m wide. Riparian forests are still the dominant feature, although in many areas they have been cleared for agriculture (hay and food crop production). This section harbors several rich, forested areas that are home to a number of rare plant species (see Map 1-2 and Attachment A). Vernal pools are common in this section as well. A number of beaver-influenced wetlands occur on the west side of the Housatonic River channel near the Canoe Meadows Wildlife Sanctuary. A representative cross-section is provided in Figure 1-2.

South of the Pittsfield WWTF and in the vicinity of New Lenox Road, significant portions of the riparian forests have been cleared for agriculture. The remaining forest fragments are bordered by wetland and upland fields that were largely fallow during the survey period. Despite the forest clearing, numerous open pools dominated by emergent, herbaceous vegetation occur in the low areas of the field. It was found that these pools were being used by breeding amphibians and wading birds. The Housatonic River channel is highly sinuous in this area and a number of oxbow pools were found. Channel banks are still vertically cut and a number of mucky sand beaches and accretion bars were located that often harbored the rare mudflat spikesedge. A representative cross-section is provided in Figure 1-3.

Nearing the Yokum Brook confluence and below, the floodplain becomes limited on the east side due to the proximity of October Mountain. It is extensive on the west side of the channel, however, and the floodplain commonly exceeds 500 m in width. Here the river channel lacks the well-defined, vertically cut banks of the upper portions of the PSA. Bottom substrate is typically silt and fine organic particles. Numerous, and often large, backwater pools and sloughs occurred in this area. These inundated habitats are vegetated by a diversity of plants (e.g., emergent, floating-leaved, submergent). Floodplain forests are restricted to high banks adjacent to the channel. Most of the forested areas are dominated by swamps. These forested wetlands occur in lower areas that are saturated at or near the surface and frequently enriched with high pH groundwater discharge (pH typically greater than 7.0). These seepage swamps contain

the highest concentration of rare plants in the PSA and show the least amount of influence from non-native plants (see Map 1-2 and Attachment A). They are also the largest forested tracts in the PSA. Although largely intact, portions of the forests in this portion of the PSA have been cleared for railroad lines and power lines. Two major streams enter from the west, with large wetland complexes prior to their confluence. The downstream end of the PSA is comprised of the impoundment creating Woods Pond. This moderately alkaline pond is relatively shallow and contains aquatic vegetation. A representative cross-section is provided by Figure 1-4.

For descriptive purposes, the natural communities occurring in the PSA have been grouped together into systems. Systems are large-scale classification units comprised of different natural communities that share common features, such as hydrology and canopy development. Four systems occur in the PSA: lacustrine (Section 3.1); riverine (Section 3.2); palustrine (Section 3.3); and terrestrial (Section 3.4). Definitions for these systems are found preceding the natural community descriptions in each section.

Figure 1-1 **Representative section of PSA - upper section (Reach 5A).**

Figure 1-2 **Representative section of PSA - middle section (Reach 5A).**

Figure 1-3 **Representative section of PSA - lower section (Reach 5B)**

Figure 1-4 **Representative section of PSA - lower section (Reach 5C).**

3.1 Lacustrine Communities

The lacustrine system is made up of wetlands and deepwater habitats located in topographic depressions and impounded river channels. These communities have limited (less than 30 percent) areal coverage of woody and emergent herbaceous plants and may also have active wave-formed shoreline features (Cowardin *et al.* 1979).

Most of the lacustrine communities in the PSA are impoundment features created either by humans or American beavers. Due to their location and high pH (7.0–9.0), these ponds are considered moderately alkaline lake/pond communities. This community type is found in the Central Valley region of Berkshire County and overlies high-pH bedrock, such as limestone and marble, which creates alkaline, hard water conditions. Alkalinity measurements usually range from 18 – 73 mg/liter HCO_3^- (Weatherbee and Crow 1992). At the downstream end of the PSA is a dam that creates Woods Pond. This 20-ha impoundment was largely less than 2 m deep and contains abundant submerged and floating-leaved vegetation.

3.2 Riverine Communities

The riverine system is made up of wetlands and deepwater habitats with continually or periodically flowing water contained within a channel. They are not significantly dominated by woody or emergent herbaceous vegetation (having less than 30 percent areal cover) and do not have ocean-derived salts exceeding 5 ppt. Riverine systems may occur in natural or created channels, and sometimes are merely connections between two bodies of water (Cowardin *et al.* 1979).

Four riverine communities were identified in the PSA. The majority of the Housatonic River in the PSA is classified as a low-gradient stream, characterized by slow-moving water, fine sediments, and abundant vascular vegetation. The upstream portion of the main stem of the Housatonic River, north of the Pittsfield WWTF outfall, is classified as medium-gradient stream due to moderate-flowing water, courser substrate, and general lack of aquatic vegetation. Several high-gradient streams enter the PSA from the steep slopes of October Mountain State Forest. These fast-moving, low-order streams possess

gravel and cobble substrate and are generally devoid of plants in the channel itself. Spring communities are small, ephemeral or permanent features that resemble spring rivulets or tiny pools. They emerge along or at the base of slopes when groundwater is redirected by an impervious layer. One spring was located in the PSA. It was not mapped, however, due to its small size.

3.3 Palustrine Communities

The palustrine system is made up of various types of non-tidal wetlands that are dominated by plants (Cowardin *et al.* 1979). These communities may occur in topographic depressions and drainage basins, adjacent to lakes and rivers, or anywhere groundwater is discharged, such as at the base of a slope that intersects an impermeable layer. As these communities are wetlands, the soil is inundated or at least saturated at or near the surface during a portion of the growing season.

Eleven palustrine communities were identified in the PSA. These communities are often divided into two groups for classification purposes—those that are forested and those that are open. Transitional floodplain forests are the dominant forested wetland in the PSA. These forests are dominated by silver maple, box-elder, and eastern cottonwood, and are temporarily flooded during high water events. Transitional floodplain forests are the most common wooded community upstream of New Lenox Road. South of this road, this community type is restricted to the edge of the river channel. High–terrace floodplain forests are somewhat similar but are found on elevated banks and berms and possess a flora characteristic of high-nutrient sites. This community is restricted in occurrence and the best examples are found upstream of the Pittsfield WWTF outfall. Red maple swamps were found in the vicinity of the Pittsfield WWTF outfall and south of New Lenox Road. These forested wetlands are dominated by red maple and occur in lower, wetter areas than the floodplain forests. The final type of forested wetland identified in the study area is black ash-red maple-tamarack calcareous seepage swamp. This community is dominated by red maple, black ash, and bur oak and is located in downstream portions of the PSA where high pH groundwater discharge occurs. This

community contains a number of species with affinity to calcareous substrate, and was found to harbor the greatest concentration of state-listed rare plants.

Emergent marshes are open, herb-dominated wetlands in which the vegetation grows upright, above the water level (when standing water is present). Three types of marshes were observed in the PSA. Deep emergent marshes are those wetlands that frequently remain inundated through the growing season and are dominated by robust, often grass-like herbs. Shallow emergent marshes occur in areas with saturated soils or shallow water, and they lack the tall, grass-like plants. Wet meadows are similar to shallow emergent marshes but are periodically disturbed by mowing or grazing, which alters the character and species composition. All of these marsh types become more abundant in the PSA as one moves south of the Pittsfield WWTF outfall.

Four additional wetland communities that lacked closed canopies were observed in the PSA. Shrub swamps are one of the most extensive community types found in the 10-year-floodplain. This community is dominated by a number of short, woody plants and occasionally had scattered trees as well. Shrub swamps are likely common in the PSA due to land use history. Significant portions of the Housatonic River Valley State Wildlife Management Area were farmed at one time, and shrub swamp communities appear to represent a stage of succession from wet meadow to forested wetland. Also observed was the riverine point bar and beach, which is a river shore community comprised of sand or mucky sand substrate in the form of linear beaches and accretion bars. This community is dominated by short-statured, often annual, herbs that are tolerant of submersion. Mud flat is another community that appeared later in the season as the water level receded from vernal pools and shallow water areas of the Housatonic River. It is generally a sparsely vegetated community growing on saturated mud.

3.4 Terrestrial Communities

The terrestrial system is comprised of uplands that lack prolonged inundation or soil saturation. They may have closed canopies or be relatively open and dominated by low herbs. Terrestrial communities occur in a variety of locations with respect to elevation, slope, and aspect.

Four terrestrial or upland communities were identified in the PSA. Only one of the terrestrial communities was an open habitat lacking trees. Cultural grasslands are herb-dominated habitats that are periodically disturbed by mowing, grazing, or burning. Though managed, and not necessarily natural, they are included under the category of natural communities as they are used extensively by wildlife common to minimally managed areas, including rare birds. The community ranges from mesic (e.g., pastures and fields) to xeric (e.g., open barrens and airports). The former type often has a higher percentage of non-native species.

Northern hardwoods–hemlock–white pine forests are located near New Lenox Road where upland inclusions occur within the ten-year-floodplain. This community is dominated by red oak, eastern hemlock, sugar maple, and eastern white pine. Red oak–sugar maple transition forest is limited in extent in the PSA. These forests are transitional in species composition between southern and northern forests. Dominant trees included red oak, sugar maple, American beech, and white ash. Spruce–fir–northern hardwood forests were identified in higher elevation, cooler microsites in October Mountain State Forest. Common canopy trees include red spruce, white spruce, red maple, paper birch, balsam fir, and mountain ash. Successional northern hardwoods are young forest stands growing on sites with a history of past disturbance. Quaking aspen, paper birch, and eastern white pine are common colonizing trees on these sites. This habitat occurs in and around the borrow pits near the Pittsfield WWTF.

3.5 Rare Natural Communities and Plants

3.5.1 Rare Natural Communities

Seven communities of state conservation concern were identified in the PSA: black ash–red maple–tamarack calcareous seepage swamp; transitional floodplain forest; high-terrace floodplain forest; riverine point bar and beach; woodland vernal pool; calcareous seepage marsh; and rich mesic forest. A brief discussion of the rare natural communities and their conservation status follows. Detailed descriptions of the natural communities can be found in Attachment A.

Black ash–red maple–tamarack calcareous seepage swamps are forested wetlands enriched with high-pH groundwater. This community is ranked S3 in Massachusetts and occurrences are restricted to the western portion of the state. It is one of the more common communities in the PSA on the west side of the Housatonic River south of Yokum Brook confluence. Black ash–red maple–tamarack calcareous seepage swamps have been impacted in the PSA by clearing for railroad lines and power line rights-of-way. One area harboring rare species was being inundated by a beaver impoundment in 2000.

Transitional floodplain forests are wooded areas subject to flooding during high water events. This community is ranked S2 in Massachusetts and occurrences are found primarily in the western portion of the state. It can be found adjacent to the river channel nearly throughout the PSA, but it is best developed from the confluence of the East and West Branch Housatonic River to the Yokum Brook confluence area. Extensive clearing and development of this community has occurred in Pittsfield and Lenox for agriculture, residential lot construction, and river channelization. The proximity of urban Pittsfield has led to extensive colonization of non-native species in some areas. Garlic-mustard and dame's rocket are ubiquitous in the floodplain forests of this area, while cuckoo flower, Morrow's honeysuckle, moneywort, and purple loosestrife are common in particular tracts.

High-terrace floodplain forests are wooded areas adjacent to river channels that are positioned on elevated terraces or berms so that they are less frequently flooded than the previous community. This community is ranked S2 in Massachusetts and occurrences are concentrated in the western half of the state. The best example of this community in the PSA is found upstream of the Pittsfield WWTF.

Riverine point bars and beaches are stream shoreline communities created by the accretion of fluvial sediments. This habitat can be found in the PSA upstream of the Yokum Brook confluence. This community is ranked S3 in Massachusetts and occurrences are restricted to the western half of the state.

Woodland vernal pools are temporary bodies of water in upland settings that may be used as breeding habitat by amphibians. This community is ranked S3 in Massachusetts and occurrences are scattered throughout the state. Examples in the PSA can be found in October Mountain State Forest.

Calcareous seepage marshes are herb-dominated wetlands that are supplied with high pH groundwater. This community is ranked S2 in Massachusetts and occurrences are restricted to the western half of the state. This habitat can be found at the Hinsdale Flats SWMA reference area. The single observed occurrence of this community has been impacted by a railroad line. The wetland has been bisected by a large berm of crushed stone and the site's hydrology has likely been affected as well. The unusual aspect of calcareous seepage marshes is provided by the calciphilic flora that is supported by enriched groundwater seepage.

Rich mesic forests are wooded areas that usually occur on or at the base of slopes and are enriched by groundwater seepage or gravity-assisted accumulation of nutrient matter. This community is ranked S3 in Massachusetts and occurrences are scattered throughout the state. Examples in the PSA can be found along the west facing slopes of October Mountain. Canopy clearing is a major threat to this community. Maintenance of forest integrity is an important conservation measure. Limiting disturbance also assists in preventing the colonization of non-native species.

3.5.2 Rare, Threatened, and Endangered Plants

The landscape analysis yielded 32 plants of state conservation concern that are known or suspected to occur in the PSA. These species are presented in Table 1-3. Field surveys documented a total of 20 state-listed species from 37 sites, including 19 from the landscape analysis and 1 additional Special Concern species (pendulous bulrush). These results are summarized in Table 1-4. Discussion of each species from the PSA follows and includes population details, species ecology, and threats. New England state occurrences were gathered from Seymour (1982) and Magee and Ahles (1999). Rare plant listings for New England states were obtained through the The Natural Heritage Network (2001). See Attachment G for rare plant data forms.

Table 1-3 Rare plants known or suspected to occur in the PSA[1]

Species	Historically Present In Area	Found during 1998[2], 1999, or 2000 Surveys	State Status	Communities Present In PSA That Species Is Likely To Occur In
black maple (*Acer nigrum*)	Yes	Yes	Special Concern	High-terrace Floodplain Forests
green dragon (*Arisaema dracontium*)	No	No	Threatened	High-terrace Floodplain Forests
smooth rock-cress (*Arabis laevigata*)	No	No	Threatened	High-terrace Floodplain Forests
foxtail sedge (*Carex alopecoidea*)	Yes	Yes	Threatened	Wet Meadow, Open areas in floodplains
Davis's sedge (*Carex davisii*)	No	No	Endangered	High-terrace Floodplain Forests
Gray's sedge (*Carex grayi*)	Yes	Yes	Threatened	Black Ash-Red Maple-Tamarack Calcareous Seepage Swamps, Transitional Floodplain Forests
Schweinitiz's sedge (*Carex schweinitzii*)	No	No	Endangered	Black Ash-Red Maple-Tamarack Calcareous Seepage Swamps
hairy-fruited sedge (*Carex trichocarpa*)	No	No	Threatened	Transitional Floodplain Forests
cat-tail sedge (*Carex typhina*)	No	No	Threatened	Alluvial Red Maple Swamps
early blue cohosh (*Caulophyllum giganteum*)	No	Yes	Watch List	High-terrace Floodplain Forests, Rich Mesic Forests
Virginia spring beauty (*Claytonia virginica*)	No	No	Threatened	High-terrace Floodplain Forests
hemlock-parsley (*Conioselinum chinense*)	No	Yes	Special Concern	Black Ash-Red Maple-Tamarack Calcareous Seepage Swamps

Species	Historically Present In Area	Found during 1998[2], 1999, or 2000 Surveys	State Status	Communities Present In PSA That Species Is Likely To Occur In
mudflat spikesedge (*Eleocharis intermedia*)	No	Yes	Threatened	Mud Flats
downy wild-rye (*Elymus villosus*)	No	Yes	Threatened	High-Terrace Floodplain Forests
variegated scouring-rush (*Equisetum variegatum*)	No	Yes	Watch List	Disturbed, hydric ground in limestone bedrock regions
Frank's love grass (*Eragrostis frankii*)	No	No	Threatened	Riverine Point Bar and Beaches
fringed gentian (*Gentianopsis crinita*)	No	Yes	Watch List	Wet Meadows
many-fruited false loosestrife (*Ludwigia polycarpa*)	No	No	Threatened	Oxbows in Transitional Floodplain Forests
winged monkey-flower (*Mimulus alatus*)	No	No	Endangered	Mud Flats
bur oak (*Quercus macrocarpa*)	Yes	Yes	Special Concern	Black Ash-Red Maple-Tamarack Calcareous Seepage Swamps
bristly crowfoot (*Ranunculus pensylvanicus*)	Yes	Yes	Threatened	Openings in swamps and floodplains
eastern black currant (*Ribes americanum*)	Yes	Yes	Watch List	Black Ash-Red Maple-Tamarack Calcareous Seepage Swamps, Transitional Floodplain Forests
swamp dock (*Rumex verticillatus*)	No	No	Threatened	Transitional Floodplain Forests
Wapato (*Sagittaria cuneata*)	Yes	Yes	Endangered	Mud Flats, Shallow Emergent Marshes (in depressions within Transitional Floodplain Forests)
hoary willow (*Salix candida*)	Yes	Yes	Watch List	Calcareous Seepage Marshes

Species	Historically Present In Area	Found during 1998[2], 1999, or 2000 Surveys	State Status	Communities Present In PSA That Species Is Likely To Occur In
autumn willow (*Salix serissima*)	No	Yes	Watch List	Wet Meadows, Shrub Swamps
cluster sanicle (*Sanicula odorata*)	No	Yes	Threatened	High-terrace Floodplain Forests
hard-stem bulrush (*Schoenoplectus acutus*)	No	Yes	Watch List	Deep Emergent Marshes, Calcareous Seepage Marshes
oblong bulrush (*Schoenoplectus acutus* X *S. tabernaemontanii*)	No	Yes	not formally listed	Deep Emergent Marshes, Calcareous Seepage Marshes
crooked-stem aster (*Symphyotrichum prenanthoides*)	No	Yes	Special Concern	Red Maple Swamps
Culver's root (*Veronicastrum virginicum*)	Yes	No	Special Concern	High-terrace Floodplain Forests
barren strawberry (W*aldsteinia fragarioides*)	No	No	Threatened	High-terrace Floodplain Forests

[1] List was compiled through landscape analysis and agency consultations.
[2] TechLaw, Inc. 1999

Table 1-4 Summary of rare plants documented in the PSA and reference areas

Common Name	Latin Name	State Status[1]	State Rank	Global Rank	Year First Observed	Number of Sites	Town(s)	Element Occurrence Rank
black maple	*Acer nigrum*	SC	S2	G5	1999	1	Pittsfield	C
foxtail sedge	*Carex alopecoidea*	E	S2	G5	1998	1	Lenox	C
Gray's sedge	*Carex grayi*	T	S2	G4	1998	1	Lenox	B
early blue cohosh	*Caulophyllum giganteum*	WL	S?	G3/G5	2000	3	Pittsfield, Lee, Washington	B-C
hemlock-parsley	*Conioselinum chinense*	SC	S3	G5	1998	1	Lenox	C
mudflat spikesedge	*Eleocharis intermedia*	SC	S2	G5	1998	3	Pittsfield, Lenox	B-C
downy wild-rye	*Elymus villosus*	T	G5	S2	2000	1	Pittsfield	C
variegated scouring-rush	*Equisetum variegatum*	WL	S3	G5	1998	3	Pittsfield, Washington	B-C
fringed gentian	*Gentianopsis crinita*	WL	S4	G4	2000	1	Sheffield	D
bur oak	*Quercus macrocarpa*	SC	S3	G5	1998	1	Lenox	A
bristly crowfoot	*Ranunculus pensylvanicus*	T	S2	G5	1999	1	Lenox	C
eastern black currant	*Ribes americanum*	WL	S4	G5	1998	7	Pittsfield, Lenox	C
wapato	*Sagittaria cuneata*	E	S1	G5	1998	3	Lenox	B-D
hoary willow	*Salix candida*	WL		G5	2000	1	Washington	C
autumn willow	*Salix serissima*	WL	S3	G5	1999	1	Sheffield	B
cluster sanicle	*Sanicula odorata*	T	S2	G5	2000	1	Lenox	C
hard-stem bulrush	*Schoenoplectus acutus*	WL	S?	G5	2000	1	Hinsdale	B
oblong bulrush	*Schoenoplectus acutus* X *S. tabernaemontanii*	NA	NA	G?	2000	2	Washington-Hinsdale, Pittsfield	B-C
pendulus bulrush	*Scirpus pendulus*	SC	S2	G5	1999	3	Lenox, Washington	C-D
crooked-stem aster	*Symphyotrichum prenanthoides*	SC	S3	G4/G5	1998	1	Lenox	C

[1] State status explanation: E=endangered; T=threatened; SC=special concern; WL=watch list.

Black Maple

Black maple is a deciduous tree that can reach a height of 40 m (Figure 1-5). It normally grows in rich, mineral soil of rocky hillsides and floodplains. This species occurs primarily in the eastern half of the United States and adjacent southern Canada. In New England it occurs in all states except Maine and Rhode Island. Black maple is listed as a species of conservation concern in all New England states in which it occurs in. The rarity of this species is likely due to the clearing of its habitat, particularly floodplain areas that are preferred areas for agriculture in most New England states. As well, New England is near the northern limit for this species.

Figure 1-5 Leaves and fruit of black maple.

Black maple was located in the PSA at Canoe Meadows Wildlife Sanctuary, south of the Holmes Road and west of the Housatonic River channel (Map 1-2). This station is a historically known locality that was rediscovered during 1999 field efforts. It occurred as a single individual in a floodplain forest near the base of the upland terrace. The tree had an approximate diameter of 50 cm. No flowers or fruits were observed during the first observation on 27 May 1999. Developing fruits were observed, however, in the spring of 2000. The black maple tree was part of a floodplain forest community, which in this location is merely a narrow strip along the river that likely exwas more extensive prior to clearing for agriculture. Much of the surrounding landscape is open field or early successional forest. Associated species include sugar maple, green ash, false hellebore, wild leek, bloodroot, zig-zag goldenrod, Morrow's honeysuckle, lady fern, and Pennsylvania sedge.

Due to land ownership of the site (Massachusetts Audubon), black maple likely has no short-term threats to its existence in the PSA. Long-term prospects for continued existence are poor. With only a single mature tree known from the area, it will likely be difficult for the population to maintain itself indefinately. This station was provided an EO rank of C on the basis of small population size, relic community size, and public ownership of property.

Mudflat Spikesedge

The mudflat spikesedge is a diminutive, tufted sedge that grows in wet soil of open areas (Figure 1-6). As its name implies, this species frequents muddy areas such as rivershores and tidal flats. It occurs in the eastern United States and adjacent Canada. In New England it is found in all states except Rhode Island. Mudflat spikesedge is also listed as a species of conservation concern in Maine and Vermont. In New England, this species favors soil of high pH, and therefore is usually found in limestone regions. This type of bedrock is relatively scarce in New England and, therefore, so is the mudflat spikesedge. Pittsfield was the first town in Massachusetts found to harbor a population of this plant (date of collection 1902) (Hoffman 1904).

Figure 1-6 Mudflat spikesedge.

Data for mudflat spikesedge occurrences were collected at three locations in the PSA (Map 1-2). A fourth location on the West Branch Housatonic River could not be surveyed in detail due to storm flow conditions. All locations were mucky silt/sand beaches and bars on the rivershore, commonly on the inside of bends where silt and organic particles accumulate. One site on the West Branch Housatonic River was not

documented due to flood flows and heavy siltation, which made locating and counting the plants impossible. Common associates include false pimpernel, common water-purslane, Canada lovegrass, dock-leaved smartweed, false nutsedge, barnyard grass, and common cocklebur. Due to the type of habitat this plant occurred in, most sites were small and limited to 15 m stretches along the accretion bars. EO ranks for the three surveyed sites were B (one site) and C (two sites).

Though mudflat spikesedge populations are small, there are several stations in the PSA and this species also occurs in most Central Valley towns in Berkshire County (Weatherbee 1996). EO ranks for PSA populations range from B (one site) to C (three sites). Threats to this plant include factors that would alter or disrupt channel flows, such as impoundments, continued urbanization of upstream areas (leading to abrupt water level changes after storm events), and natural changes in stream location (e.g., oxbow formation).

Pendulous Bulrush

Pendulous bulrush is a grass-like, perennial herb of wet, open areas such as meadows, fens, and graminoid marshes (Figure 1-7). It has inconspicuous, wind-pollinated flowers, which together with its vegetative morphology, creates a plant that is frequently overlooked. It is found primarily in the eastern half of the United States. In New England, pendulous bulrush occurs in Maine, New Hampshire, Vermont, Massachusetts, and Connecticut and is listed as a species of conservation concern in those states. The rarity of this species in Massachusetts is due, in part, to this state being near the periphery of the plant's range and its preference for higher pH sites, which are naturally scarce. This species was first documented in Massachusetts in the town of Stockbridge (date of collection 1902) (Hoffman 1904).

Figure 1-7 Inflorescence of pendulous bulrush.

Pendulous bulrush was observed in wet gravel of a parking lot near the Housatonic River, at the edge of a managed pond in the October Mountain State Forest, and in damp, open depressions along the Willow Creek Road (Map 1-2). The land adjacent to the parking lot is predominantly open land and is maintained as such due to power line right of ways and agriculture. Much of the open area is wetland, with significant areas of shrub swamp and wet meadow. Due to the highly disturbed nature of the site and a small population, this occurrence was considered to possess an EO rank of D. The pond shore site is a small impoundment with an open, maintained lawn on the west shore. Pendulous bulrush grew in shallow water at the very edge of the shoreline and its flowering stem was cut during mowing of the lawn. This site also consisted of few individuals, but due to public land ownership, it was considered a C-ranked occurrence. The sites along the Willow Creek Road are maintained as openings due to road and power line passage. The main population was the largest observed, consisting of about 15 individuals with a total of approximately 75 flowering stems. Associated species included silky willow, white bedstraw, fox sedge, black bulrush, jointed rush, northern arrowwood, heart-leaved willow, meadowsweet, and pointed broom sedge. Some of the smaller colonies of pendulous bulrush are known to be recent stations as they are now occurring in the center of trails that were essentially devoid of vegetation (due to frequent use) in 1998. This occurrence was given an EO rank of C.

Threats to pendulous bulrush include extensive site disturbance and community succession. Though this species frequents areas that have been modified by past human activity, it is not typically a weed species of exposed soils. It appears to prefer areas that

have been cleared of dense woody vegetation but have had time to recover as wet meadows. However, most sites would not remain open meadows; they would succeed to shrub-dominated and, later, tree-dominated communities, ultimately excluding pendulous bulrush from those sites. This sedge likely inhabits the landscape in a dynamic fashion, colonizing new openings while being extirpated from other areas by canopy formation.

Autumn Willow

Autumn willow is a branched shrub that grows from 1 – 4 m tall (Figure 1-8). Willows are dioecious species, meaning that they have unisexual flowers (i.e., flowers that bear pollen or ovules, but not both) borne on separate plants. Therefore, reproduction in most species requires two individuals of complimentary sex. Autumn willow grows in fens and swamps that are influenced by relatively high-pH groundwater, due to circumneutral or basic bedrock. Autumn willow occurs primarily in the northern United States east of the Rocky Mountains and in mid-western and eastern Canada. In New England, this willow is found in Massachusetts, Connecticut, and Vermont. It is listed as a species of conservation concern in all of those states. This is due to the requirement of high-pH wetlands, a resource that is naturally scarce in New England.

Figure 1-8 Carpellate (i.e., seed-bearing) plant of autumn willow.

Autumn willow was found in a circumneutral shrub swamp that bordered a rich, wet meadow north of Threemile Pond (Map 1-3). The fen-like meadow possesses a number of plants that indicate its unusual character and high pH. These plants included shrubby cinquefoil, grass-of-Parnassus, purple avens, and swamp saxifrage. Autumn willow occurred on the periphery of this meadow, mixed with plants typical of shrubs swamps of

the region, such as pussy willow. Approximately 50 plants were observed, nearly half of these with dehisced capsules and dispersing seeds. The population area was ca. 50 m × 20 m. This station possessed an EO rank of B due to the moderate population size and unsual character of the natural community.

Threats to the autumn willow include cutting and alteration of water level. The wet meadow is a small, low area in a larger agricultural field. It has been cleared in the past during periodic cutting of the field. If attempts are made to reclaim/expand the current field by cutting of adjacent shrubs, the autumn willow could be extirpated from this site. The shrub swamp is immediately north of and hydrologically connected to Threemile Pond. Future adjustments to the pool level of Threemile Pond, which is impounded by an earth dike at the south end, may have adverse effects on the autumn willow population.

Wapato

Wapato is a floating-leaved or, more commonly in Massachusetts, an emergent aquatic plant of shallow, still or slow moving water (Figure 1-9). Due to the extreme variability in type and shape of leaves produced by species of this genus, identification usually depends on flowers or fruits. Wapato occurs over a large portion of northern United States and southern Canada. In New England, this plant is found in all states except Rhode Island. It is also considered a species of conservation concern in Connecticut and New Hampshire. Oddly, it is rare and localized in Massachusetts, absent from many areas with suitable habitat (Sorrie 1987).

Figure 1-9 Leaves and flowers of wapato.

From a vernal pool in the Housatonic River floodplain.

One station of wapato was rediscovered in 1998 and two new stations were discovered in 1999 (Map 1-2). The 1998 location was north of New Lenox Road in a moderate-sized, permanent backwater pool of the Housatonic River. The pool was connected to the river by a narrow channel during high water events, but it becomes separated as water levels fall. About 40 stems of this species were located in wet silt/muck near the periphery of the pool. The edges of the pool were often densely vegetated by shrubs or herbs. Wapato was not located in those areas, however, but was found in a sparsely vegetated area with some exposed substrate. Associated species at this site included common arrowhead, wool-grass, three-way sedge, purple loosestrife, American bur-reed, and pickerelweed. This station was provided an EO rank of B due to moderate population size, fair community condition, and public ownership of property.

One of the stations observed in 1999, found north of New Lenox Road, was located in wet mud of a shaded vernal pool. The site, located within a floodplain forest dominated by silver maple, was inundated for most of the spring season, and one plant was observed in flower after the water level had decreased. Sixteen total plants were observed in an area about 6 m^2. Associated species at that site included false water-pepper, common arrowhead, needle spikesedge, purple loosestrife, and northern water-plantain. This occurrence was provided an EO rank of C based on small population size and public ownership of property. The second station observed in 1999 was south of Willow Creek in a small pool of water at the edge of a black ash–red maple–tamarack calcareous seepage swamp. The plants were located in a seasonally flooded depression that becomes a wet, mucky basin as the water level decreases later in the growing season. Twelve plants were observed in an area about 3 m^2. Four of the wapato plants were in flower and one was in fruit. Associated herbaceous species included northern water-plantain, purple loosestrife, moneywort, sensitive fern, false-nettle, and northern water-horehound. This station was considered to possess an EO rank of C based on factors such as small population size and fair community condition.

Wapato was historically known from the PSA in seven locations. Four of these sites were carefully searched for the species. Only at the site described above (1998 rediscovery) were any plants of this species observed at previously documented stations.

At one historic location, north of New Lenox Road, the backwater area was completely filled with intertangled rhizomes of false water-pepper. There was no available substrate (e.g., exposed, saturated mud) and it is likely that wapato no longer occurs there. At the two remaining historic sites, upstream of the confluence with Yokum Brook and south of the Holmes Road, no wapato plants were observed. Common arrowhead, a closely related species, was observed at both locations.

Threats to wapato in the PSA include alteration of hydrology and invasive plants. Known stations of wapato along the Housatonic River occur in seasonally flooded pools and backwaters that show significant reduction or complete lack of standing water (except after storm events) during the summer growing season. Few plants can tolerate that range of conditions (i.e., from fully aquatic to terrestrial wetland). Changes in hydrology, such as in increase in mean pool elevation of Woods Pond, would alter the specific micro-site for one station of wapato and potentially cause local extirpations. Invasive plants are those species capable of growing at densities that exclude other vegetation. Some vernal pools immediately north of New Lenox Road have been aggressively colonized by false water-pepper. Though native, false water-pepper, which is capable of tolerating the varied seasonal conditions of temporary pools, can supplant other vegetation and form nearly monotypic colonies. Periodic monitoring and careful removal of this species from pools containing wapato could become an important conservation practice in this region.

Bristly Crowfoot

Bristly crowfoot is an annual or sometimes perennial herb of wetlands and shores (Figure 1-10). It, like many other members of its genus, is reported to possess poisonous vegetative parts. Bristly crowfoot occurs throughout northern North America and eastern Asia. This species occurs in all of the New England states. In addition to Massachusetts, it is listed as a plant of state conservation concern in Connecticut and Vermont.

Bristly crowfoot was found in a small, rocky opening along the shore of the Housatonic River north of Woods Pond (Map 1-2). Though historically known from the PSA, this station represented a new location for this species. The opening, approximately 2 m^2 in size, occurred adjacent to the river channel and was surrounded by a circumneutral shrub swamp dominated by red-osier dogwood, American hornbeam, and American hazelnut. Six plants were observed, four in flower and two in fruit. Associated herbaceous plants included sensitive fern, northern three-lobed bedstraw, northern water-horehound, clearweed, virgin's bower, tall meadow-rue, and water-parsnip. This station was considered to possess an EO rank of C based largely on small population size and public ownership of property.

Figure 1-10 Flowers and fruits of bristly crowfoot.

The historic location (i.e., mapped by MNHESP) for bristly crowfoot in the PSA was visited during the 1999 field season. This site was occupied by two crowfoots—creeping crowfoot and swamp crowfoot. Creeping crowfoot is a European species that has been introduced to North America. It is occasionally found in or adjacent to disturbed or cleared areas along the Housatonic River. Swamp crowfoot is a native species of forested wetlands and is a frequent plant of the PSA. It is not known if this location is based on a misidentified voucher specimen or if bristly crowfoot no longer occurs there.

The primary threat to bristly crowfoot is alteration of hydrology. This would include increase in mean pool elevation of Woods Pond. As the known occurrence of this species occurs immediately adjacent to the river channel, a slight increase in water level could

inundate the plants. Though this species is an obligate wetland plant, it does not normally grow in standing water.

Variegated Scouring-Rush

Variegated scouring-rush is a small, colonial, free-sporing vascular plant (Figure 1-11). Closely related to ferns, this species does not produce true flowers, but rather reproduces by spores released from a terminal spore cone. Variegated scouring-rush usually occurs in disturbed, wet areas with high pH, such as ditches, eroding banks, marble quarries, and shores in limestone bedrock regions (Sorrie 1987). This species possesses a circumboreal distribution, occurring as far south in North America as Pennsylvania and Colorado. In New England, this plant can be found in all states except Rhode Island. Variegated scouring-rush is also listed as a species of state conservation concern in Maine and New Hampshire.

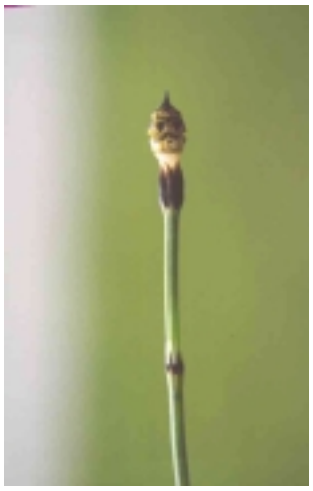

Figure 1-11 Variegated scouring-rush.

Upper stem and strobilus (i.e., spore cone).

Variegated scouring-rush was discovered growing at three locations, including two in the PSA and one in the October Mountain State Forest (Maps 1-2 and 1-4). In 1998, a large population comprised of thousands of stems was discovered on the sloping west shore of a small pool in a gravel pit near the Pittsfield WWTF. The upper part of the population was growing in dry sand, while the lower part was growing in wet sand that was inundated for much of the year. Silky dogwood, common reed, common flat-topped

goldenrod, and purple loosestrife were associated species growing with this rare horsetail. This site possesses an EO rank of B based on large population size and public ownership of property.

The second population was discovered in a small, excavated depression in a field within urban Pittsfield in 1999. The field was a former oxbow and is adjacent to the Housatonic River floodplain. Approximately 1,000 stems were observed during the 1999 field season, with 70 percent of the larger stems bearing spore cones. The plants occurred in a 15 m^2 area. Associated herb species, typical of wet, agricultural fields in New England, included common horsetail, old-field cinquefoil, heart-leaved willow, reed fescue, sensitive fern, tall goldenrod, foxtail sedge, and larger straw sedge. This site possesses an EO rank of C due to fair population size and poor community condition.

The third population was discovered in the October Mountain State Forest in 2000. The plants occurred in an 8 m × 2 m colony along the edge of a gravel road that passed between two small ponds. The shoulder of the road was vegetated with early successional herbs and shrubs including wild strawberry, golden Alexanders, beaked willow, heart-leaved willow, red clover, white bedstraw, and Canada goldenrod. Though this site was adjacent to a road and threatened by vehicle traffic and future road maintenance activities, the location was in an out-of-way area that does not experience high traffic flow. This site possesses an EO rank of C based on factors such as fair population size and public ownership of property.

Variegated scouring-rush is a wetland species that occupies recently disturbed areas of appropriately high pH. The located sites are or have been altered by mowing, grading, or excavation, and these activities have removed woody competitors. Of concern to this species would be drastic alterations to the site, such as topsoil removal, grading, paving, or ditching to lower the local water table. Such changes may eliminate the extant favorable micro-habitat and potentially preclude future opportunities for growth of variegated scouring-rush at the sites.

Eastern Black Currant

Eastern black currant is a small, somewhat colonial shrub of northeastern and north-central United States and adjacent Canada (Figure 1-12). It grows in the understory and in openings of wet-mesic to hydric forests. This species can be somewhat inconspicuous, but it is easily identified once located due to an odd coating of tiny, yellow resin dots on the leaves, flowers, and fruits. Eastern black currant is known from all New England states. No other state reports this plant as a species of conservation concern. In Massachusetts, this species is reported to be locally common along the Housatonic River (Sorrie 1987).

Figure 1-12 Flowers of eastern black currant.

This shrub was found in riparian forests nearly throughout the PSA (Map 1-2). Detailed occurrence data were collected for seven populations along the Housatonic River. Eastern black currant was found in both marginally hydric sites (i.e., high-terrace floodplain forests) and frequently inundated areas (i.e., black ash–red maple–tamarack calcareous seepage swamps). It did not appear to show preference for micro-sites, such as mounds or depressions. Populations were comprised of as few as one individual to as many as 40, although most sites had fewer than 10 individuals. Associated vascular plants varied widely due to major community differences at each site. Box-elder, red maple, silver maple, ostrich fern, drooping woodreed, and bur oak were plants that were found at two or more of the American black currant locations. All observed stations were provided an EO rank of C.

Eastern black currant was often found in and adjacent to small openings within wetland forests along the Housatonic River. The openings were caused by microsite conditions (i.e., a pool of water in which trees could not grow) and anthropogenic disturbance (i.e., forest clearing activity). This suggests that eastern black currant can tolerate, and in some cases benefit from, light canopy disturbance. However, intensive forest clearing that alters multiple community strata would likely extirpate this species. Eastern black currant is a wetland species and alterations to site hydrology would likely impact extant populations.

Bur Oak

Bur oak is a wetland tree well known for its large and conspicuously fringed fruits (Figure 1-13). It is found over much of eastern and central United States and adjacent Canada. It is known to be one of the most cold tolerant oaks and is primarily found in limestone or calcareous clay regions (Nixon 1997). The species is capable of growing to heights of 30 m.

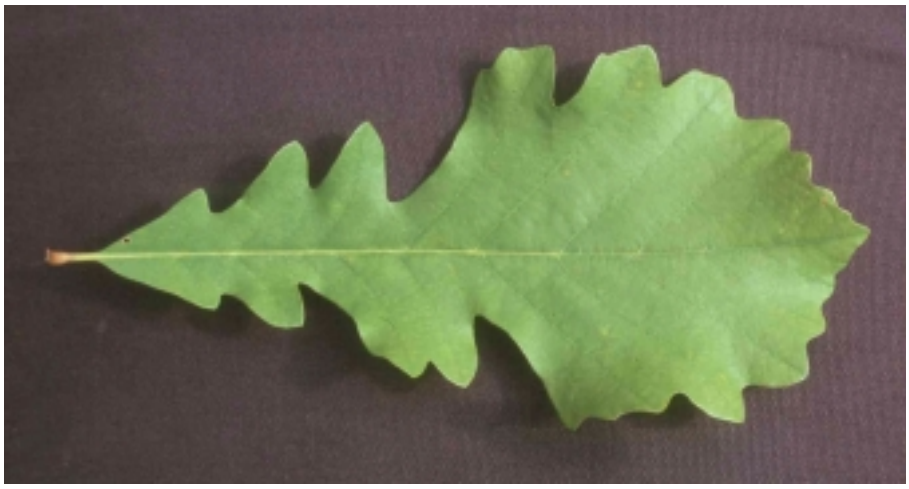

Figure 1-13 Leaf of bur oak.

This tree was found in many locations in the PSA south of New Lenox Road (Map 1-2). In all cases, it occurred in forested swamps. In most areas, it was an infrequent member of the community. In the wetter black ash–red maple–tamarack calcareous seepage swamps, for example, where surface water was often visible in depressions between the mounds, bur oaks were generally scattered subcanopy trees with narrow stems (diameter

at breast height [dbh] less than 25 cm) growing on the mounds. Associated trees in these areas were red maple and black ash. In one area, upstream of Woods Pond in the broad floodplain west of the Housatonic River, this oak was sometimes codominant, with large canopies and thick stems (many stems exceeding 40 cm dbh). Some of the trees in this area exceeded 100 years of age. In this area the ground was relatively level and micro-site differences were not great (i.e., the ground surface lacked pronounced pit and mound topography). Associated tree species at these sites included red maple and American hornbeam. Additionally, bur oak was found as a single stem or a few trees in several areas where the floodplain forest had not been cleared for agricultural purposes. This species was previously reported to occur in the PSA, but several new locations were discovered. The observations of bur oak south of New Lenox Road are considered to have belonged to a single macrosite. The occurrence was provided an EO rank of A. Though forest clearing and non-native species have reduced community condition in this area, the population was large, occurred on publicly owned land, consisted of large and reproductive individuals, and was not likely to be extirpated by extrinsic human factors.

Threats to bur oak include canopy removal and changes in site hydrology. Clearing of floodplain forest along the Housatonic River for any purpose could extirpate bur oak plants. This species can be found in wet-mesic to hydric soils in the PSA. It would be affected by changes in the water table as it was not found in well-drained soils or soils that are inundated for prolonged periods during the growing season. Therefore, preservation of bur oak in the PSA requires both local and watershed level protection of hydrological resources.

Crooked-Stem Aster

Crooked-stem aster is an upright herb of rich, moist, sometimes temporarily flooded soils of eastern United States (Figure 1-14). It is a colonial species that forms loose colonies from its underground, horizontal stem called a rhizome. Like other species of composites, it has small flowers aggregated into larger, false flowers referred to as capitula. This species is found only in Connecticut and Massachusetts in New England and is listed as a species of conservation concern in both states.

Figure 1-14 Crooked-stemmed aster.

This species was discovered growing along the edge of a narrow, single-lane road through a young red maple swamp south of New Lenox Road (Map 1-2). This forested area had been cleared for agriculture in the recent past, as evidenced by the young-aged trees and bordering open fields. Approximately 60 stems of crooked-stemmed aster were observed in 1998. Associated understory species included heart-leaved aster, sensitive fern, lady fern, and choke cherry. Crooked-stem aster was not previously documented to occur in the PSA. The occurrence was provided an EO rank of C based on factors such as moderate population size, community condition, and existence of current threats to the population.

This species is currently threatened by road maintenance. The single lane road that passes by the crooked-stem aster plants is an infrequently used right-of-way to access two fields south of New Lenox Road. In 1998, this population was decimated by vegetation clearing to keep the road open. About 25 percent of the population remained. The colony persisted but did not substantially recover in 1999 or 2000. Other activities that disturb vegetation or site hydrology are also threats to this species.

Foxtail Sedge

Foxtail sedge is a tufted, grass-like herb of wet or temporarily flooded meadows, shores, and open areas. This species produces tiny, wind-pollinated flowers borne in a spike at the summit of a slender, triangular stem (Figure 1-15). It occurs over much of the north-central and northeastern United States and adjacent Canada. Foxtail sedge is reported from all six New England states. In addition to Massachusetts, it is also listed as a species of state conservation concern in Maine, Connecticut, and Vermont.

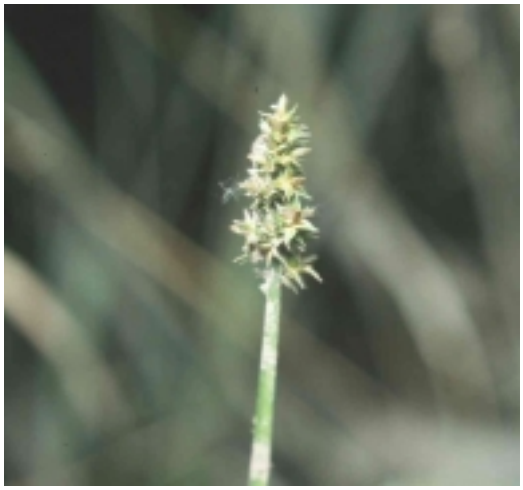

Figure 1-15 Inflorescence of foxtail sedge.

This species was observed growing in an open power line right-of-way adjacent to the Housatonic River north of New Lenox Road (Map 1-2). The site was located within the annual flood zone of the river channel and, due to vegetation management within the right-of-way, occurred as an ostrich fern meadow. The sedge occurs on level ground in deep fluvial silt deposits. The surrounding, intact community is a transitional floodplain forest. Only two individuals, both with mature fruit, were seen during the field survey. This occurrence was provided an EO rank of C. Though the population was small and within a disturbed right-of-way, it is located in the Housatonic River Valley State Wildlife Management Area where abundant suitable habitat exists. The site was last documented in 1993 by the MNHESP.

Gray's Sedge

Gray's sedge is a grass-like herb of mesic to hydric forests (Figure 1-16). In the northeast, it is frequently found growing in forests that occur on rich floodplains of medium to large rivers. The range of Gray's sedge includes north-central and northeastern United States and adjacent Canada. In New England, this species occurs in Massachusetts, Vermont, and Connecticut and is listed as a species of conservation concern in Massachusetts and Vermont. Though described as occurring "not infrequently in wet woods" by Hoffman (1904), Gray's sedge is rare and possesses a global rank of G4. The cause for concern is that much of its former habitat has been converted to agricultural land.

Figure 1-16 Inflorescence of Gray's sedge.

Approximately 25 fruiting plants of this species were seen over approximately 0.5 ha in a black ash–red maple–tamarack calcareous seepage swamp during 1998 surveys (Map 1-2). The site was west of the Housatonic River channel near the large backwater areas upstream of Woods Pond. Most of the canopies of the forested swamps in this area were dominated by red maple and black ash. However, where Gray's sedge was observed, large bur oak trees were locally common. Other herbs common in the area were brome-like sedge, sensitive fern, and calico aster. The population was provided an EO rank of B based on factors such as moderate population size, public ownership of property, and occurrence with other species of state conservation concern. Site visits in 2000 showed a reduced population due to flooding of the community. The high water levels were the result of a heavy rain year and perhaps also beaver activity, which had increased in area.

Gray's sedge was historically known from the PSA just downstream of the confluence with Yokum Brook. It was last seen in that area in 1920, but field surveys in 1998 and 2000 did not reveal any plants. Assuming the occurrence was accurately mapped, it is not known why plants no longer occur there given that an intact natural community does exist.

Gray's sedge is threatened by activities that change or degrade the quality of local plant community. These activities include forest clearing and changes in site hydrology (e.g., impoundments, ditching). The site containing Gray's sedge was inundated for most of the 2000 growing season. Gray's sedge is a wetland plant, but it does not normally grow in standing water and will likely be affected by prolonged inundation. Though the weather cannot be controlled, beaver dams that may be contributing to the observed increase in water level can be removed.

Hemlock-Parsley

Hemlock-parsley is a temperate and boreal herb of open and forested wetlands (Figure 1-17). In the northeast, it is frequently found in wetlands and stream shores that contain some conifer species in the canopy. This plant has dissected leaves and small, white flowers borne in umbels like many other members of its family (the carrot family). Hemlock-parsely is found in all New England states except Rhode Island, although only Massachusetts lists this plant as a species of state conservation concern. Sorrie (1987) reports that hemlock-parsely is common is some areas of Berkshire County but rare elsewhere in the state.

Figure 1-17 Leaf of hemlock-parsley.

Hemlock-parsley was located in a black ash–red maple–tamarack calcareous seepage swamp adjacent to the west edge of a large power line clearing north of Willow Creek (Map 1-2). This community is considered rare in Massachusetts (S2) and is enriched by calcareous groundwater as evidenced by the occurrence of brome-like sedge and rough-leaved goldenrod. Seven plants of hemlock-parsely were observed, two of which possessed flowers and fruits. In the vicinity of the plants, two conifer species, eastern hemlock and eastern white pine, were locally abundant. Associated herbs included cinnamon fern, purple-stemmed aster, and marsh fern. This species has not previously been documented in the PSA. The site is provided an EO rank of C due to factors such as small population size and good community condition.

Threats to hemlock-parsley include forest clearing and alteration to site hydrology. The seepage swamp it occurs in has been impacted to the east by a wide power line clearing. As well, the swamp is currently being cut on its west edge. If cutting activity continues further into the swamp, it may impinge on the hemlock-parsley population. As this species is a wetland plant, events that alter site hydrology can effect populations. Protecting the site from large-scale disturbances will benefit this EO.

Fringed Gentian

Fringed gentian is an annual, upright herb with showy, blue flowers (Figure 1-18) that are pollinated, in part, by bees (Order Hymenoptera). Like many other members of its family in the northeast, these species flower late in the growing season (as late as October). It

occurs in the northeastern and north-central United States and adjacent Canada. In New England, it is found in all states and is listed as a species of state conservation concern in three (Vermont, New Hampshire, Rhode Island). Additionally, it was listed as rare in Maine in the previous decade. Fringed gentian possesses a global rank of G4. It grows in open and often moist areas, such as meadows, streamsides, and occasionally ditches.

Figure 1-18 Fringed gentian.

Fringed gentian was first identified from the Threemile Pond SWMA reference area on 20 April 2000 (Map 1-3). At this time, the plants were dormant with no living material above ground. However, approximately 15 withered, persistent stems from the previous season were observed. At that time, it was growing in an open field that was adjacent to a wet, circumneutral meadow. Several high-pH indicator plants were known to grow in the vicinity, including shrubby cinquefoil, grass-of-Parnassus, and autumn willow. Other plants growing in the immediate vicinity included tall flat-topped white aster, marsh fern, red clover, male-berry, and palmate hop-clover. The site was again visited on 7 September 2000 to observe the plants in flower and collect population information. The population had moved 50 m from the location observed in the spring, and was occurring in and along an infrequently used single-lane road. Five plants were observed along less than 10 m of road. This appeared to represent a reduction in population size; however, the entire area was not systematically searched for more individuals. Fluctuation in population size and shifting location is not uncommon with annual plants. This site was provided an EO rank of D due to small population size and occurrence in a modified habitat.

As with all plants that possess large, colorful flowers, over collection by wildflower gatherers will be a continuing threat to populations. Drastic changes in site hydrology (draining or inundation) also would threaten fringed gentian. Landscape alterations that change the water level are not uncommon in agricultural areas. Therefore, protecting the site from hydrological alterations would also help preserve fringed gentian at this locality.

Hoary Willow

Hoary willow is a short, dioecious, colonial shrub of high-pH wetlands (Figure 1-19). It typically grows in open or sparsely wooded fens and marshes. Like other willows, it produces tiny unisexual flowers aggregated into an ament (or catkin). Each flower is subtended by one or more glands that function as a nectary to attract potential pollinators. This species' name is derived from the dull white hairs that cover the new stems and leaves, providing a gray cast to the plant. It is found throughout a large part of glaciated Canada and United States. Hoary willow is known from all New England states except Rhode Island. In addition to Massachusetts, Maine and Vermont also list hoary willow as rare.

Figure 1-19 Upper branch of hoary willow.

Hoary willow was seen in the Hinsdale Flats SWMA on 8 September 2000 (Map 1-5). It was growing in a calcareous seepage marsh with high organic soil content at the

northwest end of Muddy Pond. The soil was saturated to the surface or, in areas, had standing water about 1 cm deep. Approximately 110 upright stems were counted in an area less then 10 m^2. Associated plants included oblong bulrush, wire sedge, sweet gale, beaked sedge, marsh cinquefoil, pussy willow, beaked willow, and shrubby cinquefoil, the former two being dominant. Lepidopteran larvae (i.e., caterpillars) were observed on some leaves, but they did not appear to be defoliating the shrubs. This occurrence was provided an EO rank of C based on anthropogenic disturbance near the margin of the community, small population size, and publicly owned property.

Because hoary willow is a wetland shrub, activities that alter the site hydrology could threaten the plants. A large railroad line passes within 10 m of the occurrence, bisecting the wetland that the willow grows in. Crushed stone has been used to create an elevated berm for the tracks, which potentially acts as a hydrologic barrier. Continued expansion or maintenance of the railroad could further impact the wetlands around Muddy Pond. This EO should be brought to the attention of both the rail line company and land managers of the state wildlife management area for discussion of conservation issues.

Hard-Stem Bulrush

Hard-stem bulrush is a robust, grass-like herb of open wetlands (Figure 1-20). Its leaves are extremely reduced and do not perform the majority of the individual's photosynthesis as with most other plants. Instead, hard-stem bulrush photosynthesizes by its green stem. Its flowers are reduced, wind-pollinated, and aggregated together in an inflorescence near the apex of the stem. Hard-stem bulrush is found throughout most of temperate North America and occurs in all New England states except Rhode Island. In addition to Massachusetts, hard-stem bulrush is also listed as rare in Connecticut.

Figure 1-20 Upper stem and inflorescence of hard-stem bulrush.

Hard-stem bulrush was observed on the east shore of Muddy Pond on 28 September 2000 (Map 1-5). The primary occurrence was a large, rhizomatous colony consisting of over 10,000 aerial stems (i.e., above-ground). The plants grew in 30–100 cm of water. Associated plants included yellow water-lily, sweet gale, water-willow, floating pondweed, water shield, and white water-lily. Three other smaller colonies were observed at the southeast end of Muddy Pond in the vicinity of the outlet to the East Branch Housatonic River. This occurrence was provided an EO rank of B based on factors such as large population size, intact natural community, and public ownership of property.

Also located on the shores of Muddy Pond were four colonies of the hybrid between hard-stem and soft-stem bulrush (Map 1-5). This hybrid, referred to as oblong bulrush, is relatively similar to hard-stem bulrush, but it varies subtly in several morphological characters when closely inspected (Figure 1-21). Three of the colonies occurred at the southeast end of the pond and one colony (the larger) occurred at the northwest end of the pond. Those found at the southeast end occurred in relatively similar habitat to the hard-stem bulrush (i.e., shallow water associated with aquatic plants). The colony located at the northwest end, however, grew in soils with high organic matter content and very shallow water (i.e., less than 10 cm deep). Associated plants there included broad-leaved cattail, wire sedge, beaked sedge, hoary willow, shrubby cinquefoil, and marsh cinquefoil. This station of oblong bulrush was provided an EO rank of B due to factors

such as moderate population size, presence of other state-listed species, and public ownership of property.

Figure 1-21 Upper stem and inflorescence of oblong bulrush.

Oblong bulrush is the hybrid of hard-stem bulrush and soft-stem bulrush.

Oblong bulrush was also found along the southeast shore of Silver Lake. It grew in a deep emergent marsh community that has been reduced in size by road construction and several concrete shoreline structures. The population was large, occurring over 90 meters of shoreline and comprised of at least 4,000 aerial stems. Associated species included broad-leaved cattail, red-osier dogwood, northern three-lobed bedstraw, pussy willow, and American willow-herb. Non-native species such as narrow-leaved cattail, purple loosestrife, and yellow iris were also prevalent. Hybrid plants such as oblong bulrush tend to be more prevalent in somewhat disturbed habitats (Smith 1969). Therefore it is not surprising these plants were located where they were. Despite its moderately large population size, this EO was provided a C rank due to the poor community condition (e.g., anthropogenic impacts and non-native species).

Both hard-stem and oblong bulrush normally occur as large, rhizomatous colonies in open habitats and are not often collected by people. Therefore, threats to these plants are similar to those that threaten the community they occur in. Wetland impacts such as filling and ditching are prime examples of activities that can harm populations of these sedges. Protecting the surrounding natural community will serve to protect these two plants.

Downy Wild-Rye

Downy wild-rye is a slender, tufted perennial grass of forests, woodlands, rocky slopes, and riverbanks. It often occurs in mesic soils in limestone bedrock regions but is also found on drier substrates in the western and northern plains (Barkworth and Campbell, in ed.). The tiny flowers of this species are borne in arching to drooping spikes and are concealed by subtending scales that terminate in long bristles (Figure 1-22). Downy wild-rye is found in all New England states except Maine and New Hampshire. It is listed as a species of state conservation concern in Massachusetts, Rhode Island, and Vermont.

Figure 1-22 Inflorescence of downy wild-rye.

Downy wild-rye was discovered in the PSA in a rich, floodplain terrace of the Housatonic River upstream of the Pittsfield WWTF outfall. The high-terrace floodplain forest had been reduced in size due to clearing for agricultural land. Furthermore, the forest community was occupied by many non-native species (e.g., Morrow's honeysuckle, Japanese barberry, common buckthorn, wood bluegrass). The site, nonetheless, possesses qualities that make it a valued occurrence, which included harboring additional state-listed species and being one of few remaining examples of its community type in the Pittsfield area. Downy wild-rye grew under a canopy of basswood, white ash, and black cherry. Fifty-five aerial stems were observed along a 115-m stretch of floodplain. Additional associated species included early blue cohosh, white snakeroot, wild leek, long-beaked sedge, stream bank wild-rye, bottlebrush grass, and American hornbeam. Though the population was of moderate size and occurred on

public property, the community was inhabited by many non-native species and has been greatly diminished in size. Therefore, this population was provided an EO rank of C.

Threats to downy wild-rye include forest clearing and invasive species. The community that currently harbors downy wild-rye has been drastically reduced in size to make space for agricultural purposes (currently for corn). Further clearing would threaten this rare grass. Several non-native shrubs were prevalent at the site and are capable of reducing vigor of, or eliminating, downy wild-rye through competition for space and light. These non-native plants may need to be controlled if preservation of downy wild-rye is considered an important conservation objective.

Early Blue Cohosh

Early blue cohosh is an upright, deciduous, perennial herb of northeastern United States and adjacent southern Quebec. It grows in rich, mesic, hardwood forests and is most common, at least in New England, in limestone bedrock regions. This species possesses somewhat precocious flowers. This means that the flowers mature prior to the expansion and development of mature leaves (Figure 1-23). Early blue cohosh has unusual seeds. As the ovules develop, they soon rupture the ovary wall and mature as naked, bright blue seeds. This species is found in New England only in New Hampshire, Vermont, and Massachusetts.

Figure 1-23 Flowering stem of early blue cohosh.

Early blue cohosh was discovered in three locations: two in the PSA and one in the October Mountain State Forest reference area (Maps 1-2 and 1-4). One site adjacent to the Housatonic River was located in Pittsfield upstream of the WWTF. The physical and

biological details of this site are discussed under downy wild-rye. Associated spring-emerging species included trout lily, wild leek, and Dutchman's breeches. The early blue cohosh population was comprised of 55 aerial stems in a 50 m × 30 m area. This site was provided an EO rank of C based on moderate population size and marginal community condition (i.e., prevalence of invasive species).

The second site adjacent to the Housatonic River was in Lenox along the Woodland Road. The plants were located near the upland edge of the river floodplain in a rich mesic forest. The canopy was dominated by white ash and black cherry. Choke cherry, hazelnut, and Morrow's honeysuckle were common shrubs. Associated herbs included Virginia waterleaf, trout lily, Christmas fern, purple trillium, wild ginger, bellwort, false Solomon's seal, and long-stalked sedge. The population of early blue cohosh was moderately large, comprised of over 800 stems. This EO is provided a rank of B due to population size, good community condition, and publicly owned property.

The third site for early blue cohosh was in the October Mountain State Forest. It was located in a mesic, hardwood forest southeast of Washington Mountain Lake. The young canopy was dominated by sugar maple, white ash, and paper birch. Common shrubs were sugar maple and balsam fir seedlings. Dominant herbs included trout lily, Christmas fern, marginal wood fern, wild leek, and white wood aster. The population was comprised of over 150 aerial stems. This population is provided an EO rank of C based on moderate population size and young age of canopy trees.

The prime threat to early blue cohosh populations is forest clearing. Extensive canopy removal for any purpose will modify the understory habitat and be detrimental to this species. Policies that protect forest stands will serve to also protect early blue cohosh.

Cluster Sanicle

Cluster sanicle is a perennial herb of the carrot family with palmately divided leaves (Figure 1-24). It possesses unisexual flowers borne in separate portions of the inflorescence on the same plant. Its carpellate (i.e., ovule-bearing) flowers appear as burs due to the abundant prickles borne on the ovary. This species occurs in the eastern United States and adjacent southern Canada. Cluster sanicle is found in every New

England state except Rhode Island. It is listed as a species of state conservation concern in Massachusetts, Maine, and New Hampshire.

Figure 1-24 Upper stem and fruits of cluster sanicle.

Cluster sanicle was observed growing along a historic railroad line north of Willow Creek (Map 1-2). The site is located in a mixed hardwood-conifer forest adjacent to a large, red maple swamp complex. Eastern hemlock was observed as a locally dominant canopy tree in the area. Other species of herbs that favor rich mesic sites were present, such as lopseed. This colony of cluster sanicle was provided an EO rank of C based on factors such as moderate population size and occurrence in a disturbed community.

Threats to cluster sanicle include forestry activity and recreational traffic. Though it may utilize small openings and edges, cluster sanicle is a species of forests and would likely be extirpated from areas of widespread canopy clearing. The railroad bed this plant occurs along was infrequently used by motor vehicles and was being used as a horse-riding trail. Trampling of stems or road maintenance may have an adverse affect on the plants. Locating the occurrence and diverting activity away from the plants could be achieved through landowner contact.

4.0 Developed Communities

Developed communities are those areas that have recent and on-going human modification. These communities, such as residential and business lots, roadways, and intensely managed fields, are substantially different from regionally pristine sites.

Absence of forest canopy, large areas of impervious surface, and prevalence of non-native, colonizing plants serve to identify developed communities in the absence of obvious indicators such as buildings, paved roads, and recreational fields.

4.1 Agricultural Lands

Significant portions of the Housatonic River floodplain in Pittsfield and Lenox have been used for food and hay production. Those areas that are still in use, such as upstream of the Pittsfield WWTF outfall, are considered here. Areas no longer managed for food or hay production, although sometimes mowed on an annual basis, are described as wet meadow or cultural grassland, depending on site hydrology. Corn is a major crop plant in the Housatonic River valley, along with pumpkin and squash. This community generally resembles a monoculture of the planted food species, with non-native species occupying the edge of the tilled ground. Horse-nettle, oak-leaved goosefoot, pigweed, and alfalfa are common species seen near agricultural fields and rarely elsewhere in the PSA. Use of agricultural fields has affected the condition of remaining natural communities. Non-native species that become established in agricultural fields are able to colonize disturbed areas in natural communities. Pumpkins, for example, can be observed growing on riverine point bars and beaches upstream of New Lenox Road. Animals can be directed away from natural communities during certain seasons based on the availability of refuse crops. American crows, gray squirrels, and Canada geese, in particular, utilize agricultural fields during fall and winter rather than exclusively using natural communities.

4.2 Residential, Commercial, and Public Development

Urban Pittsfield represents the largest tract of public development in and adjacent to the PSA. This community is characterized by homes, lawns, buildings, and paved lots. Its influences on the natural communities of the Housatonic River are apparent. Much of the public development is relatively impervious to precipitation. This causes storm water to rapidly enter the East Branch Housatonic River and quickly alter the water level. Many species of ornamental shrubs have escaped and now occur as a non-native presence in the riparian forests. These plants include European spindle-tree, Chinese spindle-tree,

Morrow's honeysuckle, goutweed, and common privet. Clearing of floodplain forests, channelization of the river, and filling former oxbow ponds are additional impacts of public development on local natural communities. Accumulation of trash and discarded debris are apparent in some areas of the PSA.

4.3 Transportation

Transportation-related development in the PSA largely consists of roads (both paved and gravel) and rail lines. Both of these features form bisecting paths through riparian and upland communities in the study area. Maintenance of these passages disturbs soil and provides a colonization site for non-native species. Morrow's honeysuckle, for example, is most common, and sometimes dominant, in October Mountain State Forest within 100 m of the main gravel roads. Beyond this distance, the species becomes scarce or absent. The rail line system has a characteristic flora that grows on the xeric, crushed stone substrate. Spotted knapweed, thyme, purple lovegrass, common mullein, and tower-mustard are commonly observed along railroad systems but not in undisturbed communities in the PSA.

4.4 Recreational Facilities

Several types of outdoor enthusiasts utilize the Housatonic River and the associated riparian communities. Paddlers are frequent on the downstream sections of the river and the Joe Decker Canoe Launch (off New Lenox Road) was constructed, in part, for this purpose. Hunters and anglers also use this boat launch, as well as an informal landing at Woods Pond, to access waterfowl and fish resources. Several trails, including those off the Brunswick Road near the confluence, the Woodland Road, and the Springfield Terminal rail line are used by people for walking and birding. The Woodland Road (October Mountain State Forest) also experiences extensive use by runners and mountain bikers.

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Chapter 2 Macroinvertebrates

1.0 Introduction

Components of the invertebrate community in the PSA were studied over a three-year period, from 1998 to 2000. The goal of the invertebrate investigations was to gather qualitative information on invertebrates in the PSA. This was not a complete, comprehensive survey of all taxa because of the immense diversity that naturally occurs in a local or regional invertebrate community. Instead, several species groups were selected that were relatively easy to sample with specific methods, targeted for tissue analysis as part of ongoing ecological and human health risk investigations, or easy to sample in conjunction with the other targeted invertebrate and vertebrate studies. The invertebrate groups selected included freshwater mussels, dragonflies, vernal pool invertebrates, earthworms, and terrestrial litter invertebrates.

2.0 Methods

2.1 Incidental Observations

The presence of certain invertebrate taxa within the PSA was documented during year-round field investigations in 1998, 1999, and 2000. Many of those field investigations were detailed studies in support of ecological risk assessment surveys, and consisted of specific methods targeted at collecting animals from a variety of taxonomic groups to sample their tissues. Those investigations also provided an opportunity to confirm the presence of some invertebrate populations within the PSA and reference areas through incidental observations of any species. During the course of the field investigations, observations and opportunitic captures of certain invertebrates (i.e., freshwater mussels and dragonflies) within the PSA and reference areas were recorded, along with the habitat that they occurred in. When appropriate, other notes were recorded, including activity, interactions with other species, and general health.

2.2 Mussel Survey

Freshwater mussel surveys were undertaken in 1998 to: 1) determine the historic distribution of mussels in the Housatonic River drainage; 2) determine the historic and current distribution of mussels within the PSA, as well as upstream and downstream; 3) identify the host fish, if known,

for the mussels that occurred or still exist within the PSA; and 4) identify the wildlife species that are known or expected to prey upon the mussel species found in the PSA.

To accomplish the survey objectives, a literature study and a field study were conducted. Dr. Doug Smith of the University of Massachusetts at Amherst was retained to determine the historic distribution of mussels in the Housatonic River drainage system. This was accomplished by summarizing scientific and technical literature on historic and recent freshwater mussel surveys in the region, and by reviewing collections at regional museums including the Museum of Zoology at the University of Massachusetts, Amherst, MA, the American Museum of Natural History in New York, the Museum of Comparative Zoology at Harvard University in Cambridge, MA, and the National Museum of Natural History in Washington, D.C. In addition, regional guides on the distribution and ecology of freshwater mussels (Clarke 1981, Fichtel and Smith 1995, Smith 1995, Strayer and Jirka 1997, Nedeau *et al.* 2000) and various scientific journals were reviewed to identify the ecology, habitat requirements, and natural history of mussel species occurring in Massachusetts, particularly any found within the PSA.

Field surveys incorporating largely qualitative search methods commonly used for freshwater mussel surveys were conducted within the PSA, as well as at upstream and downstream sites. Surveys were conducted in areas that were shallow enough to observe the river bottom through viewing scopes or glass-bottomed viewing buckets. This was generally limited to water that was less than 1 m (3 ft.) deep, depending on clarity, and included a nearly continuous search from the upstream end of the PSA to just upstream of the Pittsfield WWTF. In downstream portions of the PSA, deeper water and soft sediments restricted the work to shorelines and shallow areas that were surveyed with viewing buckets from a canoe.

Similar surveys were conducted in representative habitats upstream and downstream of the PSA. In general, representative habitats for freshwater mussels include stable substrates of coarse sand or sand-gravel mixtures, although some species (particularly the genus *Pyganodon*) use soft, silty sediments (Pennak 1978, McMahon 1991). Upstream surveys extended up the East Branch Housatonic River to Hinsdale and included five sites, while downstream surveys were conducted at six sites that extended down the main stem of the Housatonic River to Great Barrington (Map 2-1). In addition, mussel observations were also recorded from the reference areas used for other

ecological surveys in 1999 and 2000 (Muddy Pond, Ashley Lake, Washington Mountain Lake, and Threemile Pond).

At all sites where mussels were found, the total number of each species (both live and relic shells) was recorded. Any observations on the condition of the mussels such as gravid females or gross shell deformities were also recorded. Finally, habitat characteristics such as substrate, water depth, and water velocity were recorded on data sheets at all survey sites, regardless of the presence or absence of mussels. Mussel locations within the study area were also located by GPS survey.

2.3 Dragonfly Surveys

2.3.1 Exuvia Collection

When larval dragonflies (also called nymphs) leave the water to transform into their adult form, they shed their exoskeletons and transform into their first flight-capable stage, called the teneral stage. Tenerals then mature to become adult dragonflies. These shed exoskeletons that are left behind are called exuvia. Dragonfly surveys in the PSA consisted of exuvia collection along the riverbanks and the opportunistic aerial netting of teneral and adult dragonflies. Exuvia surveys were conducted along nine 200-m transects (Maps 2-2, 2-3, and 2-4), which are characterized in Table 2-1. Transect locations were based on the diversity of communities to ensure the maximum number of habitat types were represented from the confluence of the East and West Branch Housatonic River downstream to the inlet of Woods Pond. Each transect was surveyed five times between May and September 1999. Two observers slowly walked or canoed each transect and collected exuvia from vegetation, rocks, logs, and exposed substrates. Because larvae rarely travel more than 2 m from the water when they shed their exuviae, surveys were conducted by foot in the shallow upstream portions of the PSA and by canoe in the deeper downstream areas along the immediate shoreline of the river. Exuviae were placed in round paperboard containers, cataloged, and sent to a contracted lab for identification.

Table 2-1 Exuviae transect habitat descriptions.

Transect Number	Bank Morphology	Adjacent Communities	Channel Width (m)	Flow Characteristics	Substrate	Water Depth (m)
1	Vertically cut bank with exposed roots; accretion bar at abrupt turn.	Transitional floodplain forest.	16	Quick-flowing water; pool, riffle, and run habitats.	Sand and cobble.	0.6–2.5
2	Vertically cut bank with exposed roots; accretion bar at abrupt turn.	Transitional floodplain forest.	16–25	Quick-flowing water; pool, riffle, and run habitats.	Sand, cobble, and soft muck.	1.3
3	Vertically cut bank with exposed roots; accretion bar at abrupt turn.	Transitional floodplain forest.	20–25	Slow-flowing water; run habitats.	Sand, cobble, and soft muck.	1.3
4	Vertically cut bank with exposed roots; accretion bar at abrupt turn.	High-terrace floodplain forest.	25–33	Slow-flowing water; pool and run habitats.	Sand, cobble, and soft muck.	1.3–2.0
5	Sloping bank; accretion bar at abrupt turn.	High-terrace floodplain forest.	25–33	Slow-flowing water; pool and run habitats.	Sand, cobble, and soft muck.	1.3–2.0
6	Vertically cut bank with overhanging vegetation.	Shrub swamp, wet meadow, and transitional floodplain forest.	23–26	Slow-flowing water; run habitat.	Soft muck.	>2.0
7	Vertical bank with emergent herbaceous and woody vegetation.	Shrub swamp, wet meadow, and transitional floodplain forest.	25–30	Slow-flowing water; run habitat.	Soft muck.	>2.0
8	Sloping bank consisting of shrub vegetation; narrow peninsula dominated by reed canarygrass.	Shrub swamp, shallow emergent marsh, and transitional floodplain forest.	25–33	Slow-flowing water; run habitat.	Soft muck.	>2.0
9	Sloping bank with emergent herbaceous and woody vegetation.	Shrub swamp, deep emergent marsh, and transitional floodplain forest.	25–150	Still and slow-flowing water.	Soft muck.	>2.0

Figure 2-1 Dragonfly exuvia on reed canarygrass.

Abandoned exoskeletons of the larvae are known as exuviae and are as useful in identification to species as are the larvae themselves (Brunelle 1999).

Exuviae were also collected opportunistically, when observed, from throughout the PSA and reference areas. Reference areas included Muddy Pond in Hinsdale Flats SWMA, Washington Mountain Lake in October Mountain State Forest, and Threemile Pond SWMA (Maps II-1, II-2, and II-4).

2.3.2 Adult Collection

Opportunistic aerial netting for dragonflies and damselflies was also conducted during the course of exuviae collections and other field surveys. The opportunistic collection period was between early June and late September, coinciding with the exuviae surveys. Teneral and mature adult dragonflies and damselflies were netted, given a preliminary identification, euthanized in a killing jar if needed, cataloged as reference specimens, and sent to a contracted lab for verification. Since this method was more destructive to the individual dragonflies, it was limited to a maximum of two specimens for each common species and one specimen for rare species. Dragonflies and damselflies were also collected from reference areas including Threemile Pond SWMA, Washington Mountain Lake in October Mountain State Forest, and Muddy Pond is the Hinsdale Flats State Wildlife Management Area. Field identification was aided by the use of Walker (1953, 1958), Needham and Westfall (1954), Walker and Corbet (1975), Holder (1996), and Legler *et al*. (1998).

2.4 Vernal Pool Invertebrate Survey

Seventeen vernal pools in the PSA were surveyed for aquatic macroinvertebrates during 1998 (Map 2-5). Each pool was surveyed twice, once in May and once in June. Ten aquatic funnel traps were randomly placed in each of the 17 pools selected for sampling by establishing a transect line along the long axis of the pool, selecting random distances along the transect, and then selecting random distances laterally from the transect, into the pool. Traps were placed in the pools either in the evening, and collected the following morning, or in the early morning, and collected several hours later. The time and date when traps were placed in the pool were recorded on data sheets. Water quality data, such as water temperature, pH, conductivity, and dissolved oxygen, were also recorded. When traps were collected, all aquatic invertebrates in the aquatic funnel traps were collected and preserved in 90 percent ethyl alcohol and submitted to an identification laboratory (Lotic, Inc. of Unity, ME). In addition, all 68 vernal pools identified within the PSA in 1998 were visited and presence of common invertebrates (e.g., fairy shrimp, water beetles, mayflies) was noted.

2.5 Earthworm Sampling

Earthworms were collected from three sites in the PSA for toxicological analysis. These collection sites were co-located with small mammal collection sites (Sites 13, 14, and 15) (Map 6-7). Two sites occurred in transitional floodplain forest communities and one in a black ash–red maple–tamarack calcareous seepage swamp community. Earthworms were collected from the soil surface to 15 cm below the surface. Reference earthworms were collected from each site and shipped to an earthworm taxonomist at Ohio State University for identification, which followed Dindal (1990).

2.6 Terrestrial Litter Invertebrate Survey

Terrestrial litter invertebrates were collected in conjunction with the earthworm collection. Invertebrates were collected by hand from the leaf litter and beneath decaying woody debris. Invertebrates were identified to order, and percentages of total mass per order were estimated.

3.0 Macroinvertebrate Community Descriptions

3.1 Aquatic Macroinvertebrates

3.1.1 Mussels

Twelve species of freshwater mussels are known to occur in Massachusetts, and all of these are historically or presently known to occur somewhere in the Housatonic River drainage (Table 2-2). However, five species have not been seen in the drainage since the mid-1800s or early 1900s (Smith 1999). Of the remaining seven species, only five are known from the portion of the Housatonic River drainage that is in Massachusetts and none are known from within the PSA.

Field surveys within the PSA resulted in the location of three freshwater mussel species, including eastern elliptio, eastern floater, and triangle floater. Of these, the eastern floater was the most abundant and occurred in the lower portion of the PSA, from the mouth of Yokum Brook to the north end of Woods Pond in Lenox and Lee (Map 2-6). Eighteen live individuals and fourteen relic shells were found on shallow flats less than 0.6 m deep or near the surface on steep riverbanks. Three of the live individuals were gravid females ranging from 98 – 122 mm long. Several of the relic shells found had indications of predation such as cracked or chewed shells.

Eastern floater sites were mostly soft silt and muck substrates near Woods Pond and firmer silt loam banks with occasional rocks and gravel deposits at upstream sites. Host fish for eastern floater include common carp, white sucker, threespine stickleback, bluegill sunfish, and pumpkinseed sunfish (Clarke 1981, Martin 1997, Nedeau *et al.* 2000). All but the stickleback are known to occur within the PSA.

Table 2-2 Freshwater mussels of the Housatonic River drainage.

Scientific Name	Common Name	State/Fed Status*	Observed at 1998 Survey Sites?	Notes**
Alasmidonta heterodon	Dwarf wedgemussel	E/E	No	Known only from 1840s records from CT.
Alasmidonta undulata	Triangle floater	SC/NL	Yes	Extant population in PSA. Shells found at Reference Site 11.
Alasmidonta varicosa	Brook floater	E/NL	No	Known only from 1920s records from CT.
Anodonta implicata	Alewife floater	NL	No	Known only from 1840s records from CT.
Elliptio complanata	Eastern elliptio	NL	Yes	Relic shell found in PSA. Population found at Reference Site 9 and shells found at Reference Site 11. Also found at Muddy Pond, in the Hinsdale Flats reference area.
Lampsilis cariosa	Yellow lampmussel	E/NL	No	Known only from 1840s records from CT.
Lampsilis radiata	Eastern lampmussel	NL	No	Extant populations in drainage in CT and NY.
Leptodea ochracea	Tidewater mucket	SC/NL	No	Known only from 1840s records from CT.
Ligumia nasuta	Eastern pondmussel	SC/NL	No	Extant populations in the drainage in NY.
Margaritifera margaritifera	Eastern pearlshell	NL	No	A population at Reference Site 9 was reported in 1998 but was not verified during field investigations.
Pyganodon cataracta	Eastern floater	NL	Yes	Extant population in PSA. Also found at Muddy Pond, in the Hinsdale Flats reference area.
Strophitus undulatus	Creeper	SC/NL	Yes	Shells found at Reference Site 11.

Sources: Strayer and Jirka 1997, Smith 1995

* E = Endangered, SC = Special Concern, NL = Not Listed

** See Map 2-1 for Reference Site Locations.

The triangle floater (also known as the heavy-toothed wedgemussel) was the next most abundant mussel found in the PSA during field surveys. It is listed as a Special Concern species (MNHESP 2000). A small population of eight live mussels was found just downstream of the Holmes Road bridge in Pittsfield (Map 2-6). These mussels ranged from 25 – 54 mm long and one was a gravid female 45 mm long. Substrates at the site consisted of soft, fine, shifting sands in the western half of the river channel and packed, algae covered gravel in the eastern half of the channel. Individual mussels, however, were found only in the packed gravel substrate. Water depths in the area ranged from 7.6 – 50.8 cm deep. Known host fish for this species include the common shiner, longnose and blacknose dace, white sucker, pumpkinseed sunfish, fallfish, largemouth bass, and slimy sculpin (Martin 1997, Strayer and Jirka 1997, Nedeau *et al.* 2000). All except the slimy sculpin are known to occur in the PSA.

One relic shell of an eastern elliptio was found in the PSA. This specimen was found just downstream of a gravel riffle, between Dawes and Pomeroy Avenues (Map 2-6). Known host fish for the eastern elliptio include yellow perch, largemouth bass, and banded killifish, which have been historically documented in the Housatonic River, and several species of sunfish (Clarke 1981, Martin 1997, Strayer and Jirka 1997).

Table 2-3 lists the results of mussel surveys conducted at the upstream and downstream reference sites. In general, four species were found. These included the three species found in the PSA in addition to the creeper. Mussels were only found at two sites, both of which occurred in the Stockbridge-Great Barrington area, well downstream of the PSA.

Reference sites upstream of the PSA were largely dominated by cobble habitats while downstream sites generally had packed gravel and sand habitat with occasional gravel and cobble riffles. Site 11 had the greatest species richness, with shells of four species being found. Of the four species found, triangle floater shells were the most abundant (15 shells), followed by the creeper (8), eastern floater (2), and eastern elliptio (1).

Table 2-3 1998 freshwater mussel survey results at reference sites.

Site Number*	Town	Species	Notes
Upstream Sites			
1	Hinsdale	None	Cobble/gravel.
2	Dalton	None	Cobble/boulder.
3	Dalton	None	Packed gravel.
4	Dalton	None	Cobble/boulder.
5	Pittsfield	None	Packed gravel.
Downstream Sites			
6	Lee	None	Cobble.
7	Lee	None	Gravel and cobble/gravel.
8	Lee	None	Packed gravel and sand.
9 (Konkapot Brook)	Stockbridge	Eastern elliptio	Packed gravel and sand. >50 live elliptios found.
10	Great Barrington	None	Cobble and cobble/gravel.
11	Great Barrington	Eastern elliptio Eastern floater Creeper Triangle floater	Packed gravel and sand. Only relic shells were found.
*See Map 2-1 for site location map.			

The creeper is another species of Special Concern in Massachusetts. Its known host fish include the creek chub, largemouth bass, yellow perch, fallfish, spotfin shiner, golden shiner, common shiner, plains killifish, fathead minnow, longnose dace, bluegill, green sunfish, walleye, slimy sculpin, and the black and yellow bullhead (Clarke 1981, Strayer and Jirka 1997, Nedeau *et al.* 2000). However, it is believed that the creeper is one of the few species of freshwater mussel that has a free-living larval stage that is not dependent on a host fish (Strayer and Jirka 1997).

Site 9, Konkapot Brook (Map 2-1), was the only other downstream reference site where mussels were found. Konkapot Brook is a small tributary to the Housatonic River in Stockbridge that averages 1 - 1.5 m wide and 15 – 40 cm deep. A group of over 50 live elliptio was found approximately 450 m from the confluence of the river and Konkapot Brook, and relic shells were found in the brook within 45 m of the confluence. A population of eastern pearlshells was reported at this site in 1998, the first confirmed record of this species within the Housatonic River drainage in Massachusetts (D. Smith, University of Massachusetts, Amherst, pers. comm.). However, this species was not found during these field investigations.

Of the reference areas used during other 1999 and 2000 field investigations, only Muddy Pond in Hinsdale Flats SWMA was found to contain freshwater mussels. Large populations of eastern elliptio and eastern floaters were found in the soft substrate of the pond. No estimate of population size was made, although well over 100 live individuals of each species was observed.

Historical records indicate that the Housatonic River drainage once had a relatively diverse assemblage of 12 freshwater mussel species (Table 2-2). However, seven of these species were only known from the lower part of the drainage in Connecticut and New York. Furthermore, five of those species—the dwarf wedgemussel, brook floater, yellow lampmussel, tidewater mucket, and alewife floater—have not been found since their original documented reports by Linsley and Jacot in the mid-1800s and early 1900s (Smith 1999). More recent surveys have documented only five species within the

Massachusetts portion of the drainage (Smith 1982), and no information is available on historical mussel surveys in PSA.

Because of a lack of historical (i.e., pre-1900s) mussel information from within the PSA itself, it is difficult to speculate if current low mussel richness and abundance has always occurred or is due to natural factors or human-induced impacts. Suitable mussel habitats do occur in the PSA, particularly the upper half, which was dominated by fast water over packed gravel and sand substrates with riffles of cobble/gravel substrates. These habitats are suitable for adults of most species and for the establishment of juvenile mussels (Neves and Widlak 1987). Despite this, only one relic elliptio shell and one small, localized triangle floater population were found. The eastern floaters that were found in the lower portions of the PSA were in softer sediments, which is typical habitat for that species (Clarke 1981).

Many natural factors can limit the occurrence and distribution of freshwater mussels. Rivers of the North Atlantic Slope (i.e., Housatonic River to Atlantic Canada) have low mussel diversity compared to those of southern Atlantic and interior (Mississippian) watersheds, due to limited refugia during the last glaciation (Smith 1982, Strayer 1990, Strayer and Jirka 1997). The Taconic Mountains and the southern Green Mountains form the divide between the species-depauperate northeastern watersheds and the species-rich Mississippian watersheds (Smith 1982).

Mussel diversity also tends to decrease in low order (i.e., upstream) portions of a watershed (Strayer 1983, Mackie and Topping 1988), and rivers that are hydrologically unstable (i.e., prone to frequent flooding) typically have fewer species than river systems that are more stable (Strayer 1993, Di Maio and Corkum 1995). This helps explain some of the present distribution of mussels in the Housatonic River drainage. For example, the PSA is located far upstream in the drainage (Map 2-1), and rich species assemblages in the drainage were historically known only from high order (downstream) portions of the watershed (Smith 1999). In addition, the PSA is prone to periodic flooding in spring, and during summer and fall storm events.

A number of natural predators of are known to feed on freshwater mussels including muskrats, raccoons, river otters, and birds (Strayer and Jirka 1997). Among these, muskrat predation can have the greatest effect on local mussel populations (Neves and Odom 1989). Muskrats were the most commonly observed mussel predator in the PSA, and some shells had indications of predation such as shell fractures at the abductor muscle locations. However, large shell middens often made by muskrats were not observed, indicating that muskrats are not preying on large numbers of mussels in the study area, middens have been periodically washed downstream during high flows, or that large populations of mussels are simply not available for muskrats.

While any of these natural factors could have affected the freshwater mussel community in the area, human-induced impacts have also occurred. River channelization and realignment is common in urban areas and has the potential to destroy individual mussels and create unsuitable habitats such as well-armored banks of boulders, rubble, and other hard materials. Floodplain clearing and conversion to agricultural lands can increase erosion and sedimentation into a river because of less stable banks, and the decrease in bank shading tends to increase water temperature (Strayer and Jirka 1997). In addition, construction of dams can flood riffle habitats, accumulate soft sediments, impede the movement of suitable host fish, and scour suitable habitats below the dam (Strayer 1993, Martin 1997). All of these types of disturbances can be detrimental to mussel populations and have occurred in the PSA.

Also associated with past land uses and urban development is decreased water quality from biological and chemical pollutants. Freshwater mussels are filter feeders and have the ability to filter large amounts of water. Strayer *et al*. (1994) found that some freshwater mussel beds can filter anywhere from 0.1 - 2.0 m^3 of water per m^2 of substrate per day. Uptake of biological or chemical pollutants in the water, such as agricultural herbicides and pesticides, sewage and wastewater treatment effluent, and industrial pollution, can occur during the course of normal feeding and can significantly affect mussel populations (Metcalfe and Charlton 1990, Goodreau *et al*. 1993).

It is likely that many of these environmental and anthropogenic factors identified above have helped shape the freshwater mussel community within the PSA and the Housatonic

River watershed as a whole. The results of the 1998 surveys indicate that some mussels, including gravid females, exist within the PSA and may represent populations that have been maintaining themselves. Conversely, they could also represent populations that are beginning to reestablish in the area. However, there are large areas of suitable habitat in the PSA that are uninhabited by mussels. Definitive reasons for the lack of mussels in these areas are unknown.

3.1.2 Dragonflies

There are currently 164 Odonate species recorded in Massachusetts, with 97 species documented for Berkshire County. The 164 Odonates in Massachusetts include 115 species of dragonflies and 49 species of damselflies. In Berkshire County, the 97 species of Odonates include 70 species of dragonflies and 27 species of damselflies (Leahy *et al*. 2000). A total of 40 species were identified during the 1999 dragonfly surveys. This included 38 species from the PSA and two species found only in the reference areas (Table 2-4).

A total of 628 dragonfly exuviae, representing 21 species, were collected from within the PSA. The results of the exuviae collection surveys are summarized in Table 2-5. Three State-listed species were collected: arrow clubtail, zebra clubtail, and riffle snaketail. The zebra clubtail has a state status of endangered, while the arrow clubtail and riffle snaketail both have a state status of threatened (MNHESP 1999). Zebra clubtail exuviae were collected from eight transect locations, while arrow clubtail and riffle snaketail exuviae were collected from six and two transect locations, respectively (Table 2-5). The lance-tipped darner was the only species identified during opportunistic exuviae collections that was not observed during transect collection, bringing the total number of dragonfly species for which exuviae were collected in the PSA to 22.

Opportunistic aerial netting of adult and teneral dragonflies collected 44 specimens from the PSA and reference areas, representing 24 confirmed species. Two arrow clubtails were collected, one along an exuviae survey transect, and the other at the Threemile Pond SWMA reference area. Opportunistic aerial netting of adult and teneral damselflies collected 19 specimens from the PSA, representing six confirmed species (Table 2-6).

Opportunistic collection of exuviae and adult dragonflies from the reference areas resulted in 12 confirmed species from Threemile Pond, five species from Washington Mountain Lake, and six species from Hinsdale Flats (Table 2-4). The delta-spotted spiketail and Williamson's emerald were the only two species observed in the reference areas that were not observed in the PSA. Due to taxonomic uncertainty within the scientific community concerning the status of the meadowhawks, specimens collected during this study were grouped at the genus level. This grouping represents a potential of three separate meadowhawk species. Similar difficulty occurred in trying to separate the spine-crowned clubtail from the mustached clubtail (Jeremiah Trimble pers. com.), so these specimens were also grouped at the genus level. Six damselfly species were identified during opportunistic adult and teneral collections within the PSA, while four additional species were collected at two reference areas (Threemile Pond and Hinsdale Flats SWMAs). Some exuviae and adult dragonfly specimens were damaged by floodwater flows and other natural conditions. While these specimens were identified to the genus level when possible, some could not be identified.

Table 2-4 1999 dragonfly survey results.

Common Name	Scientific Name	Housatonic River (PSA)	Threemile Pond SWMA	Muddy Pond in Hinsdale Flats SWMA	Washington Mountain Lake in October Mountain State Forest
Canada darner	*Aeshna canadensis*	X			X
lance-tipped darner	*Aeshna constricta*	X			
variable darner	*Aeshna interrupta*	X			X
shadow darner	*Aeshna umbrosa*	X			
common green darner	*Anax junius*	X	X		X
lilypad clubtail	*Arigomphus furcifer*	X			
unicorn clubtail	*Arigomphus villosipes*	X			
fawn darner	*Boyeria vinosa*	X			
calico pennant	*Celithemis elisa*	X			X
halloween pennant	*Celithemis eponina*	X	X		
delta-spotted spiketail	*Cordulegaster diastatops*		X		
racket-tailed emerald	*Dorocordulia libera*	X	X	X	
black-shouldered spinyleg	*Dromogomphus spinosus*	X			
beaverpond baskettail	*Epitheca canis*	X			
common baskettail	*Epitheca cynosura*	X			
prince baskettail	*Epitheca princeps*	X		X	
eastern pondhawk	*Erythemis simplicicollis*	X			
spine-crowned clubtail[1] or mustached clubtail	*Gomphus abbreviatus* / *Gomphus adelphus*	X			
lancet clubtail	*Gomphus exilis*	X			
ashy clubtail	*Gomphus lividus*	X			
dusky clubtail	*Gomphus spicatus*	X			
dragonhunter	*Hagenius brevistylus*	X			
crimson-ringed whiteface	*Leucorrhinia glacialis*	X		X	
dot-tailed whiteface	*Leucorrhinia intacta*	X			
slaty skimmer	*Libellula incesta*	X		X	

Common Name	Scientific Name	Housatonic River (PSA)	Threemile Pond SWMA	Muddy Pond in Hinsdale Flats SWMA	Washington Mountain Lake in October Mountain State Forest
chalk-fronted skimmer	*Libellula julia*	X	X	X	
widow skimmer	*Libellula luctuosa*	X	X		
common whitetail	*Libellula lydia*	X	X		
twelve-spotted skimmer	*Libellula pulchella*	X	X		
riffle snaketail[2]	*Ophiogomphus carolus*	X			
rusty snaketail	*Ophiogomphus rupinsulensis*	X			
blue dasher	*Pachydiplax longipennis*	X			
eastern amberwing	*Perithemis tenera*	X	X		
forcipate emerald	*Somatochlora forcipata*	X		X	
Williamson's emerald	*Somatochlora williamsoni*		X		
zebra clubtail[3]	*Stylurus scudderi*	X			
arrow clubtail[2]	*Stylurus spiniceps*	X	X		
saffron-winged meadowhawk	*Sympetrum costiferum*	X			X
cherry-faced meadowhawk[1] ruby meadowhawk Jane's meadowhawk	*Sympetrum internum* *Sympetrum rubincundulum* *Sympetrum janae*	X	X		
yellow-legged meadowhawk	*Sympetrum vicinum*	X	X		
	Species Richness =	38	13	6	5

[1] Questionable taxonomy of this group precluded accurate determination (Leahy *et al.* 2000).

[2] State threatened

[3] State endangered

Table 2-5 1999 dragonfly exuviae collection results.

Common Name	Scientific Name	Transect								
		1	2	3	4	5	6	7	8	9
shadow darner	*Aeshna umbrosa*									2
darner spp.[1]	*Aeshna* spp.									1
common green darner	*Anax junius*						1			3
lilypad clubtail	*Arigomphus furcifer*									1
fawn darner	*Boyeria vinosa*	6	14	58	35	13	12	6		
racket-tailed emerald	*Dorocordulia libera*								1	
black-shouldered spinyleg	*Dromogomphus spinosus*						1		1	
beaverpond baskettail	*Epitheca canis*								4	
common baskettail	*Epitheca cynosura*			1					1	12
prince baskettail	*Epitheca princeps*									1
eastern pondhawk	*Erythemis simplicicollis*								1	7
spine-crowned clubtail[2] or mustached clubtail	*Gomphus abbreviatus* *Gomphus adelphus*							1		
lancet clubtail	*Gomphus exilis*			1				7		
ashy clubtail	*Gomphus lividus*			1	3	1		1		
dusky clubtail	*Gomphus spicatus*							3		
dragonhunter	*Hagenius brevistylus*					1				
dot-tailed whiteface	*Leucorrhinia intacta*								3	
common whitetail	*Libellula lydia*								4	

Common Name	Scientific Name	Transect								
		1	2	3	4	5	6	7	8	9
skimmer spp.[1]	*Libellula* spp.									1
riffle snaketail[3]	*Ophiogomphus carolus*	1	1							
rusty snaketail	*Ophiogomphus rupinsulensis*	1			1					
snaketail spp.[1]	*Ophiogomphus* spp.			1						
blue dasher	*Pachydiplax longipennis*									1
zebra clubtail[4]	*Stylurus scudderi*	3	4	85	57	4	13	23	1	
arrow clubtail[3]	*Stylurus spiniceps*			12	35	6	88	69	5	
cherry-faced meadowhawk[1] ruby meadowhawk Jane's meadowhawk	*Sympetrum internum* *Sympetrum rubincundulum* *Sympetrum janae*								1	7
	Total Number of Exuvia =	11	19	159	131	25	115	110	22	36

[1] Identification limited to genus level because of partial specimen.

[2] Questionable taxonomy of this group precluded accurate determination (Leahy *et al.* 2000).[3] State threatened

[4] State endangered

Table 2-6 1999 damselfly survey results.

Common Name	Scientific Name	Housatonic River	Threemile Pond	Muddy Pond
variable dancer	*Argia fumipennis*	X		
river jewelwing	*Calopteryx aequabilis*	X		
ebony jewelwing	*Calopteryx maculata*	X		
familiar bluet	*Enallagma civile*		X	
skimming bluet	*Enallagma geminatum*	X	X	
orange bluet	*Enallagma signatum*	X		
fragile forktail	*Ischnura posita*			X
eastern forktail	*Ischnura verticalis*	X	X	X
elegant spreadwing	*Lestes inaequalis*			X
slender spreadwing	*Lestes rectangularis*		X	
	Species Richness =	6	4	3

3.1.3 Vernal Pool Invertebrates

A variety of aquatic invertebrates were collected in the aquatic funnel traps at the 17 surveyed vernal pools. Major groups collected were crustaceans, arthropods, mollusks, annelids, roundworms, and flatworms. The common orders collected included water fleas (Cladocera), scuds (Amphipoda), mayflies (Ephemeroptera), beetles (Coleoptera), flies and midges (Diptera), and bivalves (Bivalvia). Table 2-7 lists invertebrates that were collected in the 17 intensively surveyed vernal pools in 1998. Unless otherwise noted, the data presented in the text refers to the intensive funnel-trap sampling of the 17 pools in 1998. Other data were also collected in 1998, 1999, and 2000 on an incidental basis in the entire set of 68 pools located in the PSA. These data, some of which are also presented in the text, refer to overall…

Table 2-7 1998 aquatic funnel trap results from 17 vernal pools.

GROUP	FAMILY	GENUS	COMMON NAME	VERNAL POOL IDs																
				5-VP-2	5-VP-3	8-VP-1	8-VP-4	18-VP1	18-VP-2	23A-VP-1	23B-VP-1	23B-VP-2	40-VP-3	42-VP-1	46-VP-1	46-VP-2	46-VP-5	61A-VP-1	61A-VP-2	66A-VP-1
COELENTERATA	Hydridae		Hydras											X				X		
TURBELLARIA			Flatworm								X									
TRICLADIDA	Planariidae		Flatworm	X				X	X	X		X	X	X	X		X			X
NEMATODA			Roundworm							X				X		X				
GASTROPODA			Snails								X				X					
GASTROPODA	Hydrobiidae		Little pond snail																X	
GASTROPODA	Hydrobiidae	*Amnicola*	Little pond snail															X	X	
GASTROPODA	Lymnaeidae		Pond snail						X	X										
GASTROPODA	Lymnaeidae	*Fossaria*	Pond snail			X	X	X			X			X					X	
GASTROPODA	Lymnaeidae	*Stagnicola*	Pond snail					X	X	X	X	X	X	X						X
GASTROPODA	Physidae		Pouch snail						X	X			X	X						
GASTROPODA	Physidae	*Aplexa*	Pouch snail			X	X	X	X	X			X							
GASTROPODA	Physidae	*Physa*	Pouch snail						X	X			X	X						
GASTROPODA	Physidae	*Physella*	Pouch snail	X	X	X		X					X	X			X	X	X	X
GASTROPODA	Planorbidae		Orb snail	X	X				X	X			X	X					X	
GASTROPODA	Planorbidae	*Gyraulus*	Orb snail								X	X					X			
GASTROPODA	Planorbidae	*Planorbella*	Orb snail										X							
GASTROPODA	Planorbidae	*Promenetus*	Orb snail					X	X	X	X		X							
GASTROPODA	Valvatidae	*Valvata*	Pond snail																X	
BIVALVIA	Sphaeriidae		Clams		X			X	X	X	X		X	X		X		X	X	X
BIVALVIA	Sphaeriidae	*Musculium*	Clams	X	X						X	X	X	X		X	X	X	X	
BIVALVIA	Sphaeriidae	*Pisidium*	Pill clams								X									
BIVALVIA	Sphaeriidae	*Sphaerium*	Sphere clams				X												X	
OLIGOCHAETA	Lumbriculidae		Aquatic earthworm												X					
OLIGOCHAETA	Lumbriculidae	*Lumbriculus*	Aquatic earthworm	X		X					X								X	

GROUP	FAMILY	GENUS	COMMON NAME	VERNAL POOL IDs																
				5-VP-2	5-VP-3	8-VP-1	8-VP-4	18-VP1	18-VP-2	23A-VP-1	23B-VP-1	23B-VP-2	40-VP-3	42-VP-1	46-VP-1	46-VP-2	46-VP-5	61A-VP-1	61A-VP-2	66A-VP-1
OLIGOCHAETA	Naididae		Aquatic earthworm																X	
OLIGOCHAETA	Naididae	*Pristina*	Aquatic earthworm	X										X					X	
OLIGOCHAETA	Tubificidae		Sludge worm	X							X			X					X	
OLIGOCHAETA	Tubificidae	*Limnodrilus*	Sludge worm											X						
GNATHOBDELLIDA	Hirudinidae	*Haemopis*	Leech								X		X							X
PHARYNGOBDELLIDA	Erpobdellidae	*Erpobdella*	Leech				X	X	X	X			X	X						
RHYNCHOBDELLA	Glossiphoniidae		Leech					X	X				X					X		
RHYNCHOBDELLA	Glossiphoniidae	*Alboglossiphonia*	Leech					X	X											
RHYNCHOBDELLA	Glossiphoniidae	*Helobdella*	Leech						X	X	X					X				
ACARIFORMES	Eremaeidae		Water mite							X										
ACARIFORMES	Hydrachnidae	*Hydrachna*	Water mite																X	
ACARIFORMES	Hydryphantidae	*Pseudohydryphantes*	Water mite								X		X							X
ACARIFORMES	Pionidae		Water mite											X						
ACARIFORMES	Pionidae	*Tiphys*	Water mite	X																
ACARIFORMES	Sperchonidae	*Sperchon*	Water mite			X														
ORIBATEI	Eremaeidae		Mite										X							
COLLEMBOLA			Springtail	X				X	X											
COLLEMBOLA	Sminthuridae	*Bourletiella*	Globular springtail	X												X				
EPHEMEROPTERA	Baetidae	*Callibaetis*	Mayfly															X		
EPHEMEROPTERA	Baetiscidae	*Baetisca*	Mayfly											X						
EPHEMEROPTERA	Caenidae	*Caenis*	Mayfly																X	
EPHEMEROPTERA	Ephemerellidae		Mayfly																X	
EPHEMEROPTERA	Ephemerellidae	*Ephemerella*	Mayfly														X			
EPHEMEROPTERA	Ephemerellidae	*Eurylophella*	Small mayfly	X	X						X	X		X						X
EPHEMEROPTERA	Leptophlebiidae	*Leptophlebia*	Small mayfly	X																
EPHEMEROPTERA	Siphlonuridae	*Siphlonurus*	Mayfly	X	X		X	X			X		X	X	X	X	X	X	X	X
ODONATA	Aeshnidae	*Aeshna*	Mosaic Darner										X	X						

GROUP	FAMILY	GENUS	COMMON NAME	VERNAL POOL IDs																
				5-VP-2	5-VP-3	8-VP-1	8-VP-4	18-VP1	18-VP-2	23A-VP-1	23B-VP-1	23B-VP-2	40-VP-3	42-VP-1	46-VP-1	46-VP-2	46-VP-5	61A-VP-1	61A-VP-2	66A-VP-1
ODONATA	Corduliidae	*Epitheca*	Baskettail																X	
ODONATA	Gomphidae	*Stylurus*	Hanging clubtail		X															
ODONATA	Libellulidae	*Libellula*	King Skimmer																	
ODONATA	Libellulidae	*Sympetrum*	Meadowhawk								X	X			X					
ODONATA	Coenagrionidae	*Coenagrion*	Broad-winged Damselly															X		
ODONATA	Coenagrionidae	*Enallagma*	Bluet															X		
ODONATA	Lestidae	*Lestes*	Spread-winged Damselfly	X	X				X	X			X	X				X	X	
HEMIPTERA	Belostomatidae	*Lethocerus*	Giant water bug										X							
HEMIPTERA	Corixidae		Water boatman		X	X		X	X						X	X		X	X	
HEMIPTERA	Corixidae	*Callicorixa*	Water boatman	X																
HEMIPTERA	Corixidae	*Hesperocorixa*	Water boatman	X	X			X	X	X	X		X	X		X	X	X	X	
HEMIPTERA	Corixidae	*Ramphocorixa*	Water boatman											X						
HEMIPTERA	Gerridae	*Limnogonus*	Water strider		X															
HEMIPTERA	Notonectidae		Backswimmer															X	X	
HEMIPTERA	Notonectidae	*Notonecta*	Backswimmer	X	X	X			X	X			X	X						
HEMIPTERA	Pleidae	*Neoplea*	Pigmy backswimmer															X	X	
TRICHOPTERA	Limnephilidae	*Limnephilus*	Northern caddisfly	X		X	X	X	X	X		X				X	X			X
COLEOPTERA			Beetles			X										X				
COLEOPTERA	Curculionidae		Weevil										X							
COLEOPTERA	Curculionidae	*Emphyastes*	Weevil		X															
COLEOPTERA	Curculionidae	*Lixus*	Weevil										X	X		X	X			
COLEOPTERA	Dytiscidae	*Acilius*	Predaceous diving beetle	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X
COLEOPTERA	Dytiscidae	*Agabetes*	Predaceous diving beetle	X			X					X			X					X
COLEOPTERA	Dytiscidae	*Agabus*	Predaceous diving beetle	X		X	X	X	X	X	X	X		X		X	X		X	X
COLEOPTERA	Dytiscidae	*Celina*	Predaceous diving beetle								X									
COLEOPTERA	Dytiscidae	*Colymbetes*	Predaceous diving beetle								X		X	X						
COLEOPTERA	Dytiscidae	*Copelatus*	Predaceous diving beetle	X																X

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				5-VP-2	5-VP-3	8-VP-1	8-VP-4	18-VP1	18-VP-2	23A-VP-1	23B-VP-1	23B-VP-2	40-VP-3	42-VP-1	46-VP-1	46-VP-2	46-VP-5	61A-VP-1	61A-VP-2	66A-VP-1
COLEOPTERA	Dytiscidae	*Copotomus*	Predaceous diving beetle					X	X				X	X						
COLEOPTERA	Dytiscidae	*Dytiscus*	Predaceous diving beetle		X	X	X	X			X		X	X		X	X	X		X
COLEOPTERA	Dytiscidae	*Hydaticus*	Predaceous diving beetle					X	X				X			X	X		X	
COLEOPTERA	Dytiscidae	*Hydroporus*	Predaceous diving beetle	X	X	X		X	X	X	X		X	X		X		X	X	
COLEOPTERA	Dytiscidae	*Hydrovatus*	Predaceous diving beetle								X		X			X			X	
COLEOPTERA	Dytiscidae	*Hygrotus*	Predaceous diving beetle		X		X	X	X	X	X		X	X		X		X	X	X
COLEOPTERA	Dytiscidae	*Ilybius*	Predaceous diving beetle	X					X	X		X	X				X			X
COLEOPTERA	Dytiscidae	*Laccophilus*	Predaceous diving beetle	X	X	X	X	X	X	X		X	X	X		X			X	X
COLEOPTERA	Dytiscidae	*Laccornis*	Predaceous diving beetle				X	X	X											
COLEOPTERA	Dytiscidae	*Lioporius*	Predaceous diving beetle				X													
COLEOPTERA	Dytiscidae	*Neoscutopterus*	Predaceous diving beetle	X				X												
COLEOPTERA	Dytiscidae	*Oreodytes*	Predaceous diving beetle				X										X			
COLEOPTERA	Gyrinidae	*Gyrinus*	Whirligig beetle												X					
COLEOPTERA	Haliplidae	*Haliplus*	Crawling water beetle		X		X	X	X		X		X	X		X		X	X	
COLEOPTERA	Haliplidae	*Peltodytes*	Crawling water beetle															X	X	
COLEOPTERA	Helophoridae	*Helophorus*	Water scavenger beetle	X		X								X						
COLEOPTERA	Hydrophilidae		Water scavenger beetle			X														
COLEOPTERA	Hydrophilidae	*Berosus*	Water scavenger beetle										X			X				
COLEOPTERA	Hydrophilidae	*Enochrus*	Water scavenger beetle							X										
COLEOPTERA	Hydrophilidae	*Helochares*	Water scavenger beetle									X								
COLEOPTERA	Hydrophilidae	*Hydrochara*	Water scavenger beetle	X		X	X	X	X	X			X	X	X	X				
COLEOPTERA	Hydrophilidae	*Tropisternus*	Water scavenger beetle				X	X			X		X	X		X			X	
COLEOPTERA	Noteridae	*Hydrocanthus*	Burrowing water beetle					X						X				X		
COLEOPTERA	Scirtidae	*Cyphon*	Marsh beetle																	X
COLEOPTERA	Scirtidae	*Scirtes*	Marsh beetle										X					X		
MEGALOPTERA	Corydalidae	*Chauliodes*	Fishfly																	X
MEGALOPTERA	Sialidae	*Sialis*	Alderfly					X	X	X										

GROUP	FAMILY	GENUS	COMMON NAME	VERNAL POOL IDs																
				5-VP-2	5-VP-3	8-VP-1	8-VP-4	18-VP1	18-VP-2	23A-VP-1	23B-VP-1	23B-VP-2	40-VP-3	42-VP-1	46-VP-1	46-VP-2	46-VP-5	61A-VP-1	61A-VP-2	66A-VP-1
DIPTERA	Chaoboridae	*Chaoborus*	Phantom midge				X								X	X			X	
DIPTERA	Chironominae	*Chironomus*	Midge		X		X	X				X	X	X			X	X	X	
DIPTERA	Chironominae	*Endochironomus*	Midge	X												X				
DIPTERA	Chironominae	*Glyptotendipes*	Midge										X							
DIPTERA	Chironominae	*Parachironomus*	Midge													X			X	
DIPTERA	Chironominae	*Paratendipes*	Midge	X																
DIPTERA	Culicidae		Mosquito						X	X										X
DIPTERA	Culicidae	*Aedes*	Mosquito	X		X					X	X		X						
DIPTERA	Dolichopodidae		Midge											X						
DIPTERA	Orthocladiinae	*Camptocladius*	Midge																	X
DIPTERA	Orthocladiinae	*Cricotopus*	Midge								X			X						
DIPTERA	Orthocladiinae	*Euryhapsis*	Midge																	X
DIPTERA	Stratiomyidae	*Hedriodiscus/ Odontomyia*	Soldier flies																X	
DIPTERA	Tanypodinae	*Natarsia*	Midge								X									
DIPTERA	Tanypodinae	*Procladius*	Midge											X						
DIPTERA	Tanypodinae	*Psectrotanypus*	Midge		X						X			X						
DIPTERA	Tanypodinae	*Tanypus*	Midge																X	
DIPTERA	Tanypodinae	*Thienemannimyia*	Midge								X									
DIPTERA	Tipulidae		Cane fly	X																
CLADOCERA			Water flea	X	X	X	X	X					X	X	X	X	X	X	X	
COPEPODA			Copepod	X		X					X		X	X	X	X	X	X	X	X
CONCHOSTRACA			Clam shrimp								X	X						X		
AMPHIPODA			Scuds		X		X						X	X		X			X	
AMPHIPODA	Crangonyctidae		Scuds													X				
AMPHIPODA	Crangonyctidae	*Crangonyx*	Scuds	X	X	X	X	X	X	X	X	X	X	X		X	X		X	X
AMPHIPODA	Hyalellidae	*Hyalella*	Scuds													X		X	X	

GROUP	FAMILY	GENUS	COMMON NAME	VERNAL POOL IDs																
				5-VP-2	5-VP-3	8-VP-1	8-VP-4	18-VP1	18-VP-2	23A-VP-1	23B-VP-1	23B-VP-2	40-VP-3	42-VP-1	46-VP-1	46-VP-2	46-VP-5	61A-VP-1	61A-VP-2	66A-VP-1
DECOPODA	Cambaridae		Crayfish		X											X				
ISOPODA	Asellidae	*Caecidotea*	Aquatic sow bug											X		X		X	X	X
OSTRACODA			Seed shrimp	X				X	X	X	X	X	X	X		X	X	X	X	X
			Total Number of Taxa per Pool:	36	25	21	23	34	34	29	37	18	45	50	13	35	20	29	45	26

Crustaceans

Crustaceans were the most abundant group of aquatic invertebrates recorded from vernal pools in the PSA. Crustacea is a subphylum of Arthropoda, which contains 80 percent of all known species in the animal kingdom (Peckarsky *et al.* 1990). Four major crustacean classes were collected from the PSA vernal pools, including Branchipoda, Malacostraca, Copepoda, and Ostracoda.

Seed shrimp (Ostracoda) were the most abundant of all the invertebrates, with over 3,000 individuals captured. They were recorded from all but 5 of the 17 pools sampled with funnel traps. Most seed shrimp species are not free-swimming and thus are less likely to be captured in aquatic funnel traps, suggesting that the true abundance of this invertebrate is likely even greater than reported here Seed shrimps have a bivalve carapace and resemble tiny clams, typically less than 1 mm long (Pennak 1978). These tiny crustaceans can be found in nearly every aquatic habitat, tolerating a wide range of temperature and water chemistry. They are commonly found among aquatic vegetation and in the decaying matter on the pool bottom where they feed on detritus, algae, bacteria, and molds. Small fish and other invertebrates such as midges, worms, and copepods prey upon seed shrimp (Thorp and Covich 1991).

Copepods were the second most abundant invertebrate; however, more than 90 percent of the individuals were collected from one pool. Copepods are microcrustaceans made up of seven orders, four of which are parasitic and three are free-living. Copepods captured during aquatic funnel trapping were made up of the free-living orders: Calanoda, Cyclopoida, and Harpacticoida. Free-living freshwater copepods range in size from 0.5 – 2.0 mm in length (Thorp and Covich 1991). They are found in a variety of habitats, with Calanoda being associated primarily with plankton and Cyclopoida and Harpacticoida being primarily littoral and benthic. Copepods are extremely abundant, often making up the major portion of biomass and secondary production in a wide variety of aquatic habitats (Thorp and Covich 1991). Copepods play an important role in the food chain as intermediates between microscopic plankton and larger carnivores, such as

fish. Within vernal pools, copepods are likely preyed upon by other aquatic invertebrates and larval amphibians.

Branchiopods included water fleas (Cladocera), clam shrimp (Conchostraca), and fairy shrimp (Anostraca). Water fleas were collected from 70 percent of the sampled pools, while clam shrimp were found in only three pools; however, they were very abundant in those three pools. Like copepods, these microcrustaceans play an important role in food chains as intermediates between microscopic plankton and larger carnivores (Thorp and Covich 1991). Fairy shrimp are common microcrustacean in vernal pools and were observed in approximately one-third of the 68 pools within the PSA; however, none were caught in aquatic funnel traps during 1998. Fairy shrimp are obligate vernal pool species and were documented in 5 of the 17 pools sampled with aquatic funnel traps and 20 of the 68 pools surveyed overall in 1998.

Taxa in the Malacostraca were dominated by three orders: scuds (Amphipoda), sow bugs (Isopoda), and crayfish (Decopoda). Scuds were one of the most universal invertebrates, being collected from all but one of the funnel-trapped vernal pools. Scuds, like the water fleas and clam shrimp, are important intermediates in aquatic food webs (Thorp and Covich 1991). Aquatic sow bugs (Isopods) were the least common crustaceans captured in aquatic funnel traps and were found in small numbers in only four pools. Isopods are scavengers and detrital feeders and are most commonly found on the pool bottoms beneath stones and woody debris (Thorp and Covich 1991), which indicates that they were probably under-represented in the aquatic funnel trap samples.

Crayfish were the only group of macrocrustaceans found in the PSA, and several small crayfish were collected in aquatic funnel traps in 1998. Crayfish were more common in the river channel, but they were occasionally seen in vernal pools. Interestingly, many adult crayfish were observed undertaking overland travel from vernal pools to the river as the pools began drying, and were captured in pit traps during 1999 and 2000 wood frog and leopard frog studies. In addition, crayfish were captured for toxicological analysis from the river channel throughout the PSA during 2000. Nearly all the crayfish collected were *Orconectes virilis*. A small number of *Cambarus robustus* were collected from rocky medium-gradient stream communities near Dalton, MA, upstream of the PSA.

Crayfish are omnivorous, feeding on vegetation (mainly detritus) and a variety of animals (mainly invertebrates). Crayfish play a role in several trophic levels; they are important decomposers of detritus as well as herbivores and carnivores. Crayfish are preyed upon by many aquatic or semi-aquatic organisms, including fish, turtles, mink, otter, and raccoons.

Arthropods

A wide variety of arthropods were commonly found during aquatic funnel trapping. The largest classes of arthropods observed, excluding crustaceans, were the insects. Insects are the most widespread class of arthropods, and include mayflies (Ephemeroptera), caddisflies (Trichoptera), fishflies and alderflies (Megaloptera), midges and mosquitoes (Diptera), dragonflies (Odonata), beetles (Coleoptera), and true bugs (Hemiptera). Mayflies, caddisflies, fishflies, alderflies, midges, mosquitoes, and dragonflies are aquatic only during their larval stages, while aquatic beetles and bugs can be found in the water during all of their life stages. Aquatic beetles and true bugs typically utilize vernal pools during the breeding season, fly to more permanent water to overwinter, and return to the pools in the spring. Spiders and mites (Arachnids) were another common class of arthropod found within vernal pools, consisting primarily of mites. Springtails were the final class of arthropods found within the vernal pools.

Mayflies were recorded from 88 percent of the 17 surveyed pools. Mayflies were the most abundant insects with 847 individuals of 8 genera captured, representing 7 mayfly families. The Siphlonuridae was the most abundant and widespread family, making up more than 80 percent of the individuals collected, and were found in 82 percent of the sampled pools. Ephemeridae was another common family, being found in approximately half of the vernal pools. Mayflies are ephemeral in that they emerge in mass, form large swarms, mate, deposit eggs, and die all within a few hours to a few days. Eggs may hatch soon after being laid or the eggs may diapause over winter, with the nymphs developing rapidly after hatching in the spring. The nymph stage may last from two weeks to two years depending upon the pecies, but most mayflies utilizing permanent habitats overwinter as nymphs, and metamorphose into adults the following spring. Most mayfly nymphs are grazers feeding on algae and detritus, and a few are predaceous,

especially *Siphlonurus.* (Merrit and Cummins 1978, Peckarsky *et al.* 1990, Thorp and Covich 1991)

Beetles were the second most abundant insects recorded from the funnel-trapped vernal pools. Two suborders of beetles were recorded, Adephaga and Polyphaga. Water beetles (Adephaga) are aquatic during all of their life stages and include the predaceous diving beetle, the most abundant beetle collected. Polyphaga includes some species with aquatic adult stages but most are terrestrial.

The predaceous diving beetle is the largest family of water beetle, with about 30 genera occurring in the northeastern United States. Eighteen of these genera were recorded during the funnel trap survey. These beetles are highly adapted to the aquatic environment. Adults range from 1 – 40 mm in length and have elongated, flattened hind legs, which serve as oars to propel them through the water (Pennak 1978). One generation is produced each year. Adults mate and lay eggs in the spring on aquatic vegetation near the surface. Larvae typically develop over a few weeks time, during which they are voracious feeders taking a variety of aquatic insects, tadpoles, and even small fish. Larvae leave the water and burrow into nearby soil to pupate, which typically lasts 5 – 14 days. Adults emerge and re-enter the aquatic habitat, taking similar prey as the larvae. Adults will fly from pool to pool and typically fly to permanent water to overwinter. Most predaceous diving beetles live for one year, dying after mating in the spring, but a few species have been known to live for two or three years (Peckarsky *et al.* 1990, Thorp and Covich 1991).

The crawling water beetle (Haliplidae) was another commonly observed water beetle. Crawling water beetles are small (2.5–5.0 mm) and despite their name are adapted to swim (Thorp and Covich 1991). These beetles are herbivorous and are commonly found on aquatic vegetation and in filamentous algae mats. The larvae are not able to swim and spend the 3 – 5 weeks of this life stage crawling on aquatic vegetation. Pupation occurs in moist soil near the larval development site, lasting 2 – 3 weeks. Adults emerge and re-enter the water. Most adults overwinter in the water, but a few species are known to overwinter in terrestrial sites adjacent to the water (Peckarsky *et al.* 1990).

Whirligig beetles and burrowing water beetles were also recorded from the funnel-trapped vernal pools but in smaller numbers than other water beetles. The life histories of these beetles are similar to predaceous diving beetles. Both are predators of small invertebrates or scavengers. Larval burrowing water beetles are somewhat omnivorous, living and pupating among the submerged roots of vegetation. Whirligigs pupate in cocoons on emergent vegetation. They fly to, and overwinter in, permanent bodies of water, returning to the pools to mate in the spring (Peckarsky *et al.* 1990, Thorp and Covich 1991).

Water scavenger beetles are the most abundant of the Polyphaga beetles in the surveyed vernal pools. The eggs of the aquatic species are deposited in cocoons attached to aquatic vegetation or, in some species, carried by the adult. Larvae are herbivorous, crawling and feeding on vegetation. A few species have terrestrial larvae. Adults of the genera mostly crawl along vegetation, but a few species have adaptations for swimming. Adults often consume decaying vegetation, giving them the name scavenger beetles, but they also consume large amounts of living plant material, mainly algae. The life cycle is similar to other beetles with the larval stage lasting a few weeks and adults overwintering in either permanent water or moist terrestrial sites (Thorp and Covich 1991, Merritt and Cummins 1978).

Weevils were not commonly collected in the aquatic funnel traps. They are likely more common on emergent vegetation than in the water. Weevils are herbivorous during all life stages and are known to commonly occur on arrowhead, pickerelweed, water lilies, bulrushes, and sedges. A few marsh beetles were collected from the vernal pools. Adult marsh beetles are terrestrial but the larval stage is aquatic. The larvae are found on vegetation in shallow ponds, marshes, and swamps. Larvae are detritivores but little else is known about their aquatic habits (Merritt and Cummins 1978).

Flies (Diptera), including mosquitoes and midges, were another abundant order of insects observed. Two suborders of Diptera were recorded during vernal pools surveys. The first is Brachycera, which includes most true flies (e.g., horseflies, deer flies, soldier flies, drone flies), and the second was Nematocera, which includes midges and mosquitoes. True flies were uncommon in vernal pools, with only two individuals being collected.

Mosquitoes and midges were both abundant in the PSA. Phantom midges and crane flies were also recorded from the vernal pools, but they were much less common than other Nematocera.

Mosquitoes (Culicidae) were the most abundant flies, making up almost half of all Diptera collected. Mosquitoes in the PSA vernal pools are from the genus Aedes. These mosquitoes lay their eggs in moist ground depressions during the late summer and the eggs remain dormant until they are flooded the following spring. Mosquito larvae are abundant in pools during the early spring and are an important food source for many aquatic organisms. The larval stage typically lasts seven to ten days during which they feed on detritus. Mosquito larvae molt four times with the final molt producing the pupa. The pupal stage last three or four days during which the pupa floats at the surface of the pool and does not feed. The adult develops within the pupa and emerges by splitting the dorsum. The adult then uses the pupal skin as a float until wings dry (Thorp and Covich 1991). Adult mosquitoes feed on plant juices to meet their energy requirements. Females require a blood meal to obtain the needed protein for egg production, making them vectors for many human and animal diseases (Merritt and Cummins 1978). Mosquitoes were not collected from a large number of pools during funnel trapping. This is likely due to the timing of the surveys; many mosquitoes may have already emerged by the time surveys were conducted. Mosquito larvae were observed in nearly all of the 68 pools during the early spring.

Midges (Chirononmidae) were also abundant in the vernal pools. Midges from three subfamilies and thirteen different genera were collected from 65 percent of the sampled vernal pools. Tanypodinae and Chironominae subfamilies were the most common, as they prefer lentic, warm-water habitats. The Orthocladiinae were less common and typically prefer cold-water habitat with rock and gravel substrate. Like other flies, midges have four life stages: egg, larvae, pupa, and adult. The eggs hatch within a few days of being laid and the larval stage lasts from several weeks to years, largely dependent upon water temperature. The pupal stage lasts only a few days after which adults emerge, swarm, mate, and die typically within a few days time. Most midges feed only during the larval stage and most are opportunistic omnivores, feeding on a variety of

algae, diatoms, detritus, and small invertebrates (Thorp and Covich 1991). The most abundant midge genera in the PSA vernal pools were the *Chironomus*. These midges burrow into the substrate or build small tubes to protect themselves and are primarily herbivorous, as are most Chironominae and Orthocladiinae. Tanypodinae, especially the common *Psectrotanypus*, are primarily predaceous. They are free swimming and actively search for prey, which is often water fleas, scuds, and other midges (Merritt and Cummins 1978, Peckarsky *et al.* 1990, Thorp and Covich 1991)

True bugs (Hemioptera) such as water boatman, backswimmers, water striders, and giant water bug were commonly collected during aquatic funnel trapping. Most are adapted to swimming by having fringes of long hair on the flattened legs. Water striders are found on the surface of water where they use the surface tension to stay above the water. Metamorphosis in true bugs is gradual, with several molts occurring and the final molt producing the adult form. Eggs are deposited in the spring and the larvae develop over several weeks, and adults emerge in the late summer and fall. These bugs are mainly predaceous, feeding on small invertebrates, with the exception of water boatman, which feed mainly on detritus, algae, and protozoans. Merritt and Cummins 1978, Thorp and Covich 1991)

Caddisflies (Tricoptera) were found in over 65 percent of the pools surveyed. Only one genus, the northern caddisfly (*Limnephilus*) was collected. Tricoptera is a large order of insects that have aquatic larvae. Many of the species that inhabit temporary pools lay gelatinous egg masses in the fall. The larvae remain within the gelatinous mass until the pools flood. After they break out of the egg masses they construct cases of sticks, leaves, and sand. Larvae consume vegetation and detritus and play an important role processing large particulate organic matter. Larvae seal off the ends of their cases and pupate within them. After 2 – 3 weeks, pupa chew out of their cases and the adults emerge (Peckarsky *et al.* 1990, Thorp and Covich 1991).

A few fishflies and alderflies (Megaloptera) were collected from vernal pools. Fishflies larvae, known as hellgrammites, commonly occur in well-oxygenated streams but are occasionally found in pools. Alderfly larvae require muddy or silty bottoms and accumulated detritus. Some species utilize temporary steams and pools by burrowing

into the substrate during dry periods. Larvae of both families are predaceous, feeding on a variety of small aquatic invertebrates.

Springtails (Collembola) were traditionally placed in the insect class, but recent taxonomy treats springtails as a separate class. Springtails were uncommon, with only three individuals being collected, each from different pools. Springtails are found on the waters surface, relying on their small body size (0.5 – 2.2 mm) and hydrophobic body surface to keep them from breaking through the surface (Peckarsky *et al.* 1990). They feed on particulate organic matter, algae, and bacteria found on the water's surface. Springtails inhabiting vernal pools are only semi-aquatic and are found in the soil and leaf litter when the pools dry. Springtails do not metamorphose, but rather undergo a series of molts that continue after the adult stage has been reached. The adult stage is reached within a few weeks of hatching and adults only live for a few weeks to a few months.

Arachnids were the final class of arthropods found in the PSA vernal pools. Mites were the only arachnids collected during aquatic funnel trapping; however, several aquatic spider species can typically be found in vernal pools. Fisher spiders (*Dolomedes* spp.) were commonly seen in many of the study area vernal pools. They are commonly found on the water surface or among emergent vegetation, but they will dive underwater for prey and can remain submerged for long periods of time. This spider feeds on a variety of aquatic insects, amphibian larvae, and small fish (Reid 2001).

Mites were commonly collected from nearly half of the vernal pools surveyed, but they were not abundant in any of the pools. The majority of water mites belong to the order Acari, commonly call acariforms. Eggs are laid in gelatinous masses attached to plants, wood, or stones. One family, Hydranchnidae, uses an elongated ovipositor to deposit eggs singularly in the stems of aquatic plants (Thorp and Covich 1991). Larvae emerge from the eggs masses one to three weeks later. Larval water mites are parasitic, with each genus preferring different hosts. Common hosts of the four genera present in the PSA are beetles, true bugs, mosquitoes, midges, dragonflies, and caddisflies. The engorged larvae usually drop off the host and metamorphose into nymphs. Some species, especially those that use long-lived hosts, undergo this metamorphosis while still attached

to the host. This allows the larvae to remain on the host for longer periods of time and to utilize temporary habitats by avoiding pools during the dry period. The nymph stage may last from several weeks to several months depending upon the species. Nymphs are predaceous often feeding on the eggs and larvae of their host species. After reaching an adult size, the nymphs become inactive and prepare to transform into adults. Many of the species utilizing temporary pools, particularly Pionidea, have a long nymph stage surviving the dry period burrowed into the pool bottom in the inactive stage. Adult males typically live for a few days to a few weeks and die soon after mating. Mating occurs in the fall, but fertilization is delayed until the following spring. Females live longer, typically overwintering and laying eggs the following spring. In contrast, species inhabiting vernal pools lay their eggs soon after mating to ensure that offspring will reach a life-history stage capable of surviving the dry period.

Mollusks

Two major classes of mollusks were collected from the PSA vernal pools. They are snails and clams. Clams collected from the vernal pools were fingernail clams, pill clams, and sphere clams, all of which are small (less than 1.2 cm in diameter) (Reid 2001). Clams made up approximately 2.5 percent of the total invertebrate population, with fingernail clams being the most abundant. Clams are filter feeders, consuming detritus, plankton, and microscopic invertebrates. All of the clam species collected during this survey are hermaphroditic and self fertilize. Young are contained within the gills until they are fully formed. An adult can contain anywhere from 1 – 60 young in various stages of development. These clams survive dry periods by burrowing into the substrate and remaining inactive until the habitat floods again.

Snails made up just over four percent of the relative abundance of aquatic invertebrates collected during this survey. Snails were observed in nearly all of the 68 vernal pools, and their abundance is likely greater than suggested by funnel trapping surveys because they are not free swimming and, thus, are less likely to be captured in funnel traps than other invertebrates. All of the snails collected had spiral shell architecture except for the orb snails. Snails within the vernal pools were found on submerged and emergent

vegetation, on woody debris, rocks, or floating on the surface. Snails feed mainly on detritus, periphyton, and algae; some will also consume carrion.

Annelids

Annelids are segmented worms including aquatic earthworms, sludge worms, tubifex, and leeches, and make up less than two percent of the total invertebrate abundance collected in the aquatic funnel traps. Leeches were the most common annelid found in the vernal pools. Leeches are considered to be aquatic, but some, such as Haemopis, commonly crawl across land, feeding on living and dead invertebrates, especially earthworms. Leeches have a wide variety of hosts including waterfowl, reptiles, amphibians, and other invertebrates. Many leeches will also consume decaying carrion.

Aquatic earthworms, sludge worms, and tubifex are similar in structure and life histories to terrestrial worms. They are commonly found burrowing in the substrate and among dense mats of filamentous algae. These species feed by ingesting the substrate and extracting the organic component, or on filamentous algae, diatoms, and detritus.

Nematodes

Nematodes, or roundworms, are abundant in aquatic systems, but they were not commonly collected during the funnal trap survey. Most nematodes are parasites, although some are free-living. Most of the free-living species feed on decaying matter and some may be herbivorous, carnivorous, or omnivorous. Parasitic species can be found in nearly all animals, with individual species having specific hosts.

Flatworms

Flatworms are mainly free-living, but some, such as tapeworms and flukes, are parasitic. Freshwater flatworms can be found in nearly every aquatic habitat, usually associated with the substrate. Planarians were the genera found during the funnel trapping surveys and were abundant in many of the vernal pools. Planarians are common laboratory specimens and are studied in many science classrooms. Planarians consume dead and decomposing animal matter and small invertebrates. Flatworms can reproduce sexually

or asexually through budding, and utilize both methods depending upon ecological conditions.

Hydra

Hydras belong to the same phylum as jellyfish and have a similar body structure. Only one hydra was collected during funnel trapping surveys. Hydras can be found clinging to the stems of submerged aquatic plants, sticks, and stones. Hydras consume a wide variety of invertebrates. They capture prey by grasping them with their tentacles, stunning them by stinging, and then engulfing them alive. The tentacles move the prey to the mouth and into the coelenteron, a sack-like internal space, where digestive juices break it down. Food particles are carried by vacuoles through the endodermal cells and into body tissues. After the digestion process, the indigestible remains are returned to the coelenteron and regurgitated. Hydra reproduce by budding and by gametes produced from the ectoderm.

3.2 Terrestrial Macroinvertebrates

3.2.1 Earthworms

Three species of earthworms were collected during earthworm sampling at three of the small mammal trap sites: *Aporrectodea longa*, *Aporrectodea trapezoids*, and *Eisenoides carolinensis*. *A. longa* and *A. trapezoids* were collected from Site 13 (see Map 6-7). *A. trapezoids* and *E. carolinensis* were collected from Sites 14 and 15. Because the earthworm survey was designed to target species that would likely be consumed by American robins, woodcocks, and other birds, collection was done only within the first 15 cm of the soil. It is also likely that some *Lumbicus* species are present; however, these species dwell deeper than 15 cm below the surface (McKeegan per. comm.).

3.2.2 Litter Invertebrates

Litter invertebrates were collected from the litter and woody debris on the forest floor during the earthworm collection work. Table 2-8 identifies the Orders collected and the percentage of total mass for each. Slugs and snails made up the greatest amount of mass.

Sow bugs were the most abundant group, but due to their smaller size, they did not make the greatest mass. A cicada from Site 15 made up the greatest amount of mass due to it large size. Beetles, spiders, harvestman spiders ("daddy long legs"), centipedes, and millipedes were all common. Earwigs and caterpillars were also collected.

Table 2-8 2000 terrestrial litter invertebrate collection results.

Common name	Class	Order	Percent of total mass		
			Site 13	Site 14	Site 15
Millipede	Diplopoda	N/D[1]	1	6	< 1
Centipede	Chilopoda	N/D	< 1	1	5
Sow bug	Crustacea	Isopoda	5	16	12
Spider (general)	Arachnida	Araneida	< 1	1	1
Harvestman spider	Arachnida	Phalangida		1	1
Earwig	Insecta	Dermaptera			5
Cicada	Insecta	Homoptera			40
Beetle	Insecta	Coleoptera	2	3	5
Caterpillar	Insecta	Lepidoptera		1	
Snail	Gastropoda	N/D	30	3	
Slug	Gastropoda	Opisthobrachia	61	68	25
Unknown Larvae		N/D	< 1		5

[1]Order not determined.

4.0 Rare, Threatened, and Endangered Macroinvertebrates

Seven species of freshwater mussels historically known from the Housatonic River drainage are currently species of conservation concern in Massachusetts (Table 2-2). Five of these species, however, were only ever known from Connecticut and four of them have not been seen since they were first documented in the mid-1800s and early 1900s. Two species of concern, the triangle floater and the creeper, were observed in the PSA or at reference sites.

A small population of triangle floater, a species of Special Concern in Massachusetts, was found in the PSA (Map 2-6), and many relic shells were found at the most downstream reference site in Great Barrington, MA (Map 2-7). The triangle floater is found in most Atlantic Coast drainages from North Carolina to Nova Scotia, west to the tributaries of the lower St. Lawrence River. It occurs in every New England state and is also listed as Special Concern in Maine (Nedeau *et al.* 2000). The triangle floater has relatively broad habitat requirements and can occur in slow to fast rivers, in lakes, and on substrates ranging from fine shifting sands to mixed aggregates of boulders, cobble, and gravel (Clarke 1981, Fichtel and Smith 1995, Strayer and Jirka 1997). In the PSA, triangle floaters were found on packed, algae-covered gravel in the eastern half of the channel, but they were not found on fine, shifting sands in the western half of the channel. Water depths in the area ranged from 8 – 50 cm. At the downstream reference site, the substrate was mostly packed gravel. Only relic shells were found in shallow water (i.e., less than 50 cm) deep. No live aniamls were observed, as most areas were too deep to survey with viewing buckets.

Eight creeper shells were found at a downstream reference site near the mouth of the Green River in Great Barrington, MA. Though listed as a species of Special Concern in Massachusetts, the creeper is the most widely distributed species in the United States, occurring throughout the Mississippi, Great Lakes, and St. Lawrence drainages and all major Atlantic Coast drainages. It occurs in every New England state and is listed as Special Concern in Maine (Nedeau *et al.* 2000). The creeper typically occurs in streams and rivers but also occasionally in lakes. It occurs in variable substrates, although it is

usually most common in aggregates of gravel and sand (Clarke 1981, Fichtel and Smith 1995, Strayer and Jirka 1997). At the reference site where it was found, the substrate was mostly packed gravel with moderate flows.

Dragonflies

Six state-listed dragonfly species were historically known from Berkshire County, including one Endangered and five Special Concern species (MNHESP 2000). The species of Special Concern are the skillet clubtail, brook snaketail, ringed emerald, slender emerald, and beaverpond clubtail. The Endangered species is the harpoon clubtail. While none of the six species were collected during the surveys, three additional state-listed species, arrow clubtail, zebra clubtail, and riffle snaketail, were found. All three species have not been recorded as occurring in Berkshire County by the MNHESP (2000). Literature searches, however, revealed that individual observers have recorded these species in the county (Leahy *et al*. 2000).

The arrow clubtail (Figure 2-2) is a moderate-sized dragonfly of eastern North America that normally measures 57–68 mm in length (Needham *et al*. 2000). It prefers high-order rivers, usually with sandy bottoms, although it is rarely found in streams or. It is found along the Atlantic Seaboard as far south as Tennessee, and occurs in the north from Quebec and New England west to the Great Lakes States (Dunkle 2000). This species has been recorded in all New England states except Maine and Rhode Island (Needham *et al*. 2000). In New England, the arrow clubtail is also a species of conservation concern in Connecticut (The Natural Heritage Network 2000).

Emergence periods for the arrow clubtail have been recorded from 23 June to 15 September in Connecticut (Wagner and Thomas 2000), and as late as 18 October in Virginia (Needham *et al*. 2000). Adults perch on grass, shrubs, and treetops while away from the water (Dunkle 2000). Males are most active from late afternoon to dark, and males can be seen patrolling low over the river late in the day during August and September (Nikula 1998, Dunkle 2000).

Figure 2-2 Adult female arrow clubtail.

Arrow clubtail exuviae were collected from Transects 3–8 along the Housatonic River (Maps 2-2, 2-3, 2-4, and 2-8). These transects contain slow-flowing water with sand or soft muck substrate. This dragonfly was also collected from the Threemile Pond SWMA reference area (Map 2-9). This species was ubiquitous during our surveys. Associated dragonfly species are presented in Table 2-4 and Table 2-5. This species has been recorded in six counties in Massachusetts (four in western Massachusetts), including Berkshire County (Leahy *et al*. 2000). In western Massachusetts, the arrow clubtail has been observed along the Connecticut River in Sunderland and Northfield (Nikula and Sones 1998).

The zebra clubtail (Figure 2-3) is a moderate-sized dragonfly that usually measures 57–58 mm in length (Needham *et al.* 2000). It prefers forest streams with slight to moderate current, intermittent rapids, a sand or muck bottom and also, occasionally, lakes (Walker 1958, Dunkle 2000). This species occurs in eastern North America from Nova Scotia to South Carolina, and in the north it occurs west to the Great Lakes States (Dunkle 2000). In the southern part of its range, it occurs inland along the Appalachian Mountains (Dunkle 2000). In Massachusetts, the zebra clubtail is apparently the most widespread of

its genus (Nikula 1998). This species has been recorded in all the states of New England (Needham *et al*. 2000).

Figure 2-3 Adult male zebra clubtail.

Emergence periods for the zebra clubtail have been recorded from late July through August in Maine (Brunelle 1999), 10 August to 11 September in Connecticut (Wagner and Thomas 2000), and as early as 11 June in New York (Needham *et al*. 2000). Unlike most dragonflies, the zebra clubtail may transform from larva to adult during daylight (Legler *et al*. 1998, Needham 1901). The zebra clubtail forages along forest edges and clearings. Males perch on sand, logs, and hanging leaves (Dunkle 2000).

Zebra clubtail were collected from Transects 1–8 along the Housatonic River (Map 2-8). These transects contain fast- and slow-flowing water with sand, cobble, or soft muck substrate. This species was ubiquitous during our surveys; associated species are presented in Table 2-4 and Table 2-5. No collections were made in the reference areas. This species has been recorded in four counties in Massachusetts (three in western Massachusetts), including Berkshire County (Leahy *et al*. 2000). In western Massachusetts, this species has also been found along Hop Brook in Tyringham, the Connecticut River in Sunderland, and the Fort River in Amherst (Nikula and Sones 1998, 1999).

The riffle snaketail (Figure 2-4) is a small-sized dragonfly that usually measures 40–45 mm in length (Needham *et al.* 2000). It inhabits shallow, stony riffles in low order woodland streams (Needham and Westfall 1954), and clear, rapid, sandy, streams and

rivers (Walker 1958, Dunkle 2000). Since the larvae burrow shallowly into the substrate in streams and rivers, they are vulnerable to flood scouring (Dunkle 2000). This species occurs in eastern North America (Dunkle 2000). It is found along the Atlantic Seaboard as far south as Virginia and in the north as far west as the Great Lakes States (Dunkle 2000, Bick and Mauffray 2001). In New England, it is known from all states except Connecticut and Rhode Island (Needham *et al*. 2000).

Emergence periods for riffle snaketails have been recorded for mid-June to mid-July in Maine and as early as 1 May in New York (Brunelle 1999, Needham *et al.* 2000). In Wisconsin, emergence of exuviae occurs on rocks from mid-May to mid-August (Legler *et al*. 1998). Nymphs burrow in silt beds and basins, and upon transformation, they leave their cast exoskeletons flat on sloping banks at the edge of the water (Needham and Westfall 1955). Males perch on exposed tops of boulders (Needham *et al.* 2000) and vegetation along the shore (Legler *et al*. 1998). Away from water, they perch on the tips of plants, broad leaves in clearings and tree crowns, or if the air is cool, on the ground (Dunkle 2000).

Figure 2-4 Adult female riffle snaketail.

Riffle snaketails were collected from Transects 1 and 2 (Map 2-8). No collections were made at any reference areas. Both transects contain riffle and run habitats with sand and cobble substrate. Associated species collected along Transect 1 include the fawn darner and zebra clubtail. Associated species collected along Transect 2 include the fawn

darner, rusty snaketail, and zebra clubtail. In Massachusetts, the riffle snaketail has been observed in three counties in the western part of the state, including Berkshire County (Leahy *et al*. 2000). This species has been found in recent years in Massachusetts on the Green, Westfield, and Farmington Rivers (Nikula 1998).

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Chapter 3 Fish

1.0 Introduction

Fish are found at the upper trophic levels of the aquatic food web, functioning as predators, foragers, and bottom feeders. Given this trophic status, as well as their role as prey for certain mammals and birds, fish are an important component of the modeling study of PCB contamination in the Housatonic River (Beach *et al*. 2000).

Fish populations were qualitatively and quantitatively sampled within the PSA during 1998-2000. Additional surveys (see McCabe 1943, Bergin 1971, Stewart Laboratories 1982, Blasland and Bouck Engineers, P.C. 1991, and Chadwick & Associates 1993, 1994) have also included areas within the PSA. The results of these surveys will be summarized and used to describe the composition of the fish community in the PSA.

2.0 Methods

The fish community within the PSA has been characterized using several methods, including:

- Developing a species:habitat association matrix
- Review of existing fisheries data
- Site-specific electrofishing, trot-line, and netting data from 1998-2000

The PSA has been broken down into reaches, which are described by Beach *et al*. (2000). Using the methods described below, the fish community in the PSA was characterized, with specific reference to reaches. Species-specific biomass estimates are being developed for each reach as part of ongoing investigations in the PSA (Woodlot Alternatives, Inc. *in prep*).

2.1 Species:Habitat Association

Natural communities have been identified and mapped as part of ongoing investigations of the PSA. There are three major communities, or habitat types, in the riverine portions

of the PSA: medium-gradient stream; low-gradient stream; and moderately alkaline lake/pond. Medium-gradient streams can be generally described as moderate-flowing water with sand and gravel substrate and sparse aquatic vegetation, while low-gradient streams can be generally described as slow-moving water with silt and muck substrate, often with abundant aquatic vegetation. Moderately alkaline lake/pond communities include open water, lacustrine habitat with water pH ranging from 7.0 – 9.0 occuring in calcareous bedrock regions. Submergent floating leaved vegetation may be abundant in this community (see Section III, Chapter 1, Natural Communities). Additionally, high-gradient streams, characterized by steep slopes, high water velocity, and course substrates, flow into the river and Woods Pond on the lower slopes of October Mountain in Lee. The fish species known or expected to occur within each of these communities are identified in Attachment C, a species:habitat matrix that also includes a list of special habitat requirements for each species.

2.2 Existing Fisheries Data

Hartel *et al*. (1996) have annotated a working list of the inland fishes of Massachusetts that references both historic and recent scientific investigations of the distribution of fish in the state and within the Housatonic drainage. Some studies (e.g., McCabe 1943, Bergin 1971) have included the Housatonic River. Other fisheries investigations in the PSA have been conducted for the General Electric Company (see Stewart Laboratories 1982; Blasland and Bouck Engineers, P.C. 1991; and Chadwick & Associates 1993, 1994). These existing fisheries data were reviewed as part of the effort to characterize the fish community in the PSA.

2.3 Electrofishing and Netting

Four separate fish collection events occurred within the PSA during 1998-2000. The principle method employed to collect fish was electro-shocking fish (electrofishing) from one or two boats operated by the United States Fish and Wildlife Service (USFWS). Limited use of trot-lines and gill nets also occurred in areas inaccessible to the shock boats. Sample sites for these studies are shown on Maps 3-1, 3-2, 3-3, and 3-4.

In September and October 1998, electrofishing was conducted to collect fish community characterization data and fish tissue. Timed (30-minute) surveys to collect community composition data were conducted between river miles 3 and 4 and between river miles 8 and 11. During each timed event the total number of all fish per species observed was estimated and recorded. In addition, target species within different taxonomic fish groups (e.g., largemouth bass, yellow perch, brown bullhead, common carp) were collected for tissue analysis. These collections occurred along river miles 3 and 7–11, and at Woods Pond. Each fish was weighed and measured prior to processing for analysis. A sample of otoliths and scales were collected from largemouth bass to estimate ages of specimens (USFWS 1999).

In May 1999, largemouth bass and bluegill were collected to support fish toxicology studies. The collection locations for this survey included Woods Pond and the "deep reach" upstream of Woods Pond (modeling Reaches 5C and 5B, in part), to New Lenox Road bridge. Morphometric data collected from specimens included total weight and total length. In addition, otoliths were collected to estimate ages of largemouth bass.

In October 1999, common carp, goldfish, and white suckers were collected from Woods Pond and one backwater north of Woods Pond to support a mink reproductive study. Morphometric data collected from specimens included total weight and total length.

Most recently, sampling efforts to obtain fish biomass data from the PSA were conducted during August and October of 2000 (Woodlot Alternatives, Inc. *in prep*). The objective of this study was to estimate biomass for largemouth bass, goldfish, common carp, bluegill sunfish, pumpkinseed sunfish, cyprinids (golden shiner, common shiner, spottail shiner, or others from family Cyprinidae), brown bullhead, yellow perch, and white sucker in each modeling reach of the Housatonic River (Roy F. Weston, Inc. 2000).

3.0 Fish Community Description

There are 32 families, encompassing 98 species, of native and introduced inland fishes known to currently occur in Massachusetts (Hartel *et al*. 1996). Since the early 1940s, 41 species of fish have been reported from the Housatonic River in Massachusetts (Table

3-1). These surveys have included portions of the PSA, as well as upstream and downstream reaches.

Table 3-1 Fishes of the Housatonic River system.

Species	McCabe	Bergin	Stewart	Chadwick	1998–2000 Surveys
Brook trout	•	•	•		•
Brown trout*	•	•	•	•	•
Rainbow trout*	•	•	•		•
Bluegill*	•	•	•	•+	•
Black crappie*		•	•	•+	•
White crappie*				•	
Green sunfish*			•		
Largemouth bass*	•	•	•	•+	•
Smallmouth bass*	•	•		•	•
Pumpkinseed sunfish	•	•	•	•+	•
Redbreast sunfish	•				
Redear sunfish*			•		
Rock bass*	•	•	•	•+	•
Chain pickerel	•	•	•	•+	•
Redfin pickerel	•				•
Northern pike*				•+	•
Muskellunge*			•		
Tessellated darter		•		•	•
Yellow perch	•	•	•	•+	•
Trout perch[1]	•				
Brown bullhead	•	•	•	•+	•
Yellow bullhead*				•	•
Longnose sucker	•	•		•	
White sucker	•	•		•+	•
Creek chubsucker	•	•			
Blacknose dace	•	•		•+	•
Bluntnose minnow				•+	
Bridle shiner	•				
Common carp*				•+	•
Common shiner	•	•		•+	•
Creek chub	•	•		•+	
Fallfish	•	•		•+	•
Fathead minnow*				•	
Golden shiner	•	•		•+	•
Goldfish*		•		•+	•
Longnose dace	•	•		•+	•
Spottail shiner		•		•+	•
Killifish sp.		•			
Banded killifish				•	
Burbot		•			
Slimy sculpin	•	•			
Species Richness	25	27	14	28	25
References:	Bergin (1971) Chadwick & Associates (1993 and 1994)			McCabe (1943) Stewart Laboratories (1982)	

*Species introduced to Massachusetts; +Chadwick & Associates collections from primary study area (20 species)

[1] The trout-perch (*Percopsis omisomaycus*) was collected at the mouth of the Green River in the Housatonic River drainage (Great Barrington) by Britton McCabe in 1940-42. Surveys between 1978-1990 failed to locate this species and it is presumed extirpated from Massachusetts (Hartel *et al*. 1996).

Surveys in the PSA have generally been conducted for specific purposes, such as obtaining biomass estimates or tissue samples, and were not intended to be exhaustive taxonomic inventories. The most recent surveys by Chadwick & Associates (1993, 1994) and the present study resulted in the collection of 28 and 25 species, respectively. The Chadwick & Associates collections from within the PSA, however, included only 20 species. The results of the Chadwick & Associates collections from within the PSA and the present study were combined to develop a list of the 27 fish species recently confirmed to occur in the PSA. An additional 10 species potentially occur based on the range of the species and the habitat in the PSA. These 37 species are indicated in the species:habitat matrix in Attachment C.

The lake chub (*Couesius plumbeus*) is an endangered species (state-listed) that could hypothetically occur in the upper reaches of the PSA. The likelihood of this occurrence, however, is so low that the species is not included on the species:habitat matrix. It is not known at this time if the American eel (*Anguilla rostrata*) historically occurred in the PSA or if the American brook lamprey (*Lampetra appendix*) currently exists in the Housatonic River watershed. Considering this, these two species are not included on the species:habitat matrix.

Surveys conducted in 2000 illustrate the composition of the fish communities within each reach of the PSA. Table 3-2 documents the composition of the fish community based on biomass (total grams of fish caught) and is summarized by feeding strategy (i.e., predators, forage fish, and bottom feeders).

Pooling all sample reaches, the five dominant fish species were white sucker, largemouth bass, yellow perch, bluegill, and common carp. Largemouth bass and yellow perch can be classified primarily as predators, bluegills are forage fish, and white suckers and common carp are bottom feeders. The dominant five species, therefore, encompass all three major feeding strategies.

White suckers are clearly the dominant fish species in Reaches 5A and 5B. They still represent the greatest component of the sample biomass in Reach 5C, but decline to a smaller component of the fish community in the Backwaters and Woods Pond (Figure

3-1). In Reach 5C, as well as in the Backwaters and Woods Pond, common carp become a more common member of the bottom-feeding guild. Goldfish and brown bullhead also represent significant proportions of the bottom-feeding guild in the Backwaters and Woods Pond.

Bluegills, pumpkinseed, cyprinids, and rock bass share dominance of the forage fish group, which comprised 11 – 24 percent of the overall fish community (based on biomass) in Reaches 5A – 5C and the Backwaters. Bluegills, however, were abundant in Woods Pond, where they represented 30 percent of the total biomass sample, and where forage fish as a group comprised 40 percent of the overall fish community. Largemouth bass and yellow perch were the predominant predators in all reaches.

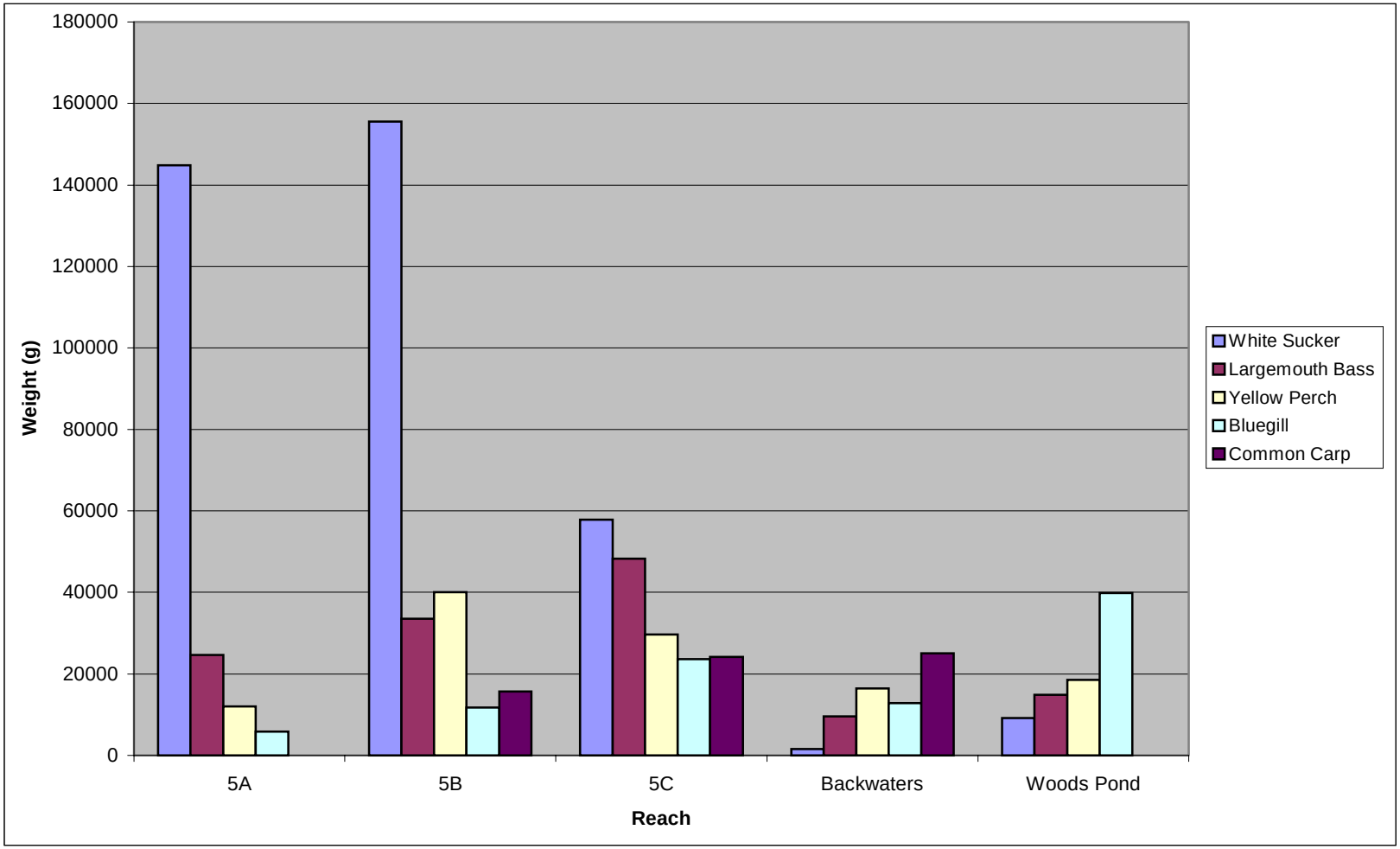
Table 3-2 2000 fish biomass sampling results.

Feeding Strategy and Species	Reach									
	5A		5B		5C		Backwaters		Woods Pond	
	Total Weight (g)	% of Total Sample	Total Weight (g)	% of Total Sample	Total Weight (g)	% of Total Sample	Total Weight (g)	% of Total Sample	Total Weight (g)	% of Total Sample
Predators										
Largemouth Bass	24,701.5	11.1	33,471.5	11.6	48,302.7	21.0	9,558.1	9.2	14,899.2	11.2
Smallmouth Bass	894.8	0.4	458.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Yellow Perch	12,070.0	5.4	40,048.3	13.9	29,683.2	12.9	16,405.7	15.7	18,576.9	14.0
Northern Pike	6,268.0	2.8	8,038.0	2.8	6,526.5	2.8	3,401.2	3.3	6,671.6	5.0
Chain Pickerel	492.0	0.2	701.5	0.2	2,315.1	1.0	371.5	0.4	134.5	0.1
Redfin Pickerel	633.5	0.3	1,130.5	0.4	667.6	0.3	0.0	0.0	26.6	0.0
ChainxRedfin Hybrid	0.0	0.0	0.0	0.0	432.5	0.2	0.0	0.0	0.0	0.0
Brown Trout	225.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rainbow Trout	1,006.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predator Subtotal	*46,290.8*	*20.8*	*83,848.3*	*29.0*	*87,927.6*	*38.2*	*29,736.5*	*28.5*	*40,308.8*	*30.4*
Forage Fish										
Bluegill	5,764.5	2.6	11,665.2	4.0	23,642.4	10.3	12,874.9	12.4	39,783.8	30.0

Feeding Strategy and Species	Reach									
	5A		5B		5C		Backwaters		Woods Pond	
	Total Weight (g)	% of Total Sample	Total Weight (g)	% of Total Sample	Total Weight (g)	% of Total Sample	Total Weight (g)	% of Total Sample	Total Weight (g)	% of Total Sample
Bluegill Hybrid	45.0	0.0	356.0	0.1	14.0	0.0	25.8	0.0	137.0	0.1
Pumpkinseed	709.1	0.3	5,014.5	1.7	8,213.2	3.6	6,132.5	5.9	7,632.9	5.8
Cyprinids	11,611.3	5.2	3,609.6	1.2	1,582.1	0.7	110.9	0.1	259.0	0.2
Black Crappie	301.5	0.1	1,110.5	0.4	2,629.6	1.1	3,574.7	3.4	712.0	0.5
Rock Bass	12,533.0	5.6	11,432.8	4.0	18,776.0	8.2	0.0	0.0	3,974.1	3.0
Forage Fish Subtotal	*30,964.4*	*13.9*	*33,188.6*	*11.5*	*54,857.3*	*23.9*	*22,718.8*	*21.8*	*52,498.8*	*39.6*
Bottom Feeders										
White Sucker	144,843.8	65.2	155,596.2	53.8	57,845.0	25.2	1,557.0	1.5	9,205.8	6.9
Brown Bullhead	0.0	0.0	0.0	0.0	4,234.1	1.8	9,582.5	9.2	17,866.3	13.5
Yellow Bullhead	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	113.5	0.1
Common Carp	0.0	0.0	15,649.2	5.4	24,172.1	10.5	25,079.0	24.1	10.0	0.0
Goldfish	0.0	0.0	827.0	0.3	897.5	0.4	15,505.0	14.9	12,523.0	9.4
Bottom Feeder Subtotal	*144,843.8*	*65.2*	*172,072.4*	*59.5*	*87,148.7*	*37.9*	*51,723.5*	*49.6*	*39,718.6*	*30.0*
Total	***222,099.0***	***100.0***	***289,109.3***	***100.0***	***229,933.6***	***100.0***	***104,178.8***	***100.0***	***132,526.2***	***100.0***

Note: Sample sizes in each reach were roughly equal.

Figure 3-1 Weight of dominant fish captured during 2000 biomass sampling.



3.1 Reach 5A and 5B Fish Community – Confluence to Roaring Brook

Reach 5 includes the area from the confluence of the East and West Branches of the Housatonic to the backwaters of Woods Pond. In this 13-km (8.0-mile) reach the channel slope is very shallow (0.31 m/km), and the riverbed elevation drops 3.96 m to the confluence of Woods Pond. Reach 5 is characterized by two flow regimes; one is relatively free flowing (Reaches 5A and 5B) and the other (Reach 5C) is subject to the backwater influences of Woods Pond Dam.

Reach 5A, downstream of the confluence of the East and West Branches to the WWTF, and Reach 5B, downstream from the WWTF to the confluence with Roaring Brook, are characterized as a free-flowing river that is oriented roughly NNW–SSE. These reaches include a wide floodplain, numerous meanders and remnant oxbows, and riverbanks that are generally scoured and eroded. The width of the meandering river in the free-flowing section is about 15 – 36 m with depths up to 3 m. Reflecting the generally slow current velocity of this flat reach, the sediment bed consists of coarse to fine sands with approximately ten percent silts and clay.

Fourteen species of fish were captured in Reach 5A during the 2000 biomass sampling events. Fifteen were collected in Reach 5B. White suckers, a bottom feeder, and largemouth bass, a predator, accounted for over 75 percent of the biomass in the samples from Reach 5A (Table 3-2). In Reach 5B, white suckers, yellow perch (a predator), and largemouth bass represented greater than 75 percent of the biomass. These reaches, which are dominated by two or three species, are less structurally balanced when compared to the downstream sub-reaches (i.e., 5C, the Backwaters, and Woods Pond), which are dominated by five or six species that include predators, forage fish, and bottom feeders.

3.2 Reach 5C Fish Community – Roaring Brook to Backwaters

Reach 5C, downstream of the confluence with Roaring Brook, is the section of Reach 5 where flows begin to be influenced by a backwater effect from the Woods Pond Dam. The river, oriented approximately N–S, is characterized by a broad wetland floodplain

(approximately 243 – 915 m wide) on the west bank with numerous backwater areas, channels and meanders. The inundated remnant floodplain is easily visible in this section of the river as broad and shallow backwater "embayments" with stands of emergent vegetation, submerged aquatic vegetation, and surface algal mats. The steep slopes of October Mountain confine the narrow floodplain on the east bank of the river, and the width of the river channel ranges approximately 18 – 48 m with depths of 1.2 – 2.4 m. Under high flow conditions, the numerous backwater areas are hydrologically connected to flow in the main river channel; under low flow conditions, however, the backwater areas are largely isolated from the influence of flows in the main river channel. The depositional sediment bed (in the river channel) is characterized by fine sands and silt.

Sixteen species of fish were captured in Reach 5C during the 2000 biomass sampling events. Five species, however, accounted for more than 75 percent of the biomass in the 2000 sampling in Reach 5C: white sucker (bottom feeder), largemouth bass (predator), yellow perch (predator), common carp (bottom feeder), and bluegill (forage fish).

3.3 Reach 6 Fish Community – Woods Pond and Backwaters

Woods Pond is a broad, shallow 24-ha impoundment of the Housatonic River formed by the construction of the Woods Pond Dam in the late 1800s. The adjacent upstream deep channel (Reach 6A) and backwater areas (Reach 6B) account for an additional 25 ha. The remnant river channel on the eastern and southern shores of Woods Pond is considerably deeper (maximum depth approximately 5 m) than the shallower depths (approximately 0.3 – 0.9 m) of the remnant floodplain that is characterized by stands of submerged and emergent macrophytes and dense surface algal mats. A deep hole, characterized by a depth of 4.8 m, is located in the southeastern area of the remnant stream channel (Reach 6C). The hole is further characterized by a thick deposit (approximately 4.9 m) of soft silt-clay sediments that has accumulated over the past +/- 100 years or so since construction of the Woods Pond Dam. In the shallow remnant floodplain areas of Woods Pond (Reach 6D), the sediments are characterized as silt with a high organic content. Although the broad, shallow areas of Woods Pond are well mixed, the region defined by the hole exhibits thermal stratification during the summer.

Fourteen species of fish were captured in the Backwater Reach during the 2000 biomass sampling events. Sixteen were collected from Woods Pond. Six species accounted for more than 75 percent of the biomass in the Backwaters: common carp (bottom feeder), yellow perch (predator), goldfish (bottom feeder), bluegill (forage fish), brown bullhead (bottom feeder), and largemouth bass (predator). In Woods Pond, five species accounted for more than 75 percent of the biomass, including bluegill (forage fish), yellow perch (predator), brown bullhead (bottom feeder), largemouth bass (predator), and goldfish (bottom feeder).

4.0 Rare, Threatened, and Endangered Fish

No rare, threatened, or endangered fish species listed by MNHESP (1999) have been confirmed to exist in the PSA by recent investigations. Two species—bridle shiner and longnose sucker—hypothetically could occur in the PSA. The trout-perch has recently been declared extirpated from Massachusetts, but it was last found at the confluence of the Green River and the Housatonic in Great Barrington, downstream of the PSA (Hartel *et al*. 1996).

The bridle shiner is a small warm-water minnow of creeks, ponds, rivers, and lakes with clear to moderately stained water. In Massachusetts it is listed as a species of Special Concern (MNHESP 1999). The bridle shiner is discontinuously distributed along the middle Atlantic coastline, from Virginia to southern Maine and inland through New York, where its range extends to Lake Ontario and the upper St. Lawrence River (Page and Burr 1991). Much of Massachusetts is within a large gap in this range, although this species can be found in extreme southwestern portions of the state. McCabe (1943) documented the bridle shiner in the Housatonic, Westfield, Chicopee, and southern Connecticut Rivers. It has not been found in subsequent fisheries surveys in the Housatonic River in the vicinity of the PSA (Bergin 1971, Stewart Laboratories 1982, Chadwick & Associates 1993, 1994). Whitworth (1996), however, states that it is found in all major drainages of Connecticut, including the Housatonic River. It should therefore be considered to potentially occur in the PSA.

The longnose sucker is listed as a species of Special Concern in the State of Massachusetts. They are similar to the white sucker, but extensive surveys during 1998 – 2000 in the PSA failed to locate this species. Longnose suckers in Massachusetts are found in cool upper sections of streams and rivers in the western part of the state, specifically in the main channels and tributaries of the Hoosic River, Housatonic River, and sections of the Connecticut River (MNHESP 1994a).

The trout-perch was known from two sites in western Massachusetts: (1) the Hoosic drainage in Williamstown; and (2) the Housatonic River at the mouth of the Green River in Great Barrington. The last time they were captured on the Housatonic was in the early 1940s, and surveys from 1978 – 1990 have failed to locate this species (Hartel *et al.* 1996).

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Chapter 4 Reptiles and Amphibians

1.0 Introduction

The reptiles and amphibians (hereafter called herptiles) in the PSA were studied over a three-year period, from 1998 to 2000. To conduct this work, several work plans were prepared that either targeted specific species or the herptile community as a whole (Roy F. Weston, Inc. 2000). A community-wide assessment, culminating in this report, was designed to characterize the herptile community in the PSA by mapping available habitats, assessing the quality of those habitats, and conducting surveys to document the presence of herptiles and their use of the available habitats. Some of the targeted surveys were conducted to collect specific species for tissue analysis or for off-site reproduction assessments (Roy F. Weston, Inc. 2000). Another study investigated reproductive indices of amphibians breeding in pools within the PSA (Woodlot Alternatives, Inc. *in prep*).

To characterize the community, a literature review of local species and populations was conducted along with the collection of field data. Field data collected as part of the targeted species surveys were used to supplement data collected for community-wide characterization purposes.

2.0 Methods

2.1 Species:Habitat Association

The goal for the characterization of the study area herptile community was to identify all species that could reasonably be expected to occur, the habitats they would use, and the timing of that use. The foundation of this work included a review of relevant literature on the reptile and amphibian populations in western Massachusetts. Local and regional references on herptile communities in the PSA were first used to identify the species whose range encompassed the study area (DeGraaf and Rudis 1983, Conant 1986, Klemens 1993, DeGraaf and Yamasaki 2001). General and technical references on the habitat requirements and use, seasonality of occurrence, and relative abundance in the region were then used to refine the list and build a matrix to include only those species

whose preferred habitats occur within the PSA (Wright and Wright 1949, Bishop 1943, Pfingsten and Downs 1989, Ernst *et* al. 1994, Petranka 1998, Hunter *et al.* 1999, DeGraaf and Yamasaki 2001).

As part of this effort, local and regional experts were consulted to obtain unpublished records regarding the historic occurrence of some species in the area. For example, the Massachusetts Natural Heritage and Endangered Species Program and the Massachusetts Division of Fisheries and Wildlife (MDFW) were contacted to identify historic or recent occurrences of rare reptiles and amphibians in the vicinity of the PSA.

Field surveys were then conducted to compliment the information compiled on the species matrix (Attachment C). Field surveys largely focused on determining species' presence, although several methods were used to more quantitatively document species and their relative abundance or to sample animal tissues, and are described below. Observations recorded in the field were used to refine the matrix to accurately depict habitat use and seasonality of occurrence for all herptiles species expected to occur in the primary and reference study areas.

2.2 Incidental Observations

Herptile presence in the PSA was documented during year-round field investigations in 1998, 1999, and 2000. Many of those field investigations supported ecological risk assessment surveys. Those investigations provided an opportunity to confirm the presence of reptiles and amphibians within the PSA by recording incidental observations of any species seen. During the course of those other investigations, herptiles observed within the PSA and reference areas were recorded, along with the habitat that they occurred in. When appropriate, other notes were recorded, including activity, interactions with other species, and general health.

2.3 Visual and Acoustic Surveys

General, reconnaissance-level surveys of the herptile community were conducted using a method often referred to as visual encounter surveys (Crump and Scott 1994). These types of surveys consist of traveling through a site and searching for herptiles. The exact search method used varied with the habitat and species. For example, the shoreline and shallow water of backwater habitats were searched in spring for basking frogs and turtles and frog and salamander egg masses. In wooded areas, rocks and logs were overturned to located terrestrial salamanders and snakes. When animals were observed, notes on location, species, habitat, and activity were recorded and used to modify the species matrix.

2.4 Breeding Pool Surveys

More detailed surveys were also conducted to document the occurrence of spring breeding habitats (i.e., vernal pools) and to document use of those habitats by various herptiles. Aerial photographs and topographic maps of the PSA were reviewed to identify areas that could potentially provide spring breeding habitat for herptiles. Efforts were made to identify isolated, temporary pools (vernal pools) in well-vegetated habitats (Figure 4-1). These types of temporary aquatic areas can be important breeding habitat for a number of frogs and salamanders, and some species may require these habitats exclusively (Kenney 1995). However, other breeding habitats, including open backwater areas associated with Woods Pond, were also identified.

Sixty-eight potential breeding areas were visited (Map 4-1) and MNHESP Vernal Pool Data Sheets, defining the site conditions and species use, were filled out for each area (Attachment E). Not all pools met the definition of a vernal pool as defined by Kenney (1995). For example, spotted salamander egg masses were observed in some backwaters of the river. Because these areas, while not meeting the strict vernal pool definition, represented suitable breeding habitats for some amphibians, including vernal pool species, data sheets were completed. To document species occurring in the pools, the shoreline of each area was searched and species observed were recorded, as was the type of observation such as adult, larvae, or egg mass. In some areas, dip nets were used to

capture individuals for positive identification. Dip nets were also used to identify aquatic invertebrates, potential predators and food sources for larval amphibians, in each pool. Finally, data on the location, size, and habitat within and around each pool surveyed were recorded.

Figure 4-1 Typical floodplain vernal pool in mid-April and mid-June.

This pool, 38-VP-2, is on the west shore of the river, upstream of New Lenox Road.

2.5 Aquatic Funnel Trap Surveys

Aquatic funnel traps (AFTs) were used to sample larval amphibians and aquatic invertebrates in 17 pools during 1998 (Map 2-5). Ten AFTs (Figure 4-2) were randomly placed in each of the pools selected for sampling. AFTs were placed in the pools either in the evening, and collected the following morning, or in the early morning, and collected several hours later. Pools were trapped three times from mid-May to mid-June 1998. The time and date when traps were placed in and removed from the pool were recorded on data sheets. Water temperature, pH, conductivity, and dissolved oxygen were also recorded on data sheets.

Figure 4-2 An aquatic funnel trap being removed from pool.

Contents were then filtered to collect larval amphibians and aquatic invertebrates.

When traps were collected, the total number of larval amphibians, by species, was recorded and a sample of 25 individuals per species were measured (total and tail length for tadpoles, total and snout-vent length for salamander larvae) from each trap (Figure 4-3). Specimens were checked for gross external deformities, and returned to pools.

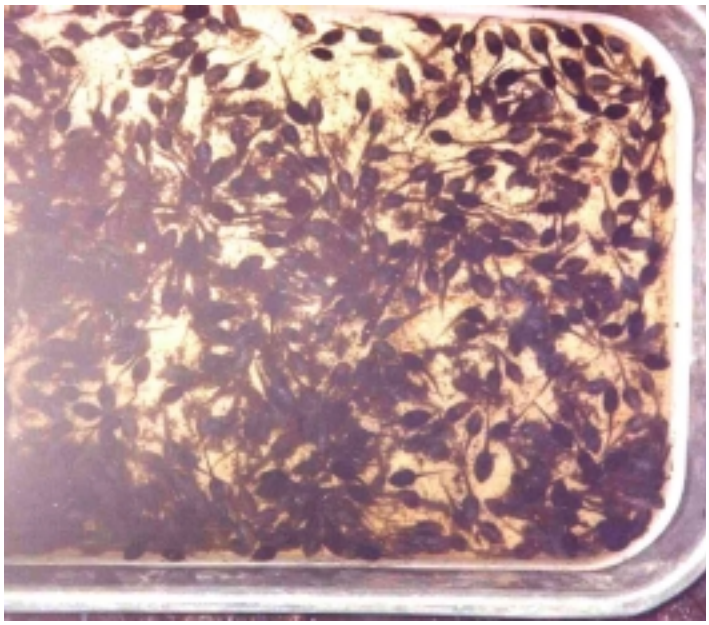

Figure 4-3 Wood frog tadpoles.

Tadpoles were counted after being caught in aquatic funnel traps.

2.6 Pitfall Trap Surveys

Pitfall traps were constructed around four pools (8-VP-1, 8-VP-2, 38-VP-2, and 46-VP-5) in 1999 (see Map 4-1) (Woodlot Alternatives, Inc. *in prep).* Traps were placed along plastic drift fencing (Figure 4-4) and all individuals entering and exiting the pools were captured, identified to species, sexed, weighed, measured for total length, tail length, hind leg length, and foreleg length. During 2000, drift fences and pitfall traps were used to capture metamorphosed wood frog juveniles emerging from the pools at 8-VP-1, 18-VP-1, 23B-VP-1, 23B-VP-2, 38-VP-1, 38-VP-2, 46-VP-1, 46-VP-5 (Map 4-1), and three pools in the October Mountain State Forest reference area designated as WML-1, WML-2 and WML-3. Pit traps were also installed throughout the PSA to capture breeding leopard frogs during 1999 and 2000. Incidental species captured in pit traps were recorded.

Figure 4-4 Drift fencing and pit traps encircling a vernal pool.

3.0 Reptile and Amphibian Community Descriptions

3.1 Herptiles

Herptile populations in the PSA are diverse. Sixteen reptile and 19 amphibian species could potentially occur in the PSA, based on range, habitat requirements, and habitat availability. Only four (25 percent) of the potentially occurring reptiles were documented in the PSA, whereas 14 (75 percent) of the amphibians were documented. This discrepancy may be due to the different reproductive strategies these species exhibit that make them more, or less, observable. Frogs and salamanders, for example, tend to

congregate during the breeding season, with the frogs vocalizing to attract mates. This makes theses species quite obvious and simple to document using even the most general survey methods. Even among the reptiles, the turtles have reproductive strategies and daily habits that make them more observable, such as overland travel to nesting sites and basking on rocks and logs, and three of the possible seven species were documented in these situations. Snakes, by contrast, live largely solitary lives, have cryptic coloration, and usually utilize structurally complex microhabitats that make them difficult to observe. Consequently, only two of the nine species potentially occurring in the PSA were observed.

3.2 Reptiles

The potential reptile community within the PSA consists of 13 snake species and 7 turtle species (Attachment C). Only two species of snake, the garter snake and northern water snake, were observed in the study area. Three turtle species were observed: common snapping turtle, painted turtle, and wood turtle. The snapping turtle and painted turtle were common and seen in most riverine and wetland habitats. The wood turtle, a species of Special Concern, was rarely observed (see Section 4.0).

3.2.1 Snakes

The northern water snake, northern brown snake, northern redbelly snake, common garter snake, ribbon snake, northern ringneck snake, northern black racer, eastern smooth green snake, and eastern milk snake could potentially occur in the PSA. Only the common garter snake and northern water snake were observed. The garter snake is ubiquitous and was found in a variety of wetland and terrestrial habitats. It was observed at the edges of isolated pools, in transitional floodplain forest, red maple swamp, shrub swamp, and in most of the terrestrial community types. Garter snakes were also observed swimming across the river. During pitfall trapping efforts, garter snakes were routinely observed traveling along the drift fencing and occasionally seen swallowing wood frogs (Figure 4-5).

Figure 4-5 Common garter snake.

Common garter snakes were commonly seen near pit trap areas in transitional floodplain forests where they preyed on wood frogs (look closely to see the wood frog in this snake's mouth).

A single northern water snake was observed swimming in Woods Pond near the footbridge during the summer of 2000. This was the only sighting of this species despite the presence of suitable habitat.

Of the remaining snake species expected to occur in the PSA, many tend to favor upland rather than wetland habitats. Since investigations focused largely on wetland habitats, it is not surprising that fewer species of snakes were observed. One species, however, the ribbon snake, routinely uses wetland habitats but was not observed in the PSA. It is a semi-aquatic species, inhabiting grassy and shrubby stream edges, ponds, bogs, vernal pools, and wet woodlands.

3.2.2 Turtles

Seven turtle species potentially occur in the study area: common snapping, common musk (or stinkpot), spotted, wood, bog, eastern box, and painted turtle. Of these, snapping and painted turtles are common and were routinely observed in the Housatonic River, adjacent backwaters, and pools. Wood turtles, a species of conservation concern in Massachusetts, were recorded at several PSA locations (Section 4.0).

Snapping and painted turtles were largely associated with aquatic communities, being observed most often in backwaters of deep emergent marsh, although both species were seen in the river channel itself. Snapping turtles were more uniformly

distributed through the PSA, being commonly found in backwaters, shallow and deep emergent marshes, and vernal pools. Painted turtles, however, appeared to utilize deep emergent marshes over other habitats.

Snapping turtles were also observed in more terrestrial habitats, presumably while traveling to temporary feeding or nesting areas. Several small snapping turtles were caught in pitfall traps placed in transitional floodplain forests near the confluence of the East and West Branch Housatonic River and just north of New Lenox Road. Additionally, adults were observed in a large number of vernal pools. The seasonal abundance of invertebrates and, perhaps more importantly, amphibian larvae likely attract snapping turtles to these areas. Turtles were also observed nesting in the PSA. Several snapping turtles nests were found along the Springfield Terminal Railroad tracks along the west side of the river. Painted turtles were seen nesting along road shoulders, and hatchlings were observed in the gravel pits, which provide excellent nesting habitat, north of the Pittsfield WWTF (Figure 4-6).

Figure 4-6 Female painted turtle laying eggs.

The wood turtle (Figure 4-7) is a Special Concern species in nearly every state of its range, which extends from Nova Scotia, southern Quebec and Ontario, south into northernmost Virginia, and west to northern Michigan, Wisconsin, and Minnesota (see section 4.0). Wood turtles prefer slow moving streams with sandy bottoms and heavily vegetated banks and were observed in this type of habitat along the West Branch and northern East Branch of the Housatonic River during 1998 and 1999. During the spring and summer wood turtles make long daily movements, through both upland and wetland

habitats, searching for mates, traveling to nesting sites, and foraging. Wood turtles are omnivorous, feeding in water or on land. They consume a variety of vegetation, grass, moss, mushrooms, berries, insects (aquatic and terrestrial), tadpoles, fish, and carrion. Wood turtles can often be found in vernal pools during the spring, where they take advantage of the abundant food items. Several wood turtle observations in the PSA occurred in or near vernal pools (Map 4-2).

Figure 4-7 Adult wood turtle.

The spotted turtle and common musk turtle would be expected to occur in similar habitat as the painted turtle in the PSA. However, neither was observed during any of our surveys. The spotted turtle is uncommon in New England and listed as a species of Special Concern in Massachusetts (see Section 4.0). The small size and secretive habits of the common musk turtle makes observation of this species difficult; it is nocturnal and highly aquatic, emerging from the water only to nest. The bog turtle occurs in open sphagnum bogs, wet meadows, and clear meadow streams. It is Endangered in Massachusetts, having been documented in only three locations in the state. The eastern box turtle is also Special Concern species and is the most terrestrial turtle potentially occurring in or near the PSA. Even though the PSA is within the known ranges and contains suitable habitats for these turtles, none of these species were found during the extensive field investigations from 1998 – 2000.

3.3 Amphibians

Due to life history characteristics that make them more visible, 14 of the 19 amphibians identified as potentially occurring in the PSA were confirmed (Attachment C). Breeding populations within the PSA were recorded for most of these species. Of the 68 breeding pools that were originally surveyed in 1998, temporary pools supported an average of 4.4 species per pool, while semi-permanent to permanent pools supported an average of 6.0 species per pool (Table 4-1). Wood frogs and spotted salamanders were the most common species breeding in temporary vernal pools. Leopard frogs, green frogs, bullfrogs, and red-spotted newts were more common in the semi-permanent pools and backwaters connected to the Housatonic River.

Table 4-1 Species use of 68 vernal pools in the PSA.

Pool Designation	Pool Habitat*	Permanency	Snapping turtle	Wood turtle	Painted turtle	Garter snake	Red-spotted newt	Spotted salamander	Jefferson salamander	Red-backed salamander	Four-toed salamander	American toad	Spring peeper	Gray treefrog	Northern leopard frog	Pickerel frog	Wood frog	Green frog	Bullfrog	Fairy shrimp	Total No. Species
5-VP-1	SEM	T																		A	1
5-VP-2	SEM	T																			0
5-VP-3	SS	P	A	A								T	A		A			A	A		7
8-VP-1	DEM	T	A		A	A	A , J	A,E,L		A		A	A	A	A		A,E,T	A	A	A	14
8-VP-2	SEM/SS	T	A		A	A						A	A		A		A,E,T	A	A	A	10
8-VP-3	SS	T																		A	1
8-VP-4	DEM	P						E									E			A	3
8-VP-5	SS	T															E , T			A	2
8-VP-6	SS	T																A			1
12-VP-1	SS	P						E					A	A			E , T				4
18-VP-1	DEM/SS	T											A		A		A,E	A	A	A	6
18-VP-2	DEM/SS	T				A	A	E				A	A , T		A , T	A	A,E,T	A		A	10
19-VP-1	SEM	T															A,E,T			A	2
19-VP-2	SEM	T																		A	1
19-VP-3	SEM	T																	A		1
19-VP-4	SEM	T																	A		1
19-VP-5	SEM	T			A										A	A	A	A	A		6
19-VP-6	DEM	P			A								A		A		A	A	A		6
19-VP-7	SEM	T													A		A,E,T	A	A		4
19-VP-8	SEM	P			A										A		A	A	A		5
23-VP-1	SS	T																			0
23-VP-2	SEM	T																			0
23-VP-3	DEM	P	A		A													A	A		4
23A-VP-1	DEM/SS	P	A				A	E	E				A		A , E		T	T			8
23B-VP-1	SS	T	A		A , J	A						A	A		A , T		A,E,T	A	A	A	10
23B-VP-2	SS	T			A , J	A						A	A		A , T		A,E,T	A	A	A	9
26-VP-1 (A+B)	SS	T				A		E					A		A		E				5

Pool Designation	Pool Habitat*	Permanency	Snapping turtle	Wood turtle	Painted turtle	Garter snake	Red-spotted newt	Spotted salamander	Jefferson salamander	Red-backed salamander	Four-toed salamander	American toad	Spring peeper	Gray treefrog	Northern leopard frog	Pickerel frog	Wood frog	Green frog	Bullfrog	Fairy shrimp	Total No. Species
27-VP-1	DEM	P			A										A		E , T	A			4
27-VP-2	DEM	P	A		A	A												A	A		5
27A-VP-1	SEM	T						E										A		A	3
27B-VP-1	TFF	T												E				A	A	A	4
27B-VP-2	TFF	T															E , T	A		A	3
27B-VP-3	TFF	T															E , T	A		A	3
33-VP-1	TFF	T																		A	1
33-VP-2	SS	T											A							A	2
38-VP-1	SEM	T	A			A	J	E , L		A			A		A		A,E,T	A	A	A	11
38A-VP-1	SS	T						E									E			A	3
38-VP-2	SEM	T	A		A	A	A , J	A,E,L				A , T	A		A		A,E,T	A	A	A	12
38-VP-3	SEM	T						E									E			A	3
39-VP-1	DEM	P			A		A	E							A		E , T				5
40-VP-1	SEM	T						E					A	A	A		A	A			6
40-VP-2	DEM/SS	P			A								A	A	A		A	A			6
40-VP-3	DEM/SEM	T					A					T	A	A	A		A	A,E			7
40A-VP-1	SEM	T																			0
42-VP-1	DEM	T											A		A , E		A,E,T	A,T	A		5
42-VP-2	SEM	T											A		A		A,E,T	A	A		5
42-VP-3	DEM	T											A		A		E , T	A	A		5
42-VP-4	DEM	T										E	A		A						3
42-VP-5	SEM	T															E , T				1
42A-VP-1	DEM	P											A		A			A			3
46-VP-1	SS	T	A		A	A		E , L				A , T	A		A		A,E,T	A	A	A	11
46-VP-2	DEM/SS	P			A		A	E										A			4
46-VP-3	DEM	P			A			E										A			3
46-VP-4	RMS	T															E				1
46-VP-5	RMS	T	A		A	A	A , J	A,E,L	A , E	A	A	A	A		A		A,E,T	A	A	A	15
49-VP-1	DEM	P					A											A,T			2

Pool Designation	Pool Habitat*	Permanency	Snapping turtle	Wood turtle	Painted turtle	Garter snake	Red-spotted newt	Spotted salamander	Jefferson salamander	Red-backed salamander	Four-toed salamander	American toad	Spring peeper	Gray treefrog	Northern leopard frog	Pickerel frog	Wood frog	Green frog	Bullfrog	Fairy shrimp	Total No. Species
49A-VP-1	SS	T					A	E									E	A			4
49B-VP-1	TFF	T						E							A		A	A	A		5
54-VP-1	DEM	P	A				A	A				A	A	E	A	A	A	A	A,T		11
55-VP-1	DEM	P			A								A					A	A		4
55A-VP-1	DEM	P	A				A , J	A				A			A	A	A	A	A		9
56A-VP-1	DEM	P					A	E					A		A						4
58A-VP-1	DEM	P	A				A	E		A		A	A		A , E	A	A,E	A	A		11
61A-VP-1	DEM	P	A				A	A		A		A	A		A	A	A	A,T	A		11
61A-VP-2	DEM	P	A		A		A	E		A		A	A		A , E	A	A,T	A	A,T		12
66A-VP-1	RMS/SS	T						E , L									T	T			3
67A-VP-1	DEM/SS	T						E													1
69-VP-1	SEM/SS	T						E													1
Number of Pools Species Occurred in:			16	1	19	11	17	28	2	6	1	16	30	7	34	7	42	43	29	24	
Percent Frequency of Occurrences***:			24	1	28	16	25	41	3	9	1	24	44	10	50	10	62	63	43	35	

* Habitats
SEM = Shallow Emergent Marsh
DEM = Deep Emergent Marsh
SS = Shrub Swamp
TFF = Transitional Floodplain Forest
RMS = Red Maple Swamp

T = Temporary
P = Permanent

Average Number of Species in Temporary Pools: 4.4
Average Number of Species in Permanent Pools: 6.0

Includes species captured in Aquatic Funnel Traps.

** Letter indicates Life Stage Observed, as Follows:
A = Adult
E = Egg mass
T = Tadpole(s)
L = Larvae

*** Percent Frequency of Occurrence = (No. of Pools Species Observed In/Total No. of Pools)*100

3.3.1 Toads and Frogs

Frogs were the most commonly observed group of herptile species and eight of the nine potentially occurring species were observed in the PSA. Wood frogs and American toads were common in nearly all the terrestrial and wetland habitat types. Spring peepers and gray treefrogs, although rarely seen, were heard in a variety of habitats, predominately floodplain forest vernal pools and shallow emergent marshes. Northern leopard frogs and pickerel frogs are semi-terrestrial and were observed in most of the wetland habitats, predominately emergent marsh communities during the breeding season and wet meadows during the summer. Northern leopard frogs were the most common of these two species, being found throughout the PSA, while the distribution of pickerel frog was somewhat limited. Green frogs were abundant in backwaters and pools throughout the entire PSA. Bullfrogs were also common throughout the PSA, but they were most abundant during the long summer breeding period in large open wetlands, particularly the backwaters near Woods Pond. Individual bullfrogs, however, were observed in transitional floodplain forests, red maple swamps, and vernal pools.

Wood frogs were the most abundant species in the PSA and were a target of two detailed studies. In 1999, a large number of adults and recently metamorphosed juveniles were trapped as part of a study on the reproductive success of amphibians in four vernal pools of the PSA (Figure 4-8 and Figure 4-9) (Woodlot Alternatives, Inc. *in prep)*. Wood frogs are terrestrial except during the breeding season, when they congregate in small, usually temporary pools. During the 1998 vernal pool survey, 81 percent of the pools containing wood frog eggs or tadpoles were temporary pools.

Figure 4-8 Adult wood frogs captured in pit traps.

Captured during the 1999 vernal pool amphibian reproductive study. Note the spotted salamander barely visible among the frogs along the right hand side of the pit.

Figure 4-9 Wood frogs in amplexus.

Amplexus is the mating position in which the male tightly grips the female, signaling her to begin laying eggs.

Wood frogs are explosive breeders, arriving at breeding pools in mass, mating, laying eggs, and returning to their terrestrial habitat within a matter of days. This explosive breeding occurred during the last week of March or first week of April during the three years of investigation. Petranka and Thomas (1995) noted that 80 percent of adult wood frogs breed within a three-day period. Wood frogs lay 2,000 – 3,000 eggs surrounded by a globular, gelatinous mass, attached to submerged twigs (Knox 1999a) (Figure 4-10).

Figure 4-10 Wood frog egg masses.

These egg masses are attached to dogwood branches at the edge of a vernal pool. Female wood frogs often lay their egg masses in a communal aggregation such as this.

After hatching, tadpole metamorphosis occurs in 6 – 15 weeks depending upon site conditions. In 1999, metamorphs began leaving their pools in mid-June, but in 2000, they did not leave until early July, despite the fact that breeding occurred on very similar dates during both years (Figure 4-11). This difference could be in response to the drier pool conditions observed in 1999, which has been suggested to stimulate an earlier, faster metamorphosis by tadpoles (Wilbur and Collins 1973, Duellman and Trueb 1986).

Figure 4-11 Wood frog metamorph.

Recently metamorphed wood frog with remnant tail.

Spring peepers were also common in nearly all the habitat types in the PSA (Figure 4-12). Though they were not seen or captured as often as other larger species, their chorusing revealed that they were abundant. Breeding populations were densest in a series of semi-permanent shallow emergent marshes and temporary pools immediately

north of New Lenox Road, along the shallow backwater edges north of Woods Pond, the extensive marshes of Yokum Brook and Willow Creek, at Washington Mountain Lake, in a reference permanent pool in October Mountain State Forest, and in the calcareous wet meadows north of Threemile Pond.

Figure 4-12 Spring peeper

The characteristic dark cross or "X" pattern on the back, gives the spring peeper its specific epithet of *crucifer*.

Spring peepers forage among the leaf litter, woody debris, tree bark, and vegetation near the forest floor. Small spiders are the common prey item, making up more than 48 percent of the diet (Knox 1999b). Mites, ants, beetles, ticks, leafhoppers, nematode worms, and caterpillars are also commonly eaten.

The gray treefrog is a treefrog found in the PSA. They were less common than spring peepers, being heard at only a few locations and never captured or seen. Lack of observations is likely due to their arboreal habits and their ability to climb over drift fences and out of pits. Except for their breeding season, gray treefrogs spend all their time hidden beneath the bark and cavities of trees. In the PSA, they were commonly heard calling from the same pools as spring peepers. Both sexes reach sexual maturity after their second winter.

American toads were the only toads observed in the PSA (Figure 4-13). Fowler's toads could potentially occur, but none were observed during the three years of study. American toads were relatively uncommon in the open and forested wetland communities

of the PSA, but they were more common in terrestrial habitats. American toad eggs and tadpoles were found in many vernal pools, semi-permanent pools, shallow riverine backwaters, and marshes. American toad egg masses were most common in warm, shallow roadside ditches and ruts of seldom used dirt roads in the October Mountain State Forest reference area.

Figure 4-13 Male American toad vocalizing during breeding season.

The northern leopard frog and pickerel frog are two closely related semi-terrestrial frogs found in the PSA. Leopard frogs are the more abundant of the two in the PSA; however, in some localized areas such as Threemile Pond and Muddy Pond in the Hinsdale Flats SWMA, pickerel frogs outnumbered leopard frogs.

Two taxa of leopard frogs were formally recognized: northern and southern. Within New England the northern leopard frog is found from Maine south into Massachusetts and Connecticut along the Housatonic and Connecticut River valleys. Southern leopard frogs occur immediately south of New England and to the west in eastern New York. Within this region, northern and southern leopard frogs are difficult to distinguish by visual observation alone and populations may overlap. Klemens (1993) reports that these species can be separated based on dissection and presence or absence of vestigial oviduct in the males. He found that leopard frogs collected from the Housatonic watershed more closely resembled southern leopard frogs (that former taxon is now a species called *Rana utricularia*) collected in northern New Jersey and southeastern New York than other northern leopard frogs in New England. Individuals from the Housatonic River might be

more accurately placed within the southern leopard frog taxon, they might belong to a unique taxon, or they might be a hybrid population. Either way, further research is needed to accurately identify this population. For the purposes of this investigation, the common consensus of available literature suggests the population within the PSA to be northern leopard frogs.

Leopard frogs breed in ponds, marshes, shallow slow moving streams, bogs, semi-permanent and temporary pools in April and May (Figure 4-14). In the PSA, leopard frogs were heard calling and egg masses were seen most commonly in shallow, vegetated backwaters associated with the Housatonic River and the marsh systems of Yokum Brook and Willow Creek. Metamorphs were common in September of 1998 and 1999 and were observed crossing a variety of riparian habitats. A large number of leopard frogs and egg masses were collected in 1999 and 2000 as part of a leopard frog reproduction laboratory study (Roy F. Weston, Inc. 2000). A number of leopard frogs were also caught in pitfall traps during the 1999, vernal pool amphibian reproduction study. Adult and juvenile leopard frogs were caught throughout the study period, which extended from early April to mid-July. Individual animals were caught entering and leaving the vernal pools, presumably during typical feeding and movement habits.

Figure 4-14 Northern leopard frog.

Round spots with halos and white dorsolateral lines are characteristic of northern leopard frogs.

The pickerel frog is closely related to the leopard frog and these two species generally have similar habits and life history (Figure 4-15). Like the leopard frog, pickerel frogs were found in open wet meadows, marshes, and wet woodlands during the summer months. However, far fewer pickerel frogs were observed compared to leopard frogs, with less than a dozen documented during the three years of field investigations. The preponderance of emergent wetlands and wet meadow habitats in close proximity to the river likely make the PSA slightly more suitable for leopard frog populations than pickerel frogs (Mairs 1999). Conversely, pickerel frogs were more common at the Threemile Pond SWMA reference area, where few leopard frogs were observed.

Figure 4-15 Pickerel frog.

Pickerel frog showing bright yellow-orange coloration on undersurface of hind legs and squared off blotches on back.

Green frogs (Figure 4-16) were abundant in the more aquatic habitats in the PSA. They were also commonly caught in pitfall traps at vernal pools in transitional floodplain forests and red maple swamps. Those areas are used as summer foraging grounds because some of the common prey of green frogs—beetles, flies, grasshopper, and caterpillars (Hamilton 1948)—are found at vernal pools then.

Figure 4-16 Male green frog.

The sex of a male green frog can be determined by the diameter of the tympanum (eardrum), which is larger than the eye in males.

Green frogs were documented breeding within the PSA. Egg masses (Figure 4-17) were found at two locations, both of which were semi-permanent pools and ponds filled with deep and shallow emergent marsh vegetation. Characteristic egg mass locations for green frogs consist of shallow water in permanent water bodies, likely because the larval period, in the northern parts of its range, lasts for at least one full year (Stockwell 1999). Efforts did not focus on locating their egg masses in permanent water bodies and, consequently, none were found. However, based on calls heard at those habitats, green frogs breed in these areas within the PSA.

Figure 4-17 Green frog egg mass.

Green frog egg mass containing up to 5,000 eggs in a large flat mass floating on the water surface among aquatic vegetation.

Bullfrogs are closely related to green frogs and share many similar traits. They are the largest North American frog, with adults commonly exceeding eight inches in length (snout to vent length). Bullfrogs are highly aquatic and rarely found away from water. They were most common in the backwaters north of Woods Pond, where they were heard calling throughout the summer months. However, they commonly traveled from the river to nearby vernal pools in transitional floodplain forests and red maple swamps, where they took advantage of the high densities of prey items.

Breeding occurs in deep permanent water with emergent vegetation, and less commonly in semi-permanent pools, from late May to July. The calling heard from many of the backwaters indicates that bullfrogs are indeed breeding in the PSA. Bullfrogs were captured from the PSA in 1999 for tissue analysis (Roy F. Weston, Inc. 2000). During that time period 29 individuals were captured in upper and lower portions of the PSA. Bullfrogs were also captured at the Threemile Pond (12 individuals) and Hinsdale Flats (11 individuals) SWMA reference areas. This work was conducted as part of ecological risk assessment, but also for the assessment of human health risks, as some people eat bullfrogs.

3.3.2 Salamanders

Ten species of newts and salamanders may occur in the PSA. Of these, seven were recorded in the PSA.

Red-spotted newts (Figure 4-18) are common throughout the eastern United States and were abundant in the backwaters near Woods Pond, in oxbows, backwater channels, and permanent pools associated with the river throughout the PSA, as well as in the river itself. Only in the upper two miles, where the river travels between steep banks, were newts noticeably absent. Red efts, the juvenile, terrestrial stage of the red-spotted newt, were also observed throughout the PSA (Figure 4-19). Red-spotted newts were common in Threemile Pond, Washington Mountain Lake, and a semi-permanent pool in October Mountain State Forest.

Figure 4-18 Red-spotted newt adult.

Figure 4-19 Red eft.

Red eft is the terrestrial juvenile stage of the red-spotted newt.

Newts are unique in that they are the only eastern salamander that has three distinct stages in their life cycle. Breeding occurs in the spring in shallow bodies of water with soft bottoms and vegetation. The larvae spend 5 – 7 months in aquatic habitats during which time they have a keeled tail and external gills. The gills shrink throughout the summer, until they disappear completely during fall metamorphosis, when the newts take on the color and body shape of the terrestrial juvenile stage, known as the red eft stage. The efts leave the water for terrestrial woodland habitats, where they spend the next 3 – 7 years. A second metamorphosis then occurs when the red efts become sexually mature, at which time they migrate back to aquatic habitats, where they take on the characteristics of the adult form, and spend the remainder of their life in the water.

Four of the salamanders potentially occurring in the PSA—spotted, Jefferson, blue-spotted, and marbled salamanders—are known as the mole salamanders because of their burrowing habits. These relatively large, robust salamanders (Figure 4-20) occur in forested habitats throughout the eastern United States. All of these species breed in temporary vernal pools, but they show slightly different trends in breeding. Spotted salamander is the only member of the group that is common in Massachusetts, with the remainder being species of conservation concern.

Figure 4-20 Spotted (upper two) and Jefferson salamanders.

The spotted and Jefferson salamanders are two of the four mole salamanders in western Massachusetts.

Spotted salamander adults, eggs (Figure 4-21), and larvae were common in many of the vernal pools throughout the PSA. They were found in 28 of the 68 vernal pools originally surveyed in 1998 (Table 4-1). Spotted salamanders are usually identified as an obligate vernal pool species (i.e., species that presumably breed only in the absence of fish in temporary pools). Klemens (1993), however, identifies a number of other habitats used for breeding, including floodplain swamps, marshes, bogs, margins of lakes and reservoirs, and beaver ponds, among others. Similar, varied habitat use was documented in the PSA and reference areas. While spotted salamanders were routinely documented in vernal pools, breeding activity and egg masses were also in shallow backwater habitats. Adults were also captured in pit-fall traps along the shoreline of the river.

These pitfall traps were on the opposite shore from the nearest suitable non-breeding habitat (i.e., upland hardwood forest), indicating that these salamanders do, in fact, cross and use these more permanent water bodies.

Figure 4-21 Spotted salamander egg masses.

Spotted salamander egg masses are often characterized by a milky opaque jelly capsule, with 50 to 150 eggs.

During the breeding period, male spotted salamanders migrate to breeding pools first, followed by females a few days later. This usually occurs at the very beginning of April in the PSA. Both sexes may travel as far as 120 m (400 feet) from nonbreeding territory to a breeding pool (Madison 1997). Spotted salamanders tend to congregate in large numbers after the first warm spring rain, and breed in mass. Males deposit spermatophores on the bottom of the pools during an elaborate courtship of nudging, intertwining, and tail fanning. The females then pick up the spermatophores and store them in their cloaca for egg fertilization. These spermatophores can be seen littering the bottom of pools immediately following breeding events. Spotted salamanders show a high degree of fidelity to breeding pools, returning to the same location year after year. Whitford and Vinegar (1966) reported that 86 percent of marked spotted salamanders returned to the same pool after one year and 77 percent returned the second year, with an estimated annual mortality of 10.5 percent.

Interestingly, an un-spotted spotted salamander was found in the PSA (Figure 4-22). While this animal was originally thought to be a hybrid between a spotted and Jefferson salamander, because of the lack of spots and a thinner, more streamlined body form,

further investigation has found that adults lacking spots do occur in low frequencies in certain populations and that this individual was most likely a spotted salamander (Husting 1965, Easterla 1968, Petranka 1998).

Figure 4-22 Spotted salamander without its usual markings.

Note faint pigment spots located on the side of the neck, just in front of the right foreleg, and on base of tail.

Jefferson salamanders were less common than spotted, occurring only at vernal pool 46-VP-5 in the red maple swamp south of New Lenox Road and at a semi-permanent pool in October Mountain State Forest (Maps 4-2 and 4-3). The timing of breeding and breeding habitat requirements for Jefferson salamanders is very similar to spotted salamanders, although Jefferson salamanders usually show up a few days before spotted salamanders. Jefferson salamander egg masses are deposited a few days after courtship, in small masses contained within a gelatinous coating that adhere to aquatic vegetation or submerged branches (Figure 4-23).

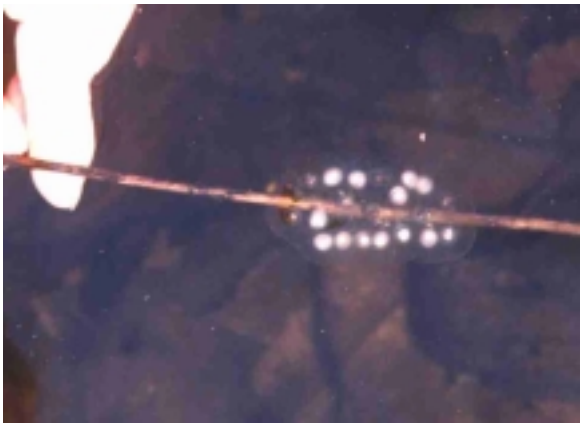

Figure 4-23 Jefferson salamander egg mass.

Masses are smaller, sausage-shaped, and contain fewer eggs than spotted salamander egg masses – usually around 30 (Klemens 1993).

The Jefferson salamander, blue-spotted salamander, and their hybrids form a group known as the Jefferson complex (see Section 4.0). Visually, these species and hybrids are difficult to distinguish and often electrophoretic evidence is the only method to identifiy an individual with certainty. However, in general, Jefferson salamanders are uniformly grayish brown and have larger egg masses. Blue-spotted salamanders and the hybrids usually have varying amounts blue flecks and deposit their eggs singularly or in small groups of 2 to 4 (Knox 1999b). The hybrids, which usually have varying amounts of faint blue flecks or undertones, tend to produce intermediate-sized egg masses.

Marbled salamanders are unique among the mole salamanders found in the PSA in that they breed in the fall (September to October). Marbled salamanders congregate in dry vernal pools and courtship takes place under the leaf litter. The eggs are then deposited individually in a nest, usually in a small cavity under a log or leaf litter. The female remains to guard her eggs until fall rainwater floods the pools, inundating the eggs. Hatching is triggered by inundation and occurs a few days after the pool fills with water. Marbled salamander eggs are able to withstand extended desiccation without mortality and in some cases when the pool fails to flood in the autumn, eggs may be able to overwinter and hatch in the spring (Klemens 1993).

All adult mole salamanders are terrestrial when not breeding, spending their lives predominately underground in burrows or beneath large decaying logs and rocks. They

often utilize small mammal tunnels and burrows but will excavate their own if necessary. A study in New York found that 80 percent of the small mammal tunnels utilized by spotted salamanders during the summer were short-tailed shrew burrows, but overwintering sites were either white-footed mice burrows or rock recesses (Madison 1997). Their home ranges are small, but largely unreported. One tracking study found spotted salamanders using an area of only 0.03 m^2 (0.3 square feet) around their burrows (DeGraaf and Yamasaki 2001). Burrows are located within the proximity of breeding pools, usually within 213 m (700 feet) (Kleeberger and Werner 1983, Madison 1997, Semlitsch 1998). Mole salamanders spend most of the year within their burrows, foraging nocturnally for earthworms, snails, slugs, and larval and adult insects, particularly beetles. Mole salamanders may occasionally forage aboveground, under the leaf litter during rainy periods, but stay within close proximity to their burrows. The only above-ground travel done by mole salamanders is during the spring or fall migration to and from breeding pools and by newly metamorphosed juveniles dispersing from the pools.

The remaining salamanders expected to occur in the vicinity of the PSA, which include northern dusky, northern two-lined, spring, four-toed, and redback salamander, are all members of the plethodontid family. These salamanders have no lungs and absorb oxygen through their moist skin and membranes in their throat. Their physiology requires these salamanders to inhabit cool, moist habitats. They mostly use terrestrial habitats, such as mesic upland forests or small high-gradient streams on rocky slopes, so they would not be expected to be common in the PSA because of the presence of forests that are flooded one or more times annually.

The northern redback salamander, the only entirely terrestrial salamander in New England, was the most commonly observed of these species, although sightings were infrequent. In many forested communities these small salamanders make up a large percentage of the total vertebrate biomass. In the Hubbard Brook Experimental Forest in New Hampshire, red-backed salamanders have been estimated to have a biomass of 1,770 g/ha (Burton and Likens 1975) and densities of approximately one per square yard have been reported from southern Maine (Witham 1999). They are most abundant in well-

drained upland habitats and typically avoid extremely wet bottomland areas. Within the PSA they were most common near the upland edges of transitional floodplain forests.

The northern dusky salamander, northern two-lined salamander, and northern spring salamander require undisturbed high-gradient stream or spring communities such as those found on October Mountain. They are not likely to occur in the PSA in any significant numbers, with the possible exception of Roaring Brook and no effort was made to specifically target these species during our survey effort. The only observations of these species were one sighting of a northern spring salamander crossing Woodland Road in the vicinity of Roaring Brook on a rainy night in the summer of 1999, and one northern two-lined salamander captured in a pit trap near Yokum Brook in 2000.

Finally, one four-toed salamander was captured in a pitfall trap in a red maple swamp (Figure 4-24). This species is typically found in wet forests and bogs. It breeds in small pools or slow moving streams in boggy, mossy areas, where it lays its eggs, sometimes communally. The pool where this individual was caught, 46-VP-5, is surrounded by suitable habitat (red maple swamp and black ash-red maple-tamarack calcareous seepage swamp) that is infrequently flooded.

Figure 4-24 Northern four-toed salamander captured in PSA.

Note the four toes and slight constriction, or narrowing, at the base of the tail. This individual dropped its tail soon after, a habit characteristic of this species as predator defense.

4.0 Rare, Threatened, and Endangered Reptiles and Amphibians

Nine species listed by the MNHESP potentially occur in the PSA, including one Endangered, one Threatened, and seven Special Concern species. Turtles represent four of these while salamanders make up the remaining five.

4.1 Reptiles

The wood turtle was the only reptile of conservation concern in the PSA that was actually observed. Wood turtles were once common throughout New England but are currently rare. They are listed as Special Concern in Massachusetts, Maine, Vermont, and Connecticut. In Massachusetts only 153 sightings were recorded in 97 locations from 1978 to 1994 (MNHESP 1994a). Since 1998, eight wood turtles were documented in the PSA. Over two days in May 1998, two males and a female were observed in the vicinity of the confluence. Another nearby occurrence (less than a quarter mile away) not long afterwards included a female with eggs that was struck and killed by a car in Pittsfield. While the death of one breeding-age female may be significant to small populations, the discovery of that particular female indicated that wood turtles are indeed attempting to breed and nest in the PSA.

The remaining listed turtles include the spotted, eastern box (both Special Concern), and bog turtle (state Endangered). The bog turtle, while extremely unlikely to occur in the PSA due to its affinity for fens, has a known range from Berkshire County south into Connecticut. Furthermore, the wet meadows and shrub swamps of the PSA could provide marginal habitat for them. Box turtles are highly terrestrial and would therefore not be expected to use the PSA. Suitable adjacent habitat along October Mountain, however, would allow for infrequent use of the PSA by box turtles, if they occur there. They are known from the Hinsdale Flats SWMA reference area (T. Gulo, MDFW, personal communication).

While several state listed snakes (such as black rat, northern copperhead, and timber rattler) have historically occurred in western Massachusetts, no recent occurrences are known from the PSA. Additionally, since these species would not typically use the wetland habitats here, none are expected to occur.

4.2 Amphibians

Five salamanders of conservation concern potentially occur within or next to the PSA: Jefferson, blue-spotted, spring, and four-toed salamanders (all Special Concern), and the marbled salamander (Threatened). Three of these species, Jefferson, spring, and four-toed salamanders, were observed in the PSA during 1998 – 2000 field studies.

The Jefferson salamander, blue-spotted salamander, and their hybrids compose the Jefferson complex. Members of this complex form a continuum in appearance from the grayish-brown coloration, pale blue flecks, and wide snout of the Jefferson salamander to the bluish-black coloration, prominent blue spots, and narrow snout of the blue-spotted salamander. It is believed that these two species originated from a common ancestor during the last Ice Age when glaciers separated the two populations. After the glacier retreated, the two populations met in New England and the Great Lakes Region, where they now commonly interbreed (Klemens 1993). The parent species normally have two sets of chromosomes and are known as diploid. Their hybrids, however, have three sets of chromosomes (triploid) and are almost always females (Petranka 1998). The hybrids having two sets of Jefferson genes and one set of blue-spotted genes are called the silvery salamander, while those hybrids having two sets of blue-spotted genes and one set of Jefferson genes are called the Tremblay salamander. These hybrids are not easily identified based on morphological characteristics, and laboratory tests are needed to positively identity them. One study conducted in Maine found that 70 percent of blue-spotted salamanders were hybrids (Knox 1999b). In areas where hybrids occur they usually outnumber the parent species two to one, resulting in females being twice as common as males. Hybrids are also commonly found in populations where only one of the parent species is known to occur.

The Jefferson salamander and its hybrids are listed as a species of Special Concern in Massachusetts. Forty-four populations are currently known in Massachusetts, primarily in the western part of the state in the Connecticut and Housatonic River valleys (MNHESP 1994b). This species occurs from southern New Hampshire south through Massachusetts and Connecticut west of the Connecticut River, into southern New York, Pennsylvania, south into West Virginia, and west into Kentucky and southern Indiana

(Petranka 1998). Jefferson salamanders range from locally common to rare in New England. Jefferson salamanders were documented breeding in one pool in the PSA (Map 4-2). Males and females were captured at this pool in 1999 and egg masses were observed. Jefferson salamander egg masses were also observed in one pool on October Mountain State Forest, near the access road to Washington Mountain Lake (Map 4-3).

The blue-spotted salamander is also listed as a species of Special Concern in Massachusetts. Ninety-nine populations have currently been documented in Massachusetts, predominately from east of the Connecticut River Valley. These populations are comprised of blue-spotted salamanders and their hybrids. Blue-spotted salamanders can be found discontinuously from the Gulf of Saint Lawrence across southern Canada to Lake Winnipeg and south throughout New England, New York, and northern Ohio, Indiana, and Illinois (Petranka 1998). The only known populations of genetically pure blue-spotteds in the northeast occurs on Prince Edward Island, Canada, and on Long Island, New York. Though widely distributed, blue-spotted salamanders are locally uncommon and threatened in much of their southern range. Blue-spotted salamanders prefer moist, shaded northern hardwood and hemlock forests, with shallow vernal pools for breeding. They were not found in the PSA.

The Marbled salamander is currently listed as a Threatened species in Massachusetts. Forty-three current populations are known to exist in Massachusetts (MNHESP 1994c). Populations in Massachusetts occur primarily east of the Connecticut River and in the Berkshire hills of western Massachusetts. This species occurs from southern New Hampshire and Massachusetts, west across southern New York and Pennsylvania to Missouri, south into eastern Texas, the Mississippi basin, and the panhandle of Florida (Petranka 1998). The marbled salamander is uncommon throughout New England, primarily because it is at its northernmost limit here. This species is found in well-drained sandy and gravelly soil in mixed deciduous woodlands, especially oak-maple and oak-hickory. Populations are small and localized in New England, occurring in forested uplands within a 213-m (700-foot) radius of breeding pools (DeGraaf and Yamasaki 2001).

The northern spring salamander is a species of Special Concern in Massachusetts and Maine and is listed as Threatened in Connecticut. This species is uncommon through most of its range. It occurs from south-central Maine, New Hampshire, and Vermont, south through the Appalachian Mountains and foothills to northern Georgia and northeastern Mississippi, west to eastern Tennessee, Kentucky, and Ohio, with the exception of the Atlantic costal plain (Petranka 1998). Within Massachusetts 37 populations have been verified from the western two thirds of the state (MNHESP 1994d). Northern spring salamanders are locally common in northwestern Berkshire County and southern Vermont. These salamanders have no lungs and must absorb oxygen through their skin and membranes in their throat (Markowsky 1999). They are large salamanders and have a small surface area, relative to their mass, through which to absorb oxygen. This restricts northern spring salamanders to cold (<12º C) water bodies with a high degree of dissolved oxygen. Northern spring salamanders are found only in undisturbed areas, as they are especially susceptible to stream degradation. One spring salamander was found crossing the Woodland Road in the vicinity of Roaring Brook, at the southern end of the PSA.

The four-toed salamander is listed as a species of Special Concern in Massachusetts, Vermont, and Maine (The Natural Heritage Network 2000). This species is widespread in Massachusetts with records from over 40 locations throughout the state, but it is still considered relatively rare (MNHESP 1994). The four-toed salamander occurs from southern Maine, New Hampshire, and Vermont west through New York, around the Great Lakes into Wisconsin, and south through the Appalachian Mountains to Georgia and Mississippi. The main habitat requirement for this species is wet moss within the vicinity of open water. In Massachusetts, four-toed salamanders are most commonly found in swamps dominated by red maple and white cedar. Due to the four-toed salamanders diminutive size, retiring habits, and nocturnal behavior, it is seldom observed and may therefore be more common than believed, especially considering the abundance of suitable habitat in New England (Burgason 1999). Two four-toed salamanders were captured in pitfall traps surrounding vernal pool 46-VP-5 during the 1999 vernal pool amphibian reproduction study (Woodlot Alternatives, Inc. *in prep*).

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Chapter 5 Birds

1.0 Introduction

The avian community in the PSA was studied over a three-year period, from 1998 to 2000. To characterize the community, a literature review of local bird species and populations was conducted along with the collection of field data. Field data included methods targeted at specific species, as well as more general, reconnaissance-level investigations of species' presence, relative abundance, and habitat use.

2.0 Methods

2.1 Species:Habitat Association

A major goal for characterization of the bird community in the PSA was to identify all species that could reasonably be expected to occur, the habitats they would use, and when they would use them. The foundation of this work included a review of relevant literature on bird populations in western Massachusetts. An array of local and regional references on bird communities in the PSA was first used to identify the species whose range encompassed the study area (Andrle and Carroll 1984, Veit and Petersen 1993, Bevier 1994, DeGraaf and Yamasaki 2001). General and technical references on the habitat requirements and use, seasonality of occurrence, and relative abundance in the region were then used to refine the list and build a matrix to include only those species whose preferred habitats occur within the PSA (Bellrose 1980, Ehrlich *et al.* 1988, Sauer *et al.* 2000, DeGraaf and Yamasaki 2001).

As part of this effort, local and regional experts were consulted to obtain unpublished records regarding the historic occurrence of some species in the area. For example, the MNHESP, the MDFW, and the USFWS were contacted to determine present or historical occurrences of species of conservation concern, and the Berkshire Museum and the Massachusetts Audubon Society were consulted to determine if any records of raptors from the Housatonic River drainage were available from surveys sponsored or conducted

by these agencies. Any information received from these agencies, organizations, and individuals was then incorporated into the species matrix.

Field surveys were conducted to compliment the information compiled in the species matrix. These surveys focused on determining species' presence, although several methods were used to quantitatively document relative species and their abundance, or to sample animal tissues, as described below. Observations that were recorded in the field were used to refine the matrix to accurately depict the habitat use and seasonality of occurrence for all bird species expected to occur in the primary and reference study areas.

2.2 Incidental Observations

The presence of birds within the PSA was documented during field investigations in 1998, 1999, and 2000. Many field investigations were detailed studies in support of ecological risk assessment surveys and consisted of specific methods targeted at collecting animals from a variety of taxonomic groups to sample their tissues. Those investigations, however, provided an opportunity to confirm the presence of birds within the PSA by recording incidental observations of birds seen. During the course of those other investigations, birds observed within the PSA and reference areas were recorded, along with the habitat that they occurred in. When appropriate, other notes were recorded, including activity, interactions with other species, and general health.

2.3 Waterfowl Trapping

Waterfowl were trapped and collected in 1998 to provide tissue samples to USEPA as part of a human and ecological risk assessment. Two floating traps and one clover-leaf walk-in trap were used to capture waterfowl in backwaters near Woods Pond from 27 August to 16 September, 1998 (Map 5-1) (Figure 5-1). Trapping was conducted to supplement a sample of wood ducks and mallards captured by the MDFW in Woods Pond and adjacent backwaters. Three traps were also placed at the Threemile Pond SWMA reference area.

Figure 5-1 Clover-leaf walk-in type trap.

2.4 Wading and Marshbird Surveys

Marsh and wading bird surveys were conducted in 1998 using playback point counts to identify species utilizing the PSA wetlands. Forty-seven survey stations were established on seven general survey routes (Map 5-2). Survey routes were selected based on the location of suitable deep and shallow emergent habitat. Individual survey stations were established at a density of approximately one point per 4.9 ha of wetland.

Wading bird use was assessed using the methods described by Gibbs and Melvin (1993). The survey routes were visited three times from 8 June to 9 July 1998. Visits occurred between 30 minutes before, to approximately four hours after, sunrise. All marsh and wading birds seen or heard during a 15-minute period prior to the start of a survey were also recorded. Playbacks from a portable cassette player (Figure 5-2) were broadcast at each station for Virginia rail, sora, green heron, American bittern, least bittern, American coot, common moorhen, pied-billed grebe, and king rail. Approximately 50 seconds of calls per species were broadcast, interspersed with 10 seconds of silence. Additional information recorded at each survey location included wetland name, start- and end-time, observer, date, visit number, wind speed, cloud cover, precipitation, responses per species, and all other wildlife sightings.

Figure 5-2 Wading bird survey in PSA.

2.5 Hawk and Owl Surveys

Playback point counts (Kennedy and Stahlecker 1993) were used to survey hawks and owls (i.e., raptors) within the PSA and in three reference areas in 1999. Owls were surveyed on five occasions from February to June, and hawks were surveyed on three occasions from May to August. Within the PSA, hawk transects were positioned along the Housatonic River, from the confluence of the East and West Branches to Woods Pond. Owl transects were positioned along the Woodland Road in October Mountain State Forest near Woods Pond, and along the railroad tracks north of Lenox Station (Map 5-3). Hawk surveys were conducted at all reference areas (Maps 5-4, 5-5, and 5-6), while owl surveys were conducted only at Threemile Pond (Map 5-6). Point count locations were set at intervals of approximately 305 m (1,000 feet). At each survey point, playback calls were broadcast at 60°, 180°, and 300° for 10 seconds followed by 30 seconds of silence between each call. This was repeated with calls for the eight species of hawks or five species of owls expected to occur in the PSA and reference areas (Fuller and Mosher 1981, Veit and Petersen 1993).

Playbacks began with smaller-sized species and proceeded to larger species to avoid suppressing the responses of smaller species with the initial playbacks of the larger species. Approximately 10 minutes were spent at each point, during which time all hawks and owls observed or heard were identified and recorded. Additional data recorded included type of observation (e.g., call, visualization) and behavior. Hawk surveys were conducted between one half-hour before sunrise to sunset, while owl surveys were conducted one half-hour after sunset to sunrise. Raptor transects were visited a minimum of three times during the breeding and post-breeding seasons (Fuller and Mosher 1981). Surveys were not performed when weather conditions were considered detrimental to nesting raptors with eggs or young (i.e., temperature or precipitation stress).

2.6 Belted Kingfisher Nest Surveys

In 1998, surveys for belted kingfisher nest sites were conducted to assist the USEPA in determining if this species would be a suitable candidate for a more detailed study. Surveys were conducted by canoe in the PSA. During the surveys, kingfisher activity and observation locations were recorded and riverbanks were inspected for potential kingfisher nest sites. Nest sites were identified based on the size of the excavated hole according to measurements from Bent (1940). Potential nest sites were photographed and mapped. Additional data including bank height, bank soil type, and top-of-slope vegetation were recorded.

2.7 Forest Bird Surveys

Point counts with unlimited distance were conducted in 1998 to identify the forest birds within the PSA (Blondel *et al*. 1981) (Map 5-7). Sixteen survey sites were selected to sample the forested habitat types and were distributed, or stratified, according to the abundance of each habitat type. Sample points were separated by a minimum distance of approximately 488 m (1,600 feet) to reduce the chance of overlap of bird observations (Ralph *et al.* 1993). Each point was visited once in late June 1998 during the early morning hours (i.e., one half-hour before sunrise to four hours after sunrise). At each point, all birds seen or heard during a 20-minute sampling period were recorded.

Additional information recorded at each survey location included date, start- and end-time, percent cloud cover, degree of precipitation, wind speed and direction, temperature, natural community type, dominant species of overstory, sapling, shrub, herb, and woody vine stratums, and mean and maximum tree height. Five photographs were taken at the survey points: one in each of the four cardinal directions and one vertically to document canopy composition. Results of point counts were used to revise the bird species matrix.

3.0 Bird Community Description

Birds represent the most diverse assemblage of vertebrate species in the PSA. A total of 173 species were identified as potentially occurring in the vicinity of the PSA (Attachment C). Of these, 122 are passerines (songbirds and forest birds), 19 are raptors (hawks and owls), and 32 are water birds (wading, marsh, and shore birds, waterfowl, and gulls). The list of species expected to occur was based on the review of scientific literature, historical surveys, and local and regional references on species distribution. Of those species expected to occur, 101 occur only during the breeding period, 50 occur year-round, 12 only during migration, and 10 only in winter. Nearly 80 percent of these, or 139 species, were confirmed to occur in or near the PSA during the three years of field investigations.

The diversity of the bird community is largely due to the diverse nature of the habitats available within the PSA. The preponderance of large, open aquatic communities surrounded by forested and scrub-shrub habitats in the lower part of the PSA (i.e., Woods Pond and its backwaters) allows for use by waterbirds as well as many of the forest and shrub-associated landbirds. Ducks and geese were common in this area, as were green and great blue herons. The emergent and shrub swamp borders of these areas provide nesting habitat for a number of wetland-dependent species such as red-winged blackbirds and swamp sparrows. Swallows, cedar waxwings, and nighthawks feed over these habitats. Kingfishers also commonly use these areas, as well as the river, while hunting. The almost daily observations of kingfisher throughout the growing season indicates that they are likely nesting in the study area. Surveys for nest sites in 1998 indicated that there are suitable nesting locations, some of which appear to be used.

The middle and upper sections of the PSA are composed of a mixture of forested communities adjacent to open, largely agricultural lands or wet meadow habitat. These areas are suitable for a different assemblage of birds than those using Woods Pond and the adjacent backwaters. For example, far fewer waterfowl and marshbirds were observed north of Yokum Brook than south of it, but many of the forest songbirds observed during point counts occurred from Woods Pond to the Holmes Road. Species common to these areas included habitat specialists that require forested habitats, such as the thrushes and wood warblers, and habitat generalists that are found in a variety of habitats, such as the American robin, black-capped chickadee, and blue jay.

The forested wetland communities of the PSA generally provide habitat for the most number of bird species, from 88 species in red maple swamps to 96 species in transitional floodplain forests. The higher number of species in these areas is in response to the diverse vertical structure available from the ground to the forest canopy in these communities, as well as their adjacency to an abundant food supply. The upland forests, while having larger trees, often have less developed shrubs, saplings, and subcanopy trees, which reduces the structural diversity in these forests.

Open habitats tend to have fewer birds associated with them, again because of reduced structural diversity. An exception to this is the cultural grasslands, with 88 species potentially occurring. While this community receives high bird use, relatively few birds nest in these areas. Birds that do nest include killdeer, some sparrows, bobolinks, and, where shrubs are invading, some shrub nesters. Most of the bird use of this community is for feeding during the growing season; a wide range of species can be observed feeding in these areas, from the game birds (ring-necked pheasant, bobwhite, turkey) and songbirds (American robin, Northern cardinal, sparrows) that feed on plant matter and terrestrial invertebrates, to swallows, hawks, and nightjars that feed on flying insects and larger animal prey. The remainder of the open habitats, such as wet meadows, agricultural fields, and residential areas, tend to have fewer birds associated with them because of periodic or constant disturbances.

3.1 Carnivorous Birds

Carnivorous birds, those feeding almost exclusively on animal tissue, are represented by a wide range of species. The smallest avian carnivores, such as the swallows, flycatchers, and warblers, tend to feed on small insect prey while larger carnivores, such as hawks and owls, feed on larger vertebrate prey. Exceptions to this occur, however. For example, waterfowl, despite their larger size, feed primarily on small aquatic invertebrates and plants. Conversely, the northern shrike, a robin-sized songbird, preys on small mammals that can be up to half its size. Regardless of the target prey species, most tend to be opportunistic while feeding and may take a wide range of animals. The great blue heron, for example, feeds mostly on fish but also invertebrates, amphibians, reptiles, birds, and mammals (Butler 1992).

3.1.1 Hawks and Owls

No historic hawk and owl (raptor) surveys had been conducted in the Housatonic River valley by any of the agencies or groups contacted over the course of these investigations. However, the North American Breeding Bird Survey (BBS) is a large-scale avian survey program initiated in 1966 and coordinated by the USGS. The BBS is a roadside survey program, with more than 4,100 45-km (24.5-mile) long survey routes that are surveyed annually. Three survey routes occur in Berkshire County: in Pittsfield, Cheshire, and Sheffield. Since 1966, observers on these three routes have documented eight raptor species: turkey vulture, bald eagle, sharp-shinned hawk, Cooper's hawk, broad-winged hawk, red-tailed hawk, American kestrel, and barred owl (Sauer *et al.* 2000). Data for the red-tailed hawk were not available, but all of the other documented species were seen infrequently over that time period. In fact, bald eagles and sharp-shinned hawks were only observed once and Cooper's hawks were only observed twice on all three of these routes, combined. The turkey vulture, broad-winged hawk, and American kestrel were observed only slightly more often. Barred owls occurred very infrequently on the Cheshire and Pittsfield BBS routes (although two were recorded on the Pittsfield route in 1999), but they were more common on the Sheffield route, with three of the last four years having five or six owls recorded (Sauer *et al.* 2000).

Initial, reconnaissance-level observations of hawks and owls in the PSA in 1998 documented 10 raptor species. These included all species recorded on the BBS routes except Cooper's hawk, with the addition of osprey, northern harrier, and northern goshawk. Some species were observed during the nesting season, but most observations occurred largely in late summer and early fall, when these species migrate. Turkey vultures were common throughout the summer and were usually observed soaring over agricultural lands adjacent to the Housatonic River. Osprey and bald eagles were observed during the fall migration periods and were most commonly observed flying, feeding, or perching in the vicinity of Woods Pond and, in the case of the osprey, seen feeding on goldfish. Broad-winged and red-tailed hawks were commonly observed, along with American kestrels. These three species were most common in upland habitats adjacent to the Housatonic River, but they were also observed hunting over wet meadow and shallow emergent habitats in the PSA. Sharp-shinned hawks, northern goshawks, and barred owls were also seen, but observations were very infrequent. Despite the confirmation of nearly one-half of the species expected to occur, the lack of breeding season observations prompted playback surveys in 1999.

The playback surveys documented 11 raptor species during the nesting season (Table 5-1), including four species that had not previously been observed. Seven species responded to calls played in the PSA and a total of seven species responded from the reference areas. Northern harrier and red-shouldered hawk responses were documented in the PSA but not at the reference areas. Conversely, the sharp-shinned hawk, Cooper's hawk, and northern goshawk (all woodland accipiter hawks) responses were documented only in the reference areas. Great horned, barred, and northern saw-whet owls were documented in the PSA during playback surveys. Only the great horned and barred owls responded to playback surveys at the Threemile Pond SWMA reference area.

Differences in the results of the hawk surveys are attributable to habitat differences between the PSA and the reference areas. Northern harriers and American kestrels breed in open habitats, particularly open wetlands, wet, lightly grazed pastures, old fields, freshwater marshes, dry uplands, and mesic grasslands and many of the other species hunt in and near these areas (MacWhirter and Bildstein 1996, DeGraaf and Yamasaki

2001). The PSA has an abundance of this type of habitat. The PSA also contains a large amount of floodplain forest dominated by silver maple, one of the preferred habitats of the red-shouldered hawk (Crocoll 1994). This species generally requires extensive forest stands consisting of mature trees and an open, park-like appearance to the subcanopy and understory (Crocoll 1994). However, no red-shouldered hawk nests were found in the PSA.

The reference areas differed from the PSA in that they generally consisted of isolated aquatic communities surrounded by relatively intact upland deciduous and mixed forest. The three accipiters (sharp-shinned hawk, Cooper's hawk, and northern goshawk) that responded to playback calls only in the reference areas are species of extensive mixed and deciduous forest (Rosenfield and Bielefeldt 1993, Squiers and Reynolds 1997, Bildstein and Meyer 2000) and would, therefore, prefer the forests surrounding the reference areas and the lower half of the PSA, which is also part of a large contiguous forest (i.e., October Mountain State Forest).

Most species documented through incidental observations likely do not breed within the PSA. These individuals (such as osprey and bald eagles) were simply migrating through the area. Other species that breed nearby likely use the PSA only infrequently and, therefore, were not documented during playback surveys.

Table 5-1 1999 raptor survey results.

Species Name	PSA	Threemile Pond SWMA	October Mountain State Forest	Hinsdale Flats SWMA
Turkey vulture				
Osprey				
Bald eagle				
northern harrier	CR		IO	
sharp-shinned hawk	IO			CR
Cooper's hawk	IO	CR	CR	
northern goshawk	IO		CR	
red-shouldered hawk	CR			
broad-winged hawk	CR	CR	IO	CR
red-tailed hawk	CR	CR	IO	CR
Rough-legged hawk			yes	
American kestrel	CR			
Peregrine falcon				
Common barn owl				
great horned owl	CR	CR		
barred owl	CR	CR	IO	
northern saw-whet owl	CR			
bald eagle	IO	IO		
osprey	IO		IO	
turkey vulture	IO	IO	IO	IO

CR = Call response during playback surveys.

IO = Incidental observation, not observed during playback surveys.

During the playback point counts and throughout the 1998-2000 field seasons, efforts were made to identify and locate nests of breeding hawks and owls within the PSA and reference areas. Only one confirmed nest was found, that of an American kestrel on the west side of the Housatonic River, just north of New Lenox Road. The nest cavity was located near the top of an approximately 20-m telephone pole, positioned in the middle of a cleared field, adjacent to forested upland habitat. Two adult kestrels, one of which was confirmed as male, were observed entering the cavity, and what sounded like begging cries were heard originating from the cavity. Young were not observed fledging from the cavity, but four or five juvenile kestrels (aged according to Palmer 1988a) were observed perching along power lines located approximately 300 m from the cavity. The response of raptors to playback calls represents a territorial behavior attributable to nesting activities. Therefore, while only one raptor nest was found, it is likely that other raptors, such as red-shouldered hawks, do nest in the vicinity of the PSA.

3.1.2 Wading Birds

Four wading bird species were observed in the PSA: American bittern, great blue heron, green heron, and black-crowned night heron. Only one species, the green heron, was documented during playback surveys in 1998 (see Section 3.2.2). However, these observations were of birds flying along the river near the survey points but not directly responding to the calls. Great blue herons were by far the most abundant wading bird observed. They occurred in a variety of shoreline habitats, particularly around Woods Pond and the nearby backwaters. Great blue herons were frequently observed hunting for fish and other aquatic prey in low-gradient stream, deep emergent marsh, and shallow emergent marsh communities. The green heron was the next most commonly seen wading bird. Observations of this species were distributed throughout the entire PSA and usually occurred in or near shrub swamp, the species' preferred habitat (DeGraaf and Yamasaki 2001). American bitterns were observed throughout the PSA on several occasions, mainly during spring and fall migration. One individual, however, was heard calling from within the PSA in July of 1999, indicating an intent to breed in the area. This species was most commonly observed in shallow emergent marsh communities.

Finally, only one black-crowned night heron was observed. One dead individual was found in a parking lot adjacent to the East Branch Housatonic River in Pittsfield.

3.1.3 Belted Kingfishers

During the 1998 surveys, three potential belted kingfisher nest sites were located in the PSA (Map 5-8). All three sites, along with a fourth found upstream of the PSA on East Branch Housatonic River, were located on sloping to steep eroded banks, which are typical nest sites for this species. The kingfisher nest sites were distributed largely in the northern half of the PSA. Despite the sparse distribution of nest sites, use of the river by kingfishers is much more widespread, with observations occurring from the confluence to Woods Pond.

3.1.4 Tree Swallows

Tree swallows, along with the other northeastern swallows, are highly insectivorous birds that were commonly observed feeding over the river. The tree swallow is the focus of a detailed reproductive study in the PSA by the USGS. As part of that study, a large number of nesting boxes were erected along the river to provide subject animals for the study. The USGS has provided the results of that study, including nest box occupancy (Custer 2002). Anecdotal observations suggest that the nest boxes were frequently used by tree swallows. Other birds that used the boxes in the PSA included house wrens and black-capped chickadees.

3.1.5 Other Species

The wildlife species matrix (Attachment C) identifies a large number of additional species with carnivorous feeding habits. Most of these species are insectivorous forest songbirds. These species take predominantly flying insects using a variety of methods, including active aerial pursuit by swallows and nightjars, sallying by flycatchers, and rapid capture and gleaning off leaves by vireos and warblers. Additionally, terrestrial invertebrates are caught by a number of species that actively probe the soil or search the stems, branches, foliage, and forest leaf litter.

The forest bird surveys conducted in 1998 documented 47 species, most of which were passerines, or perching songbirds (Table 5-2). The surveys were conducted largely in forested wetland communities, with red maple swamps and ash-maple-tamarack swamps being sampled the most. Consequently, a greater number of species were documented in these communities (32 and 35 species, respectively) than in the less-sampled floodplain forests and shrub swamps (7 and 26 species, respectively).

The veery was the most common songbird, seen at all 16 point count survey sites. The American robin, common yellowthroat, and black-capped chickadee were also common, occurring at 13, 11, and 9 survey sites, respectively. Other commonly observed species included the American goldfinch, northern waterthrush, red-winged blackbird, and yellow warbler, all of which occurred at half of the survey sites. Incidental observations of the avian community documented similar results with respect to the relative abundance of birds in the PSA.

Table 5-2 1998 forest bird survey results.

Species	Ecosystem, Community Type, and Survey Point Number																Percent Frequency
	Forested Wetlands													Shrub Wetlands			
	Red Maple Swamp					Black Ash-Red Maple-Tamarack Calcareous Seepage Swamp							Transitional Floodplain Forest	Shrub Swamp			
	2	3	4	5	7	6	9b	10	11	12	13	14	1	8	9a	Yokum	
Veery	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	100%
American robin	X	X	X	X		X	X		X	X	X		X	X	X	X	81%
Common yellowthroat	X		X			X	X	X	X		X		X	X	X	X	69%
Black-capped chickadee	X	X	X	X		X	X	X	X	X							56%
American goldfinch	X	X	X		X	X	X							X		X	50%
Northern waterthrush		X				X	X		X	X	X	X			X		50%
Red-winged blackbird			X						X	X	X	X		X	X	X	50%
Yellow warbler	X		X		X				X		X			X	X	X	50%
American crow	X	X	X	X		X		X							X		44%
Chestnut-sided warbler		X			X	X			X				X	X			38%
Great crested flycatcher	X	X					X		X					X	X		38%
Song sparrow	X	X	X								X	X	X				38%
Cedar waxwing					X				X		X				X	X	31%
Rose-breasted grosbeak	X		X	X					X						X		31%
Brown-headed cowbird	X							X						X	X		25%
Eastern wood pewee				X	X	X				X							25%
Northern flicker	X						X				X					X	25%
Red-breasted nuthatch			X	X	X					X							25%
Red-eyed vireo				X	X	X		X									25%
Warbling vireo		X						X						X	X		25%
Common grackle		X													X	X	19%
Gray catbird										X				X	X		19%
Hairy woodpecker		X		X						X							19%
Least flycatcher					X	X										X	19%
Mourning dove										X	X	X					19%
Northern cardinal				X										X		X	19%
Ovenbird				X		X		X									19%
White-throated sparrow	X		X					X									19%
Belted kingfisher						X					X						13%
Blue jay	X		X														13%
Baltimore oriole							X							X			13%
Swamp sparrow												X		X			13%
Tree swallow			X												X		13%
Wood thrush						X							X				13%
American redstart													X				6%
Black and white warbler				X													6%
Black-throated blue warbler						X											6%
Canada warbler								X									6%
Chimney swift	X																6%
Chipping sparrow		X															6%
Eastern pheobe			X														6%
Golden-crowned kinglet								X									6%
House wren															X		6%
Tufted titmouse										X							6%
Turkey vulture															X		6%
Willow flycatcher																X	6%
Wood duck																X	6%
unknown warbler						X											6%
No. Species per Site	15	13	15	12	9	16	9	11	11	11	11	6	7	14	17	13	
No. Species per Habitat	32					35							7	26			

* PFO = Palustrine Forested, PSS = Palustrine Scrub-Shrub, PEM = Palustrine Emergent wetland habitats

Percent Frequency = The number of plots at which a species was observed divided by the total number of plots (16) multiplied by 100.

3.2 Omnivorous Birds

Relatively fewer birds have diets equally mixed of animal and plant materials. Of the birds that have an omnivorous feeding strategy, most utilize peaks of food abundance as they are available. For example, in order to meet the nutritional demands of egg laying, many species of waterfowl time their migrations to arrive on breeding grounds when aquatic invertebrates, rich in protein, can form a high proportion of the diet of nesting hens and developing young (Krapu and Reinecke 1992). They then switch their feeding to the fruits, seeds, and tubers of aquatic and emergent plants as invertebrate populations decline and plant materials ripen or become available in late summer and fall.

3.2.1 Waterfowl

Nine species of ducks and geese potentially occur within the PSA and all but one, the ring-necked duck, have been observed. Three of these species, Canada geese, wood duck, and mallard, readily breed and broods of each species were routinely observed during the three years of study. Broods were observed most commonly in the backwater channels and wetlands between New Lenox Road and Woods Pond. Wood duck broods were also observed in the main channel of the river between Holmes Road and New Lenox Road. Similarly, Canada geese broods were observed in the river channel, backwaters, Woods Pond, and on residential lawns.

Trapping efforts in 1998 resulted in the collection of 15 wood ducks and one mallard in the backwaters of Woods Pond during 14 – 15 September 1998. Eight wood ducks and one mallard were retained for tissue analysis, along with 12 wood ducks and three mallards provided by MDFW. In addition, 20 wood ducks were captured from the Threemile Pond SWMA reference area and retained for tissue analysis. Many of the wood ducks caught in the PSA exhibited juvenile plumage characteristics, indicating that they were hatched and reared from within or very near the PSA.

Several waterfowl species were observed only during migration, including green-winged teal, common goldeneye, common merganser, and snow goose. Interestingly, American black ducks were only commonly observed in winter. Small groups of black ducks were

usually observed from November to April and often formed mixed flocks with mallards. No black duck broods were observed in the PSA and very few individual black ducks were observed during the nesting season.

3.2.2 Marsh Birds

Marsh bird surveys conducted in 1998 documented four of the nine species potentially occurring in the PSA (Table 5-3). The Virginia rail (Figure 5-3) was the most common species observed, with 11 individuals documented from eight survey sites between the Pittsfield WWTF and Woods Pond. Incidental observations of Virginia rails also occurred at the confluence of the East and West Branches and at a site north of New Lenox Road. Common moorhen responses were documented from four playback survey sites in downstream portions of the PSA and several additional individuals were repeatedly seen there in 1998. One sora was recorded adjacent to the Pittsfield WWTF. American coots were observed in the PSA during migration, but they were not documented during the playback surveys.

Figure 5-3 Virgina rail.

Rails were the most common marsh bird responding to playback surveys. This individual was displaced by a July 1998 storm event that flooded their typical shallow and deep emergent marsh habitats.

Table 5-3 1998 marsh and wading bird survey results.

Species	West Branch	Canoe Meadows	WWTF	Canoe Launch	Yokum Brook	Cul-de-sac North	Woods Pond	Total
	3 sites	4 sites	8 sites	9 sites	3 sites	10 sites	10 sites	47 sites
Virginia rail	0	0	3	4	0	1	3	11
Sora	0	0	1	0	0	0	0	1
Green heron	0	1	0	0	0	0	1	2
American bittern	0	0	0	0	0	0	0	0
Least bittern	0	0	0	0	0	0	0	0
American coot	0	0	0	0	0	0	0	0
Common moorhen	0	0	0	0	0	2	4	6
Pied-billed grebe	0	0	0	0	0	0	0	0
King rail	0	0	0	0	0	0	0	0
Total	0	1	4	4	0	3	8	20

Refer to Map 5-2

Numbers indicate total number of each species that responded during playback surveys.

Numbers are combined for all three visits at each site.

3.2.3 Other Species

Very few other species or species groups are categorized as omnivorous birds. Included are the jays and crows, which have a varied diet of insects, bird eggs and young, carrion, and trash. Blue jays and American crows are common in the PSA and have been documented using most of the available habitats.

3.3 Herbivorous Birds

Very few (only 11 species) species are solely herbivorous and, in the PSA, include geese, doves, ruby-throated hummingbird, and the finches (Attachment C). Most of these species occur within the PSA, except for the pine grosbeak and pine siskin. One snow goose was observed in an agricultural field I the fall. This species is expected to only occasionally occur, during spring and fall migration. Similarly, pine grosbeaks could occur seasonally, mostly in winter. Pine siskins may breed in the hills surrounding the Housatonic River (Veit and Petersen 1993). Bobwhite quail are also primarily herbivorous and, while not known from the PSA, could potentially occur, as they were heard in adjacent habitat.

4.0 Rare, Threatened, and Endangered Birds

Several state- and federally-listed birds were observed within the PSA and reference areas during the 1998, 1999, and 2000 field investigations (MNHESP 1999). Following are brief descriptions on the nature of these observations.

American Bittern

The American bittern is listed as Endangered by the MNHESP. American bitterns breed in eastern North America from Newfoundland to North Carolina, west to central Oklahoma and Manitoba, and they winter in coastal marshes from Massachusetts to the Gulf Coast (Gibbs *et al.* 1992). In Massachusetts, breeding populations of American bitterns have been declining since the 1960s. Between 1976 and 1980, the Massachusetts Breeding Bird Atlas project confirmed only 17 breeding pairs in the state (Veit and

Petersen 1993). This decline is due in a large part to the disappearance of extensive cattail marshes, their primary breeding habitat.

Nests are constructed from sticks, grass, and sedges in tall emergent vegetation (Ehrlich *et al.* 1988). The PSA provides suitable nesting habitat for American bitterns, and they were documented from 1998 to 2000 (Map 5-9) and in the October Mountain State Forest reference area in 2000 (Map 5-10). Observations during the three years ranged from May to September, with the most occurring in August and September. Bitterns were usually observed in wet meadow, shallow emergent marsh, and deep emergent marsh habitats. Only one of the bitterns, observed in early July 1999, was heard calling from within the PSA, indicating an intent to breed in the area. No bitterns responded to marshbird playback calls in 1998. MNHESP Rare Animal Forms for American bitterns are included in Attachment H.

Bald Eagle

The bald eagle is listed as Threatened by the USFWS and Endangered by MNHESP. The bald eagle historically nested throughout the United States and Canada in deciduous and coniferous forests, especially along bodies of water. Eagle populations have experienced significant declines, due to egg shell thinning from DDT poisoning, habitat loss, and shooting, to the point that the species was formerly listed as Endangered nation-wide. Bald eagle populations are currently recovering due to habitat protection and other recovery efforts such as hacking. Hacking at artificial nest platforms on Quabbin Reservoir, for example, has led to the first successful Massachusetts breeding record in recent years, when two pair produced a total of three young (Veit and Petersen 1993).

Bald eagles are closely associated with aquatic habitats, usually nesting in large trees along shorelines and feeding on fish. The PSA does provide nesting and foraging habitat for bald eagles. In the mid-1990's, a pair of bald eagles were reported to have constructed a nest at Woods Pond (T. Gulo, MDFW personal communication). The nest was reportedly destroyed during an April snowstorm and the pair did not attempt to re-nest. Bald eagles were documented in the PSA and reference areas eight times during the course of field investigations, although some of those observations may be of the same

individuals (Map 5-9). Most observations occurred near Woods Pond and the adjacent backwaters and many of the eagles observed were apparently hunting over these shallow water habitats. MNHESP Rare Animal Forms for bald eagles observed in 1998 are included in Attachment H.

Northern Harrier

Breeding populations of northern harriers in Massachusetts have declined since 1955 (Veit and Petersen 1993) and they are currently listed as Endangered by MNHESP. Their range extends across the United States and Canada. They typically nest on elevated ground in dense herbaceous vegetation of wet meadows, old fields, and shrublands (Ehrlich *et al*. 1988).

The PSA and reference areas provide suitable habitat for northern harriers. Nesting and foraging habitat is available in many of the larger emergent wetlands, and in the wet meadow habitats south of New Lenox Road. Old fields in uplands adjacent to the study area also provide suitable nesting and foraging areas. Prey items consist mainly of small vertebrates such as voles, birds, snakes, frogs, and also invertebrates such as grasshoppers (Ehrlich *et al.*1988). Prey is captured while the harrier is in flight, as it hovers low to the ground searching fields and agricultural areas for food items.

Thirteen northern harriers were observed in the PSA and near Washington Mountain Lake in the October Mountain State Forest reference area on 12 occasions (Maps 5-9 and 5-10). Most observations occurred either early (May) or late (September and October) in the season and were of individuals displaying migratory behavior (i.e., high, rapid, non-hunting flight) (Attachment H). One observation in July of 1999 occurred in the nesting season for this species although no breeding behavior (e.g., displays, territoriality) was observed by this individual.

Sharp-shinned Hawk

The sharp-shinned hawk is presently listed as a species of Special Concern by MNHESP. This hawk ranges across the United States and the southern half of Canada and is common throughout Massachusetts during migration (Veit and Petersen 1993).

However, while historically abundant, there have only been a few confirmed instances of breeding sharp-shinned hawks in Massachusetts since the 1950's. A Massachusetts State biologist described a sharp-shinned hawk in Lee, MA, during the summer of 1999 as a potential breeder, but no confirmed account was reported (T. Gulo, MDFW, personal communication). In winter, sharp-shinned hawks can occur throughout the state (Bildstein and Meyer 2000).

Sharp-shinned hawks nest in coniferous, deciduous, and mixed woodlands where they constructs stick nests at heights of 3 – 18 m (10 – 60 feet) in deciduous and coniferous trees (Ehrlich *et al.* 1988, Palmer 1988b). Palmer (1988b) notes that the nest is typically in a stand of dense young conifers near a forest opening. Prey items include mainly birds, and occasionally small mammals, frogs, lizards, and insects (Ehrlich *et al.* 1988, Palmer 1988b, Peterson and Peterson 1980).

Sharp-shinned hawks were seen in the PSA and the Hinsdale Flats SWMA reference area during the field investigations (Maps 5-9 and 5-11). Most observations occurred from early fall to early winter. Two observations, however, occurred during the 1999 hawk playback surveys at the Hinsdale Flats SWMA reference area. These occurred approximately a week apart and included an aggressive response from the birds. Due to the similarity in response, it is likely that the two observations were of the same individual and that it is likely nesting in the vicinity. No behavior indicative of nesting was displayed by any of the sharp-shinned hawks observed in the PSA. Data sheets for these observations are provided in Attachment H.

Cooper's Hawk

The Cooper's hawk is a species of Special Concern in Massachusetts. Its range extends throughout most of the United States and extreme southern Canada. In Massachusetts, the Cooper's hawk is a rare and local breeder, with breeding records located in the central and eastern portion of the state (Veit and Petersen 1993). Like the other species in this genus, Cooper's hawks nest in forested habitats, particularly deciduous, riparian forest stands (DeGraaf and Yamasaki 2001). Cooper's hawks nest on a platform of sticks positioned in deciduous and coniferous trees at heights of 7 – 15 m (25 – 50 feet) (Ehrlich

et al. 1988, Palmer 1988b). Prey items include medium-sized birds, small mammals, and occasionally reptiles, amphibians, and insects (Ehrlich *et al.*1988, Palmer 1988b).

Both the PSA and the reference areas provide suitable nesting habitat for Cooper's hawks. They were seen on seven occasions in 1999 and 2000: three times in the PSA, once at the Threemile Pond SWMA reference area, and three times near Washington Mountain Lake in the October Mountain State Forest reference area (Maps 5-9, 5-10, and 5-12). The PSA observations occurred in the vicinity of New Lenox Road and southward. These observations were outside the nesting season. At the Threemile Pond SWMA reference area, one adult responded to playback surveys in the middle of June 1999, and was presumed to be nesting in the area. At the October Mountain State Forest reference area, a Cooper's hawk was observed chasing a broad-winged hawk. This territorial display is indicative of nesting activity. In addition, a single bird and a pair of adults were observed near Washington Mountain Lake in early May 2000, well within the nesting season for this species. Data sheets for these observations are provided in Attachment H.

Common Moorhen

Common moorhens occur across the eastern and southwestern United States. In Massachusetts, they are listed as a species of Special Concern. Scattered localized breeding has been confirmed throughout Massachusetts, including Pittsfield (Veit and Petersen 1993; T. Gulo, MDFW personal communication).

Common Moorhens breed in freshwater marshes, lakes, and ponds with emergent vegetation and grassy edges. Moorhens typically nest over water, where they form a rimmed-cup nest of aquatic plants, which is lined with grass (Ehrlich *et al*. 1988). Common Moorhens were repeatedly observed in the PSA in 1998 and 1999. Some individuals responded to playback surveys in June and July, 1998, while others were observed during the course of concurrent investigations. Moorhen sightings were generally limited to the lower one mile of the PSA, typically at the north end of Woods Pond and the adjacent upstream backwaters (Map 5-9), and one individual was observed at Washington Mountain Lake (Map 5-10). The responses elicited by moorhens during

the playback survey indicate that moorhens were territorial and likely nesting within the PSA. However, no moorhen broods were observed in either year. Rare animal data sheets documenting moorhen sightings are located in Attachment H.

Northern Parula Warbler

The northern parula is listed as a Threatened species in Massachusetts (MNHESP 2000). Northern parulas are common during migration, but a slow and steady decline of breeding populations has prompted this listing (MNHESP 1994a). Breeding populations are restricted to the eastern part of the state, north of Boston and along the southern shore of Cape Cod. Three observations of northern parula were recorded in two locations in the PSA during May 1999. These observations occurred during the migration period and do not represent a breeding population.

Blackpoll Warbler

The blackpoll warblers is a species of special concern in Massachusetts due to its rarity during the breeding period (MNHESP 1994b, 2000), although it is common during the migration period. The preferred habitat of the blackpoll warbler, stunted spruce fir forest, is very limited in Massachusetts and restricted largely to the summit of Mt. Greylock, north of the PSA (MNHESP 1994b). Six observations of blackpoll warblers were recorded from five locations within the PSA during May in 1999 and 2000. These observations were during the migration period and do not represent a breeding population.

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Chapter 6 Mammals

1.0 Introduction

The mammalian community in the PSA was studied over the three-year period, from 1998 to 2000. To characterize the community, a literature review of local species and populations was conducted along with the collection of field data. Field efforts included methods targeted at specific species, as well as more general, reconnaissance-level investigations of species presence, relative abundance, and habitat use.

2.0 Methods

2.1 Species:Habitat Association

The principle goal for the characterization of the mammal community was to identify all species that could reasonably be expected to occur in the PSA, the habitats they would use, and when they would use them. The foundation of this work included a review of relevant literature on the mammal populations in western Massachusetts. Local and regional references on bird communities were first used to identify the species whose range encompassed the PSA (Burt and Grossenheider 1976, Godin 1977, DeGraaf and Yamasaki 2001). General and technical references on the habitat requirements and use, seasonality of occurrence, and relative abundance in the region were then used to refine the list and build a matrix (Attachment C) to include only those species whose preferred habitats are within the study area (Whitaker and Hamilton 1998, DeGraaf and Yamasaki 2001).

As part of this effort, local and regional experts were consulted to obtain unpublished records regarding the historic occurrence of some species in the area. For example, the Massachusetts Natural Heritage and Endangered Species Program, the MDFW, and the USFWS were contacted to identify any historic mammal occurrences and to review historic trapping records from the area. Information received from these agencies, organizations, and individuals was then incorporated into the species matrix.

Field surveys were then conducted to complement the information compiled in the species matrix. Field surveys largely focused on determining species' presence, although several methods were used to more quantitatively document species and their relative abundance or to sample animal tissues, as described below. The observations that were recorded in the field were used to refine the matrix to accurately depict the habitat use and seasonality of occurrence for all mammal species expected to occur in the PSA.

2.2 Incidental Observations

The presence of mammals within the PSA was documented during year-round field investigations in 1998, 1999, and 2000 (Roy F. Weston, Inc. 2000). Several of the other investigations were detailed studies in support of ecological risk assessment surveys, and consisted of specific methods targeted at documenting or collecting animals from a variety of taxonomic groups to sample their tissues. Those investigations provided an excellent opportunity to confirm the presence of all mammals within the PSA by recording incidental observations of any mammals or mammal sign seen (e.g., tracks, scat, browsing). During the course of those investigations, mammals observed within the PSA and reference areas were recorded, along with the habitat in which they occurred. When appropriate, other notes were recorded, including activity, interactions with other species, and general health.

2.3 Mink and Otter Surveys

2.3.1 Snow Tracking

Mammal snow track counts (Halpin 1984, Halpin and Bissonette 1988) were conducted during the winters of 1998-1999 (hereafter 1999) and 1999-2000 (hereafter 2000) in the riparian habitats of the PSA as well as in four reference areas (Threemile Pond SWMA, Washington Mountain Lake in October Mountain State Forest, Muddy Pond in Hinsdale Flats SWMA, and Ashley Lake). During the 1999 survey, six 500-m (1,650-ft) transects were established in the PSA so that many of the habitat types (e.g., low-gradient stream, black ash–red maple–tamarack calcareous seepage swamp, shrub swamp, deep emergent marsh, shallow emergent marsh, and wet meadow) could be sampled (Map 6-1).

Transects were surveyed after a fresh snowfall for a minimum of two or three snow events each winter. Mammal tracks were recorded according to species (or lowest identifiable taxonomic level), and photographs were taken of notable tracks (e.g., large carnivores, otter, mink). Transect locations were recorded and plotted on a map of the study site. Ashley Lake and Washington Mountain Lake in the October Mountain State Forest were surveyed as reference areas during the 1999 winter. The entire shorelines of these lakes were surveyed rather than establishing transects.

During the 2000 surveys, three transects were established in the PSA and were sampled in a similar fashion as the 1999 transects (Map 6-1). During that winter, however, mink and otter scents were placed every 60 m (200 feet) along the transects in an effort to attract these animals to the actual transects and determine whether or not those species were present in the PSA (Roy F. Weston, Inc. 2000). In addition, three transects were established at each of the four reference areas (Maps 6-2, 6-3, 6-4, and 6-5). Identification of tracks followed Murie (1974), Halfpenny and Biesiot (1986), Forrest (1988), and Rezendes (1999).

2.3.2 Scent Post Surveys

Scent post station surveys (Conner *et al.* 1983) were used during the autumns of 1998 and 1999 and concurrent with the winter 2000 snow tracking surveys to determine the presence of mink and river otter in the PSA (Roy F. Weston, Inc. 2000). Three transects were established during the autumn surveys, one each in the upper, middle, and lower portions of the PSA (Map 6-6). Each transect ran parallel to the shoreline for 500 m (1650 feet) and consisted of 10 scent post stations placed at 60-m (200-foot) intervals and 0.3 – 1.5 m (1 – 5 feet) from the shoreline. Each scent station consisted of a 1-m (3.3-foot) diameter circle of moist sand sifted into place, with a wooden dowel smeared with a commercial lure (Leon Lures® Mink #1 Super All Call and Otter Super All Call) placed in the center of the circle (Linhart and Knowlton 1975, Phillips 1982). Lures were alternated between stations so that half of the stations on each transect were baited with mink lure and half with otter lure (Humphrey and Zinn 1982).

During the winter 2000 surveys, scent posts were placed along the snow tracking transects in the PSA (Map 6-1) and in each of the four reference areas (Maps 6-2, 6-3, 6-4, and 6.5). The methods of applying, spacing, and alternating the scents were the same as the autumn surveys, except that, rather than using sand as a track medium, the snow surrounding each scent post was examined.

2.3.3 Otter Scat Analysis

River otter scats discovered during the scent post and snow tracking surveys were collected to analyze prey species. After collection, scats were measured, photographed, and analyzed for prey composition. Fish scales were removed and placed in envelopes to dry. The scales were shipped to the Laconia, New Hampshire Office of Fishery Assistance, USFWS, where they were identified to lowest possible taxonomic group and aged. Identifications were based upon voucher scales taken during previous fish sampling events from the Housatonic River, or from other areas. That information was summarized by the USFWS (Smithwood 2002).

2.4 Small Mammal Surveys

2.4.1 Small Mammal Trapping

Small mammal trapping was conducted in September 1998 and August to September 1999 to verify the occurrence of some small mammal species within the PSA and to provide tissue samples to the USEPA for PCB analysis (Roy F. Weston, Inc. 2000). Sixteen potential small mammal trapping array sites were flagged in the PSA. Soils at these sites were then analyzed for PCB concentrations. Three of the sites (1B, 3, and 8) were chosen as actual trapping locations in 1998 and three (13, 14, and 15) in 1999 (Map 6-7). At each trap site, 100 small mammal traps baited with peanut butter were placed in an "+" pattern (when possible), with each axis being approximately 150 m (490 feet) in length (Clough 1987, Lortie and Pelletier 1987). Fifty trap stations spaced at 3-m (10-foot) intervals were placed on each axis. One trap was placed at each trapping station on the line and every tenth trapping station was a pit trap, which is more effective for

capturing shrews (Kirkland 1982). Where small mammal runways were apparent, traps were placed on the runways to increase capture efficiency.

Because pit traps tend to be more efficient at capturing shrews, pit trap arrays were also used at each trapping site. These arrays consisted of four plastic drift fences 7.6 m (25 feet) long and 0.6 m (2 feet) high, arranged in an "+" formation with a 15-m (50-foot) gap in the center of the "+". Individual pit traps were installed on both sides and at either end of each of the four drift fences, for a total of 16 pits per array. The pit trap arrays were situated near one of the axes of the larger snap trap arrays.

All trap arrays were set on one day and run for five consecutive nights for a total of 580 trap nights (116 traps times 5 nights equals 580 TN) per trap site. Captured individuals were placed in plastic bags, labeled, and placed on wet ice for transport to the central processing area.

2.4.2 Placental Scar Analysis

Species, sex, weight (g), total length (mm), tail length (mm), hind foot length (mm), and ear length (mm) were recorded for each individual small mammal collected. Each individual was also aged (adult versus juvenile) and inspected for abnormalities or deformities, which were described on data forms. Length (mm) and width (mm) of the testes were measured for all males. Each female was checked for milk production and the uterus was removed for placental scar analysis.

During placental scar analysis, the uterus was placed on a microscope slide and the number of placental scars and embryos were counted with the aid of a dissecting microscope. Placental scars were grouped and counted based on the size, shape, and opacity (Harder and Kirkpatrick 1994). Finally a sketch was prepared and a photograph was taken of each sample (Figure 6-1 and Figure 6-2).

Figure 6-1 Small mammal uterus.

Uterus showing placental scars and, at left, the ovaries.

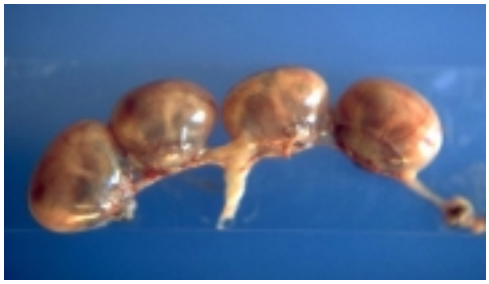

Figure 6-2 White-footed mice fetuses.

2.5 Bat Surveys

2.5.1 Field Sampling

Bat species were surveyed by recording their echolocation calls (de Oliveira 1998, Fenton and Bell 1981). Three transects were established along the riverbank at the upstream (Reach 5A), central (interface of Reaches 5B and 5C), and downstream (Reach 5C, 6A, 6B, and 6C) sections of the PSA (Map 6-8 through 6-11). Transects ran parallel to the river for approximately 1 km. Each transect was visited for three consecutive nights during either late July or August 1999. Surveys began at dusk (ca. 21:30) and continued for two hours to take advantage of the period of highest bat activity (Crampton and Barclay 1998). Transects were either surveyed by foot or canoe, depending on water levels.

During each survey the echolocation noise of bats was recorded using an Anabat II® Bat Detector (Titley Electronics, Ballina N.S.W., Australia), which transforms ultrasound to an audible output capable of being recorded by normal-speed tape recorders (de Oliveira

1998). The Anabat detector was set at a division ratio of 16 and microphone sensitivity of 8–9. A calibration tone of 40 KHz was recorded between each bat call or at 15–second intervals. Recorded calls were analyzed to identify species using Analook®, a PC sound analysis software program to determine the number of flyover passes for each species.

2.5.2 Computer Analysis

The recorded bat calls were downloaded into the Anabat V computer software program using the Anabat V Zero Crossing Analysis Interface Module (ZCAIM®, Titley Electronics). Each bat call is composed of a rapid series of short pulses, which are displayed as a string of points. The monitor mode, which uses established criteria to determine if recordings should be saved as a bat call, was used to download files (Corben 1999). When these criteria were met, the program saved the calls in 15-second sequences. After the calls were downloaded, they were processed to eliminate background noise and to separate individual calls, when possible.

The calls were then loaded into Analook® (Titley Electronics), a software program that extracts call parameters that are used to identify the calls to species. The parameters examined by Analook® include maximum frequency, minimum frequency, average frequency, duration of pulse, time between pulses, average slope of plotted pulse, and the knee of the pulse (the point at which the slope of the pulse changes from sloping to flat). These call parameters were then compared to known reference calls of northeastern bat species to determine species. Reference calls were primarily obtained from recordings of Maine bats, although some call parameters (e.g., call length and minimum, maximum and characteristic frequencies) from bats recorded in New Hampshire, Massachusetts, New York, and Kentucky were also used.

3.0 Mammal Community Description

Forty-two mammal species were documented in the PSA during the three years of field surveys. An additional 10 species are likely to occur but were not verified, for a total of 52 species potentially occurring (Attachment C). Many species were quite common and were observed throughout the PSA in a variety of habitats. These common species tend

to be ones with more cosmopolitan habitat requirements, such as white-footed mice, meadow voles, short-tailed shrews, little brown bats, cottontails, gray squirrels, raccoons, red fox, coyotes, and white-tailed deer, all of which were observed in forested and non-forested habitats as well as riverine, shoreline, wetland, upland, and residential habitats. Other species that utilize primarily riverine and wetland habitats, such as muskrat and beaver, were also commonly seen.

Forested communities, such as red maple swamp, black ash–red maple–tamarack calcareous seepage swamp, transitional floodplain forest, and high-terrace floodplain forest, supported the greatest number of species. Agricultural and residential habitats had few recorded species, which is reflective of survey effort but also of the reduced habitat value associated with periodically disturbed habitats. No surveys were conducted in these habitat types; all records were incidental observations that occurred during travel to and from other locations. Several of the species not observed in the PSA, such as the snowshoe hare and short-tailed weasel, were common in nearby reference areas. Other species not recorded, such as the Indiana bat and southern bog lemming, are state listed and considered rare throughout the region (see Section 4.0).

3.1 Piscivorous Mammals

Two piscivorous mammals, river otter and mink, occur very infrequently in the PSA. Mink were observed during 1999 and 2000 surveys. River otter sign was recorded in the PSA only during February and March 2000. River otters, however, were much more common in reference areas, having been recorded during all three years of study.

Piscivorous mammals are of special interest because of their diet and habitat usage. The aquatic nature of these mammals, river otters being almost entirely aquatic and mink being semi-aquatic, results in these species having greater exposure to water-borne contaminants than most other mammals. The diets of mink and river otters consist largely of aquatic organisms (fish, crayfish, amphibians, muskrat, and waterfowl), making them some of the highest trophic level aquatic predators in the PSA and thus increasing the potential of these species to bioaccumulate high levels of environmental contaminants. PCB concentrations in fish tissue have been shown to be positively

correlated with levels of PCBs in mustelid species (Foley *et al.* 1988). Many studies have shown that the concentrations of PCBs in wild mink accumulate to levels that are harmful in experimental animals (Auerlich *et al.* 1971, Bleavins *et al.*1980, Foley *et al.* 1988, Heaton *et al.* 1995, Wren *et al.* 1987). Less is known about the accumulation of PCBs and their effects in river otters. Concentrations of PCBs have been reported to be higher in river otters than in mink when these animals were collected from the same location (Foley *et al.* 1988); however, mink are thought to be more sensitive to PCBs (Heaton *et al.* 1995). Organ (1989) found that otters from the Housatonic River watershed had the highest level of PCBs of any otters in Massachusetts.

3.1.1 River Otter

Trapping data from the MDFW show that river otters have been present in the Housatonic River watershed for nearly every year with available data (1977–1999) (S. Langlois, MDFW, personal communication). However, it is not known if these individuals were captured from the Housatonic River or other bodies of water within the watershed. River otters were not recorded in the PSA during 1998 or 1999 snow tracking or scent post surveys.

River otter tracks, slides, and scats were observed in the PSA during February 2000 winter track and scent post surveys. One set of slides, tracks, and scat occurred approximately 485 km south of the confluence of the East and West Branches of the Housatonic River. Scats were observed one month later and appeared old, having likely been buried under the snow during earlier visits. They consisted primarily of fish scales and bones, with some containing small amounts of crayfish exoskeletons. Another set of slides, tracks, and scat was observed further downstream, just north of New Lenox Road during the winter 2000 snow tracking and scent post surveys (Figure 6-3 and Figure 6-4). The individual appeared to have been attracted by the lure and deposited its scat and scent markings.

Figure 6-3 River otter forefoot track.

Figure 6-4 River otter tracks.

River otter tracks are characterized by having five toes on both front and hind feet, prominent claw marks, circular front feet, hind feet 1.5–2.5 times as long as wide, and generally large size.

An additional river otter scat was collected adjacent to Woodland Road, approximately 800 m (0.5 mile) downstream of the Yokum Brook confluence. This scat was fresh at the time of collection on 22 March 2000, and consisted of fish scales and crayfish fragments. This was an incidental observation, not the direct result of snow tracking or scent post surveys.

River otters were commonly observed at all four of the reference areas. In 1998, a group of three otters were observed at Threemile Pond. In 1999, river otter sign was seen at Ashley Lake and Washington Mountain Lake. In 2000, they were present at all four reference areas.

Ten otter scat samples were collected, seven from the PSA and three from Muddy Pond at the Hinsdale Flats SWMA reference area. Scats were composed of primarily fish scales and bones (Figure 6-5). Five of these scats contained small amounts of crayfish exoskeleton as well; total crayfish composition never exceeded 20 percent of the scat volume. These results are similar to what was expected, based on available literature.

Figure 6-5 River otter scat.

Composed of crayfish exoskeleton and fish scales

Though river otter diet consists primarily of fish, other prey, including crayfish, amphibians, turtles, and insects are also taken. Birds, especially young waterfowl, and small mammals are occasionally taken, and small amounts of plant material, such as blueberries and rose hips, are eaten (Whitaker and Hamilton 1998). Liers (1951) observed free-ranging captive river otters digging into the mud to remove frogs and turtles from hibernacula. River otters have been shown to prefer foraging in shallow water and eating primarily slow-moving, shallow-dwelling fish, such as chubs, suckers, catfish, daces, darters, and schooling fish such as bluegill and other sunfish (Whitaker and Hamilton 1998, Sheldon and Toll 1964). When studying river otters in the Adirondacks, Hamilton (Whitaker and Hamilton 1998) found fish in 70 percent of their stomachs but found only 5 percent were trout.

River otter habitat is often associated with beaver activity; beaver ponds provide an abundant supply of prey, stable water levels, den sites, and escape cover (Newman and Griffin 1994). Along with beaver activity, vertical banks, rock formations, and

backwater sloughs have been shown to be associated with denning sites for river otters. Points of land, tributary streams, fallen logs, log jams, conifer trees, and pools have all been correlated with river otter latrines (Sheldon and Toll 1964, Dubuc *et al.* 1990, Newman 1990, Swimley *et al.* 1998).

The Housatonic River in the PSA offers an abundance of habitats that fit these characteristics. However, otter sign was very infrequent, much lower occurrence than what would be expected considering the available habitats and food resources. For example, despite hundreds of hours conducting track and scent post surveys for otters and thousands of hours of field time spent characterizing the ecological communities in the PSA, very few otter or signs of otter were observed. Conversely, despite substantially fewer hours spent at these areas, otters were observed at each reference area. River otters are highly mobile and maintain territories within their home ranges. Home ranges may be quite large, up to 8.5 km^2 (22 sq mi), and extend along nearly 80 km (50 mi) of waterway shoreline (DeGraaf and Yamasaki 2001). Considering this, it is possible that the PSA lies within a river otter home range but is not a highly used portion of it (i.e., not within a maintained territory inside the home range).

3.1.2 Mink

Mink occur in a variety of wetland habitats, but their populations are greatest in marshes (Whitaker and Hamilton 1998). Mink typically forage within sight of open water, although when waterbodies are iced over, mink will often forage further inland (Kurta 1995). This is consistent with mink observation in the PSA, which occurred either in emergent marsh habitat or forested communities adjacent to the river and lake shorelines.

Mink tracks (Figure 6-6) and scat were observed at several locations in the PSA during snow tracking surveys. Tracks were distributed at each end of the PSA, occurring near the confluence of the East and West Branch Housatonic River and near Willow Creek; no observations occurred in the middle portions. One set of tracks near the confluence crossed tracks several times before blood-stained snow suggested that the mink had killed a cottontail. Tracks near Willow Creek were associated with a hole in the ice that accessed the impounded portion of the creek.

Figure 6-6 Mink tracks.

Side by side placement, five toes, and inter-digital, asymmetrical V-shaped pad are characteristic of the mustelid family.

During the fall 1999 scent post survey, an additional set of mustelid tracks and scat were observed south of the confluence of the East and West Branch Housatonic River. Due to sexual dimorphism among mustelid species, male long-tailed weasel and female mink overlap in size. Therefore, tracks alone cannot always distinguish between these species. The size of the observed tracks fell within the overlap of these two species and could not be positively identified. Scat found at this location was composed of fragments of bones and fur from a small mammal (Figure 6-7).

Figure 6-7 Mustelid scat.

Narrow, looped cords with tapered ends and dark brown coloration is characteristic of scats from the mustelid family.

Other mink observations consisted of tracks recorded at the October Mountain State Forest and Ashley Lake reference areas during 1999 and 2000 surveys. Mink tracks were

observed traversing the northwest cove of Ashley Lake on 11 March 1999. On 23 February 2000, mink tracks were observed on the western shoreline of Washington Mountain Lake near where a small brook emerges from the lake and meanders through shallow emergent marsh and wet meadow habitat.

Mink diet varies considerably with prey availability, but it consists largely of fish, crayfish, frogs, small mammals, and birds. Melquist *et al.* (1981) found that fish, mostly cyprinids 7 – 12 cm (2.8 – 4.7 inches) long, made up 59 percent of the mink's diet in Idaho. In prairie marshes of North Dakota, birds (mostly waterfowl), mammals, amphibians, and reptiles accounted for 78, 19, 2, and 1 percent of the mink's diet respectively, with the amount of prey taken closely paralleling prey availability (Eberhardt and Sargeant 1977). Other studies have also found waterfowl to be an important component of the mink's diet during the spring and early summer when young waterfowl are abundant (Melquist *et al.* 1981, Talent *et al.* 1983). Crayfish have been found to be a large component of the mink's diet in areas where they are abundant (Burgess 1978, Melquist *et al.* 1981, Allen 1986). During the winter, mammals are the primary food source for mink. In areas where muskrat are abundant, male mink may feed heavily on them (Allen 1986). Female mink are smaller and thus tend to take smaller mammals such as mice, voles, and young rabbits (Kurta 1995, and Whitaker and Hamilton 1998).

Mink have variable home range sizes, often with an average of 3.2 – 4.8 km (2 – 3 mi) in diameter (DeGraaf and Yamasaki 2001). Linear distances along shorelines have been reported to be from 1.6 – 3.6 mink per mile of shoreline (DeGraaf and Yamasaki 2001). This is greater than what was observed within the PSA. It appears that mink densities within the PSA are low, and that the observations that did occur may have been the result of individuals passing through the area from adjacent sites.

3.2 Omnivorous and Carnivorous Mammals

A wide variety of omnivorous and carnivorous mammals occur in the PSA. Coyote and fox were the most common carnivores, being recorded in nearly every habitat type in the PSA. Other carnivorous mammals observed in the PSA include bobcats, fishers, and

long-tailed weasels. Omnivorous mammals were one of the most abundant groups of mammals found in the PSA. Common omnivores observed include mice, raccoons, striped skunks, Virginia opossums, and black bears.

3.2.1 Large

Coyotes were the most common large carnivore found in the PSA. Coyotes have very broad habitat requirements and occupy a variety of habitats from open fields and agricultural lands to forested communities. Within the PSA coyotes were observed in every habitat type except for those consisting of open or deep water and spruce fir-northern hardwood forests. Lack of coyote observations inspruce fir-northern hardwood forests is likely due to the rarity of this habitat type within the PSA rather than lack of use by coyotes. In winter, coyotes more readily used the river and marsh communities for travel and hunting. Coyotes prey upon a variety of mammals, birds, herpetiles, and insects, with small mammals and rabbits being the most important food sources. Seasonally, their diet can be quite omnivorous, as they often eat berries in summer and early fall. Larger game, such as deer, is occasionally taken when coyotes are hunting cooperatively in packs. Coyote scats were commonly observed in the PSA, and they consisted of small mammals, squirrel, cottontail, and white-tailed deer fur and bones. Scats collected near the Pittsfield WWTF contained large amounts of crow feathers and pieces of plastic and other trash.

Coyotes were also common at all four reference areas. Coyotes were especially abundant at Washington Mountain Lake in the October Mountain State Forest and Threemile Pond SWMA reference areas, where their tracks were often seen intermingled with those of white-tailed deer.

Red foxes were the next most common carnivore observed in the PSA. Both red foxes and gray foxes can occupy a variety of habitats, but the red fox prefers open areas such as agricultural land and forest edges while the gray fox is more common in forested areas. Within the PSA, red foxes were recorded in many habitat types (Attachment C). While being largely carnivorous, their diet may be more omnivorous based upon the seasonal availability of insects, fruits, and nuts. Fox scat collected from the PSA contained small

mammal bones and fur and bird feathers. Foxes form small family units during breeding season but, unlike coyotes, remain solitary for the majority of the year. They vigorously defend small territories averaging 100 ha. Young foxes are taken by a variety of other carnivores and coyotes will kill adults, but otherwise they have few natural enemies.

Bobcats were observed in the PSA but were not common. Tracks and two possible dens were observed, in the vicinity of the Pittsfield WWTF. Both den sites were located near the WWTF sludge dump: one den in an open field that appeared to be abandoned and the other in the side of a dirt mound at the WWTF sludge dump. This second den appeared to have several entrances and there were recent tracks leading from the den and throughout the vicinity. Bobcat tracks were also observed on the river's edge in this area during early spring 1999 (Figure 6-8). A bobcat was sighted in Great Barrington on the Brush Hill Road Bridge in the spring of 1999, near the Threemile Pond SWMA reference area.

Figure 6-8 Bobcat tracks.

Four toes, round shape, two anterior and three posterior lobes on heel pad, and large size characterize bobcat tracks.

Terrestrial mustelid species, including the short-tailed weasel, long-tailed weasel, and fisher, were found in the PSA and, more commonly, in the reference areas. Fisher signs were found in the southern section of the PSA during both winters of snow tracking surveys. Long-tailed weasels were found near the confluence of the East and West Branch Housatonic River and six (an adult female and five young) were inadvertently caught in pit traps placed along a spit shallow emergent marsh vegetation in June 1999.

In addition, a female long-tailed weasel was captured at 46-VP-5 in June 1999. Short-tailed weasels were not recorded in the PSA, but they were common at the Ashley Lake, Threemile Pond SWMA, and Hinsdale Flats SWMA reference areas.

These mustelid species are all carnivores, preying upon a variety of small mammals. The smaller weasel species rely primarily upon mice, voles, shrews, squirrels, rabbits, and occasionally insects, birds, and amphibians. Fishers also take small mammals, but their diet also contains larger prey items such as snowshoe hares, porcupines, raccoons, and even deer. Fishers will also consume nuts, seeds, and fruits. Hawks, owls, and other carnivorous mammals will prey upon the weasels, but fishers have few natural enemies. Populations of these mustelids have been reduced due to human trapping for the fur trade, but habitat protection and stricter trapping laws have allowed populations to increase in recent years (Whitaker and Hamilton 1998).

Black bears are the largest omnivore found in the study area, typically weighing 50 – 227 kg (110 – 500 pounds), with males being larger than females (Whitaker and Hamilton 1998). Black bears use a variety of habitat types, but they were observed predominately in forested habitats in the PSA (Attachment C). They were most common in the southern part of the PSA, although one individual was observed near the confluence of the East and West Branch Housatonic River. Other observations occurred near Yokum Brook, in a shallow emergent marsh and shrub swamp community south of New Lenox Road, in the shrub swamp and rich mesic forest adjacent to Woodland Road, crossing East New Lenox Road into an open field scattered with apple trees, and on the railroad tracks just south of the New Lenox Sportsman Club. A number of black bears (Figure 6-9), including a mother and three cubs, were seen crossing Woodland Road. Tracks of an additional adult and cub were seen in the October Mountain State Forest reference area.

Figure 6-9 Black bear.

Black bears once occurred throughout the eastern United States but are now limited primarily to secluded northern forests of Maine, New Hampshire, Vermont, and New York, and south along the Appalachian Mountains into Georgia. Though carnivorous, bears are largely omnivorous, with their diet depending upon seasonal and regional food availability. They feed on buds, grasses, and forbs in the spring, and fruit and mast during the summer and fall. Insects—such as ants, wasps, bees, beetles, and their larvae—make up the largest portion of animal matter in the black bear's diet. Small mammals and fish are occasionally eaten and carrion is readily consumed (Whitaker and Hamilton 1998).

3.2.2 Small

The Virginia opossum, raccoon, and striped skunk are all common in the PSA. While all three have teeth designed for carnivory, the feeding habits of these species is opportunistic and consists of a wide range of plant and animal material.

The raccoon was the most abundant of these omnivores observed in the PSA. Raccoons occur throughout the United States, with the exception of the desert communities of the southwest, and are common to abundant throughout their range. They are found in forest communities interspersed with open fields and watercourses. Populations are often high in wetland communities, near streams, pools, and lakeshores, where they forage for crayfish, amphibians, and fish. Densities vary depending upon suitability of available

habitat ranging from one raccoon per 1.8 ha (4.4 acres) in suburban woodlands to one per 28 ha (68.4 acres) in agricultural areas (DeGraaf and Yamasaki 2001).

Within the study area, raccoons were found in most of the wetland habitats, as well as agricultural and residential areas. Their tracks were common on the point bars and mud flats along the river and near many of the vernal pools. Raccoons are opportunistic feeders, consuming a wide variety of animal matter, vegetation, seeds, and berries depending upon availability. Crayfish, earthworms, amphibians, turtle eggs and young, bird eggs (especially those of cavity nesting waterfowl such as wood ducks) and carrion are common animal food types (Whitaker and Hamilton 1998). In agricultural areas, large amounts of corn, wheat, and other grains are consumed. Raccoons have adapted well to humans and are common in urban parks and residential areas, where they often become nuisances feeding on garbage. Raccoon are dormant throughout the winter but do not enter true hibernation. They rely mainly on fat stores throughout the winter, but they will emerge to forage during periods of mild weather.

Striped skunks are less common in the PSA, being observed primarily in terrestrial habitats and high-terrace floodplain forest communities. Striped skunks are common throughout the eastern United States (Whitaker and Hamilton 1998). They can occur in a variety of habitats but prefer woodlands, meadows, and agricultural areas. Like the raccoon, striped skunks have adapted well to human presence and are often found in residential areas and trash dumps. Stripped skunks are omnivorous, their diet typically containing insects, rodents, bird eggs, carrion, garbage, seeds, fruits, and nuts. During the spring and summer, insects are the most important prey items, making up as much as 43 percent of the diet (DeGraaf and Yamasaki 2001). Fruits, grains, and nuts become more important food items in the fall and winter. Skunks are mostly inactive during winter, relying on fat stores to meet their energy needs, which are reduced by communal denning, lowered body temperatures, and decreased activity. The striped skunk's defense of spraying predators with a mephitic musk deters most attacks. However, great horn owls commonly feed on skunks, and other predators such as coyotes, bobcats, and foxes will take skunks when under food stress.

Virginia opossums were the least common of the small omnivores observed in the PSA. They were recorded in only two habitats: transitional floodplain forests and residential areas. Virginia opossums are somewhat uncommon in the New England region, as they reach their northern limit here. Virginia opossums can occur in a variety of habitats from forests to urban areas, and are often common in wet woods and swamps. Like raccoons and skunks, Virginia opossums are opportunistic feeders, eating a wide variety of plant and animal matter. They are also common in urban and residential areas, where they feed on garbage and are often killed by dogs and automobiles. Natural enemies include raptors, especially great horned owls, snakes, coyotes, bobcats, foxes, and raccoons.

3.3 Insectivorous Mammals

3.3.1 Bats

The big brown bat, silver-haired bat, red bat, hoary bat, eastern pipistrelle, and northern myotis occur within the PSA and were recorded during bat surveys. The little brown bat also occurs, but its echolocation calls are difficult to distinguish from small-footed myotis and Indiana bat. It was assumed, however, that most calls exhibiting characteristics of these three species were from little brown bats (see discussion below).

Echolocation recordings cannot give an exact number of individuals of each species present, as it is possible that one individual could be recorded multiple times. They can, however, give an estimation of relative abundance.

Table 6-1 identifies the total and relative abundance of each species recorded during surveys. As noted above, there is a large amount of overlap between the call characteristics of the little brown bat, small-footed myotis, and Indiana bat, making it extremely difficult to distinguish between these *Myotis* species using echolocation. When recording the results, these three species were all labeled as *Myotis* sp. In light of the fact that the little brown bat is typically the most abundant component of the bat community in the Northeast (Krusic *et al.* 1996, Zimmerman and Glanz 2000), it is likely that the majority of these calls in the PSA were of little brown bat. Additionally, the flight and feeding behavior of most of the bats observed during the field survey was

typical of the little brown bat. A small number of *Myotis* sp. calls, however, had parameters that suggested small-footed myotis rather than little brown bats or Indiana bats. Small-footed myotis, a species of Special Concern in Massachusetts (see Section 4.0), cannot be confirmed without having animals in hand for visual identification.

Table 6-1 1999 bat survey results.

Common Name	Transect 1			Transect 2			Transect 3			Total # of calls	Relative Abundance
	Night 1	Night 2	Night 3	Night 1	Night 2	Night 3	Night 1	Night 2	Night 3		
Big Brown bat	41	0	0	14	12	9	2	26	8	112	6%
Eastern Red bat	1	3	6	2	9	2	25	13	0	61	3%
Hoary bat	4	0	0	11	8	0	1	2	1	27	1%
Silver-haired bat	4	4	0	35	23	23	19	20	30	158	9%
Myotis sp. *	38	134	125	155	257	241	250	108	113	1421	79%
Northern myotis	0	1	1	0	3	1	12	0	0	18	1%
Eastern pipistrelle	0	1	0	0	0	0	6	3	0	10	1%
Total # of calls	88	143	132	217	312	276	315	172	152	1807	
Mean # of calls	121			268			213				

*May include little brown bat, small-footed myotis, or Indiana bat

Unknown *Myotis* sp. bats accounted for 79 percent of all echolocations recorded, and it is likely that the little brown bat made up the majority of those recordings. This may be due in part to their general abundance in the New England region and their preference to feed over and close to the water surface (Whitaker and Hamilton 1998). Both of these characteristics made them more likely to be recorded during the survey. During bat

surveys, these small bat were often seen feeding in large swarms directly above the river channel. They were most common near New Lenox Road, where the river is surrounded by open wet meadows, and over open backwaters and pools throughout the PSA. Little brown bats feed on a variety of small insects, with midges (Diptera, Chironomidea) being the staple food source. Males consume about 1.22 grams of food a day and females consume 0.93 grams (Coutts *et al.* 1973). After evening feeding, these bats return to communal roost sites where elevated temperatures aid in digestion and energy conservation. Roost sites are typically in man-made structures such as houses, barns and bridges, but tree cavities and caves are also used when available.

Little brown bats are active from April to October, after which they migrate to their hibernacula, traveling as mush as 300 km from their summer habitat. These bats hibernate in small clusters in caves, abandoned mines, and less commonly man-made structures. Most bat species have seen rapid declines in their number in recent years due to insecticide poisoning, control measures in buildings, disturbance in wintering colonies, and general habitat loss. Little brown bats and big brown bats, however, have remained abundant and even increased their populations in some areas. The success of these two species is likely due to their adaptability to human presence and their reliance upon man-made structures for roosting sites. Other studies conducted in Maine, New Hampshire, and Massachusetts found little brown bats to be the most abundant species present (Krusic *et al.* 1996, Buresch 1999, Zimmerman and Glanz 2000).

The silver-haired bat was the next most abundant species recorded. They also tend to fly near the ground and feed primarily over water. Silver-haired bats are generally uncommon in New England. Recent studies have recorded their presence, especially during fall migration when they travel from their summer habitat of northern hardwood and mixedwood forests to winter hibernacula in the southern United States, but generally report low numbers of individuals (Krusic *et al.*1996, Buresch 1999). The PSA offers prime habitat for these bats, as they prefer to feed over watercourses on emerging aquatic insects (DeGraaf and Yamasaki 2001). Silver-haired bats roost in tree cavities, under loose bark, and in furrowed bark folds, preferring willow, maple, and ash (Kurta 1995). The abundance of large silver maples with optimal roost sites in close proximity to

preferred feeding habitat may explain why silver-haired bats are relatively common in the PSA.

The big brown bat was the third most commonly recorded bat during this survey. Big brown bats are most abundant in agricultural and residential areas, where they feed over open fields, among scattered trees, along tree-lined streets, and around city street lights (DeGraaf and Yamasaki 2001). Since the bat survey was restricted to the river course, the true abundance of this species in the area may be higher. Big brown bats were most commonly recorded near the upstream-end of the PSA, where the river flows close to residential areas. Big brown bats are beetle specialists but will consume a wide variety of insects. Big brown bats, like the little brown bats, roost in man-made structures but are seldom found with little brown bats, as they prefer cooler roost sites. These bats, unlike most species, do not migrate south to hibernate. Big brown bats seldom travel more than 80 km to reach winter hibernacula and will often hibernate in buildings within close proximity to their summer roost sites (DeGraaf and Yamasaki 2001, Kurta 1995). Big brown bats are active for more of the year (March to November) than any other bat in the study area and are occasionally seen during mild periods throughout the winter.

Although the red bat is typically uncommon in the state, it was routinely detected during this survey. The PSA provides optimal habitat for both feeding and roosting locations. Red bats establish feeding territories, preferably over still water or along forest edges, within 1.2 km (.75 mi) from roost sites (DeGraaf and Yamasaki 2001). They feed on a wide variety of insects but prefer moths. Roost sites are selected in dense foliage of hardwood trees or large shrubs, such as elm, maple, cherry, and walnut, with shade above and to the side, but open below. Roost sites will differ day to day but are often in close proximity to one another. In the fall, red bats migrate south in small groups to winter hibernacula.

The hoary bat, eastern pipistrelle, and northern myotis were each recorded in low numbers in the survey. Low numbers of the hoary bat and eastern pipistrelle were expected, as they are considered uncommon in northeastern United States. Hoary bats are forest-dwelling bats with life histories similar to the red bat, except that they more commonly roost in coniferous trees. The echolocation calls of northern myotis have low

amplitude, making this species less detectable with the Anabat system (Krusic *et al.* 1996). This may account to some extent for the low number of recordings.

Bats in general have few predators, owls and hawks being the most common predators. Bats are most vulnerable in their roosts where snakes, predaceous birds (especially blue jays), and mammals (especially cats and raccoons) will prey upon them. Highest mortality rates are among the young, and falling from maternity sites is the greatest cause of death for young. Poisoning from insecticide ingestion is a common cause of mortality (Whitaker and Hamilton 1998). Bats are also at risk of bioaccumulating environmental contaminants, such as PCB and DDE, which reduce reproductive success and cause tremoring and mortality (Clark and Lamont 1976, Clark and Stafford 1981, Clark 1978). Prolonged tremoring, which is characteristic of organochlorine poisoning, can be especially lethal to bats because it can reduce fat stores needed to survive hibernation (Clark and Stafford 1981). Any disturbance during hibernation uses fat stores and reduces survival. Many bat populations have been reduced due to repeated disturbances from human recreation in caves, and some species (i.e., Indiana bat) that have large percentages of their entire population hibernating in only a few caves are at greatest risk due to this type of disturbance (Whitaker and Hamilton 1998).

3.3.2 Shrews

Masked shrews, smoky shrews, northern short-tailed shrews, and northern water shrews all occur in the PSA (Attachment C). Short-tailed shrews were the most abundant shrew in the PSA and made up 14 percent and 26 percent of small mammal captures in 1998 and 1999, respectively (see Table 6-2 in Section 3.4.2 below). They were also routinely captured in pit traps during wood frog and leopard frog studies. Masked shrews were also common but in smaller numbers than the short-tailed shrews. Smoky shrews were less common than the masked and short-tailed shrews; only a few were captured in pit traps during wood frog and leopard frog studies. The northern water shrew is rare, having been observed only once in the PSA.

The northern short-tail shrew is a large shrew commonly found in a wide variety of habitat types from open meadows to forests throughout the northeastern United States,

although its primary habitat requirement is cool, moist soil (Whitaker and Hamilton 1998). Within the PSA they can be found in most forested, shrub swamp, and wet meadows communities. Short-tailed shrews feed primarily on invertebrates, with earthworms as the most important food, followed by slugs and snails (DeGraaf and Yamasaki 2001). Amphibians, mice, and birds are occasionally eaten. The short-tailed shrew consumes some plant material—such as roots, nuts, berries, and fungi—especially during the winter when caches of such food help to conserve energy. Populations of this shrew show high annual variation, with densities ranging from 1.6 to 121 individuals per hectare but averaging 2.5 (Whitaker and Hamilton 1998, DeGraaf and Yamasaki 2001). Northern short-tailed shrews typically breed after their first year and have three litters a year ranging in size from one to seven young (Whitaker and Hamilton 1998). Adult northern short-tailed shrews captured in the PSA had lengths ranging from 114 – 137 mm and weights from 18.3 – 32.9 grams. Seventeen females were captured during trapping efforts, but only seven of these showed signs of breeding (i.e., placental scars, embryos, lactation).

The masked shrew was commonly encountered during trapping events but in low numbers. This tiny shrew is the smallest mammal occurring in the PSA. Individuals captured during small mammal surveys ranged from 92 – 107 mm long and weighted only 3.4 – 3.7 grams. The masked shrew occupies habitats ranging from moist, grassy fields to dense boreal forests. It can be found in most of the wetland and terrestrial habitat types within the PSA. Masked shrews feed on small insects, mollusks, annelids, and the carrion of larger animals. Ants often make up a large portion of their diet, as do beetle larvae, slugs, snails, and spiders (Whitaker and Hamilton 1998). Masked shrews have home ranges of 405 m^2 (0.10 acres) per individual and densities of 22 individuals per hectare with large annual variation (DeGraaf and Yamasaki 2001). Masked shrews reach sexual maturity at four months, after which they have up to three liters, averaging seven in size, each year. Two breeding female masked shrews were captured in the PSA. One individual had two fetuses and the other displayed uterine vascularization indicative of early pregnancy, but fetuses were not yet visible.

Smokey shrews were uncommon in the PSA, although they are generally common throughout New England. This species prefers shady, damp northern forests with dense ground cover and an abundance of moss-covered logs and boulders. It can, however, be found in a variety of habitats such as bogs, swamps, talus slopes, and stream banks. Within the PSA, smoky shrews were found only in red maple swamp communities. Smoky shrews feed on small leaf litter invertebrates, earthworms, and small salamanders. Population densities of 12 – 35 per hectare are most common, but densities as high as 143 per hectare have been reported (Whitaker and Hamilton 1998).

Only one northern water shrew was observed in the PSA. This was a dead individual observed washed up on the shoreline of the river in the southern part of the PSA. The northern water shrew is a species of conservation concern in Massachusetts and is uncommon throughout New England (see Section 4.0). The northern water shrew occurs in wet habitats, especially grass-sedge marshes and shrub communities along streams. It is most common in swift-flowing, coldwater mountain streams with boulders, woody debris, and tree roots to provide cover. Like all shrews, the northern water shrew is insectivorous, with stonefly, mayfly, and caddisfly larvae making up the largest part of its diet. It also consumes a variety of other invertebrates, small fish, and amphibians.

3.3.3 Moles

Two moles, eastern and star-nosed moles, were documented in the PSA, and an additional species, the hairy-tailed mole, potentially occurs there. The star-nosed mole was the most common mole species found in the PSA. This mole prefers wet areas and is an adept swimmer, with its burrows often leading directly into a stream or pool. Within the PSA, star-nosed moles were commonly found utilizing woodland vernal pools.

The eastern mole is common throughout the Atlantic coastal plain and central United States in well-drained, open grasslands. Within the PSA, an individual was recorded in the transitional floodplain forest community north of New Lenox Road. This mole may be more common in the PSA, but it is expected to occur mostly in upland, agricultural, and residential areas that were not surveyed. The hairy-tailed mole prefers well-drained soils and can be found primarily in forests but also in open grasslands that support some

shrubs. It was not observed in the PSA, although one was observed just north of the Hinsdale Flats SWMA reference area.

Earthworms are the most important food source for all of the moles. Other insects such as beetles, their larvae, snails, slugs, centipedes, millipedes, ants, and spiders are taken in smaller quantities. Plant matter will occasionally be consumed, and the eastern mole in particular may feed heavily on vegetable matter at times. The star-nosed mole will also forage under water and take aquatic insects, mollusks, crustaceans, and occasional fish.

3.4 Herbivorous Mammals

3.4.1 Large Herbivores

White-tailed deer and moose are the only large herbivores found in the PSA. White-tailed deer were found to be abundant throughout the PSA. Deer are browsers that feed on grasses, forbs, and new leaves of woody plants during the summer. They feed heavily on acorns, beechnuts, and other mast as these foods become available. During the winter they feed on buds and twigs of woody plants.

Moose were found primarily in the October Mountain State Forest reference area. Moose are uncommon in Berkshire County, but recent trends indicate an increasing population (Whitaker and Hamilton 1998). Moose are also browsers, although they tend to rely more upon trees and shrubs during the spring and summer than do deer. They are commonly found in lakes and ponds during the spring and early summer, where they feed on the aquatic vegetation.

3.4.2 Small Herbivores

Small terrestrial herbivores occurring in the PSA include snowshoe hares, cottontails, squirrels, eastern chipmunks, woodchucks, porcupines, mice, voles, and southern bog lemmings. A total of 221 small mammals representing 5 species and 121 small mammals representing 6 species were captured during 1998 and 1999, respectively (Table 6-2). White-footed mice were by far the most abundant, making up 64 percent and 62 percent of all captures. In addition to small mammal trapping, numerous small mammals were

captured in pitfall traps installed for amphibian studies, and tracks of many of these species were commonly observed during snow tracking and scent post station surveys.

Table 6-2 1998 and 1999 small mammal trapping results.

Common Name	1998 Locations					1999 Locations				
	1B	3	8	Totals	%	13	14	15	Totals	%
white-footed mouse	45	82	14	141	63.80	23	41	12	76	62.30
northern short-tailed shrew	24	5	3	32	14.48	10	18	4	32	26.23
meadow jumping mouse	0	0	0	0	0.00	1	6	0	7	5.74
meadow vole	13	24	2	39	17.65	1	0	0	1	0.82
southern red-backed vole	0	0	6	6	2.71	0	1	0	1	0.82
masked shrew	0	1	2	3	1.36	0	0	5	5	4.10
Totals	82	112	27	221		35	66	21	122	

White-footed mice inhabit a wide variety of habitats, including forest edges, brushy areas, hedgerows, and they occasionally venture into open grassland (DeGraaf and Yamasaki 2001). They were captured at all of the small mammal trapping locations and at numerous vernal pools, and were observed at all locations during snow tracking surveys. Woodland jumping mice typically occur in variety of forest habitats from spruce/fir to northern hardwoods. They are most commonly found in open, moist forests and are often found near streams (Whitaker and Hamilton 1998). Within the PSA, woodland jumping mice were observed in red maple swamp, black ash-red maple-tamarack calcareous seepage swamp, transitional floodplain forest, and high-terrace

floodplain forest communities. Meadow jumping mice typically occur in cultural grassland communities. Grassy clearings in forested regions may support small numbers of these species and they are often found in early successional forests (Whitaker and Hamilton 1998). Within the PSA they were observed in red maple swamp and transitional floodplain forest communities. Norway rats, first introduced to the United States in the late 1700's, are now abundant in residential and agricultural areas throughout the country. This species was captured during amphibian pit-trapping in red maple swamp and transitional floodplain forest communities, primarily at locations in proximity to residential areas.

While traditionally believed to be herbivores, the diets of mice vary greatly depending upon seasonal and regional availability of food sources and can include a high percentage of animal matter. Large amounts of insects (primarily ground beetles, caterpillars, cutworms, snails, and centipedes) are taken during the spring and summer. As the season progresses, the diet of these mammals shifts more towards seeds, nuts, berries, and fungus. White-footed mice are active year-round and often cache large amounts of seeds and nuts to last throughout the winter.

Meadow voles were also found to be abundant in the PSA and were routinely captured during small mammal trapping events as well as during wood frog and leopard frog studies. Adult meadow voles captured in the PSA ranged in length from 112 – 137 mm and in weight from 16.4 – 26.7 grams. Meadow voles inhabit wet meadows, regenerating pastures with shrub colonies, and wet forest openings. Within the PSA they were found in a variety of emergent and forested wetland communities (Attachment C). Meadow voles eat large quantities of green vegetation—predominately grasses, sedges, and their seeds, fleshy rootstocks, and bark—with amounts often exceeding the animal's weight in a 24-hour period. They also re-ingest their feces to extract the vitamins and nutrients broken down in the later stages of digestion (i.e., they are coprophagic). Meadow voles are among the most prolific small mammals in the eastern United States. A single female can produce as many as 17 litters in a year, with each litter containing 1 – 11 young (Whitaker and Hamilton 1998).

Southern red-backed voles are less common than the meadow voles in the PSA, having been captured only in the red maple and shrub swamp at Trapsite 8 (Map 6-7). Southern red-backed voles are a forest species and are seldom found in open areas. These voles feed on a variety of nuts, seeds, berries, green vegetation, roots, and fungi, depending upon seasonal availability. They store large amount of seeds and nuts to provide food in the winter, as they are active year-round.

All five members of the squirrel family—eastern chipmunks, red squirrels, gray squirrels, northern flying squirrels, and southern flying squirrels—that could potentially occur in the PSA were observed there. The eastern gray squirrel (Figure 6-10) was the most abundant squirrel, being seen in almost every forested habitat in the PSA. These squirrels are abundant in the eastern United States in a variety of forested and residential habitats. Some melanistic gray squirrels were occasionally observed in the PSA. These individuals have black fur on their sides and backs, with dark brown fur on their undersides. All five of the squirrels are forest-dwelling species, as trees are needed for nesting and food. The chipmunk is an exception to this, requiring burrows in the ground, under rocks, or in rotting stumps and logs. Of the squirrels, the red and southern flying squirrel are more carnivorous and are known to eat bird eggs, insects, and young vertebrates.

Figure 6-10 Eastern gray squirrel.

The eastern gray squirrel was the most common member of the squirrel family observed in the PSA.

The porcupine (Figure 6-11) is another common species of the northern forests. Within the PSA they were observed on October Mountain and along Woodland Road. Porcupines spend the majority of their time in trees, where they forage for leaves, buds, mast, and young twigs. Their diet is seasonal, with buds and young leaves being consumed in the spring and summer, mast in the fall, and the inner bark and young twigs in the winter. American beech, ash, basswood, apple, and aspen are favored species, as they build up less tannin in their leaves than other species such as maple and oak. Spruce, pine, and eastern hemlock are also consumed in the winter. Porcupines have relatively small home ranges for its size with summer ranges between 30 – 150 ha (75 – 370 acres) and a winter range of only 2.4 ha (6 acres) (Whitaker and Hamilton 1998). Porcupines have few natural enemies except fisher.

Figure 6-11 Porcupine.

Porcupines were most common in the PSA along the lower slopes of October Mountain State Forest.

Three lagomorph species—snowshoe hare, eastern cottontail, and New England cottontail—could potentially occur within the PSA. Snowshoe hares are a northern species that prefer dense coniferous forests and regenerating shrubs in mixedwood forests, and were found only at the Ashley Lake reference area. The eastern cottontail was the most abundant rabbit species found in the PSA. This species was commonly observed in all of the terrestrial habitats, floodplain forests, swamps, and wet meadows. Colonization of the eastern cottontail throughout the northeast has lead to the decline of

New England cottontails in much of their range. New England cottontails are now considered rare except in southern Maine, New Hampshire, and most of Massachusetts (Litvaitis and Litvaitis 1996). New England cottontails and eastern cottontails cannot be distinguished by their tracks or scat. Therefore all snowtracking sightings were labeled only as cottontail. Visually these two species can sometimes be separated based upon the presence of a black patch between the ears of New England cottontail and the presence of a white patch on the forehead of eastern cottontail. These characteristics, however, may be missing on approximately 50 percent of eastern cottontails (Godin 1977). Because no individuals within the PSA were observed to have the black patch, it is assumed that rabbits observed were eastern cottontails, even when the white patch was not observed.

All three of these species feed heavily on grasses and clover in the summer, and seeds and berries as they become available in the late summer and fall. Cottontails were commonly seen foraging on residential lawns and in agricultural pastureland in the PSA. Buds and twigs of shrubs, stems of blackberries, and sapling sprouts are the primary food sources in winter. During winter snow tracking rabbits were observed foraging on buckthorn, sumac, dogwood, and river grape. Rabbit species are preyed upon in large numbers by nearly all the predators occurring in the PSA, including bobcats, coyotes, foxes, fishers, minks, hawks, and owls.

The two aquatic, herbivorous mammals, American beavers and common muskrats, were both abundant throughout the PSA. American beavers can be found throughout North America in any area where suitable rivers, streams, ponds, or lakes exist. Their primary requirement is water deep enough to prevent ice from freezing to the bottom, which they often create by damming streams and seepages. They den by constructing large floating lodges, excavating bank dens or combining these methods (Figure 6-12). Beaver dens were common throughout the PSA.

Beavers are generalist feeders, consuming whatever plants are available. During the summer, aquatic plants such as pond-lilies, bur-reed, cattails, pondweed, and algae make up their diet. Bark, primarily from hardwoods, makes up the winter diet of beavers. Trees and shrubs are cut during the late summer and fall months to be cached for the winter. Food is stored underwater by anchoring it in mud near the lodge. Beavers are

communal animals, sharing lodges, workloads, and food caches. A typical colony consists of six individuals made up of a pair of adults, their recent young, and occasionally yearlings. Typical colony densities are 0.20 – .69 individuals per kilometer of stream (Whitaker and Hamilton 1998).

Figure 6-12 Beaver lodge.

Beaver lodges like this one are common along the Housatonic River and its backwaters.

Muskrats were found to be abundant throughout the PSA, occurring primarily in deep emergent marshes such as those found adjacent to the river and backwaters north of Woods Pond. Roots and stalks of cattails, three-square grass, and rushes are favorite food sources, although they will eat a wide variety of aquatic plants and may invade nearby fields to feed on herbaceous vegetation. They often build an extensive system of channels to allow for easy winter access between food sources and lodges. Lodges are built of aquatic vegetation with underwater access holes. Muskrats are territorial with a pair of muskrats defending a territory roughly 60 m (200 feet) in diameter around their lodge.

4.0 Rare, Threatened, and Endangered Mammals

Four mammal species of conservation concern could potentially occur in the PSA, only one of which was directly observed. The water shrew, small-footed myotis, and southern bog lemming are of species of Special Concern in Massachusetts, and the Indiana bat is consdidered Endangered by the State of Massachusetts and the Federal Government

(MNHESP 1999). Rare species report forms for rare mammals are provided in Attachment H.

Indiana Bat

The Indiana bat is a Federal- and State-listed Endangered species. Its status is due primarily to the limited number of winter hibernating sites. Eighty-five percent of Indiana bats hibernate in seven caves located in Missouri, southern Indiana, and Kentucky, with 50 percent in just two of those (Kurta 1995). In addition, range-wide population levels of this species have decreased drastically since 1960 (Whitaker and Hamilton, 1998). In summer, Indiana bats range throughout much of the eastern United States, from southern New Hampshire south along the Appalachian Mountains to the panhandle of Florida and west into northeastern Oklahoma.

Historically, Indiana bats may have used much of Massachusetts during the summer breeding period. The floodplain forests of the PSA are suitable foraging habitat, and large silver maples with exfoliating bark could provide suitable maternity sites. Indiana bats forage in upland and bottomland forests, although they prefer dense hillside and ridge forests. The Indiana bat spends 68 percent of its time foraging among trees, rather than over water (LaVal *et al.* 1977). A variety of small insects are consumed, with moths taken most often, followed by Coleoptera and Diptera (Whitaker and Hamilton 1998). Indiana bats were historically recorded in Berkshire, Hampden, and Worcester Counties; however, they are extremely rare in the northeast and have not been reported from Massachusetts since 1939 (MNHESP 1984).

Small-footed myotis

The small-footed myotis is listed as a species of Special Concern by the MNHESP (1999). It ranges from Ontario and southern Quebec, down the Appalachian Mountains to northern Georgia, and west into Arkansas and Oklahoma. These bats usually occur in mountainous regions. Small-footed myotis utilize buildings, overhanging rocks, and caves as summer roost and maternity sites. Suitable summer habitat is present in and adjacent to the PSA and it is likely that the small-footed myotis occurs there. Little is known about its feeding habits, although they are believed to be similar to other *Myotis*

species. Flies, beetles, bugs, leafhoppers, and flying ants have been found in their stomachs (Kurta 1995). They hibernate in caves and mines from November to March usually in the foothills of mountains, up to 610 m (2,000 feet) in elevation, in coniferous woodlands (DeGraaf and Yamasaki 2001).

Small-footed myotis have been recorded in western Massachusetts and documented twice since 1978 in Hampden County, MA (MNHESP 1984, Godin 1977), making their presence in the PSA possible. Other studies conducted in the region have reported small-footed myotis observations (Zimmerman and Glanz 2000, Krusic *et al.*1996). Given this, it is believed that some, albeit likely only a few, of the bat echolocations recorded as *Myotis* sp. during bat surveys were of small-footed myotis (Map 6-12). However, as previously mentioned, limitations of echolocation technology prevent this species from being positively identified.

Water Shrew

The water shrew is listed as a species of Special Concern by MNHESP. It occurs throughout much of Canada and the northeastern United States, from Maine to Connecticut, west to eastern New York and north-central Pennsylvania, extending south in the Appalachian Mountains. This species is also common in mountainous regions of western United States (Whitaker and Hamilton 1998).

Water shrews are usually found near open water. Their optimal habitats are small fast-flowing mountain streams with abundant cover provided by undercut banks, rocks, downed trees, and debris. However, they can also less commonly be found in slow-moving streams, graminoid meadows, beaver impoundments, and temporary pools. Water shrews have historically been collected in Berkshire County (Godin 1977) and the PSA contains habitat for this species. One dead individual was found in the downstream half of the PSA, adjacent to transitional floodplain forests (Map 6-12).

Southern Bog Lemming

The southern bog lemming is a species of Special Concern in Massachusetts. This species' range extends from Quebec, south through the Appalachians to the western

Carolinas, west throughout the Great Lakes region and into Kansas and Arkansas (Whitaker and Hamilton 1998). They are most abundant in the Great Lakes region. Southern bog lemmings can be found in a variety of habitats ranging from forests to grasslands, although their primary habitats are sphagnum bogs and areas supporting thick mosses and deep leaf mold (DeGraaf and Yamasaki 2001, Kurta 1995). The chief requirement for southern bog lemmings is green succulent monocots, primarily sedges and grasses, which almost entirely make up their diet. Some berries may be eaten when in season, as well as fungi and mosses.

The shrub swamp, wet meadow, and floodplain forests of the PSA offer potential habitat for the southern bog lemming, as do the mesic forest slopes of October Mountain, just east of the PSA. However, this species was not observed during any field investigations.

5.0 Literature Cited

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SECTION IV ATTACHMENTS