Appendix 6

Outstanding Resource Value Report: The Watershed Ecosystem

Eightmile River Watershed Management Plan

Eightmile River Watershed Outstanding Resource Value:
The Watershed Ecosystem

6/26/06

Authored by William H. Moorhead III

The following report is also available in its original color format from www.eightmileriver.org. Please note that this report was completed after printing of the draft appendices that were provided for public review during January of 2006. The version that appears here is of similar content but in a more complete form.

Eightmile River Watershed Biodiversity Report

Prepared for the Eightmile River Wild and Scenic Study Committee

By

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EXECUTIVE SUMMARY

The Eightmile River watershed is a relatively undeveloped drainage basin that occupies 62.4 mi^2 of hilly, mostly forested terrain in southeastern Connecticut. In 2004, the author was commissioned by the Eightmile River Wild and Scenic Study Committee to: 1) assess the biodiversity values and significance of the Eightmile River watershed, especially with respect to imperiled plants and animals; 2) identify and document those physical, biological, and ecological elements that make the watershed exemplary and unique as an intact, functioning watershed ecosystem; 3) create maps depicting unique species and natural community/habitat resources; 4) identify and document anadromous and resident fish species; and 5) develop a set of management recommendations for the watershed. This study was commissioned in support of an anticipated application for Federal Wild & Scenic River designation for the entire watershed. The author, whose primary area of expertise and background is botany and classification of vegetation and natural communities, has researched existing information relevant to the biodiversity of the watershed, and presents it in this report.

The Eightmile River is a tributary to the lower Connecticut River. The confluence of the two rivers is approximately 8 miles from the mouth of the larger river at Long Island Sound (whence the Eightmile River reportedly gets its name), and the entire watershed is within ~18 miles of Long Island Sound. At the point of confluence, the Connecticut River and the downstream-most 2.4± miles of the Eightmile River are tidal with halinities close the boundary between freshwater (< 0.5 ppt) and oligohaline (0.5-5.0 ppt). Most of this tidal section the Eightmile River is a relatively long, narrow, shallow embayment of the Connecticut River known as Hamburg Cove. The Connecticut River is doubtless a dominant influence on ambient water levels and water chemistry of Hamburg Cove, except perhaps when the Eightmile River is in flood, and then for relatively short periods. However, the Eightmile River, by way of these relatively short periods of intense floods, is believed to be a prime factor resulting in the dominance of coarse sediments in Hamburg Cove, which in turn is a critical factor in the occurrence of species and communities of high biodiversity significance.

Beyond the tidally influenced sections, the Eightmile River and its major tributaries are clear, picturesque streams with long, mostly medium-high gradient, mostly forested sections punctuated by occasional small impoundments (man- and beaver-made) and occasional low-gradient shrub-swampy or marshy sections. The landscape of the watershed may be characterized overall as one of rolling, more or less irregular, low hills and ridges separated by numerous small, narrow drainage corridors and hollows, and in places broader valleys and basins. Ambient hill-top elevations gradually decrease across the watershed from 500-650 ft at the north end to 300-400 ft at the southern end. However, beyond these generalizations, there is considerable landscape-level geomorphologic variation within the watershed, and several geologic and geomorphologic features of the watershed have recognized as exceptional in

various contexts. Among these features are an exceptional number of different bedrock types (Lundgren 1966), and the occurrence of a series of strike ridges whose east-west orientation is unique, in New England, to a small area in southeast Connecticut that includes the Eightmile watershed.

As the first step in the assessment of the biodiversity significance of the Eightmile River watershed, an inventory was completed of rare plants and wildlife known or believed to be extant in the watershed. This inventory drew in largest part on existing information, but it was also augmented by limited primary field survey by the author, focusing mainly on rare plants and natural communities. Important sources of existing information included the Connecticut Dept. of Environmental Protection's (CT-DEP) Wildlife and Fisheries Divisions, the CT-DEP Natural Diversity Data Base (NDDB, i.e., the state natural heritage program), scientists from area universities and other institutions, local naturalists, and a variety of published studies. Rare plants and wildlife were defined as species listed as "Endangered", "Threatened", or "Special Concern" under Connecticut's Endangered Species Act, species listed as "important", "very important", or "most important" in Connecticut's Comprehensive Wildlife Management Strategy, and other species identified as being of special conservation concern by other organizations, such as ICUN and the New England Wildflower Society. A total of 160 such species, referred to in this report as "at risk" species, are either known to be currently extant in the watershed, or documented recently enough (i.e., within the last 25 years) to suspect they are extant. This list is comprised of 37 vascular plants, 6 amphibians, 77 bird species, 11 fish species, 10 invertebrate species, 6 reptiles and turtles, and 13 mammals. The watershed hosts 5 globally rare species: two plants, *Bidens eatonii* Eaton's Beggar's-ticks (G2) and *Eriocaulon parkeri* Parker's Pipewort (G3), and three insects, *Callophrys irus* Frosted Elfin (G3, a butterfly), *Gomphus ventricosus* Skillet Clubtail (G3, a dragonfly), and *Enallagma minusculum* Little Bluet (G3G4, a damselfly). Also, the watershed is a breeding season and winter foraging area for one species listed as Threatened under the U. S. Endangered Species Act: the Bald Eagle. The Eightmile River watershed is the New England regional stronghold for two regionally rare plants, *Scutellaria integrifolia* Hyssop Skullcap and *Aristolochia serpentaria* Virginia Snakeroot, and the Connecticut stronghold for a third regionally rare plant, *Xyris smalliana* Small's Yellow-eyed Grass.

The biodiversity significance of the Eightmile River watershed was evaluated in two contexts: state and regional (with "regional" defined as New England) and using two measures of species rarity, state and global. Biodiversity significance may be defined in many ways, but for the purposes of this analysis, the number of extant rare species was considered to be a surrogate for high biodiversity significance. This approach was used because it is generally accepted that high densities of rare species are, more often than not, the "icing on the cake", i.e., rare species most often occur in places that have unusually high species (and natural community) richness. Using data compiled by NatureServe and originating with the six New England state natural heritage

programs, the Eightmile River watershed was compared to all other watersheds in New England, in terms of extant globally rare species (species ranked G1-G3 by NatureServe) and extant state-rarest species (species ranked S1-S2 by local heritage programs). Comparing numbers of extant rare species per unit area of watershed ("extant" being defined as having been observed within the last 25 years), the Eightmile River watershed ranks very high in both state and regional contexts. Due to differences between watershed/drainage basin classification systems at the state and federal level, a direct comparison was not possible. But a direct comparison of the two component HUC12 basins that comprise the Eightmile River watershed, the Eightmile River [mainstem] basin and the East Branch Eightmile River basin, was possible, and the two HUC12 basins rank in the 98th and 90th percentile, respectively, of the 1,931 HUC12 basins in New England in terms of total extant globally rare species per unit area, and in the 95th and 89th percentile, respectively, in terms of total extant combined state-rare and globally rare species per unit area.

The Eightmile River watershed's biodiversity significance in a state context was evaluated with the assistance of the Connecticut Department of Environmental Protection's Natural Diversity Data Base (CT-DEP-NDDB), which is the state's natural heritage program. A direct comparison to Connecticut's other regional basins was possible, and for this comparison rare species were defined as all species listed as Endangered, Threatened, or Special Concern under the Connecticut's Endangered Species Act (this includes all globally rare species as well), as well as any other species assigned a state conservation status rank of S2S3 or lower. In this comparison, the Eightmile watershed, with 49 extant state-rare species (0.7853 spp/mi^2), exceeds all but four of Connecticut's regional drainage basins, in terms of extant state-rare species per unit area. The four basins that exceed the Eightmile (the Wood, Tenmile, Hollenbeck, and Blackberry River basins) are in the two subregions of New England that have the highest numbers of extant rare species in New England: northwestern Connecticut and vicinity, and southwestern Rhode Island and vicinity.

That the Eightmile hosts a relatively high number of extant globally and state-rare species is a function largely of the existence in the watershed of intact special habitats/natural communities. As a general rule, the rarest species in any landscape are habitat specialists that are rare because their specialized habitats are rare. This certainly holds true for the Eightmile watershed, and the majority of its globally and state-rare species and other uncommon species are associated with special habitats and natural communities that cover relatively small portions of the watershed, such as freshwater and oligohaline intertidal habitats, medium fens, sandy and peaty shorelines of natural sandy-bottomed lakes, acidic and sweet seasonally wet meadows, acidic cliffs, rocky outcrops of interbedded amphibolite and marble, dry grasslands, xeric sand barrens, and Atlantic White Cedar swamps. Also, the majority (but not all) of rare and uncommon species hosted by the watershed are associated with non-forested habitats, some of which are naturally open (such as medium fens and intertidal sand-gravel flats), but many of which are open- or semi-open-

canopy habitats due to past or on-going manipulation by man.

An exceptional biodiversity feature of the Eightmile River watershed is the association of a high-profile "at risk" bird species, the Cerulean Warbler (*Dendroica cerulea*), with a forest habitat type, or complex of types, that is not itself rare, but occurs on an unusually large scale in the watershed. This neotropical migrant is not yet globally rare, but is in a rangewide decline that is believed to be due to fragmentation of large mature forest stands. The Eightmile watershed, throughout much of which the Cerulean Warbler breeds, comprises the greatest part of a regional stronghold for this species. This warbler is considered one of the most area-sensitive bird species (i.e., large unbroken mature forest blocks are required to support robust breeding populations), and it is believed that the Eightmile watershed's robust breeding population is related to the size and types of its forest blocks in juxtaposition with the watershed's near-coastal geographic position, and resulting relatively mild climate (the center of the Cerulean Warbler's breeding range is the central Appalachians – it is reaching its northern range limit in New England). Thus, the existence of a large breeding population of Cerulean Warblers is evidence that the Eightmile River watershed has a unique combination of forest size, type, and geographic position.

This study approached the evaluation of river and watershed ecosystem quality by looking for indicators (biological, ecological, and physical) of ecosystem and habitat intactness and functioning. The above-mentioned Cerulean Warbler is one such biological indicator. Other important biological indicators identified were vernal-pool-dependant amphibians, such as Spotted Salamander and Wood Frog. Both species require a landscape with two habitat elements juxtaposed: sufficient densities of undegraded vernal pool habitat for breeding sites, and large, unfragmented accessible upland forest habitat for adult foraging. Both species are found throughout the Eightmile watershed, and populations are evidently very robust in many places. These robust populations are evidence of intact and functioning complex of habitat types.

Another important biological indicator in the watershed is stream macrobenthos (i.e., the communities of invertebrates that dwell on the bottoms of streams). The CT-DEP has sampled the Eightmile River and East Branch Eightmile River, and have concluded, based on the macrobenthic species assemblage present, that the Eightmile [mainstem] is essentially pristine, while the East Branch Eightmile River ranks in the upper half of sampling sites statewide, in terms of water and habitat quality.

Several landscape level indicators of habitat intactness were assessed and used to compare the Eightmile River watershed to other watersheds in a Connecticut context. These parameters were road miles/unit area of watershed (using GIS data from the CT-DEP's Environmental and Geographic Information Center), the proportion of a watershed that is occupied by large roadless blocks (using a coverage developed by The Nature Conservancy), the total forested proportion of

the watershed, and the percent developed area of the watershed (using a land use coverage developed by University of Connecticut Center for Land Use Education and Research from 2002 satellite imagery). The Eightmile watershed, with 2.65 road miles/square mile of watershed, has the third lowest road miles/mi^2 of the 44 regional watersheds in CT (range: 1.57 to 16.5 road mi/mi^2). The Eightmile watershed ranks 2nd from the top in terms of percentage of watershed occupied by roadless blocks of 1000 ac or greater (72.2% for the Eightmile watershed). Only two of Connecticut's 44 regional watersheds have a greater percentage of forested area than the Eightmile watershed. Of special note, in light of the above-discussed hypothesis regarding the large breeding population of Cerulean Warblers centered in the Eightmile watershed, is that it exceeds all other near-coastal Connecticut watersheds in percentage forested area, by 9 to 81 percentage points. Finally, the Eightmile watershed, with 6.74% developed land, has a lower percentage of developed area than all except four of Connecticut's 44 regional watersheds, and a lower percentage of developed land than all 15 other near-coastal watersheds. For all four landscape level parameters, the Eightmile watershed is either comparable to, or is exceeded only by, the four above-mentioned Connecticut watersheds that have the highest numbers of extant rare species in New England (the Wood, Tenmile, Hollenbeck, and Blackberry River basins).

In summary, the Eightmile River watershed ranks very high in a state and regional context in terms of biodiversity values and biodiversity significance. This is indicated by a high number of species identified as "at risk" by various conservation organizations, and it is indicated by the relatively high numbers of the subset of "at risk" species that are classified as globally rare and state-rare, compared with all other watersheds in Connecticut and New England. It is a unique regional stronghold for several specific rare/at risk species. In addition, in terms of a number other parameters that are indicators of ecosystem integrity, intactness, and function, the Eightmile watershed is comparable to, or exceeded only by, a few watersheds in southern New England that have the largest concentrations of extant rare species in all of New England.

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I. INTRODUCTION

The Eightmile River watershed is a relatively undeveloped drainage basin that occupies 62.4 mi^2 of hilly, mostly forested terrain in southeastern Connecticut. In 2004, this assessment of the biodiversity values and significance of the Eightmile River watershed was commissioned by the Eightmile River Wild and Scenic Study Committee, in support of a plan to seek Federal Wild and Scenic River designation for the entire watershed. The author, whose primary area of expertise and background is botany and classification of vegetation and natural communities, has researched existing information relevant to the biodiversity of the watershed, and has presented it in this report.

II. DESCRIPTION OF THE STUDY AREA

The Eightmile River watershed, as addressed in this report, occupies approximately 62.4 mi^2 in southeastern Connecticut (see location map in Figure 1). The long axis of the watershed is roughly north-south: it is about 12.6 mi long by 7.5 mi wide at its widest point in east-west dimension. The watershed straddles the border between New London county and Middlesex County, and occupies parts of five towns: Lyme, East Haddam, Colchester, Salem, and East Lyme. The watershed straddles an east-west-running boundary between two "ecoregions", as they have been defined by The Nature Conservancy (The Nature Conservancy 2001). The northern-most 90% of the watershed lies in the Lower New England/Northern Piedmont Ecoregion, while the southern-most 10% is in the North Atlantic Coast Ecoregion.

The Eightmile River is a tributary from the east to the Connecticut River, which is tidal in this area. The downstream end of the watershed is considered to be at the mouth of Hamburg Cove in Lyme, which is nearly 8 miles upstream from the mouth of the Connecticut River. Measured from the mouth of Hamburg Cove, the downstream-most 2.4± miles of the Eightmile River are tidally influenced. The halinity regime of this tidal reach of the Eightmile River is either completely fresh, or perhaps varies seasonally to oligohaline, especially toward the mouth of the cove. Hamburg Cove is essentially a freshwater tidal embayment of the Connecticut River that extends 2.2± miles upstream to the point where the Eightmile River's downstream flow is dominant between high tides. The river is tidal for another 0.2± miles above this point, but this section clearly has stream character rather than that of an embayment. Above the head of tide, the distance in stream-miles to the head of the watershed's most distant perennial headwater is about 14.6 miles. The entire watershed is within 18± miles of the coast (i.e., the north shore of Long Island Sound).

Above the tidally influenced sections, the Eightmile River and its major tributaries are clear, picturesque streams with long, mostly medium-high gradient stretches through mostly deciduous forested terrain. Forested sections of the Eightmile River and its major tributaries are punctuated by occasional small impoundments (man- and beaver-made), occasional swampy or marshy

sections. In overview, the landscape of the watershed may be characterized as one of rolling low hills, ridges, and lines of hills that are separated by numerous small, narrow drainage corridors and hollows, and in places broader valleys and basins. Ambient hill-top elevations gradually decrease across the watershed from 500-650 ft at the north end to 300-400 ft at the southern end. However, beyond these generalizations, there is considerable landscape-level geomorphologic variation within the watershed, and several bedrock-geologic and geomorphologic features of the watershed have recognized as exceptional in various contexts. Among these features are an exceptional number of different bedrock types (Lundgren 1966), and the occurrence of a series of strike ridges whose east-west orientation is unique, in New England, to small area in southeast Connecticut that includes the Eightmile watershed.

An overview map of major habitat types of the Eightmile River watershed is presented in Figure 2. This major habitat coverage was derived from a more detailed, finer resolution vegetation/habitat coveraged synthesized by the author during this investigation. This finer resolution vegetation/habitat map is presented in Figures 4 and 5. The area and relative percentage of the watershed occupied by each vegetation/habitat unit is found in Table 1.

Based on the author's analysis, approximately 17% of the watershed may be classified as wetland, and ~83% as non-wetland.

The most abundant physiognomic vegetation type in the Eightmile River watershed is forest, which occupies ~75.5% of the watershed (unless otherwise noted, this percentage and those that follow are derived from the author's vegetation/habitat map). Most of this forest is deciduous forest (~73% of the watershed), while only a very small portion is evergreen and mixed evergreen-deciduous forest (slightly more than 2% of the watershed). Eastern Hemlock (*Tsuga canadensis*) is the dominant evergreen component in most of this portion of the watershed. In spite of its small cumulative area, this evergreen and mixed evergreen-deciduous forest portion is a significant ecological element of the watershed, because two-thirds of it occurs in a single complex of more nearly 600 acres, along the Eightmile River [mainstem] in the Devil's Hopyard – Burnham Brook area.

The entire watershed has been assigned to the Central Hardwoods-Hemlock forest, *sensu* Westveld *et al*. (Westveld *et al*. 1956; Dowhan 1976), in which oaks and low heaths dominate dry sites, oaks and hickories are dominant forest trees on dry-mesic sites, and Sugar Maple (*Acer saccharum*) and Tuliptree (*Liriodendron tulipifera*) and are dominant forest tree species on mesic sites of higher fertility (Dowhan 1976). According to a map of forest dominance types in the watershed, based on Landsat satellite imagery from 1988, 1990, and 1992 (Bonneau 1997), two dominance types comprise 81% of the total forested area of the watershed: Oak-Hickory (54%) and Mixed Deciduous (27%). According to this mapping, the matrix forest of the watershed is made up of a mosaic of these two forest types, and seven other dominance types, occurring as many small islands in the matrix and each having cumulative areal percentages

ranging from <1% to 6%, make up the remaining 19% of the watershed's forests: Oak/Pine, Red Maple, Hemlock, Birch, Tulip Poplar, Oak/Mountain Laurel, and Pine. The author has not conducted a rigorous ground-truthing of this forest type mapping, but his field work and aerial photo analyses have confirmed, at least, that these forest dominance types exist in the watershed, and that the cumulative area hierarchy of the two major types versus the seven minor types, collectively, is essentially correct. In addition to the dominance types recognized , the author has identified, though his field work, a number of other major and minor forest dominance types that occur in the watershed, such as Oak (with little or no Hickory), Hickory (with little or no oak), Beech, Sugar Maple-White Ash, Atlantic White Cedar, Oak-Hemlock (to name only a few). It appears that, of these additional dominance types not recognized in the Landsat-derived mapping, the deciduous types have most often been found in areas mapped as Oak-Hickory and Mixed Deciduous, while the evergreen and mixed evergreen-deciduous types occur in areas mapped as Hemlock, Oak/Pine, Pine, or Oak/Mountain Laurel. Thus, based on the author's work, it appears that Oak-Hickory and Mixed Deciduous forests are indeed major forest dominance types in the watershed, but that other types collectively make up a greater proportion of the forests in the watershed than is presented in the Landsat-derived mapping.

The Eightmile River watershed's forests may also be viewed as an assemblage of floristic alliances, associations, and subassociations/communities, *sensu* the International Vegetation Classification (Grossman et al. 1998) and the complementary Vegetation Classification for Connecticut (Metzler and Barrett 2006). The watershed vegetation has not yet been classified and mapped using these classification schemes, but based on the author's recent field work, it has been possible to identify the major forest associations occur in the watershed. The watershed's non-wetland forested matrix is primarily a complex mosaic of the following three associations: Northern red oak / Flowering dogwood (*Quercus rubra* / *Cornus florida*) forests, Northern red oak - Black oak - Chestnut oak (*Quercus rubra - Quercus velutina - Quercus prinus*) forests, and Sugar maple – White ash – American basswood (*Acer saccharum – Fraxinus americana - Tilia americana*) forests. The first two associations together almost certainly occupy more area the third association, but their importance relative to each other is hard to estimate. The watershed's forested wetlands, which comprise 15% of the watershed's total forested area, appear to be primarily made up of three associations: Red maple / Skunk cabbage (*Acer rubrum* / *Symplocarpus foetidus*) seasonally flooded forests, Red maple / Highbush blueberry (*Acer rubrum* / *Vaccinium corymbosum*) seasonally flooded forests, and Red maple – Pin oak (*Acer rubrum - Quercus palustris*) seasonally flooded forests. The first two associations together comprise the greatest portion of the watershed's wetland forests. The last association, which comprises only 4% of the watershed's forest wetlands, has disproportionately high biodiversity significance, because this unit is where forested vernal pools fit in this classification. Also known to occur in the watershed, and possibly occupying a significant area, is a seventh association that straddles the boundary between wetland and non-wetland forests: the Northern red oak – Yellow birch (*Quercus rubra - Betula alleghaniensis*) forests association.

About 15% of the forested portion of the watershed, or ~11% of the total watershed area and ~65% of the total wetland area in the watershed, is forested wetland. All except a small portion of this is deciduous forested basin and seepage swamp in which Red Maple (*Acer rubrum*) is the dominant, or a co-dmominant, tree species. Trees commonly co-occurring in wetlands with Red Maple are Yellow Birch (*Betula alleghaniensis*), Black Gum (*Nyssa sylvatica*), Swamp White Oak (*Quercus bicolor*), and Pin Oak (*Quercus palustris*). In the small proportion of evergreen and mixed deciduous forested wetlands that occur in the watershed, Eastern Hemlock (*Tsuga canadensis*), White Pine (*Pinus strobus*) are the most prevalent co-dominant species, but a few places, all in the vicinity of Cedar Lake, Atlantic White Cedar (*Chamaecyparis thyoides*) is dominant or co-dominant.

The 24.5% of the watershed that is not forested is comprised of non-forested wetlands (~6%), open and semi-open upland habitats (~7%), mesic to seasonally wet open and semi-open habitats (~3%), developed areas and roads (~9%).

Two thirds of the non-forested wetland portion of the watershed is divided nearly equally between of two classes of wetlands: open water habitats and deciduous forest/scrub-shrub wetlands. Open water habitats occupy, which include natural and man-made lakes and ponds, man-made and beaver-made impoundments, and tidal open water, occupy about 800 ac (12% of the watershed's wetlands area and 2% of the total watershed area). More than half of the total open water of is comprised of the five largest water bodies in the watershed: fresh to oligohaline tidal Hamburg Cove (170 ac), Lake Hayward [formerly known as Shaw Lake] (175 ac), Uncus Pond [formerly known as Hog Pond] (75 ac), Norwich Pond (30 ac), and Cedar Lake (25 ac). The latter four water bodies are the four largest lakes/ponds in the watershed, and also are all natural (though Lake Hayward is dammed and has been raised above its original level).

Deciduous forest/scrub-shrub wetlands, which comprise 13% of the total wetlands area and 2% of the total watershed area, are deciduous-shrub-dominated wetlands that also have open stands of deciduous trees with cumulative tree canopy coverage in the range of 30-60%. This wetland class has been subdivided on the basis of hydrologic regime. About 28% of the wetland area mapped as deciduous forest/scrub-shrub has been classified as "seasonally flooded/exposed", while ~69% has been classified as "seasonally flooded", and the remaining 3% have been assigned several other hydrologic regimes. Seasonally flooded/exposed wetlands are those that have been identified as potential and/or field-verified breeding sites for vernal pool indicator species.

The remaining 10% of non-forested wetland area in the watershed is comprised of a great number of wetland types, which are presented in Figures 4 and 5 and Table 1. Much of this diversity of wetland type can be attributed to past and current activities of humans and beaver in the watershed.

Approximately 10% of the watershed is occupied by open (i.e., without trees) and semi-open (i.e., having trees but with less than ~60% cumulative tree canopy coverage) upland habitats and mesic to seasonally wet habitats (this latter category occurs on non-hydric soils with a seasonally high water table). These include a great variety of grasslands, variously dense to sparse evergreen, deciduous, and deciduous shrublands, evergreen, deciduous, and mixed woodlands and savannas (i.e., sparse woodlands), xeric sand barrens, and xeric rocky outcrop communities. Of the nearly 4000 ac of open and semi-open non-wetland habitats in the watershed only a few acres, at most, occupied by a portion of the xeric rocky outcrop communities, can be said to be occurring in an unforested state "naturally" (i.e., in the absence of past or current human disturbance/manipulation). Virtually all of the open and semi-open habitats non-wetland habitats in the watershed are unforested because of human disturbance/manipulations of the land and/or

vegetation, either on-going or in the recent past. Among the most important of these disturbances/manipulations are those associated with agriculture and animal husbandry, such as raising of row crops, grazing, and hay production, timber harvest and silvicultural treatments, highway and electrical transmission right-of-way management, sand and gravel mining, and wildlife habitat management practices. A small portion of open and semi-open habitat, all in Nehantic State Forest, is being maintained by prescribed burning by the CT-DEP Forestry Division (Gluck pers. comm.).

The town of Salem, in the northeast part of the watershed, is a concentration area in the Eightmile River watershed for open and semi-open habitats, and within Salem, the Salem Valley area, transected by the East Branch Eightmile River, is a concentration of open and semi-open habitats.

Grasslands occupy nearly 1600 ac, or ~4%, of the watershed, and they comprise largest single type (36%) of the non-wetland open and semi-open habitats class. In the Eightmile River watershed vegetation/habitat map, total grasslands are subdivided into "mesic to seasonally wet grassland", which occur on non-hydric soils with a seasonally high water table, and "grassland", which occur on well-drained soils with moisture regimes that range from mesic to dry to xeric. The cumulative area ratio of "mesic to seasonally wet grassland" to "grassland" is 40:60. Both units are considered non-wetland types, but soils data from the National Soil Information System (USDA-NRCS 2003) and the author's field observations indicate that a portion of the "mesic to seasonally wet grasslands" unit is on hydric/wetland soils. Also, "hidden" in both grassland units, as depicted in the vegetation/habitat map, is some amount of herbaceous habitat in which non-grasses, such as forbs, such as goldenrod (*Solidago* spp.), or sedges (*Carex* spp., *Scirpus* spp., etc.), comprise the dominant vegetation, rather than grasses. More than 50% of the watershed's grassland area is concentrated in the town of Salem, and almost half of Salem's grassland area is concentrated in the Salem Valley area, along the East Branch Eightmile River.

The watershed's grasslands are comprised of several floristic types. All are either currently managed, or have been managed until very recently, to prevent succession to shrubland, woodland, and forest. The most abundant types of grassland in the watershed are hayfield and pasture, which are dominated by introduced cool-season grasses. However, a substantial portion of the watershed's grasslands, especially those on dry to xeric sandy soils, are dominated by native warm-season grasses. Little Bluestem (*Schizachyrium scoparium*) is the most widespread and most abundant of these, while Big Bluestem (*Andropogon gerardii*) and Indian Grass (*Sorghastrum nutans*) are somewhat less widespread, and much more restricted, as dominant species, to seasonally wet sandy floodplain and deep till soils. Both the "short-grass prairie" (Little Bluestem dominant) and the "tall-grass prairie" (Big Bluestem dominant) types of grassland occur "naturally" in the watershed, in the sense that no one planted and cultivated the native warm-season grasses (though disturbance by man was and is required to maintain open

conditions and prevent invasion by woody species and succession). These warm-season grasslands have developed spontaneously on sites formerly managed more intensively as hayfields, pasture, crop fields, and on sites of sand and gravel extraction or filling.

The bulk of the balance of the open and semi-open non-wetland habitat class is comprised of a great variety of early successional types, the greatest portion of which represents various stages of "old field succession". Lesser but significant portions represent post-logging succession, succession in abandoned sand-and-gravel mines, and succession in the corridor of an unfinished limited access highway segment. Another significant portion may be said to represent "arrested" stages succession. These are habitats such as scrub in electrical transmission rights-of-way, fields with open stands of trees and/or shrubs, woodland and/or scrubby habitat that is periodically burned, and other habitats that are managed to prevent further succession.

The 9% of the watershed that is classified as developed land is comprised predominantly of single-family residential development (6.8%), followed by roads (1.3%), and less than 1% combined industrial, commercial, public, and municipal development. Development is concentrated in certain areas: Lake Hayward and vicinity, the Rte. 85 corridor in Salem, and Hamburg Cove and vicinity.

As of May 2005, approximately 11,000 acres, or 28% of the watershed, was protected by conservation ownership or easement, based on recent research by The Nature Conservancy (Geisler and Frohling 2005). Nearly ¾ of this protected land is state-owned State Forest, State Park, and other types of conservation land. The remainder is protected by ownership, or conservation easements held by, local land trusts, The Nature Conservancy, towns and other entities.

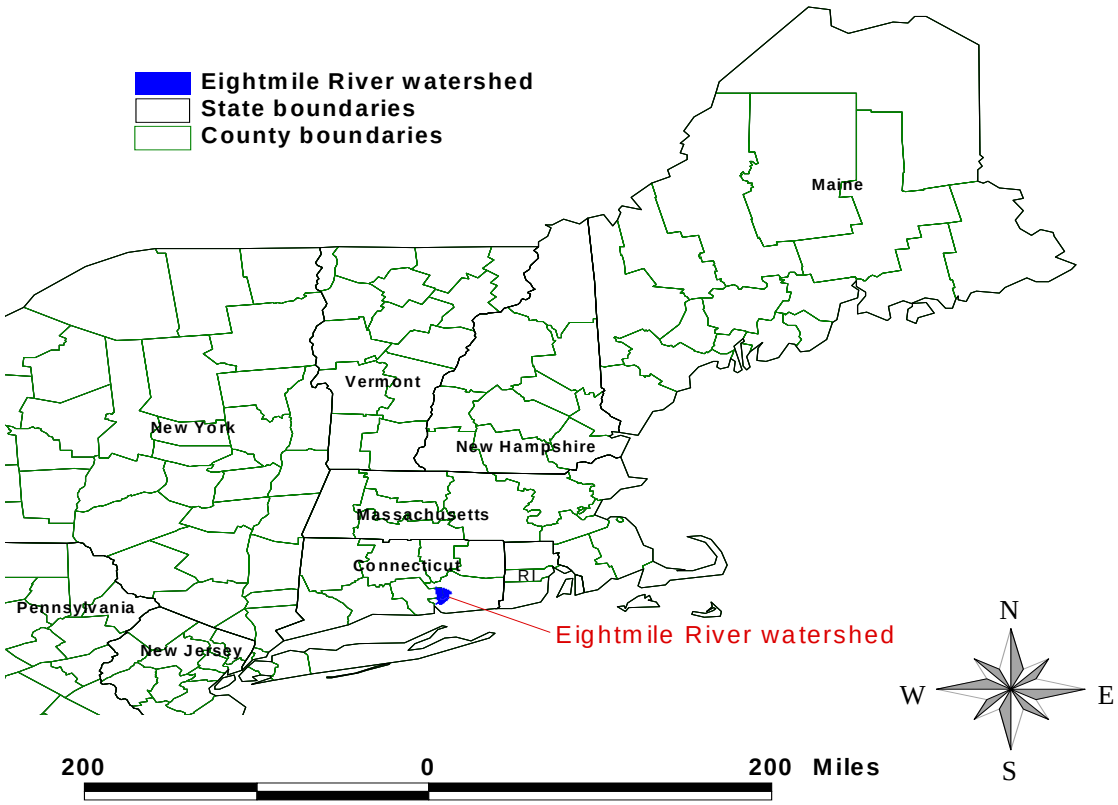

Figure 1. Location Map for Eightmile River watershed, New London and Middlesex Counties, Connecticut, USA.

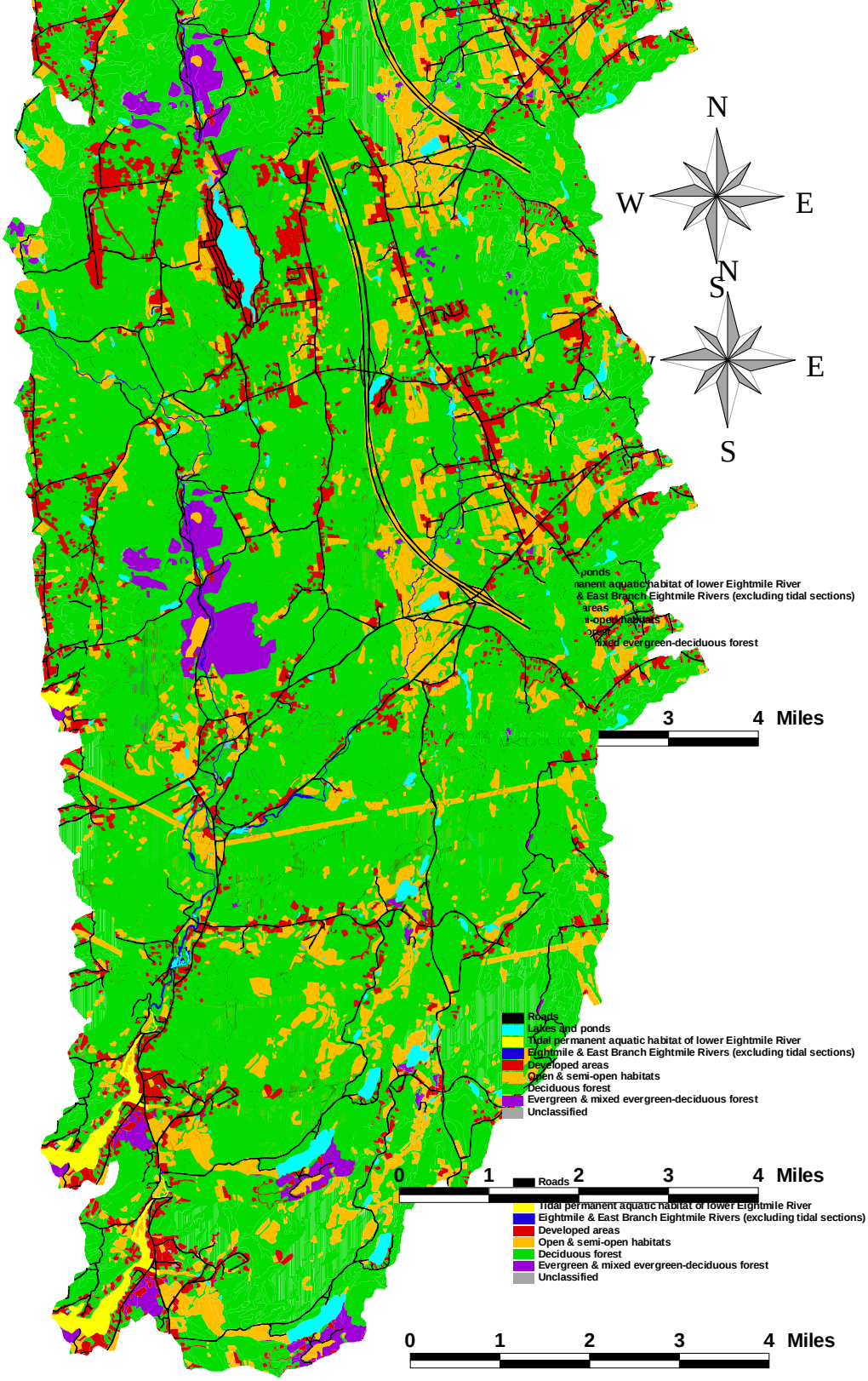

Figure 2. Map of Major Habitat Types of the Eightmile River Watershed

Figure 3. Eightmile River watershed, in relation to federal HUC10 (regional) and HUC12 (subregional) drainage basin classifications.

The Eightmile River watershed, as addressed in this report, does not occupy the same hierarchical levels in state versus federal (i.e., USDA-NRCS) drainage basin classification schemes (SEE Figure 1). According to the Connecticut Department of Environmental Protection (CT-DEP), the watershed is a naturally defined drainage basin at the regional hierarchic level, and it is comprised of 4 subregional basins: Eightmile River [main stem] (31.5 sq mi), East Branch Eightmile River (16.4 sq mi), Beaver Brook (8.3 sq mi), and Harris Brook (6.2 sq mi). By the USDA-NRCS scheme, the Eightmile River watershed (as considered herein) is not recognized as a discrete unit at either the regional or subregional basin level: it is comprised of two subregional (HUC12 level) basins, the Eightmile River (HUC12 code 010802050905 = Eightmile River + Beaver Brook above) and the East Branch Eightmile River (HUC12 code 010802050903 = East Branch Eightmile River + Harris Brook above). At the next USDA-NRCS level up, regional basins (HUC10 level), the Eightmile River watershed is combined with several other nearby watersheds on both sides of the Connecticut River to make up the HUC10-level regional "Connecticut River - Salmon River to mouth" basin. This disparity between the state and federal organization of drainage basins is highlighted here to avoid possible confusion (i.e., the Eightmile River [state-regional basin] ≠ Eightmile River [federal subregional basin]), and to preface some of the complexities involved in analyses of the Eightmile River watershed in a regional context.

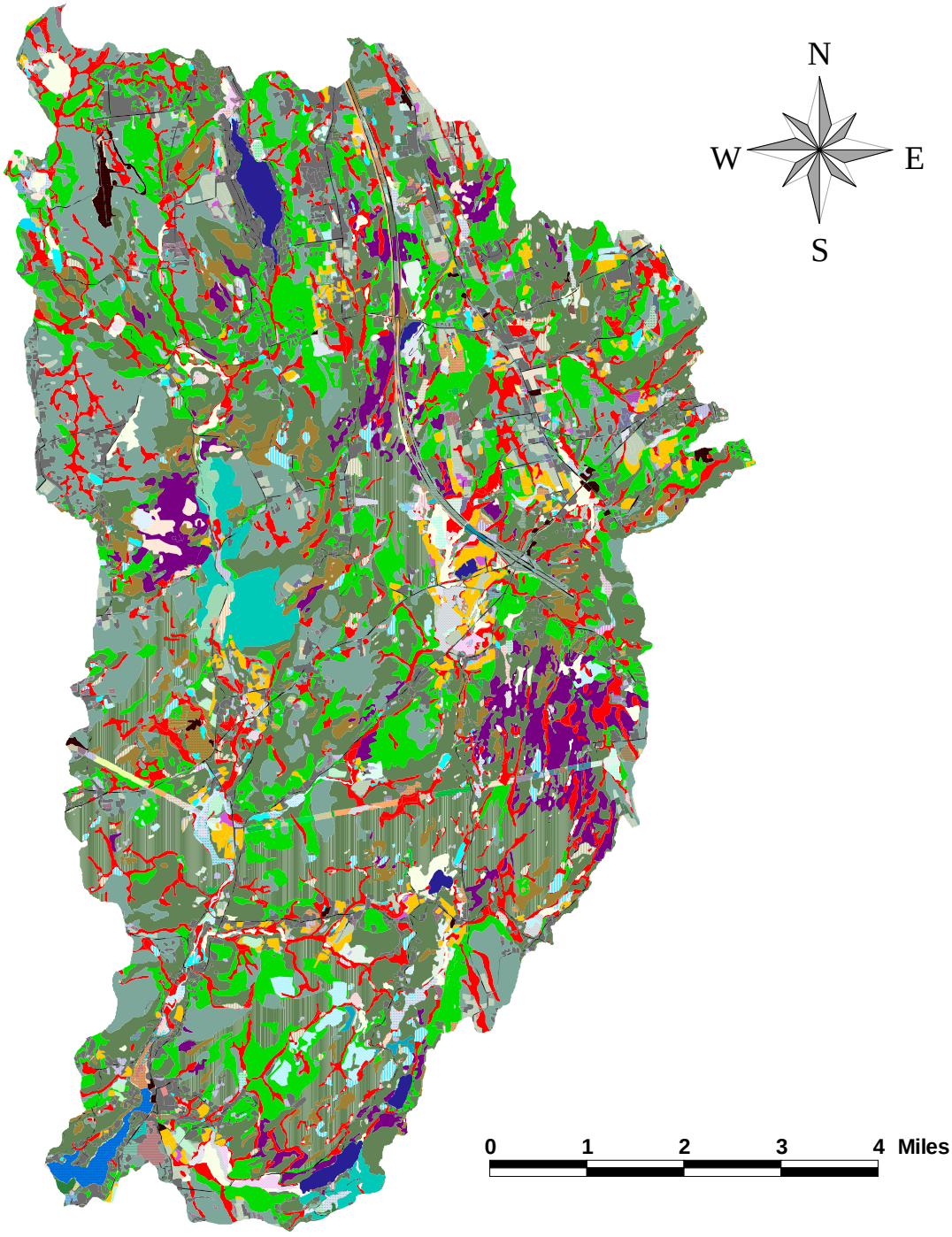

Figure 4. Vegetation/Habitat Map of the Eightmile River Watershed (map legend in next figure) legend

Figure 5. Legend for Vegetation/Habitat Map of the Eightmile River Watershed (SEE

Moorhead, page 23 of 138

previous Figure).

Table 1. Cumulative acreage and percentage of total Eightmile River watershed area occupied by each Vegetation/Habitat Map unit (SEE Figures 4 and 5), listed in order of descending cumulative area in the watershed.

Vegetation/Habitat Map unit	Cumulative acres in watershed	Cumulative % of total watershed area
dry to mesic deciduous forest	11,181.6	27.98024%
mesic deciduous forest	5,447.8	13.63218%
mesic to seasonally wet deciduous forest	5,329.3	13.33565%
seasonally flooded deciduous forest	4,012.1	10.03974%
residential development	2,709.6	6.78033%
oak/mountain laurel forest	1,725.2	4.31717%
dry deciduous forest	1,076.3	2.69329%
grassland	898.9	2.24938%
mesic to seasonally wet grassland	673.1	1.68422%
seasonally flooded deciduous forest/scrub-shrub	604.7	1.51309%
dry to mesic mixed hemlock-deciduous forest (post hemlock decline)	569.7	1.42561%
road	539.0	1.34886%
lake/open water	344.5	0.86211%
unclassified open and semi-open habitat	300.0	0.75061%
seasonally flooded/exposed deciduous forest	248.9	0.62273%
seasonally flooded/exposed deciduous forest/scrub-shrub	246.7	0.61723%
scrubby deciduous woodland	230.7	0.57724%
pond	196.6	0.49204%
commercial development	186.0	0.46555%
seasonally flooded scrub-shrub/emergent herbaceous	143.9	0.36010%
freshwater-oligohaline tidal permanent open water/vascular aquatic bed	142.1	0.35564%
pine-oak/mountain laurel forest	134.6	0.33675%
mixed evergreen-deciduous-scrubby sand barren	127.1	0.31809%
golf course	119.7	0.29950%
sand/gravel mine - active	118.3	0.29593%
mesic to seasonally wet unclassified open and semi-open habitat	116.9	0.29257%

Table 1. Cumulative acreage and percentage of total Eightmile River watershed area occupied by each Vegetation/Habitat Map unit (SEE Figures 4 and 5), listed in order of descending cumulative area in the watershed.

Vegetation/Habitat Map unit	Cumulative acres in watershed	Cumulative % of total watershed area
grassy mixed juniper-deciduous woodland	104.0	0.26022%
semipermanently flooded scrub-shrub/emergent herbaceous, beaver-influenced	101.9	0.25496%
seasonally flooded scrub-shrub	95.9	0.23993%
unclassified	95.3	0.23846%
mesic hemlock forest	81.5	0.20393%
row crops	70.3	0.17598%
temporarily flooded deciduous high floodplain forest	58.8	0.14723%
dry to mesic turf (hwy ROW)	56.7	0.14192%
mesic to seasonally wet scrubby deciduous woodland	55.1	0.13799%
rv/trailer park	52.3	0.13087%
shrubby grassland	50.6	0.12666%
farm development	49.2	0.12319%
semipermanently flooded deadwood swamp/scrub-shrub	48.7	0.12186%
seasonally flooded emergent herbaceous	47.6	0.11909%
mesic to seasonally wet scrubby grassland	46.0	0.11500%
dry to mesic scrubby deciduous woodland (post-hemlock decline)	45.0	0.11262%
mesic to seasonally wet mixed evergreen-deciduous forest	44.9	0.11238%
grassy juniper savanna	43.9	0.10977%
seasonally saturated deciduous forest	42.8	0.10698%
seasonally flooded mixed evergreen-deciduous forest	40.3	0.10092%
temporarily flooded deciduous low floodplain forest	37.4	0.09355%
public development	37.0	0.09253%
grassy sparse deciduous shrubland	34.8	0.08702%
semipermanently flooded deadwood swamp/scrub-shrub, beaver-influenced	34.0	0.08500%
mesic to seasonally wet grassy sparse deciduous shrubland	28.7	0.07187%
early post-clear-cut herbaceous	24.2	0.06056%
dry to mesic mixed juniperus-deciduous scrub (powerline ROW)	23.6	0.05895%
upper perennial stream	23.1	0.05780%

Table 1. Cumulative acreage and percentage of total Eightmile River watershed area occupied by each Vegetation/Habitat Map unit (SEE Figures 4 and 5), listed in order of descending cumulative area in the watershed.

Vegetation/Habitat Map unit	Cumulative acres in watershed	Cumulative % of total watershed area
mesic to seasonally wet scrub	22.4	0.05614%
scrubby mixed juniper-deciduous woodland	22.3	0.05570%
dry to mesic deciduous scrub (powerline ROW)	21.9	0.05488%
freshwater tidal permanent open water/vascular aquatic bed	21.5	0.05373%
semipermanently flooded deadwood swamp/emergent herbaceous, beaver-influenced	20.7	0.05187%
scrub	20.1	0.05039%
seasonally saturated/temporarily flooded mixed evergreen forest	19.9	0.04979%
grassy pine savanna	19.6	0.04914%
semipermanently flooded scrub-shrub/emergent herbaceous	19.2	0.04808%
grassy deciduous woodland	19.2	0.04808%
parklike deciduous savanna	17.7	0.04430%
grassy mixed juniper-deciduous savanna	17.4	0.04363%
mesic to seasonally wet mixed hemlock-deciduous forest	17.0	0.04256%
freshwater intertidal emergent herbaceous	16.7	0.04171%
dry to mesic mixed evergreen-deciduous forest	16.5	0.04141%
dry to seasonally wet deciduous forest	16.0	0.04015%
plant nursery field	16.0	0.03994%
mesic to seasonally wet deciduous scrub	15.6	0.03896%
mountain laurel scrub	14.3	0.03587%
semipermanently flooded deadwood swamp/open water, beaver-influenced	14.3	0.03573%
xeric mixed evergreen-deciduous scrubby woodland on rocky outcrop	14.1	0.03517%
semipermanently flooded emergent herbaceous/aquatic bed	14.0	0.03507%
dry to mesic mixed juniperus-deciduous scrub (powerline ROW)	13.4	0.03341%
dry to mesic atv course (pine savanna)	13.3	0.03328%
semipermanently flooded emergent herbaceous/floating-leaved aquatic bed, beaver-influenced	13.0	0.03254%
seasonally flooded evergreen forest	12.9	0.03226%

Table 1. Cumulative acreage and percentage of total Eightmile River watershed area occupied by each Vegetation/Habitat Map unit (SEE Figures 4 and 5), listed in order of descending cumulative area in the watershed.

Vegetation/Habitat Map unit	Cumulative acres in watershed	Cumulative % of total watershed area
mesic to seasonally wet grassy mixed juniper-deciduous woodland	12.6	0.03159%
grassy juniper woodland	12.6	0.03143%
semipermanently flooded emergent herbaceous/aquatic bed, beaver-influenced	12.6	0.03141%
post-logging deciduous woodland	12.0	0.03009%
seasonally flooded/exposed scrub-shrub	11.9	0.02984%
sparse grassy juniper shrubland	11.9	0.02980%
mesic to seasonally wet grassy deciduous savanna	11.9	0.02970%
temporarily flooded mixed hemlock-deciduous forest	11.9	0.02966%
mesic to seasonally wet scrubby disturbed land	11.7	0.02929%
parklike deciduous woodland	11.6	0.02906%
semipermanently flooded scrub-shrub/aquatic bed	11.5	0.02866%
industrial development	11.3	0.02835%
seasonally flooded deciduous forest/emergent herbaceous	11.2	0.02808%
semipermanently flooded emergent herbaceous	11.0	0.02743%
grassy pine woodland	10.8	0.02705%
semipermanently flooded scrub-shrub/floating-leaved aquatic bed, beaver-influenced	10.7	0.02687%
semipermanently flooded deciduous forest/scrub-shrub, beaver-influenced	10.5	0.02637%
mesic to seasonally wet mixed juniper-deciduous scrubby grassland	10.5	0.02632%
semipermanently flooded deadwood swamp/emergent herbaceous	10.0	0.02504%
seasonally flooded emergent herbaceous (Phalaris)	9.9	0.02484%
seasonally flooded/exposed scrub-shrub/emergent herbaceous	9.8	0.02449%
recently cleared and grubbed land	9.6	0.02403%
grassy deciduous savanna	9.6	0.02402%
seasonally saturated mixed evergreen-deciduous forest	9.3	0.02332%
mesic to seasonally wet grassy juniper savanna	9.3	0.02315%
grassy mixed juniper-deciduous shrubland	9.1	0.02288%

Table 1. Cumulative acreage and percentage of total Eightmile River watershed area occupied by each Vegetation/Habitat Map unit (SEE Figures 4 and 5), listed in order of descending cumulative area in the watershed.

Vegetation/Habitat Map unit	Cumulative acres in watershed	Cumulative % of total watershed area
juniper-scrubby mixed woodland	9.1	0.02285%
seasonally flooded/exposed emergent herbaceous	8.9	0.02218%
seasonally flooded emergent herbaceous (Phragmites)	8.8	0.02204%
grassy sparse evergreen shrubland	8.7	0.02177%
semipermanently flooded scrub-shrub	8.7	0.02171%
temporarily flooded deciduous low floodplain forest/emergent herbaceous	8.4	0.02106%
mixed juniper-deciduous scrubby grassland	7.7	0.01917%
dry to mesic parklike evergreen savanna (hwy ROW)	7.6	0.01901%
saturated scrub-shrub/leatherleaf fen	7.1	0.01782%
permanently flooded aquatic bed	7.0	0.01752%
mesic to seasonally wet grassy pine savanna	7.0	0.01743%
seasonally flooded scrub-shrub/emergent herbaceous, beaver influenced	7.0	0.01739%
sand barren grassland	6.9	0.01731%
seasonally saturated deciduous forest/scrub-shrub	6.9	0.01728%
turf, playing field	6.7	0.01665%
seasonally saturated scrub-shrub/emergent herbaceous	6.5	0.01627%
temporarily flooded grassland	6.4	0.01613%
mountain-laurel-scrubby grassland	6.4	0.01599%
dry to mesic pine forest	6.0	0.01507%
temporarily flooded unclassified open and semi-open habitat	6.0	0.01501%
freshwater intertidal sand/gravel/cobble flat community	5.8	0.01463%
Cemetery	5.7	0.01423%
dry to seasonally wet scrub	5.4	0.01355%
seasonally flooded/exposed emergent herbaceous/unvegetated	5.1	0.01284%
semipermanently flooded emergent herbaceous, beaver-influenced	4.7	0.01179%
sparse forby juniper shrubland	4.7	0.01171%
pine forest	4.6	0.01162%

Table 1. Cumulative acreage and percentage of total Eightmile River watershed area occupied by each Vegetation/Habitat Map unit (SEE Figures 4 and 5), listed in order of descending cumulative area in the watershed.

Vegetation/Habitat Map unit	Cumulative acres in watershed	Cumulative % of total watershed area
mesic mixed hemlock-deciduous forest	4.5	0.01132%
grassy open deciduous shrubland	4.3	0.01069%
closed landfill (grassland)	4.2	0.01057%
seasonally flooded mixed hemlock-deciduous forest	4.2	0.01045%
freshwater tidal stream	4.1	0.01024%
seasonally flooded mixed evergreen-deciduous forest/scrub-shrub	4.1	0.01017%
mesic to seasonally wet atv course (pine savanna)	4.0	0.00997%
freshwater intertidal emergent herbaceous (Phragmites)	3.9	0.00982%
temporarily flooded deciduous low floodplain forest/scrub-shrub	3.8	0.00959%
semipermanently flooded deadwood swamp/aquatic bed, beaver-influenced	3.8	0.00957%
scrubby juniperus woodland	3.8	0.00957%
temporarily flooded scrubby grassland	3.8	0.00954%
mesic to seasonally wet deciduous woodland	3.7	0.00937%
saturated deciduous forest/scrub-shrub	3.6	0.00908%
saturated scrub-shrub fen	3.6	0.00906%
seasonally saturated emergent herbaceous	3.6	0.00905%
semipermanently flooded emergent herbaceous/floating-leaved aquatic bed	3.3	0.00837%
scrubby juniperus savanna	3.3	0.00835%
saturated scrub-shrub/sphagnum fen	3.3	0.00833%
mesic to seasonally wet parklike deciduous woodland	3.2	0.00808%
seasonally flooded/exposed deciduous forest/emergent herbaceous	3.0	0.00760%
parklike evergreen savanna	3.0	0.00752%
semipermanently flooded scrub-shrub/aquatic bed, beaver-influenced	2.9	0.00716%
saturated evergreen scrub-shrub	2.8	0.00709%
dry to mesic evergreen forest	2.6	0.00656%
mesic to seasonally wet mixed juniper-deciduous-scrubby deciduous woodland	2.6	0.00651%

Table 1. Cumulative acreage and percentage of total Eightmile River watershed area occupied by each Vegetation/Habitat Map unit (SEE Figures 4 and 5), listed in order of descending cumulative area in the watershed.

Vegetation/Habitat Map unit	Cumulative acres in watershed	Cumulative % of total watershed area
dry to mesic mixed evergreen-deciduous woodland	2.6	0.00651%
low sand barren vegetation	2.4	0.00608%
freshwater intertidal scrub-shrub	2.4	0.00595%
freshwater intertidal scrub-shrub/emergent herbaceous	2.3	0.00580%
freshwater tidal vascular aquatic bed	2.3	0.00567%
seasonally saturated scrub-shrub	2.2	0.00559%
mesic to seasonally wet grassy evergreen woodland	2.2	0.00551%
mesic to seasonally wet grassy juniper woodland	2.2	0.00547%
scrub-shrub/wet meadow mosaic	2.1	0.00535%
grassy sparse juniper shrubland	2.1	0.00529%
mesic to seasonally wet parklike deciduous savanna	1.9	0.00483%
temporarily flooded low floodplain emergent herbaceous	1.8	0.00440%
temporarily flooded mixed evergreen-deciduous forest	1.7	0.00424%
mesic mixed white pine-deciduous forest	1.6	0.00401%
semipermanently flooded emergent herbaceous/open water, beaver-influenced	1.6	0.00397%
semipermanently flooded aquatic bed, beaver-influenced	1.6	0.00394%
seasonally flooded deadwood swamp/scrub-shrub, beaver-influenced	1.5	0.00375%
mesic to seasonally wet grassy mixed juniper-deciduous savanna	1.5	0.00365%
semipermanently flooded deadwood swamp/open water	1.3	0.00335%
mesic evergreen forest	1.3	0.00332%
evergreen plantation forest	1.2	0.00288%
oligohaline tidal permanent open water	1.1	0.00283%
mixed juniper-deciduous scrub	1.1	0.00274%
mesic to seasonally wet early post-clear-cut herbaceous	1.1	0.00271%
scrub-shrub swamp	1.0	0.00261%
mixed evergreen-deciduous-scrubby sand barren (hwy ROW)	1.0	0.00256%
saturated sphagnum/cranberry fen	1.0	0.00252%
mesic to seasonally wet grassy deciduous woodland	0.9	0.00216%

Table 1. Cumulative acreage and percentage of total Eightmile River watershed area occupied by each Vegetation/Habitat Map unit (SEE Figures 4 and 5), listed in order of descending cumulative area in the watershed.

Vegetation/Habitat Map unit	Cumulative acres in watershed	Cumulative % of total watershed area
semipermanently flooded aquatic bed	0.8	0.00189%
dry to mesic hemlock forest	0.7	0.00182%
seasonally flooded/exposed deadwood swamp/emergent herbaceous	0.7	0.00181%
seasonally flooded/exposed mixed evergreen-deciduous forest	0.6	0.00138%
mesic to seasonally wet parklike mixed evergreen-deciduous woodland	0.5	0.00114%
seasonally flooded evergreen forest/emergent herbaceous	0.4	0.00101%
temporarily flooded grassy mixed juniper-deciduous woodland	0.4	0.00100%
municipal development	0.3	0.00084%
freshwater intertidal mud flat community	0.3	0.00077%
scrubby disturbed land	0.3	0.00074%
seasonally saturated evergreen forest	0.3	0.00070%
lake beach	0.3	0.00066%
mesic to seasonally wet scrubby juniperus savanna	0.2	0.00060%
freshwater spring intertidal scrub-shrub/emergent herbaceous	0.2	0.00058%
seasonally flooded deciduous scrub-shrub	0.2	0.00056%
saturated emergent herbaceous	0.2	0.00051%
temporarily flooded high floodplain scrub	0.2	0.00046%
mesic to seasonally wet mountain laurel scrub	0.2	0.00046%
temporarily flooded/seasonally saturated grassland	0.2	0.00038%
mesic to seasonally wet scrubby mixed juniper-deciduous woodland	0.1	0.00037%
mesic to seasonally wet scrubby juniperus woodland	0.1	0.00035%
seasonally flooded deciduous forest/deadwood/emergent herbaceous	0.1	0.00029%
mesic to seasonally wet shrubby grassland	0.1	0.00028%
seasonally saturated parklike evergreen savanna	0.1	0.00022%
temporarily flooded emergent herbaceous	0.1	0.00017%
saturated sphagnum/leatherleaf fen	0.0	0.00003%

III. MATERIALS AND METHODS.

The objectives of this investigation were to first characterize as accurately as possible the existing biodiversity of the Eightmile River watershed, using existing information rather than primary field survey and inventory and then 1) compare the biodiversity of the Eightmile watershed to that of other watersheds in a state and regional context, and 2) to draw conclusions as to whether and to what to extent the Eightmile watershed is a unique, functioning, intact ecosystem. The methodology used to achieve these objectives is laid out in this section.

Biological and Ecological Inventory

The basic biological units of biodiversity in the watershed are species (and, in many cases, subspecies or varieties); the basic ecological units of biodiversity are natural communities, or habitats. The author assembled information on these elements of biodiversity in the Eightmile River watershed, with emphasis on species, species groups, and natural communities/habitats of special conservation concern. This was partly because a comprehensive inventory of all species and natural communities/habitats in the watershed would require an effort and resources well beyond those available for this study, and partly because equivalently comprehensive data does not exist for all or most other watersheds in the region, so comparisons of this total biodiversity would not be possible. The efforts of state natural heritage programs over the last 20 or more years to inventory species and natural communities of special conservation concern have generated a body of data that allows comparison of watersheds, in terms of numbers of extant rare species and significant natural communities.

To do such a comparison, the author decided to use total number of known extant rare species in a watershed as a surrogate for total biodiversity in the watershed, and perform comparisons of the Eightmile River watershed to other watersheds in two contexts: state and regional, with the region defined as New England. The author elected not to attempt to do a similar comparison of natural communities, because 1) the classification of natural communities is not sufficiently mature and consistent between state heritage programs, and 2) because of this, distributions of natural communities is much more poorly known than distributions of rare species (this opinion is based on the author's experience of the last 16 years of working for and with several state natural heritage programs). The details of the analysis are presented in Section IV.

Prior to performing this analysis, however, the author was tasked with assembling and screening the most current and reliable information on occurrences of species and natural communities/habitats of special conservation concern. The author performed a limited scope primary survey for rare plants and significant natural communities in the watershed in 2003 (the bulk of the survey), 2004, and 2005. The author queried the state natural heritage program (in Connecticut known as the Natural Diversity Data Base, a part of the Connecticut Department of Environmental Protection (CT-DEP-NDDB)), CT-DEP wildlife and fisheries resource managers,

local and regional professional and amateur naturalists, scientists at local universities and other research institutions. The author vetted reports of rare species in species groups outside of his expertise, by contacting experts in those species groups. Specific sources of information and assistance in interpreting information are cited in the sections below dealing with each species group.

The author also reviewed a number of published and unpublished inventories of portions of the watershed, from which he extracted data on species of special conservation concern in the watershed. Specific sources are mentioned in the relevant sections below.

Vegetation/habitat map

The vegetation/habitat map of the Eightmile watershed, presented as Figures 4 and 5, was synthesized as part of this investigation by the author, in collaboration with Ken Geisler, GIS specialist for the Connecticut field office of The Nature Conservancy. The purposes of the map are 1) to provide a basic ecological description of the watershed, and 2) to provide a tool for the management of the watershed. It is most accurately thought of as a first approximation of existing ecological conditions in the watershed. This map is a digital ESRI Arcview 3.2a vector data coverage. It should be viewed as a work in progress which can and should be refined and updated over time to become a more and more sophisticated management tool.

The map is a synthesis of existing GIS coverages of the watershed, the author's 2003 field survey data for communities, the author's interpretation of low-altitude aerial photography of the watershed, and a limited amount of ground-truthing field work by the author in 2005, which included driving "windshield survey", on-foot survey, and a low-altitude fixed-wing early fall (2005) fly-over of the watershed. The single most weighted element in this synthesis was the analysis and interpretation of the following low altitude aerial photograph imagery: 1) CT-DEP black-and-white 1:12,000 stereo aerial photographs from spring 2000, covering the entire watershed, and 2) digital geo-referenced true-color 1-meter-resolution "stitched" aerial imagery acquired in spring 2004, covering only the western half of the watershed.

The vegetation/habitat map classifies the Eightmile River watershed on the basis of land use, vegetation physiognomy, leaf phenology and life form of the dominant plants, hydrology/moisture regime, and, to a limited extent, dominant species. The author's definitions for the above parameters substantially follow, for non-wetland habitats, the higher levels (i.e., class, subclass, formation, etc.) of the International Vegetation Classification (Grossman *et al.* 1998) and the Vegetation Classification for Connecticut (Metzler & Barrett, in press). For wetland habitats, the author used the National Wetlands Inventory (NWI) classification (Cowardin *et al.* 1979), as modified and interpreted for Connecticut by Metzler and Barrett (Metzler and Barrett 1982). The original NWI mapping of Connecticut was done using flight year 1980 and 1981 1:80,000 aerial stereo photography, and has since been transformed into a

digital coverage. The author reviewed and updated, as appropriate, the classification the NWI wetland coverage for the Eightmile River watershed. This was done by analyzing more recent and lower altitude aerial B&W aerial stereo photography (flight year 2000, at oldest), flight year 2004 digital true color photography (for the western half of the watershed only), several hours of fixed-wing fly-over survey of the watershed in fall 2004 (concentrating on current classification of the larger wetlands in the watershed), and a few hundred hours of on-the-ground survey.

The following existing digitized GIS coverages were analyzed and used in varying measure, as explained below, to generate the Eightmile River watershed vegetation/habitat map:

- **USDA-NRCS soil series mapping.** The NRCS soils mapping was the single most important element used to define the total wetland coverage for the Eightmile River watershed. It was used also to assign moisture regime modifiers to upland forest types. Based on the USDA-NRCS soils mapping, the total proportion of hydric/wetland soils in the watershed is approximately three times higher than the wetland proportion according to either NWI or CLEAR. The author's decision to favor the USDA-NRCS hydric soils coverage over NWI and CLEAR data was based primarily on the evidence of his field and low-altitude stereo aerial photo interpretation, and it was supported by communication from Dr. Nels E. Barrett, who mapped the NWI wetlands in Connecticut (Barrett pers. comm.), and data from the National Soil Information System (USDA-NRCS 2003) presenting estimated percentages of soil series other than the nominal series occurring in Connecticut soil map units (USDA-NRCS-NASIS 2003).

- **National Wetlands Inventory (NWI) wetlands mapping.** Digitized NWI wetlands mapping was reviewed to determine if wetland polygon classification was consistent with current conditions and non-forested wetlands were checked for accuracy of wetland boundaries. Polygons were reclassified and boundaries edited as necessary, based on review of the more recent aerial photography, and for a subset, observations from the air during a fixed-wing fly-over and/or on-the-ground survey. Polygons so vetted were then pasted into the vegetation/habitat map.

- **Larry Bonneau's Forest Type coverage.** In the mid-1990s, Larry Bonneau, now with the Center for Earth Observation, Yale University, produced a landcover classification that featured forest dominance types, using Landsat Thematic Mapper ™ satellite imagery from 1988, 1990, and 1992, for a 264-square-mile area that included the Eightmile River watershed (Bonneau 1997). This map was converted from raster data to vector data by Ken Geisler, and the author experimented, with Ken Geisler's assistance, with various ways of incorporating it into the vegetation/habitat map. The Bonneau map is a very intricate mosaic, and its incorporation into the vegetation/habitat map would have produced a much more complex map than the version presented in this report. The author decided that this added complexity would have implied a higher user accuracy for the Bonneau forest

dominance type map than was suggested by the author's analyses of recent low-altitude aerial photography and his on-the-ground field survey. The author's field data suggested that, as noted also in the meta-data report (Bonneau 1997), the user accuracy varied for different forest types. The author drew on the forest types that appeared, based on his own knowledge of the watershed, to have higher user accuracy, and did not incorporate types that either appeared to have lower user accuracy, or for which the author had no data on which to decide. Using stereo-aerial analysis and field data, the author reviewed and edited the Bonneau forest type coverages as necessary before pasting them into the vegetation/habitat map

- **UCONN CLEAR 2002 land-use coverage, developed from satellite imagery.** CLEAR land-use coverage, which was developed for an area orders of magnitude larger than the Eightmile River watershed and has a minimum pixel resolution of 30 x 30 m, was not used directly to synthesize the vegetation/habitat map. However, a primary goal of the author's approach to the creation of the vegetation/habitat map was to test the CLEAR data cumulative area totals for certain critical land use categories (e.g., % developed area, % forest, etc.) in the Eightmile River watershed. Since the CLEAR data potentially allowed a comparison of the Eightmile watershed to other watersheds in a context slightly larger than Connecticut, the author's test of the CLEAR data against his analysis using low-altitude stereo-aerial photography provided an indication of what magnitude differences in cumulative land-use category totals should be considered significant/real.

- **Potential and verified vernal pool coverage developed by Lower Connecticut River Conservation District.** In 2003, consulting naturalist and soil scientist Ed Pawlak produced for the Lower Connecticut River Conservation District a mapping of potential vernal pools of an area that included the Eightmile River watershed, based on his analysis of flight year 2000 1:12,000 B&W stereo aerial photography. This mapping was heads-up/on-screen digitized for the Conservation District, and a subset of the potential vernal pools was visited by trained volunteers in 2004 for field verification. The field-verification process confirmed that that majority of the potential vernal pools were actual vernal pools, based on the presence of obligate vernal pool animal species and certain other physical parameters. The author reviewed these potential vernal pool polygons via stereo aerial photo interpretation, and assigned the appropriate NWI classification code, invented and assigned then a special hydrologic modifier, "seasonally flooded/exposed", and pasted them directly into the vegetation/habitat map. The author decided to invent the special hydrologic modifier, rather than use the term "vernal pool" because of the current confusion and debate over the meaning of the term "vernal pool".

- **Data from the author's 2003-2005 vegetation reconnaissance data and mapping of significant natural communities.** Portions of this data were incorporated directly into the

vegetation/habitat map, and resulted in the creation of some floristically defined units. This data was also used to assess the accuracy of portions of other GIS coverages, such as Larry Bonneau's above-mentioned map

For all non-forested vegetation/habitat units and some of the forest units, vegetation/habitat unit coverage for the entire watershed was produced by the author, via analysis of flight year 2000 black-and-white stereo-aerial-photo analysis, for the east half of the watershed, and analysis of both flight year 2000 black-and-white stereo-aerial-photography and flight year 2004 digital aerial photography of the western half of the watershed. These non-forested units were converted to digital polygon coverage via "on-screen digitizing", also known as "head's-up digitizing", over flight year 1990 1-meter-resolution black-and-white orthophotography for the eastern half of the watershed, and flight year 2004 1-meter-resolution geo-rectified color aerial imagery for most of the western half of the watershed.

IV. RARE SPECIES.

A summary of "at-risk" plant and animal species known from the Eightmile River watershed is presented in Table 2. This summary includes both species considered to be "rare", "threatened", or "endangered", in a state, regional, and/or global context, and species that have been identified by various organizations as of special concern for conservation, due to documented declines and threats, such as loss of habitat, etc. A total of 160 such species are found in the watershed. This list is comprised of 37 vascular plants, 6 amphibians, 77 bird species, 11 fish species, 10 invertebrate species, 6 reptiles and turtles, and 13 mammals.

On this list are five species considered to be globally rare, and one species, the Bald Eagle, that is Federally listed as Threatened. The five globally rare species are: two plants, *Bidens eatonii* Eaton's Beggar's-ticks and *Eriocaulon parkeri* Parker's Pipewort, and three insects, *Callophrys irus* Frosted Elfin (a butterfly), *Gomphus ventricosus* Skillet Clubtail (a dragonfly), and *Enallagma minusculum* Little Bluet (a damselfly). Based on its current Natureserve global rarity rank ("grank") of G2, *Bidens eatonii* Eaton's Beggar's-ticks is the rarest of the rare species known to be extant in the Eighmile River watershed; (see Appendix A for a full explanation of G- and S-ranks). Next rarest are *Eriocaulon parkeri* Parker's Pipewort, Frosted Elfin, and Skillet Clubtail, all ranked G3. The Little Bluet is borderline globally rare, with a Grank of G3G4. These globally rare species are associated with several different specific habitats, or habitat-complexes, at different localities in the Eightmile watershed. In every case, these globally rare species occur in places that also support multiple state- and regionally rare species. The two globally rare plants, *Bidens eatonii* and *Eriocaulon parkeri*, occur together and are restricted to a subset of the freshwater [perhaps seasonally oligohaline] intertidal habitats in Hamburg cove and upstream of the cove nearly to the head-of-tide. Co-occurring in these habitats with these global rarities are nine state-rare plants, and one additional state-rare plant occurs in a different habitat in close proximity to the intertidal zone. In addition, a state-rare mussel occurs in this reach (Walden & Parasiewicz 2005). Thus, with a total of 13 species, this area supports the largest concentration of globally rare and state-rare species in the Eightmile watershed.

The butterfly *Callophrys irus* Frosted Elfin is associated with dry to xeric open habitats in the eastern part of the watershed. At one locality, it is associated with a former sand and gravel excavation since developed into scrubby sand barren, and at another locality it is associated with open scrubby grass/sedge-land habitat about rocky summit bedrock outcrops, in a powerline ROW. These habitats both exist in their present state as a result of past disturbance by man, and in both cases on-going management is required to maintain the open conditions required by the butterfly. In both cases, inappropriate management actions could threaten the existence of the butterfly.

The globally rare dragonfly, *Gomphus ventricosus* Skillet Clubtail, is associated with pool

habitat in the Eightmile River, in a stretch of the river where three state-rare species (two plants and one turtle) also occur.

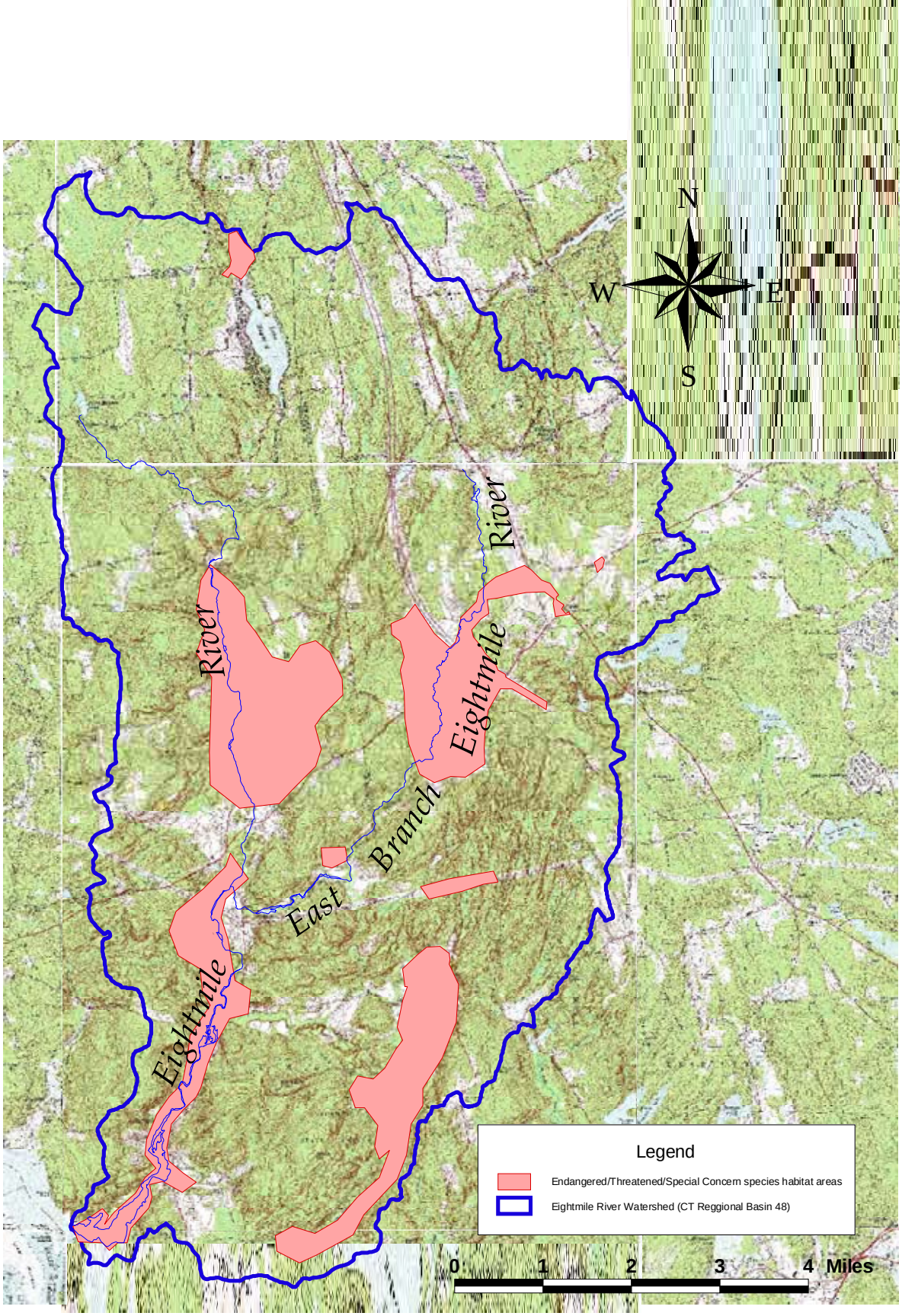

Figure 6. Concentration areas for rare species and significant natural community occurrences known to-date in the Eightmile River watershed.

The globally rare damselfly *Enallagma minusculum* Little Bluet is associated with one of the natural lakes in the Eightmile watershed.

While it is the only Federally Listed species among the at-risk species using the watershed, the Bald Eagle has a Grank of G4 and is no longer considered globally rare. Bald Eagles nest very close to the Eightmile watershed, and use it, especially in the Hamburg cove area, as a breeding-season foraging area and as part of their wintering grounds.

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
Acalypha virginica	Virginia Copperleaf	Vascular Plant	G5	SU	State-Special Concern	n/a		Occurs in managed forest clearings
Aristida longespica	Needlegrass	Vascular Plant	G5	SU	State-Special Concern	n/a		In sandy acid seasonally wet meadow community
Aristolochia serpentaria	Virginia Snakeroot	Vascular Plant	G4	S2S3	State-Special Concern	n/a	New England regional concern taxon	With several large occurrences, Eightmile watershed is a New England stronghold for this taxon. Largest populations in managed power line ROW
Asclepias purpurascens	Purple Milkweed	Vascular Plant	G5?	S1	State-Special Concern	n/a	New England regional concern taxon	Associated with old fields on thick till deposits; Eightmile hosts 3 of the ca. 8 extant occurrences known in New England
Asplenium montanum	Mountain Spleenwort	Vascular Plant	G5	S2	State-Threatened	n/a	New England regional concern taxon	Large meta-occurrence associated with Escarpment (i.e., gorge and cliffs) landscape element
Bidens eatonii	Eaton's	Vascular	G2	S1	State-	n/a	New England	Globally rarest taxon

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	Beggar-ticks	Plant			Threatened		regional concern taxon	known in the watershed; large meta-occurrence associated with sand/gravel/cobble fresh-oligohaline intertidal habitat
Carex bushii	Bush's sedge	Vascular Plant	G4	S2	State-Special Concern	n/a	New England regional concern taxon	Large meta-occurrence associate with meadows, mostly on thick till deposits
Castilleja coccinea	Indian paintbrush	Vascular Plant	G5	S1	State-Endangered	n/a	New England regional concern taxon	Historic (last observed 1962); still extant just outside of watershed
Crassula aquatica	Pygmyweed	Vascular Plant	G5	S1	State-Endangered	n/a		Associated with sand/gravel/cobble fresh-oligohaline intertidal habitat
Desmodium glabellum	Dillen's Tick-trefoil	Vascular Plant	G5	S2	State-Special Concern	n/a	New England regional concern taxon	Associated with managed forest openings, and, especially, electrical transmission line ROW
Eleocharis equisetoides	Horse-tail Spikerush	Vascular Plant	G4	S1	State-Endangered	n/a		Sandy and peaty shores/littoral of oligotrophic ponds
Elymus villosus	Slender Wild-	Vascular	G5	SU		n/a	New England regional concern	

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	rye	Plant					taxon	
Eriocaulon parkeri	Parker's Pipewort	Vascular Plant	G3	S1	State-Endangered	n/a	New England regional concern taxon	Large meta-occurrence associated with sand/gravel/cobble fresh-oligohaline intertidal habitat
Hydrocotyle umbellata	Water pennywort	Vascular Plant	G5	S1	State-Endangered	n/a		With several large occurrences, Eightmile is a stronghold in Connecticut for this species
Isotria medeoloides	Small Whorled Pogonia	Vascular Plant	G2	S1	State-Endangered	n/a	New England regional concern taxon	One historic occurrence, without precise locality data, was either in the watershed, or at most only 1.5 mi outside. This, in combination with a recently discovered occurrence only 4.5 mi outside of the watershed, and the abundance of potential habitat in the watershed, suggests this species may occur in the

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								watershed.
Lespedeza repens	Creeping Bush-clover	Vascular Plant	G5	S1	State-Special Concern	n/a	New England regional concern taxon	One of 2 known extant occurrences in CT/New England. Habitat is man-made sand barren in highway ROW
Limosella subulata	Mudwort	Vascular Plant	G4?Q	S2S3	State-Special Concern	n/a		Associated with sand/gravel/cobble fresh-oligohaline intertidal habitat
Liparis liliifolia	Lily-leaved Twayblade	Vascular Plant	G5	S1	State-Endangered	n/a	New England regional concern taxon	Eightmile hosts 2 of 6 extant occurrences known in New England
Lycopus amplectens	Clasping-leaved Water-horehound	Vascular Plant	G5	SU	State-Special Concern	n/a		Several large occurrences associated with peaty and sandy acid pond shores and Atlantic White Cedar swamp communities
Mimulus alatus	Winged Monkey-flower	Vascular Plant	G5	S3	State-Special Concern	n/a	New England regional concern taxon	Fresh tidal shores and wet meadows
Ophioglossum pusillum	Adder's tongue	Vascular Plant	G5	S1	State-Threatened	n/a	New England regional concern taxon	Acidic forested seepage wetland in southern part of

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								watershed
Orontium aquaticum	Golden club	Vascular Plant	G5	S2S3	State-Special Concern	n/a		Fresh tidal shores
Oxalis violacea	Violet Wood-sorrel	Vascular Plant	G5	S2S3	State-Special Concern	n/a	New England regional concern taxon	Dry rich forest
Panicum rigidulum var. pubescens		Vascular Plant	G5T5?	SU	State-Special Concern	n/a	New England regional concern taxon	Acid sandy seasonally wet and spring-fresh-tidal meadows
Pedicularis lanceolata	Swamp lousewort	Vascular Plant	G5	S1S2	State-Threatened	n/a	New England regional concern taxon	Fresh tidal shores and wet meadows
Platanthera flava	Pale green orchid	Vascular Plant	G4	SU	State-Special Concern	n/a		Freshwater intertidal shore habitat and managed wet meadow habitat on thick till deposits
Podostemum ceratophyllum	Threadfoot	Vascular Plant	G5	S3	State-Special Concern	n/a		Several occurrences in cobbly riffle habitat in Eightmile River (both tidal and non-tidal sections)
Ranunculus micranthus		Vascular Plant	G5	SNR		n/a	New England regional concern taxon	Open amphibolite/marble outcrops in power line ROW

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
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Rhynchospora macrostachya	Beaked Rush	Vascular Plant	G4	S1S2	State-Threatened	n/a		First discovered in the 8mile in 2004, growing in an acidic lake shore-shrub swamp interface
Sagittaria subulata	Arrowleaf	Vascular Plant	G4	S3	State-Special Concern	n/a	New England regional concern taxon	Fresh-oligohaline intertidal flat and shore habitat
Salix petiolaris6	Slender Willow	Vascular Plant	G5	SH	State-Special Concern (Historic)	n/a		Beaver-influenced open-canopy shrub-swamp
Sanicula canadensis	Short-styled Sanicle	Vascular Plant	G5	SU		n/a	New England regional concern taxon	
Schizachne purpurascens	Purple oat	Vascular Plant	G5	S3S4	State-Special Concern	n/a		Rich forest, in Burnham Brook area
Scleria triglomerata	Nutrush	Vascular Plant	G5	S1	State-Endangered	n/a	New England regional concern taxon	In sandy acid seasonally wet meadow community
Scutellaria integrifolia	Hyssop Skullcap	Vascular Plant	G5	S1	State-Endangered	n/a	New England regional concern taxon	Eightmile hosts 2 of the 3 extant occurrences known in New England
Silene stellata	Starry Campion	Vascular Plant	G5	SU	State-Special	n/a	New England regional concern	Sandy riverside levee forest habitat

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					Concern		taxon	
Sphenopholis nitida	Shiny Wedge Grass	Vascular Plant	G5	SU		n/a	New England regional concern taxon	Dry oak-hickory forest in Salem[7,14]
Sphenopholis pensylvanica	Swamp Wedgescale	Vascular Plant	G4	SU		n/a	New England regional concern taxon	Recently discovered in a mossy forested seep in Salem[7,14]
Vitis novae-angliae	New England Grape	Vascular Plant	G4G5Q	S1	State-Special Concern	n/a		Occurs in managed forest clearings
Xyris smalliana	Small's Yellow-eyed Grass	Vascular Plant	G5	S1	State-Endangered	n/a	New England regional concern taxon	With 3 large occurrences, Eightmile is a stronghold for this species in Connecticut
Vermivora chrysoptera x pinus back-cross with one of parent species	"Lawrence's Warbler"	Bird	not ranked	not ranked	Golden-winged Warbler, grandparent and possibly parent, is State-Endangered	Golden-winged Wabler, grandparent and possibly parent, is listed as Most Important	This taxon is a backcross of a F1 hybrid with one of the parents. One of the F1 hybrid's parents, the Golden-winged Wabler is on IUCN Red List: "Near Threatened" Audubon Watch-	Recently summer observations in edge habitat in Salem[1]. State Wildlife Unit does not currently consider presence of Golden-winged x Blue-winged hybrids and backcrosses at a site to be indicative of presence of Golden-winged Warblers

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							list: RED; Partners in Flight Breeding Tier IB. High Continental Priority – Low Regional Responsibility	
Empidonax virescens	Acadian Flycatcher	Bird	G5	S4B		Very Important		BBA: 3/1/2 (8mile ws appears to be a concentration area in CT)
Empidonax alnorum	Alder Flycatcher	Bird	G5	S5B	State-Special Concern	Very Important		BBA: 0/0/0 Uncommon summer resident[1] 2004 observations of probable breeding[1]
Anas rubripes	American Black Duck	Bird	G5	S3B, S4N	none	Very Important	Audubon Watch-list: YELLOW Partners in Flight Breeding Tier 1A. High Continental Priority – High Regional Responsibility/Wintering Tier I	Common summer resident[1] BBA: 1/2/0 2004 observations of breeding[1]
Falco sparverius	Amercian	Bird	G5	S2	State-	Very		BBA:1/2/1

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	Kestrel				Threatened	Important		Uncommon resident[1]
Setophaga ruticilla	American Redstart	Bird	G5	S5B		Important		Common summer resident[1] BBA: 7/1/0 2004 observations of breeding[1]
Scolopax minor	American Woodcock	Bird	G5	S5	S5	Very Important	Audubon Watch-list: YELLOW Partners in Flight Breeding Tier 1A. High Continental Priority – High Regional Responsibility	Common resdient[1] BBA: 0/4/2 2004 observations of breeding[1]
Haliaeetus leucocephalus	Bald Eagle	Bird	G4	S1B, S3N	State-Endangered; Federally Threatened	Very Important		Nests nearby and 8mile ws is part of breeding season foraging area; significant winter usage near mouth[2]
Icterus galbula	Baltimore Oriole	Bird	G5	S5B		Important	Partners in Flight Breeding Tier IIA. High Regional Concern	Common summer resident[1] BBA: 8/0/0 2004 observations of breeding[1]
Riparia riparia	Bank swallow	Bird	G5	S5B		Important		BBA: 4/1/0

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								Uncommon summer resident[1]
Strix varia	Barred Owl	Bird	G5	S5		Important		BBA: 2/1/1 Uncommon resident[1]
Ceryle alcyon	Belted Kingfisher	Bird	G5	S5B		Important		BBA: 1/1/3 Uncommon resident[1]
Mniotilta varia	Black-and-white Warbler	Bird	G5	S5B		Very Important	Partners in Flight Breeding Tier IIA: High Regional Concern	BBA: 3/3/0 Common summer resident[1]
Coccyzus erythropthalmus	Black-billed Cuckoo	Bird	G5	S5B		Very Important	Partners in Flight Breeding Tier IIA : High Regional Concern	Uncommon summer resident[1] BBA: 0/2/2
Dendroica fusca	Blackburnian Warbler	Bird	G5	S5B		Important	Partners in Flight Breeding Tier IIC : High Regional Threats	BBA: 0/1/0 (Devil's Hopyard block)
Dendroica caerulescens	Black-throated Blue Warbler	Bird	G5			Very Important		BBA: 0/0/0 Uncommon summer resident[1]
Dendroica virens	Black-throated Green Warbler	Bird	G5	S5B		Important		BBA: 0/2/0 Uncommon summer resident[1]

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.

Taxon	Common name	Higher Taxonomic Group	Global Rank16	State Rank16	Legal Status	State CWCS21 ranking	Other rankings re conservation concern	Comments specific to Eightmile Watershed
Polioptila caerulea	Blue-gray Gnatcatcher	Bird	G5	S5B		Important		Common summer resident[1] BBA: 5/1/2 2004 observations of breeding[1]
Vireo solitarius	Blue-headed Vireo	Bird	G5	S5B		Very Important		BBA: 0/1/0 Detected in summer 2003 in watershed at Devil's Hopyard4
Vermivora pinus	Blue-winged Warbler	Bird	G5	S5B		Very Important	Audubon Watch-list: YELLOW Partners in Flight Breeding Tier 1A. High Continental Priority – High Regional Responsibility	Common summer resident[1] BBA: 6/1/1 2004 observations of breeding[1]
Dolichonyx oryzivorus	Bobolink	Bird	G5	S4B	State-Special Concern	Very Important		BBA: 0/1/0 New nesting areas documented in recent years; breeding population growing[1]; 2004 observations of breeding[1]
Buteo platypterus	Broad-winged Hawk	Bird	G5	S5B		Important		BBA: 4/0/3 Uncommon summer

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Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
								resident[1]
Certhia americana	Brown Creeper	Bird	G5	S5		Important		BBA: 1/1/5 Uncommon resident[1]
Toxostoma rufum	Brown Thrasher	Bird	G5	S5B	State-Special Concern	Very Important		BBA: 2/0/2 Uncommon summer resident[1]
Wilsonia canadensis	Canada Warbler	Bird	G5	S5B		Very Important	Partners in Flight Breeding Tier 1B. High Continental Priority – Low Regional Responsibility	BBA: 1/3/1 Uncommon summer resident[1]
Dendroica cerulea	Cerulean Warbler	Bird	G4	S3B		Very Important	IUCN Red list: "Globally vulnerable" Audubon Watch-list: RED Partners in Flight Breeding Tier IB : High Continental Priority – Low Regional Responsibility	Uncommon summer resident, perhaps on increase[1] BBA: 4/0/0 Single most important bird species in 8mile – breeding confirmed and/or summer observations throughout most of watershed, excepting northern tip. 8mile generally considered an important area/stronghold for this species in

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
								southern New England[2, 10]
Dendroica pensylvanica	Chestnut-sided Warbler	Bird	G5	S5B		Very Important		BBA: 1/2/2 Uncommon summer resident[1]
Chaetura pelagica	Chimney Swift	Bird	G5	S5B		Very Important	Partners in Flight Breeding Tier IIA : High Regional Concern	Common summer resident1 BBA: 3/2/1 2004 observations of breeding[1]
Gavia immer	Common Loon	Bird	G5	S1B	State-Special Concern (breeding populations)	Very Important		Regular migrant and winterer2 BBA: 0/0/0
Gallinula chloropus	Common Moorhen	Bird		S2B	State Endangered	Very Important		BBA: 0/1/0
Corvus corax	Common Raven	Bird	G5	S2B, SNAN		Very Important		Rare winter visitor[1] BBA: 0/0/0 Recent breeding season observations suggest possible or soon nesting in watershed.

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.

Taxon	Common name	Higher Taxonomic Group	Global Rank16	State Rank16	Legal Status	State CWCS21 ranking	Other rankings re conservation concern	Comments specific to Eightmile Watershed
Accipiter cooperii	Cooper's Hawk	Bird	G5	S2B		Important		BBA: 0/1/1
Tyrannus tyrannus	Eastern Kingbird	Bird	G5	S5B		Important		Uncommon summer resident[1] BBA: 5/2/1
Sturnella magna	Eastern Meadowlark	Bird	G5	S4B	State-Special Concern	Very Important		Uncommon summer resident[1] BBA: 0/1/1 2004 documentation of breeding[1]
Otus (= Megascops) asio	Eastern Screech Owl	Bird	G5	S5		Important		Uncommon resident1 BBA: 0/0/1
Pipilo erythrophthalmus	Eastern Towhee	Bird	G5	S5B		Very Important	Partners in Flight Breeding Tier IIA. High Regional Concern	Common(±) summer resident[1] BBA: 4/3/1
Contopus virens	Eastern Wood-pewee	Bird	G5	S5B		Important		Common summer resident[1] BBA: 4/3/1
Spizella pusilla	Field Sparrow	Bird	G5	S5B		Very Important		Common summer resident[1] BBA: 3/2/2 Observations of

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Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
								nesting in 20041
Dumetella carolinensis	Gray Catbird	Bird	G5	S5B		Important		BBA: 8/0/0
Ardea herodias	Great Blue Heron	Bird		S3B		Important		BBA: 0/1/1 2005 observations of breeding[1]
Bubo virginianus	Great Horned Owl	Bird	G5	S5		Important		Uncommon resident[1] BBA: 3/2/2
Myiarchus crinitus	Great-crested Flycatcher	Bird	G5	S5B		Very Important		Common summer resident[1] BBA: 4/2/2
Butorides virescens	Green Heron	Bird	G5	S5B		Very Important		Uncommon summer resident[1] BBA: 0/2/2 2004 observations of breeding[1]
Catharus guttatus	Hermit Thrush	Bird	G5	S5B		Very Important		Uncommon summer resident[1] BBA: 1/2/0
Lophodytes cucullatus	Hooded Merganser	Bird	G5	S3B		Very Important		BBA: 1/3/4
Wilsonia citrina	Hooded Warbler	Bird	G5	S4B		Important		Uncommon summer resident[1] BBA: 1/3/4 (8mile ws

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.

Taxon	Common name	Higher Taxonomic Group	Global Rank16	State Rank16	Legal Status	State CWCS21 ranking	Other rankings re conservation concern	Comments specific to Eightmile Watershed
								appears to be part of a mid-SE-CT concentration area)
Passerina cyanea	Indigo Bunting	Bird	G5	S5B		Very Important		Uncommon summer resident[1] BBA: 4/1/0
Oporornis formosus	Kentucky Warbler	Bird	G5	S3B			Partners in Flight Breeding Tier 1B. High Continental Priority – Low Regional Responsibility	Rare summer resident[1] BBA: 0/0/3 (8mile ws appears a concentration area)
Empidonax minimus	Least Flycatcher	Bird	G5			Very Important		Common summer resident[1] BBA:3/2/3
Asio otus	Long-eared Owl	Bird	G5	S1B		Very Important	Partners in Flight Wintering Tier IIA: High Regional Concern	Recently documented wintering[1]
Seiurus motacilla	Louisiana Waterthrush	Bird	G5	S5B		Important	IUCN Red list: “Near-threatened” Partners in Flight Breeding Tier IIB. High Regional Responsibility	Uncommon summer resident[1] BBA: 3/1/2
Dendroica magnolia	Magnolia Warbler	Bird	G5	S4B		Important		Uncommon migrant[1]

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
								Detected in summer 2003 in watershed at Devil's Hopyard and Nehantic State forest[4] BBA: 0/0/0
Colinus virginianus	Northern Bobwhite	Bird	G5	S4		Very Important		Rare to uncommon resident[1] Native populations unlikely[2] BBA: 2/1/3
Colaptes auratus	Northern Flicker	Bird	G5	S5		Important		Common resident[1] BBA: 6/1/1
Accipiter gentiles	Northern Goshawk	Bird	G5	S4B		Important		Uncommon resident[1] BBA: 0/1/1 (8mile ws is effective island of probable/possible breeding in SE CT)
Parula americana	Northern Parula	Bird	G5	S1B	State-Special Concern			Detected during June counts but breeding not confirmed[1]
Stelgidopteryx serripennis	Northern Rough-winged Swallow	Bird	G5	S5B		Important		Common summer resident[1] BBA: 0/3/1 2004 observations of breeding[1]

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
Seiurus noveboracensis	Northern Waterthrush	Bird	G5	S5B		Important		Uncommon summer resident[1] BBA: 0/0/0 2004 observations of breeding[1]
Icterus spurius	Orchard Oriole	Bird	G5	S5B		Important		Uncommon summer resident[1] BBA: 0/0/2
Pandion haliaetus	Osprey	Bird	G5	S3B		Important		Nests near ws and likely forages in ws, especially near mouth2 BBA: 0/0/0
Seiurus aurocapillus	Ovenbird	Bird	G5	S5B		Important		Common summer resident[1] BBA: 7/0/1 2004 observations of breeding[1]
Dryocopus pileatus	Pileated Woodpecker	Bird	G5	S5		Important		Uncommon resident[1] BBA: 1/0/4
Dendroica discolor	Prairie Warbler	Bird	G5	S5B		Very Important	Audubon Watch-list: YELLOW Partners in Flight	Common summer resident[1]

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
							Breeding Tier 1A : High Continental Priority – High Regional Responsibility	BBA: 4/4/0
Protonotaria citrea	Prothonotary Warbler	Bird	G5	SNA			Partners in Flight Breeding Tier 1B. High Continental Priority – Low Regional Responsibility	Peripheral breeding area, if at all
Carpodacus purpureus	Purple Finch	Bird	G5	S4B		Important	Partners in Flight Breeding Tier : High Regional Concern	Uncommon resident[1]
Progne subis	Purple Martin	Bird	G5	S1B	State Threatened	Important		Uncommon summer resident, as forager, at least – nests regularly near watershed1 BBA: 0/0/1
Melanerpes erythrocephalus	Red-headed Woodpecker	Bird	G5	S1	State-Endangered	Very Important	IUCN Red list: "Globally vulnerable" Audubon Watch-list: YELLOW Partners in Flight Breeding Tier 1B.	Rare resident1 BBA: 0/0/1

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
							High Continental Priority – Low Regional Responsibility/Wintering Tier I	
Buteo lineatus	Red-shouldered Hawk	Bird	G5	S3B		Important		Uncommon summer resident1 BBA: 2/2/3
Pheucticus ludovicianus	Rose-breasted Grosbeak	Bird	G5	S5B		Very Important	Partners in Flight Breeding Tier IIA: High Regional Concern	Common summer resident1 BBA: 4/2/2
Archilochus colubris	Ruby-throated Hummingbird	Bird	G5	S5		Important		BBA: 2/2/1 2004 observations of breeding[1]
Bonasa umbellus	Ruffed Grouse	Bird	G5	S5		Very Important		Uncommon resident[1] BBA: 5/0/2
Passerculus sandwichensis	Savannah Sparrow	Bird	G5	S3B	State-Special Concern	Very Important		Probable breeder, but uncommon in watershed[1] BBA: 0/2/0
Aegolius acadicus	Northern Saw-whet Owl	Bird	G5	S2S3B	State-Special Concern	Very Important		At least one report of nesting in 198618
Piranga olivacea	Scarlet Tanager	Bird	G5	S5B		Important	Partners in Flight Breeding Tier IIA.	Common summer resident[1]

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
							High Regional Concern	BBA: 5/3/1 2004 observations of breeding[1]
Accipiter striatus	Sharp-shinned Hawk	Bird	G5	S2B	State Endangered	Very Important		Uncommon Summer Resident[1](but no breeding sites recently) BBA: 0/0/0
Asio flammeus	Short-eared Owl	Bird	G5	SHB, S1N	State-Threatened (wintering populations)	Very Important		Recently (2004) documented as early spring migrant[1]
Actitis macularia	Spotted Sandpiper	Bird	G5	S5B		Important		Uncommon summer resident[1] BBA: 0/0/0 (but probable breeder in several adjacent blocks)
Catharus fuscescens	Veery	Bird	G5	S5B		Important		Common summer resident[1] BBA: 5/2/1
Vireo gilvus	Warbling Vireo	Bird	G5	S5B		Important		Common summer resident[1] BBA: 2/1/0
Caprimulgus	Whip-poor-will	Bird	G5	S3B	State-	Very	Partners in Flight Breeding Tier IIC:	Uncommon summer

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
vociferus					Endangered	Important	High Regional Threats	resident[1] BBA: 0/3/0
Vireo griseus	White-eyed Vireo	Bird	G5	S5B		Important		Uncommon summer resident[1] BBA: 2/3/1
Empidonax traillii	Willow Flycatcher	Bird	G5	S5B		Important	Audubon Watch-list: YELLOW Partners in Flight Breeding Tier 1A: High Continental Priority – High Regional Responsibility	Uncommon summer resident[1] BBA: 0/0/3
Troglodytes troglodytes	Winter Wren	Bird	G5	S5B		Important		Rare winter visitor, migrant, and irregular breeder[1] BBA: 0/1/0 (i.e., probable in Devil's Hopyard block)
Hylocichla mustelina	Wood Thrush	Bird	G5	S5B		Very Important	Partners in Flight Breeding Tier 1A. High Continental Priority – High Regional Responsibility	Common summer resident[1] BBA: 5/3/0
Helmitheros vermivorus	Worm-eating Warbler	Bird	G5	S5B		Very Important	Partners in Flight Breeding Tier IA.	Common summer resident[1]

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
							High Continental Priority – High Regional Responsibility	BBA: 4/2/2
Coccycus americanus	Yellow-billed Cuckoo	Bird	G5	S5B		Very Important		Common summer resident[1] BBA: 0/3/3
Icteria virens	Yellow-breasted Chat	Bird	G5	S1B	Endangered	Most Important		Observed in 2006 singing during breeding season[20]
Vireo flavifrons	Yellow-throated Vireo	Bird	G5	S5B		Important		Common summer resident; 2004 observations of breeding[1] BBA: 5/3/0
Alosa aestivalis	Blueback Herring	Fish	G5			Most Important		Recent detections in Hamburg cove only[9]
Alosa pseudoharengus	Alewife	Fish	G5	S3		Most Important (anadromous populations only)		Recent detections in Hamburg cove only[9]
Anguilla rostrata	American Eel	Fish	G5	S5		Most Important		

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
Salmo salar	Atlantic Salmon	Fish	G5	SH		Very Important		Recent confirmed detections of juvenile fish (likely stocked); unconfirmed reports of adult returns.
Enneacanthus obesus	Banded Sunfish	Fish	G5	S3	State-Special Concern	Most Important		
Salvelinus fontinalis	Brook Trout (wild)	Fish	G5	S5		Most Important		Credible reports from headwaters, but not yet confirmed
Esox niger	Chain Pickerel	Fish	G5	S5		Very Important		
Erimyzon oblongus	Creek Chubsucker	Fish	G5	S3		Very Important		
Esox americanus	Redfin Pickerel	Fish	G5	S4		Very Important		
Morone saxatilis	Striped Bass	Fish	G5	S3		Very Important		Recent detections in Hamburg cove only[9]
Osmerus mordax	Rainbow Smelt	Fish	G5	S1	State-Threatened (Anadromous populations only)	Most Important		Historic records only (1959 or earlier) from at or near mouth of Hamburg Cove[9]
Petromyzon marinus	Sea Lamprey	Fish	G5	S5		Very Important		

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
Paraleptophlebia assimilis	A mayfly	Invertebrate	G4	SNR	State-Special Concern	Important		
Ladona deplanata	Blue corporal	Invertebrate	G5	S1S2	State-Special Concern	Important		
Ligumia nasuta	Eastern Pondmussel	Invertebrate	G4G5	S1S2	State-Special Concern	Important		
Lycaena epixanthe	Bog Copper	Invertebrate	G4G5	S2	State-Special Concern	Important		
Margaritifera margaritifera	Eastern Pearlshell	Invertebrate	G4	SU	State-Special Concern	Important		
Callophrys irus	Frosted Elfin	Invertebrate	G3	S2S3	State-Threatened	Very Important		At least 2 occurrences recently documented in watershed
Callophrys henrici	Henry's Elfin	Invertebrate	G5	S2	State-Special Concern	Important		
Tabanus fulvicallus	A horse fly	Invertebrate	GNR	SNR	State-Special Concern	Important		
Enallagma minusculum	Little Bluet	Invertebrate	G3G4	S1S2	State-Special Concern	Important		

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
Gomphus adelphus	Mustached Clubtail	Invertebrate	G4	S2	State-Threatened	Very Important		8mile hosts the only reliable population in Connecticut[17]
Gomphus ventricosus	Skillet Clubtail	Invertebrate	G3	S2	State-Special Concern	Important		
Merycomyia whitneyi	A Tabanid fly	Invertebrate	GNR	SNR	State-Special Concern	Important		
Clethrionomys gapperi	Southern Red-backed Vole	Mammal	G5	S5		Important		
Felis rufus	Bobcat	Mammal	G5	S2?		Very Important		
Lasiurus borealis	Red Bat	Mammal	G5	S3	State-Special Concern	Most important		Documented in the 8mile by recent mist net survey[19]
Microtus pinetorum	Woodland Vole	Mammal				Important		
Mustela frenata	Long-tailed Weasel	Mammal	G5	S5		Important		
Mustela vison	Mink	Mammal	G5	S5		Important		Documented in the 8mile by recent mist net survey[19]
Myotis lucifugus	Little Brown Bat	Mammal				Important		Documented in the 8mile by recent mist

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Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**
								net survey[19]
Myotis septentrionalis	Northern Long-eared Bat	Mammal	G			Important		Documented in the 8mile by recent mist net survey[19]
Napaeozapus insignis	Woodland Jumping Mouse	Mammal	G5	S5		Very Important		
Ondatra zibethicus	Muskrat	Mammal	G5	S5		Important		
Sylvilagus transitionalis	New England Cottontail	Mammal	G4	S2		Most Important		Recently documented in 8mile Nehantic SF[5,12] and scrubby highway ROW habitat7, and in transmission ROW habitat just E and W of 8mile[5,12.]
Ursus americanus	Black Bear	Mammal	G5	S3		Important		
Zapus hudsonius	Meadow Jumping Mouse	Mammal	G5	S5		Very Important		
Desmognathus fuscus	Dusky Salamander	Amphibian	G5	S4		Important		Locally common (e.g., at Pleasant Valley)[8]
Notophthalmus viridescens	Eastern Newt	Amphibian	G5	S5		Important		
Hyla versicolor	Gray Treefrog	Amphibian	G5	S5		Important		

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.

Taxon	Common name	Higher Taxonomic Group	Global Rank16	State Rank16	Legal Status	State CWCS21 ranking	Other rankings re conservation concern	Comments specific to Eightmile Watershed
Ambystoma opacum	Marbled Salamander	Amphibian	G5	S4		Important		Locally abundant (e.g., at Pleasant Valley)[8]
Ambystoma maculatum	Spotted Salamander	Amphibian	G5	S5		Important		Robust meta-population
Rana sylvatica	Wood Frog	Amphibian	G5	S4		Important		Robust meta-population
Agkistrodon contortrix	Copperhead	Reptile	G5	S3		Important		Fairly recently documented (1993) just S of 8mile, ca. Rogers Lake[11]
Heterodon platirhinos	Eastern Hognose Snake	Reptile	G5	S3S4	State-Special Concern	Very Important		One recent observation (2003)[11,] at Pleasant Valley; observations in 1990s at Burnham Brook and Salem Valley Basin[1, 5]
Thamnophis sauritus	Eastern Ribbon Snake	Reptile	G5	S3S4	State-Special Concern	Very Important		Confirmed near watershed; recent reliable reports from within watershed[7]
Liochlorophis (= Opheodrys) vernalis	Eastern Smooth Green Snake	Reptile	G5	S3S4		Important		No records within watershed; one 1983 record outside but near watershed[11]

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.

Taxon	Common name	Higher Taxonomic Group	Global Rank16	State Rank16	Legal Status	State CWCS21 ranking	Other rankings re conservation concern	Comments specific to Eightmile Watershed
Clemmys (= Glyptemys) guttata	Spotted Turtle	Reptile	G5	S4		Very Important	IUCN Red list: "Globally vulnerable"	Recent documentation (2002-2005) of wide distribution in watershed[11,13,14]
Clemmys insculpta	Wood Turtle	Reptile	G4	S3	State-Special Concern	Very Important	IUCN Red list: "Globally vulnerable"	Recent documentation (1999-2004) at several sites along both branches of 8mile River[9,11]
Terrapene carolina	Eastern Box Turtle	Reptile	G5	S4	State-Special Concern	Very Important		Fairly recent records from Pleasant Valley area (1999)[11], the Salem Valley Basin area (2001)[1,] and the Burnham Brook area (1990), where 2 nests were observed[18.]

TABLE NOTES:

[1]Bingham

[2]Comins

[3]BBA = Connecticut Breeding Bird Atlas (Bevier et al. 1994). Volunteers surveyed 1/6-quadragle blocks over period 1982-1985, documenting breeding with 3 levels of confidence, depending on nature of observations: confirmed, probable, and possible. Eight survey blocks significantly overlap 8mile ws. Key to code, using example, "4/2/2" = breeding confirmed in 4 blocks / breeding probable in 2 blocks/ breeding possible in 2 blocks.

[4]Craig et al. 2003

[5]CT-DEP 4/2005

Table 2. Summary of at-risk species known to occur in the Eightmile River watershed.								
Taxon	**Common name**	**Higher Taxonomic Group**	**Global Rank16**	**State Rank16**	**Legal Status**	**State CWCS21 ranking**	**Other rankings re conservation concern**	**Comments specific to Eightmile Watershed**

[6]State rank and state legal status out of date for this taxon: several occurrences have recently been documented state-wide

[7]The Maguire Group 2005

[8]Natoli pers. comm...

[9]Walden and Parasiewicz 2005, citing Whitworth et al. 1968 and/or CT-DEP fish survey data

[10]Askins pers. comm.

[11]Gruner and Klemens 2004

[12]Kilpatrick pers. comm.

[13]Connecticut River Conservation District 2004

[14]Moorhead observations 2003-2005

[15]Brumback et al. 1996. In this table "New England regional concern" taxa are those ranked in the Brumback et al. publication as "Division 1: Globally Rare Taxa occurring in New England" and "Division 2: Regionally [= New England} Rare Taxa"

[16]see Appendix A for the explanation of global and state ranks

[17]Wagner pers. comm.

[18]Goodwin 1991a

[19]Dickson (pers. comm.)

[20]Harvey 2006

[21]Connecticut's Comprehensive Wildlife Conservation Strategy

Birds

A comprehensive inventory of the birds of the Eightmile watershed has not yet been performed, but a number of studies of avifauna have focused on several parts of the watershed. Devil's Hopyard and the Burnham Brook area, in East Haddam, have been have been sites of rigorous and longitudinal bird inventories (Goodwin 1991a). Scientific bird inventories have been performed in Nehantic State Forest in Lyme and East Lyme, and in Devil's Hopyard State Park in East Haddam (Craig, Atshul, and Beal 2003). Yearly June and December bird censuses are performed in a circular area that includes much of the Salem portion of the watershed (Bingham, pers. comm.), and biologists with The Maguire Group, consultants to the Connecticut Dept. of Transportation (CT-DOT), have recently performed surveys of birds in the proposed Route 11 extension corridor in Salem and East Lyme. In addition, volunteers reported to the 1982-1986 Connecticut Breeding Bird Atlas Project for all the blocks (a "block" = 1/6 of a 7½-minute USGS topographic quadrangle map) that overlap with the Eightmile watershed.

From these sources, the author has compiled a list, presented in Table 2, of about 91 birds of special conservation concern that have been documented in and near the Eightmile River watershed in recent decades.

Figure 7. Male Cerulean Warbler (*Dendrioca cerulea*). Photo credit: © PAUL J. FUSCO - ALL RIGHTS RESERVED.

By general consensus of local/regional ornithologists (Comins pers. comm.; Askins, pers. comm.) the Eightmile watershed's most important role with respect to avian biodiversity is as a stronghold for the Cerulean Warbler (*Dendroica cerulea*), which is known to breed throughout most of the Eightmile watershed. This species has been identified as a species of special conservation concern by three international bird conservation organizations, the ICUN, Audubon, and Partners in Flight. This forest interior species evidently requires large blocks of deciduous forest, and is especially sensitive to forest fragmentation (Askins 2000). It appears that it is no coincidence that the Eightmile watershed, with its large blocks of unbroken forest (SEE Figure 7), is a stronghold for the Cerulean Warbler.

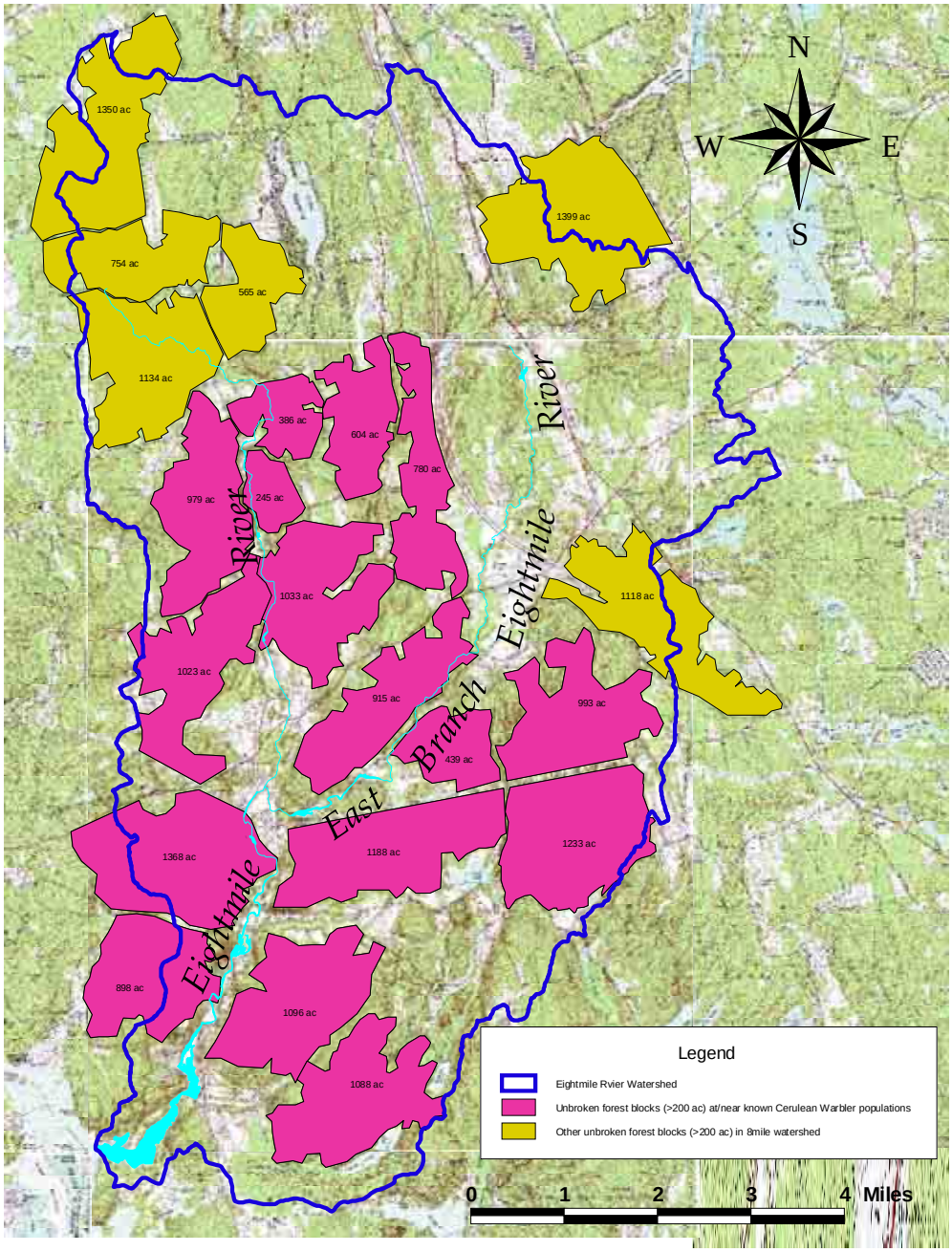

Figure 8. Unbroken forest blocks in the Eightmile River watershed, in relation to documented Cerulean Warbler breeding sites.

Portions of the Eightmile watershed have been identified by Audubon Connecticut as meeting the criteria for designation as an “Important Bird Area” in the state (Patrick Comins, pers. comm.).

Figure 9. Current nesting habitat in Salem for Bobolink (*Dolichonyx oryzivorus*) a State-listed Species of Special Concern (Bingham pers. comm.).

Invertebrates

As shown in Table 2, twelve invertebrate species listed as State-Threatened or State-Special Concern have been recently documented in the Eightmile watershed: 3 butterflies, 3 dragonflies, 1 mayfly, 1 damselfly, 2 mussels, and 2 Tabanid flies (i.e., horseflies and deerflies). A comprehensive inventory of the invertebrate fauna of the Eightmile watershed has not yet been performed, but a number of places in the watershed have for some time been recognized by amateur and professional invertebrate specialists as "hot spots" for various invertebrate fauna, and there is a considerable compilation of invertebrate data for the Eightmile watershed. Dr. David Wagner, at UCONN, and Michael Thomas, with the Connecticut Agricultural Experiment Station, have reviewed and compiled Odonata records, and the Connecticut Butterfly Society has compiled records of Lepidoptera from the Connecticut Butterfly Atlas Project. In addition, the CT-DEP-NDDB has researched and compiled records of other invertebrates (e.g., Diptera) believed to be rare in a state and/or global context.

Figure 10. Bog Copper (Lycaena epixanthe) with host plant, Large Cranberry (Vaccinium macrocarpon), and Rose Pogonia (Pogonia ophioglossoides), a nectar source, in medium fen community.

The twelve State-listed invertebrates are dependent upon several habitats in the Eightmile watershed. Four of the species - 2 dragonflies, 1 mayfly, and 1 mussel species - are associated with lotic sections of the Eightmile River itself and its larger tributaries. Three of the species - one butterfly and both Tabanid fly species - are associated with bog-like medium fen habitat. Two species – one dragonfly and a globally rare damselfly – are associated with certain sandy-bottomed natural ponds/small lakes. One of the butterflies, the globally rare Frosted Elfin, is associated with sand barrens and open rocky outcrop habitat. The third butterfly species appears to be associated with a large scrubby swamp complex. Finally, one mussel species occurs in the fresh-tidal Hamburg Cove.

In addition to documenting State-listed and globally, professional and amateur naturalists have compiled total taxa lists for certain groups of invertebrates. The Connecticut Butterfly Atlas Project documented 70 of the ~120 butterfly species known from Connecticut in blocks overlapping the Eightmile watershed.

Reptiles and Amphibians

A comprehensive, systematic inventory of the reptiles and amphibians of the Eightmile River watershed has not yet been performed, but there exists a considerable body of data on the herpetofauna of the watershed and its near vicinity, from which the author has compiled the list presented in Table 3. Sources for the data presented in Table 3 include: a GIS database of reptile and amphibian data for the Eightmile river watershed and its near vicinity, based on voucher specimens, photographs, and reliable observations by professional and avocational herpetologists (Gruner and Klemens 2004); observations by naturalist Dr. David Bingham, of Salem, CT; the biological survey of the Route 11 corridor by biologists with The Maguire Group, consultants to the Connecticut Dept. of Transportation (Zemba, Hall, and Hageman pers. comms.); a vernal pool inventory conducted by the Connecticut River Conservation District, using volunteers trained by a professional herpetologist (Connecticut River Conservation District 2004); a compilation of species documented over several decades at the Burnham Brook Nature Conservancy Preserve in East Haddam (Goodwin 1991); observations by educator and avocational herpetologist Ed Natoli, of Salem, CT; Michael Klemens' 1993 Amphibians and Reptiles of Connecticut; and the author's field observations, 2003-2005.

Based on these sources, at least 28 species of reptiles and amphibians have been documented within the Eightmile River watershed in recent decades, and an additional 2 species outside, but near, the watershed (Gruner and Klemens 2004). Among these are 4 State-listed species, all in the "Special Concern" category and all reptiles: *Heterodon platirhinos* (Hog-nosed Snake), and *Thamnophis sauritus sauritus* (Eastern Ribbon Snake), *Clemmys insculpta* (Wood Turtle), *Terrapene c. carolina* (Eastern Box Turtle). All of these species are also classified in Connecticut's Comprehensive Wildlife Conservation Strategy (CWCS) as "Very Important". Also occurring in the watershed is a reptile species that is not yet State-listed as Endangered, Threatened, or Special Concern, but is classified in the CWCS as "Very Important": *Clemmys guttata* (Spotted Turtle), which is considered by local naturalists to be not uncommon in the Eightmile River watershed.

Table 3. Reptiles and amphibians documented in and near the Eightmile River watershed.						
Taxon	**Common name**	**Higher Taxonomic Group**	**Family**	**State Legal Status**	**State CWCS status**	**Comments on status in Eightmile watershed**
Hyla versicolor	Gray Treefrog	Amphibian	Treefrogs			Abundant[5]
Pseudacris cucifer cucifer	Northern Spring Peeper	Amphibian	True Frogs			Common to abundant[5]
Rana catesbeiana	Bullfrog	Amphibian	True Frogs			Present[5]
Rana clamitans melanota	Green Frog	Amphibian	True Frogs			Common to abundant[5]
Rana palustris	Pickerel Frog	Amphibian	True Frogs			Common to abundant[5]
Rana sylvatica	Wood Frog	Amphibian	True Frogs			Common to abundant[5]
Bufo americanus americanus	Eastern American Toad	Amphibian	Toads			Common[5]
Bufo fowleri	Fowler's Toad	Amphibian	Toads			Outside but near watershed; Natoli doubts it occurs in 8mile[1]
Ambystoma maculatum	Spotted Salamander	Amphibian	Mole Salamanders			Common to abundant[1]
Ambystoma opacum	Marbled Salamander	Amphibian	Mole Salamanders			Locally abundant[1]
Desmognathus fuscus	Northern Dusky Salamander	Amphibian	Lungless Salamanders			Locally common[1]
Eurycea bislineata	Northern Two-lined Salamander	Amphibian	Lungless Salamanders			Common[1]
Hemidactylium scutatum	Four-toed Salamander	Amphibian	Lungless Salamanders			Common[1]

Table 3. Reptiles and amphibians documented in and near the Eightmile River watershed.						
Taxon	**Common name**	**Higher Taxonomic Group**	**Family**	**State Legal Status**	**State CWCS status**	**Comments on status in Eightmile watershed**
Notophthalmus viridescens viridescens	Red-spotted Newt	Amphibian	Newts			Not uncommon[1]
Plethodon cinereus	Red-backed Salamander	Amphibian	Lungless Salamanders			Abundant[1]
Agkistrodon contortrix moke	Northern Copperhead	Reptile	Pit Vipers		Important	Fairly recently (1993) observed outside but near watershed[2]
Carphophis amoenus	Eastern Worm Snake	Reptile	Harmless Snakes			Historic records (1980) for 2 localities within watershed. Current status unknown.
Coluber constrictor	Northern Black Racer	Reptile	Harmless Snakes			Two recent observations (2000, 2005) in Salem[1]
Elaphe alleghaniensis	Eastern Rat Snake	Reptile	Harmless Snakes			Very common[1]
Heterodon platirhinos	Eastern Hognose Snake	Reptile	Harmless Snakes	Special Concern	Very Important	Apparently local. Recently (2003) observed at one locality, and fairly recently (1990s) at a second locality.
Lampropeltis triangulum triangulum	Eastern Milk Snake	Reptile	Harmless Snakes			Very common[1]
Liochlorophis (= *Opheodrys*) *vernalis*	Eastern Smooth Green Snake	Reptile	Harmless Snakes		Important	One recent observation recently in Pleasant Valley (2002 or 2003)[1]
Nerodia sipedon	Northern Water	Reptile	Harmless			Very common[1]

Table 3. Reptiles and amphibians documented in and near the Eightmile River watershed.

Taxon	Common name	Higher Taxonomic Group	Family	State Legal Status	State CWCS status	Comments on status in Eightmile watershed
sipedon	Snake		Snakes			
Storeria dekayi dekayi	Northern Brown Snake	Reptile	Harmless Snakes			Common[1]
Thamnophis sauritus sauritus	Eastern Ribbon Snake	Reptile	Harmless Snakes	Special Concern	Very Important	Recently observed at one locality in the watershed (Zemba pers. comm.); 1985 and 1979/1980 reports for a second locality[6]
Thamnophis sirtalis sirtalis	Eastern Garter Snake	Reptile	Harmless Snakes			Very common[1,5]
Chrysemys picta subsp.	Painted Turtle	Reptile	Pond and Marsh Turtles			Common to absent[1]
Clemmys guttata	Spotted Turtle	Reptile	Pond and Marsh Turtles		Very Important	Not uncommon[1]
Clemmys insculpta	Wood Turtle	Reptile	Pond and Marsh Turtles	Special Concern	Very Important	Several recent observations along both branches of the 8mile River[2,3,4]
Sternotherus odoratus	Common Musk Turtle	Reptile	Pond and Marsh Turtles			Observed at least once, in 1999[1]
Terrapene carolina	Eastern Box Turtle	Reptile	Pond and Marsh Turtles	Special Concern	Very Important	Apparently local; recent (1999, 2001) records for three localities[2,4], fairly recent (1990) for a 4th locality[6]

[1]Natoli pers. comm.
[2]Gruner and Klemens 2004
[3]Walden and Parasiewicz 2005
[4] Bingham pers. comm.
[5]Author's field observations (2003-2005)

Table 3. Reptiles and amphibians documented in and near the Eightmile River watershed.						
Taxon	**Common name**	**Higher Taxonomic Group**	**Family**	**State Legal Status**	**State CWCS status**	**Comments on status in Eightmile watershed**
[6]Goodwin 1991a [7]Klemens 1993						

Mammals

A comprehensive inventory of the mammals of the Eightmile River watershed has not yet been performed, but various surveys of limited scope have been performed in or near the watershed in the last several decades. Based on these surveys, together with reliable reports of observations, and the author's field observations, approximately 39 terrestrial mammal species (36 native and 3 naturalized non-native) have been documented naturally occurring in, or very close to, the Eightmile watershed. Several more species may reasonably be expected to occur in the watershed. All of these species are terrestrial mammals, as opposed to marine. To the best of the author's knowledge, no marine mammals have been documented using Hamburg Cove, but since harbor seals have been recently observed in the Connecticut River well upstream of the Cove, it is reasonable to expect that harbor seals either have used, or will use, Hamburg Cove.

Thirteen of the mammal species (See Table 2) documented in or near the watershed within the last several decades are included in Connecticut's Comprehensive Wildlife Conservation Strategy (CWCS), as "Important", "Very Important", or "Most Important" species.

One of these species, the Red Bat (*Lasiurus borealis*), is State-listed as Special Concern, and listed in the CWCS as a "Most Important" species. The Red Bat has been documented within the Eightmile watershed by recent CT-DEP mist net survey. This tree-roosting bat uses air space over the Eightmile River as movement corridor and for foraging. It habitat preference is for an admixture of open and treed habitat (Jenny Dickson, pers. comm.). The Red Bat is the only State-listed mammal documented in the watershed.

Among the ten CWCS-listed species, those ranked rarest statewide are Bobcat (*Felis rufus*) and New England Cottontail (*Sylvilagus transitionalis*), which are ranked "S2?" and "S2", respectively, and "Very Important" and "Most Important", respectively, in the CWCS.

Bobcat sign (tracks, droppings) has been detected within the watershed as recently as 1984 (Goodwin 1991), and there have been several recent reliably reported sightings of Bobcat in 3 of the 5 towns that overlap with the watershed (CT-DEP 2003). The author could not confirm whether these sightings were also within the watershed. For unknown reasons, Bobcat are more abundant in the western Connecticut than they are in eastern Connecticut, in spite of an apparent abundance of suitable habitat in the many places in eastern Connecticut, such as the Eightmile watershed. This statewide distribution pattern appears to be stable, and thus it does not appear that the Eightmile watershed is, or will be, a stronghold for Bobcat, in state or regional context (Paul Rego, pers. comm.).

The New England Cottontail has recently been documented at two places in the Eightmile watershed, and a third location just outside of the watershed. It is associated with scrubby habitat in rights-of-way, and with forested habitat with a well-developed shrubby understory

(Howard Kilpatrick, pers. comm.; Anthony Zemba, pers. comm.).

Black Bear (*Ursus americanus*), which CWCS-listed as an "Important" species, has been recently sighted in at least 3 of the 5 towns overlapping with the Eightmile watershed, and also in towns bordering the watershed. The author could not confirm if any of these sightings were within the watershed, but there is abundant suitable habitat in the watershed and it is reasonable to assume that the watershed is being used, at least, by dispersing/wandering non-breeding Black Bear. The Eightmile watershed is outside the part of Connecticut where Black Bear is considered to be established (i.e., where they are regularly breeding), and thus the watershed is not at present considered to be an important area for bears. The Black Bear population and the areas where they are considered established are expanding in Connecticut, however, and it it is reasonable to expect that the watershed, with it's low level of development, large unbroken forest blocks, and large portion of protected land, will in the future support a breeding population of Black Bear (Paul Rego, pers. comm.).

In addition to the CWCS-listed mammals that have been documented in or near the Eightmile watershed, there are at least three additional species (1 bat, 2 small mammals) that are considered possible or likely to occur, based on our current understanding of their habitat requirements and statewide distribution (Jenny Dickson, pers. comm. [bats]; James Fischer, pers. comm. [small mammals]). These are:

- Eastern Pipistrelle (*Pipistrella subflavus*) – CWCS listing: "Important"
- Southern Bog Lemming (*Synaptomys cooperi*) - CWCS listing: "Most Important", State-Special concern
- Northern Water Shrew (*Sorex palustris*) - CWCS listing: "Most Important".

Besides "at risk" species, several other mammals deserve special mention. Like the Black Bear, Fisher (*Martes pennanti*) were extirpated in Connecticut, and have become re-established in Connecticut over the last 40 years, both via introduction in the western part of the state, and via dispersal from Massachusetts in the east. They have been especially successful in the eastern part of the state (Paul Rego, pers. comm.). There have been recent sightings and road-kills in most of the Eightmile watershed towns (CT-DEP 2003). The author observed Fisher tracks in several places in the Eightmile watershed in the winter of 2004-2005, and was scolded by a live Fisher in a tree just outside the watershed at another location. By all appearances, Fisher are well-established in the Eightmile watershed.

Plant

The Eightmile River watershed hosts extant populations of 34 plants considered rare, endangered, threatened, and otherwise of conservation concern in global, regional, and/or state

contexts (See Table 2). Of these, two species are globally rare: *Bidens eatonii* Eaton's Beggar-ticks (G2) and *Eriocaulon parkeri* Parker's Pipewort (G3); intertidal wetland habitats support robust, regional stronghold populations of both species. Twenty-four plants (including the two globally rare species) have been identified as being of New England regional conservation concern (Brumback et al. 1996). And finally, the watershed hosts 28 State-listed plants, i.e., plants listed in Connecticut as Endangered, Threatened, or Special Concern (this total includes the above-mentioned 2 globally rare species and 16 additional species of New England regional concern species; 6 of the New England regional concern species are not State-listed in Connecticut). Of the above-mentioned plants, the author personally observed populations of 30 of the 33 rare plants during the period 2003-2005, and the observation of one additional species was reliably reported in 2003 (Mattrick pers. comm.). Thus, 31 of the 33 rare plants believed extant in the watershed have been confirmed extant within the last 4 years. The remaining two species, the fern *Ophioglossum pusillum* Adder's Tongue and the grass, *Schizachne purpurascens* Purple Oat, were documented as recently as 1998 and 1990, respectively. The author has confirmed that the sites for these species are still intact, so it is reasonable to follow the NatureServe convention (i.e., last observed within the last 25 years), and consider the species to be extant in the watershed.

Figure 11. . State-Endangered and regionally rare *Scutellaria integrifolia* (Hyssop Skullcap)

The Eightmile River watershed is of special significance for several of the rare plants of New England regional conservation concern. The watershed hosts most of the individual plants still known to exist in New England of *Scutellaria integrifolia* Hyssop Skullcap (See Fig. 11). The watershed hosts the most robust occurrences, and the largest concentration of occurrences, of *Aristolochia serpentaria* Virginia Snakeroot that are known in New England. The watershed hosts the majority of the known Connecticut occurrences, and perhaps also the majority of individual plants known in New England, of *Xyris smalliana* Small's Yellow-eyed Grass (See Fig. 14). The watershed is a critical regional stronghold for these three plants in New England. Four additional plants are notable for the robustness of their populations and/or numbers of occurrences in the watershed: *Asplenium montanum* Mountain Spleenwort, *Carex bushii* Sedge, *Pedicularis lanceolata* Swamp Lousewort, *Mimulus alatus* Winged Monkey-flower, and *Asclepias purpurascens* Purple Milkweed (See Fig. 12). This last species occurs in low numbers, but in a relatively large

number of individual occurrences (3-4) for a single locality.

The total number of extant occurrences of State-listed plants currently known in the Eightmile watershed (as of May 2006 and to the best of the author's knowledge) is about 58 occurrences. Forty-nine of these occurrences were observed and confirmed extant by the author in the period 2003-2006, while observations of 3 additonal occurrences were reliably reported during the same period. The remaining 6 occurrences were last observed as long ago as 1982 and as recently as 2002, and it is reasonable to suspect that they are all still extant. .

In 2004, based on the results of the author's 2003 survey of the watershed for rare plants, the author estimated that the actual number of State-listed and regionally rare plant occurrences in the Eightmile watershed is probably at least 50% higher than the current total then known for the watershed (53). This estimate is supported by the author's subsequent discoveries of 9 additional State-listed plant occurrences and one new State-listed species in the watershed in 2004 and 2005. In considering the implications of this, it is important to realize that the majority of the occurrences discovered by this survey will likely not persist without some form of habitat management/disturbance/manipulation by man. Several of these occurrences (e.g., those of *Scleria triglomerata* Nutrush, *Asclepias purpurascens* Purple Milkweed, *Lespedeza repens* Creeping Bush-clover, *Liparis liliifolia* Lily-leaved Twayblade, *Xyris smalliana* Small's Yellow-eyed grass) may reasonably be viewed as having been discovered just in the nick to time to prevent their imminent loss. Likewise, several priority natural communities were identified which are still intact and of high quality, but are also threatened by one or more of the following: invasives, beaver activity, over-browse by deer, lack of management or less-than-optimal management, and in some cases lack of protection. The timely recognition of these community occurrences' management and protection needs, as well as timely discovery of not-yet-recognized occurrences, makes their continued existence more likely.

Figure 12. State-Special Concern and regionally rare *Asclepias purpurascens* (Purple Milkweed).

Eightmile River watershed in a New England regional context: the NatureServe analysis

There are several ways in which the regional biodiversity significance of the Eightmile river watershed may be assessed. One way is to compare the number of rare species found in the Eightmile to other watersheds of comparable scale in the region. Toward this end, in late 2004, NatureServe.org was commissioned by the Eightmile Watershed Study Committee to create a tally of extant rare species for each of all the HUC12 and HUC10 drainage basins in New England. This analysis was a first of its kind, as it was based upon data shared by state natural heritage programs, and data sharing agreements between the natural heritage programs and NatureServe had only just been finalized by late 2004.

The species used in the analysis were only those currently considered the rarest in each state (species with state ranks of S2S3 or rarer), and all globally rare species (global rarity ranks of G3G4 or rarer). There were several reasons for this restriction, which eliminates from consideration many species that are legally protected in each state, and many other species that have been identified by various organizations as of conservation concern and at-risk. One reason for the restriction was to neutralize as much as possible the geographic scale differences between states that all use the same rarity ranking system, which is based mainly on numbers of known occurrences in the state. Another reason was the supposition that the state heritage programs have a more accurate understanding of true numbers of occurrences for their rarest species than for the less rare species, because the former have been the objects of greater inventory effort.

An additional restriction on the Natureserve analysis is that it counts only species documented in the watershed in the last 25 years. This represents a best attempt to compare, between watersheds, the number of extant rare species, and, by extension, existing habitat conditions (as opposed to historic conditions). The majority of records older than 25 years are problematic to use in this kind of analysis, because locality information is for most records too imprecise to allow assignment to watershed (town is most often the most precise locality information associated with older records).

Given these restrictions, the tally of extant countable rare species for the Eightmile River watershed was 20 species (including 3 globally rare species) before incorporating recent data not available to NatureServe at the time of the analysis, and the tally is 32 species (including 5 globally rare species), after incorporating the occurrence data developed by recent surveys and research in 2003-2005 (which data had not been processed by the state heritage program and transmitted to NatureServe by the time of there analysis). Both tallies are surprisingly small compared with the number of State-listed species (55), and the summary list of “at-risk” species associated with the watershed (160). However, this reduction is understandable, given the focus of this analysis on the rarest species, in a regional, rather than a state, context.

As explained in the introduction, the hierarchical scheme of organization of drainage basins used

by the federal government differs from that used by the state of Connecticut, and the other New England states use the federal system. For this reason, it is not possible to directly compare the tally of rare species for the Eightmile River watershed, as it is defined in this report, to the New England HUC12 and HUC10 drainage basins. The majority of New England's HUC10 (i.e., regional) basins are 2X to 9X the area of the Eightmile River watershed, while most HUC12 (subregional) basins are much smaller (median size = ~31 mi^2). Comparisons of species richness among geographic units of very different area are biased toward the larger units, because species richness generally increases with area regardless of relative biodiversity values. However, the Eightmile River watershed is comprised of two federal HUC12 basins, and it was possible to directly compare each of these subsets of the Eightmile River watershed to all other HUC12 basins across New England. The results of this comparison are presented in Table 4. Also, a comparison has been made between the Eightmile watershed, as defined in this report, and all other New England HUC10 watersheds (median size = ~137 mi^2), using density of rare species per unit area, which in some measure equalizes the "advantage" of the larger size watersheds. This comparison is presented in Table 5.

Table 4. Ranking of the two Eightmile River HUC12 basins among all New England and Connecticut HUC12 basins, in terms of extant rare species/basin and extant rare species/unit basin area in New England.

		Eightmile [main stem] HUC12 code: 010802050903 (before updating data)	Eightmile [main stem] HUC12 code: 010802050903 (after updating data)	East Branch Eightmile HUC12 code: 010802050902 (before updating data)	East Branch Eightmile HUC12 code: 010802050902 (after updating data)
Number extant *globally rare species* (G1 thru G2G3) in basin		3	5	0	1
Number extant state-rare and globally rare species (S1 thru S2S3, G1 thru G2G3) in basin		19	25	2	7
New England Context Number of HUC12 basins: 1931 NE HUC12 basin area range: 0.03-265 mi^2 Median HUC12 basin area: 31 mi^2 Extant total rare species/HUC12 basin: Range = 0-60; Median = 1 Extant globally rare species/basin: Range = 0-13; Median = 0	Percentage of New England HUC12 basins hosting MORE extant *globally rare species*	2.1%	0.8%	26.8%	9.3%
	Percentage of New England HUC12 basins hosting FEWER extant *globally rare species*	95.7%	98.9%	n/a	73.2%
	Percentile rank among New England HUC12 basins based on DENSITY of *globally rare species* (i.e., species/unit area of basin)	96th	98th	n/a	90th
	Percentage of New England HUC12 basins hosting MORE extant total rare species (state-rare and globally rare combined)	4.6%	2.7%	36.7%	16.4%
	Percentage of New England HUC12 basins hosting FEWER extant rare species (state-rare and globally rare combined)	95.0%	97.0%	54.4%	81.5%
	Percentile rank among New England HUC12 basins based on DENSITY of MORE extant total rare species (state-rare and globally rare combined) (i.e., species/unit area of basin)	94th	95th	67th	89th

Table 5. Comparison of Eightmile River watershed to HUC10 watersheds in New England and Connecticut, in terms of rare species/unit area.			
		Eightmile River watershed (=Eightmile [main stem] HUC12 code: 010802050903 + East Branch Eightmile HUC12 code: 010802050902), before updating data.	Eightmile River watershed (=Eightmile [main stem] HUC12 code: 010802050903 + East Branch Eightmile HUC12 code: 010802050902), after updating data.
Number extant *globally rare species* (G1 thru G2G3) in basin		3	5
Number extant state-rare and globally rare species (S1 thru S2S3, G1 thru G2G3) in basin		20	31
New England Context Number of HUC10 basins: 417 Median HUC10 basin area: ~137 mi^2 Extant total rare species/HUC10 basin: Range = 0-112; Median = 8 Extant globally rare species/basin: Range = 0-20; Median = 1	Percentage of **New England** HUC10 basins hosting MORE extant *globally rare species*/square mile	8.6%	1.1%
	Percentage of New England HUC10 basins hosting FEWER extant *globally rare species*/square mile	91.4%	98.9%
	Percentage of New England HUC10 basins hosting MORE extant total rare species (state-rare and globally rare combined)/square mile	9.4%	4.6%
	Percentage of New England HUC10 basins hosting FEWER extant rare species (state-rare and globally rare combined)/square mile	90.6%	95.4%

To summarize the data presented in Tables 4 and 5, the Eightmile River watershed, as defined for this report, ranks among the New England regional (HUC10) and subregional (HUC12) basins with the highest concentrations of extant rare species, regardless of the several ways in which the comparison may be made. When the Eightmile watershed is ranked among the 417 New England HUC10 basins in terms of number of extant rare species per unit basin area, it ranks in the 96th percentile in terms of extant total rare species/unit basin area, and in the 99th percentile, in terms of extant globally rare species/unit basin area. In an alternative comparison of basins more similar in terms of area, the two component HUC12 basins comprising the Eightmile watershed have been ranked among the 1,931 New England HUC12 basins, in terms of extant rare species/basin. The Eightmile [main stem] basin is exceeded by only 2.7% of New England basins in terms of total extant rare species/basin, and is exceeded by only 0.8% of New England HUC12 basins, in terms of extant globally rare species/basin. The East Branch Eightmile basin is exceeded by 19.2% of New England HUC12 basins, in terms of total rare species per basin, and by 37.4% of New England HUC12 basins, in terms of extant globally rare species per basin.

The evident difference between the rare species richness of Eightmile [main stem] HUC12 basin and the East Branch Eightmile HUC12 basin is in part real, due to the several ecological systems present in the former and not in the latter. However, in part it is an artifact of the much smaller size of the East Branch basin (22.5 mi^2), compared with the Eightmile main stem (39.9 mi^2), the majority of New England HUC12 basins (median size = 31 mi^2). If the one attempts to neutralize the effect of area disparity by using *density* of rare species, the East Branch HUC12 basin ranks in the 90th percentile of New England HUC12 basins, in terms of extant globally rare species/unit basin area, and in the 89th percentile of New England HUC12 basins, in terms of total extant rare species/unit basin area.

Eightmile River watershed in a Connecticut context

In a state context, the biodiversity significance of the Eightmile watershed may be directly compared to the other regional drainage basins, using the CT-DEP organizational scheme, wherein the Eightmile watershed is defined as Regional basin No. 48. In this section, the Eightmile watershed is ranked against other Connecticut regional basins in terms of numbers of globally rare species and numbers of total rare species (i.e., state-rare plus globally rare species). A tally of extant globally rare species for each Connecticut regional drainage basin is presented in Table 6. Extant globally rare species are defined in the same way as in the previous section. Tallies were provided by the CT-DEP-NDDB in May 2005, and thus are more current, by almost one year, than the data used to generate the Natureserve New England tallies in the previous section

Table 6. Comparison of the Eightmile watershed to other Connecticut regional basins, in terms of number of extant1 globally rare and State-rare2 species per basin (regional basins listed in order of highest to lowest density of globally rare species per basin).

CT Regional Basin No.	CT Regional Basin	CT Area (sq mi)	No. of Extant Globally Rare Species	Density extant globally rare species (no. spp./mi2 of basin)	No. of total extant rare species (globally and State-rare combined)	Density total extant rare species (no. spp./mi2 of basin)
n/a	Long Island Sound	n/a	5	n/a		
11	Wood	10.2	2	0.1961	10	0.9851
63	Tenmile	35.7	4	0.1120	53	1.4843
62	Hollenbeck	42.9	4	0.0932	84	1.9580
61	Blackberry	34.4	3	0.0872	56	1.6279
48	Eightmile	62.4	5	0.0801	49	0.7853
41	Stony Brook	35.7	2	0.0560	15	0.4200
36	Pachaug	61.6	3	0.0487	36	0.5843
20	Southeast Shoreline	42.8	2	0.0467	41	0.9887
35	Moosup	48.6	2	0.0412	10	0.2056
34	Fivemile	51.9	2	0.0385	11	0.2119
50	South Central Shoreline	58.5	2	0.0342	36	0.6262
60	Housatonic Main Stem	402.3	13	0.0323	168	0.4176
38	Shetucket	124.9	4	0.0320	20	0.1601
40	Connecticut Main Stem	387.6	12	0.0310	130	0.3354
53	South Central Western Complex	104.8	3	0.0286	32	0.3053
32	Natchaug	175.4	5	0.0285	33	0.1882
66	Still	70.7	2	0.0283	38	0.5373

Table 6. Comparison of the Eightmile watershed to other Connecticut regional basins, in terms of number of extant1 globally rare and State-rare2 species per basin (regional basins listed in order of highest to lowest density of globally rare species per basin).

CT Regional Basin No.	CT Regional Basin	CT Area (sq mi)	No. of Extant Globally Rare Species	Density extant globally rare species (no. spp./mi2 of basin)	No. of total extant rare species (globally and State-rare combined)	Density total extant rare species (no. spp./mi2 of basin)
52	Quinnipiac	165.5	4	0.0242	61	0.3685
70	Southwest Shoreline	41.4	1	0.0242	27	0.7211
72	Saugatuck	89.5	2	0.0223	34	0.3800
47	Salmon	149	3	0.0201	28	0.1879
73	Norwalk	58.3	1	0.0172	10	0.1717
51	South Central Eastern Complex	182.7	3	0.0164	74	0.4050
31	Willimantic	219.1	3	0.0137	24	0.1095
42	Scantic	83.2	1	0.0120	10	0.1203
37	Quinebaug	256.3	3	0.0117	25	0.0975
43	Farmington	451	5	0.0111	109	0.2417
71	Southwest Eastern	98.6	1	0.0101	32	0.3245
30	Thames Main Stem	107.7	1	0.0093	22	0.2045
69	Naugatuck	311.2	1	0.0032	36	0.1157
65	Aspetuck	50.7	0	0.0000	5	0.0985
64	Candlewood	39.0	0	0.0000	7	0.1794
81	Croton	21.1	0	0.0000	5	0.2374
33	French	17.1	0	0.0000	1	0.0586
45	Hockanum	77.1	0	0.0000	12	0.1556

Table 6. Comparison of the Eightmile watershed to other Connecticut regional basins, in terms of number of extant1 globally rare and State-rare2 species per basin (regional basins listed in order of highest to lowest density of globally rare species per basin).

CT Regional Basin No.	CT Regional Basin	CT Area (sq mi)	No. of Extant Globally Rare Species	Density extant globally rare species (no. spp./mi2 of basin)	No. of total extant rare species (globally and State-rare combined)	Density total extant rare species (no. spp./mi2 of basin)
46	Mattabesset	108.9	0	0.0000	38	0.3489
44	Park	77.2	0	0.0000	8	0.1036
10	Pawcatuck Main Stem	47.0	0	0.0000	17	0.3617
68	Pomperaug	89.0	0	0.0000	32	0.3596
67	Shepaug	155.4	0	0.0000	40	0.2573
21	Southeast Eastern Complex	62.4	0	0.0000	27	0.4328
22	Southeast Western Complex	58.2	0	0.0000	11	0.1891
74	Southwest Western Complex	104.3	0	0.0000	13	0.1246
39	Yantic	97.8	0	0.0000	1	0.0102
	Mean	112.9	2.3	0.0275	34.8	0.4133
	Median	77.2	2.0	0.0168	27.5	0.2813
	Maximum	451	13	0.1961	168	1.9580
	Minimum	10.2	0	0.0000	1	0.0102

Source: CT-DEP-NDDB June 2005

1"extant" here means that species has been documented in the basin within the last 25 years, and it is not known to have been extirpated since the last observation

2for this analysis, "State-rare" species are defined as all species listed pursuant to Connecticut's Endangered Species Act (i.e., "State-listed"), plus any species that are not State-listed that have S-ranks of S2S3 or rarer

The data presented in Table 6 shows that the Eightmile watershed, which hosts populations of five globally rare species, ranks in the top 6 of the 44 regional basins in Connecticut, in terms of number of extant globally rare species per basin. Only two regional basins exceed the Eightmile in the number of extant globally rare species/basin, while four basins have the same number. A straight comparison of species tallies of regional basins in Connecticut means comparing geographic entities of very different area, and such comparisons are potentially biased in favor of the entities with larger area, independent of the biodiversity values of the entities. Thus, a more informative comparison may be that of density of globally rare species per basin. In terms of number of extant globally rare species per unit area of basin, the Eightmile watershed ($0.0801/mi^2$) ranks 5^{th} among the 44 Connecticut regional watersheds. In terms of total extant rare species (globally rare plus State-rare species) per unit area of watershed, the Eightmile watershed ranks 6^{th} in Connecticut. The five watersheds with with higher rare plant densities are all watershes with the highest rare species densities in New England.

V. NATURAL COMMUNITIES

Significant natural community occurrences.

Approximately 100 occurrences of natural communities in the watershed have been identified by the author as "significant" and documented by this survey (summarized in Table 7). Communities were deemed significant on the basis of rarity, uncommonness or restricted occurrence (factoring in threats, and rate and magnitude of decline over last century), high native-species-richness (often including multiple rare and uncommon plant species), and/or exemplary character and/or condition (i.e., especially, low relative prominence of exotic and/or invasive species). Each natural community occurrence was assigned a biodiversity significance rank on a scale of 1 (Very High) to 4 (Moderate) or 5 (Exemplary*) or 6 (Arguable). The following is a breakdown of the 100 natural communities by biodiversity rank:

1. Very High 7 occurrences
2. High 11 occurrences
3. Moderate-High 10 occurrences
4. Moderate 34 occurrences
5. Exemplary* 18 occurrences
6. Arguable 20 occurrences

In the context of global biodiversity, the site of highest recognized significance in the Eightmile River watershed is the concentration of rare entities in the freshwater tidal upper reaches of Hamburg Cove. Three elements of recognized global rarity occur together there: the Freshwater Intertidal Flats/ Parker's Pipewort – Dotted Smartweed (*Eriocaulon parkeri – Polygonum punctatum*) community [Global rank: G2], *Bidens eatonii* [G2], and *Eriocaulon parkeri* [G3]. These entities co-occur near the head-of-tide in close association with nine other State- and/or New England-regional rare plants and several other uncommon/restricted/suspected rare plants, most of which occur in or adjacent to several types of freshwater tidal marsh and wet meadow communities (which may also turn out to be globally rare communities). Consequently, this site

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***** the "Exemplary" rank is applied to high quality occurrences of common types of native communities, and/or to examples of common communities that are in uncommon or rare condition (e.g., a common forest type in old-growth condition), that do not or are deemed unlikely to provide critical habitat for rare plants.

hosts the most intensive concentration (11 species) of extant State-listed plants known in the watershed.

Three other sites in the watershed may have global significance owing to the presence of *potentially* globally rare natural communities: Norwich Pond, Uncas Pond, and Cedar Lake. Occurring at Norwich and Uncas Ponds are the [sandy] Acidic Pond Shore/Seven-angle Pipewort – Dortmann's Cardinalflower (*Eriocaulon aquaticum – Lobelia dortmanna*) Intermittently Exposed Forb Vegetation (global rank: G?). It is suspected that this community may be a global rarity (depending on the outcome of more range-wide inventory and classification work). Additionally, Uncas Pond hosts the second highest concentration of multiple State-listed plants in the watershed (5 species, including one New England regional rarity).

Cedar Lake hosts what the author suspects may be a globally rare community that occupies a floating peat flat that occurs along the pond shoreline where it is adjacent to shrub-swamp and Atlantic White Cedar basin swamp. This community is apparently not yet represented in International Vegetation Classification (Grossman et al. 1998), but based on its strong floristic similarity to the above-mentioned sandy pond shore community (Grank: G?) at Uncas Pond, may likewise be suspected to be a globally rare community. This community supports very robust populations of 3 of the same State-listed rare plant species that occur at Uncas Pond, including one regionally rare species, and the author strongly suspects that additional survey at this site would reveal more rare plants.

Figure 13. Freshwater intertidal sand and gravel flat supporting the globally rare (G2) Parker's pipewort – Dotted smartweed (*Eriocaulon parkeri – Polygonum punctatum*) community. The two globally rare plants *Eriocaulon parkeri* (Parker's Pipewort) [the plant with the star-like habit and small round white flowers] and *Bidens eatonii* (Eaton's Begger-tick) [the plant appearing to have toothed leaves in whorls of four, in the right half and near the bottom of the picture] grow together in this community.

In a New England regional biodiversity context, several other sites in the Eightmile River watershed have special prominence: two sections of the electrical transmission right-of-way Lyme; the meta-occurrence of meadow habitats in the vicinity of Salem Four Corners; the Pleasant Valley Preserve, in Lyme; and the meta-occurrence of acidic cliff habitat in the vicinity of Devil's Hopyard State Park, in East Haddam. All of these sites host one or more regional stronghold populations of New England-regionally rare plant species (the first three sites each host at least 3-4 State-listed species each), in association with natural communities of conservation significance, at least in a state context.

Among the potentially most important biodiversity features of Eightmile River watershed is the extensive meta-occurrence of so-called "warm-season" grasslands, which include, more frequently, little bluestem (*Schizachyrium scoparium*)- and/or *Carex pensylvanica*-dominated grasslands, and, less frequently, big bluestem (*Andropogon gerardii*)-dominated "prairies". These dry to seasonally wet/dry grasslands, which require periodic anthropogenic disturbance (fire or mowing) to persist as open-canopy communities, represent among other things an important reservoir of native genotypes of grass species whose seeds of non-local origin are purchased and planted at considerable expense by land managers in efforts to create warm-season grassland habitat by around New England. There appears to be a strong correlation between the occurrence and prominence of the tall-grass prairie species (i.e., *Andropogon gerardii, Sorghastrum nutans*, *Tridens flavus*, etc.) and the occurrence of rare and uncommon herbaceous species, and a similar, but somewhat weaker, correlation between Little Bluestem-(*Schizachyrium scoparium*)-dominated grasslands and the occurrence of rare and uncommon herbaceous species.

Figure 14. Sevenangle pipewort – Dortmann's cardinalflower (*Eriocaulon aquaticum – Lobelia dortmanna*) Intermittently Exposed Forb Vegetation (global rank : G?), along shoreline of Uncas Pond.

Table 7. Summary of significant natural communities documented to-date in the Eightmile River watershed.				
Natural Community/Natural Community group/other designation	No. Occur-rences	Biodiversity Significance Rank[s] (1=highest, 6 lowest)	Rationale for Assigning Significance	Rare Plant Habitat (Actual/Potential/Negligible)
Freshwater Intertidal Flats	2	1-2	Recognized globally rare (G2) vegetation alliance	Actual (including 2 globally rare species [G2, G3]) and potential
Freshwater Tidal Marsh	3	1-4	Uncommon/restricted to rare community (one or more may be globally rare)	Actual (including 1 globally rare species [G2]) and potential
Dry rich cedar-dogwood forb/Carex pensylvanica savannas	1 meta-occurrence	1	Rare or uncommon community; host concentrations of rare and uncommon plants with robust populations	Actual and potential
Floating seasonally flooded peat flat community	1 meta-occurrence	1	Rare (possibly globally rare) community; hosts multiple rare plants with robust populations	Actual and potential
Acidic Pond Shore community	2	1	Rare (possibly globally rare) community; hosts multiple rare plants with robust populations	Actual and potential
Fresh-spring-tidal wet meadow/acidic, sandy seasonally saturated meadow	1	1	Rare (possibly globally rare) community; hosts two regionally rare plants and several uncommon species	Actual
Big Bluestem prairies	3	2	Uncommon or rare community	Actual and Potential

Table 7. Summary of significant natural communities documented to-date in the Eightmile River watershed.				
Natural Community/Natural Community group/other designation	No. Occur-rences	Biodiversity Significance Rank[s] (1=highest, 6 lowest)	Rationale for Assigning Significance	Rare Plant Habitat (Actual/Potential/Negligible)
Sandy, acidic, seasonally saturated and/or inundated meadows	7	2-4	Rare or uncommon community, threatened without management	Potential
Wet meadows and scrubby seasonally wet meadows of Thick Till landscape in Salem	2	2	High native plant diversity including multiple rare and uncommon species; rarity?	Actual
Sand barrens, dry grasslands, dry acid cedar savannas, and acid oak woodlands	34	2-6	Uncommon community, at least as large meta-occurrence, threatened without management	Actual and potential (global rarities among potentials)
Medium and Poor Fens	6	3-6	Rare or uncommon community	Actual and potential
Ice talus forest	1	3	Rare or uncommon community	Potential
Acidic cliffs	1 large meta-occurrence	3	Exemplary meta-occurrence	Actual and potential
Open and semi-open Acidic Rocky Summit/Outcrop communities	2	3-4	Rare or uncommon community	Potential
Acidic Atlantic White Cedar Basin Swamp	1	4	Uncommon/restricted community	Actual and potential
Acidic Spring Fen	3	4	Uncommon/restricted community	Potential
Subacidic Rocky Summit/Outcrop communities	1	4	Rare or uncommon community	Potential (global rarities among potentials)
Dry Subacidic Forests	4	3-4	Rare or uncommon community	Actual and potential (global rarities among potentials)

Table 7. Summary of significant natural communities documented to-date in the Eightmile River watershed.				
Natural Community/Natural Community group/other designation	No. Occur-rences	Biodiversity Significance Rank[s] (1=highest, 6 lowest)	Rationale for Assigning Significance	Rare Plant Habitat (Actual/Potential/Negligible)
Old-age ravine hemlock forest	1	5	Exemplary	Probably negligible
Mature swamp white oak forest swamp	1	5	Arguably exemplary (large, with many large oaks)	Potential
Vernal pool communities and related draw-down swamp forests and woodlands	9	5	Exemplary	Potential for some, negligible in others
Basin Marsh	2	5	Exemplary	Potential
Riverside Seep/Riverbank Beach/Shore Community	1 meta-occurrence	5	Exemplary	Potential
Acidic Seepage Forests and Swamps	3	5-6	Exemplary	Potential
Assorted other common types of wet/seasonally wet meadows, fens, marshes and shrub swamps	7	5-6	Exemplary	Actual and potential
Acer-Fraxinus-Hepatica forests	2	2-4	Host rare and uncommon plants; may be uncommon or rare community	Actual and potential

VI. ANADROMOUS AND RESIDENT FISH

Fish Species of Special Conservation Concern

The Eightmile watershed hosts at least 7 fish species that have been identified as being of special conservation concern/significance (see Table 2). These include one State-listed species, *Enneacanthus obesus* Banded Sunfish (State-Special Concern; G5S3), which was documented for the first time in the watershed by a survey in the late 1990s, at one of the impoundments along the Eightmile River (CT-DEP-NDDB 2004; Gephardt, pers. comm.). The University of Massachusetts' Northeast Instream Habitat Program (NEIHP) conducted a summer 2004 survey of Eightmile River and it's tributaries for fish and mussels, which was restricted to lotic habitats (i.e., not including impoundments). This survey documented the presence of 3 anadromous fish species that the Connecticut Comprehensive Wildlife Conservation Strategy (CWCS) has identified as "Most Important" or "Very Important": *Anguilla rostrata* American Eel (Most Important), *Salmo salar* Atlantic Salmon (Very Important), and *Petromyzon marinus* Sea Lamprey (Very Important). In addition, the NEIHP survey documented the presence of 3 resident fish species listed in the CWCS as "Very Important": *Esox niger* Chain Pickerel, *Erimyzon oblongus* Creek Chubsucker, *Esox americanus* Redfin Pickerel. Finally, "wild" (i.e., not introduced from hatchery stock) *Salvelinus fontinalis* Brook Trout (CWCS: "Most Important"), is suspected to occur in the Eightmile River (Bingham 2005) and/or its tributaries (Walden and Parasiewicz 2004; Bingham 2005), but this has not yet been confirmed.

Figure 15. Chapman's Falls, at Devil's Hopyard State Park: this is the natural limit to upstream fish movement in the Eightmile River [mainstem].

Diadromous Fish of the Eightmile watershed

Three diadromous (i.e. migrating between freshwater and saltwater) fish species were detected in the Eightmile watershed by the 2004 NEIHP fish survey, and an additional five diadromous species have been documented by historic surveys (researched and compiled by NEIHP). These include anadromous species (which live most of their lives in saltwater, but return to freshwater to spawn), a catadromous species (living most of its life in freshwater, returning to saltwater to

spawn), and amphidromous species (migrating between salt- and freshwater for purposes other than to spawn, such as to feed).

The 2004 NEIHP survey documented the presence of juvenile Atlantic Salmon (*Salmo salar*), an anadromous species, at most sampling sites in the Eightmile River [main stem] as far upstream as Chapman's Falls, which is a natural and historic limit to upstream movement of anadromous fish returning upstream to spawn. In the East Branch Eightmile River, Atlantic Salmon were detected at all sample sites downstream of, and none above, Hales Pond, where the pond dam is currently a barrier to upstream movement (this dam is scheduled to be removed in 2005). The juvenile salmon detected by the NEIHP survey were almost certainly fish that have been released as fingerlings into the Eightmile, as part of the Atlantic Salmon restoration program that has been underway in Connecticut for several years. The restoration program has used for stocking salmon native to several rivers in Maine, our native Connecticut stock having been extirpated by the 1800s. Though there have been some reports of adult salmon (30+ inches) in the Eightmile watershed streams, no returns of adult salmon have been substantiated. However, confirmation of adult returns to the Eightmile watershed may be expected lag behind the first occurrence, since there are no monitoring traps installed on the Eightmile, as there are on the other two rivers (Salmon River and Farmington River) in which salmon restoration is being attempted (Gephart pers. comm.).

American Eel (*Anguilla rostrata*), our only catadromous species, was detected at all sample sites on the Eightmile River and its tributaries, including those upstream of Chapman's Falls and Hales Pond.

The anadromous Sea Lamprey (*Petromyzon marinus*) was detected by the NEIHP survey at one sample site on the Eightmile River [main stem].

The five additional diadromous species documented by historic surveys are the amphidromous or anadromous White Perch (*Morone Americana*) and Striped Bass (*Morone saxatilis*), and the anadromous Blueback herring, Alewife (*Alosa pseudoharengus*), and State-Threatened Rainbow Smelt (*Osmerus mordax*). All of these species except the last were detected in Hamburg Cove during recent (1989, 1990, and/or 2003) CT-DEP surveys, but there is apparently no evidence of their presence, historic or current, upstream of the Cove (Walden and Parasiewicz 2005). The Rainbow Smelt records are from 1942 and 1959 publications; it is not clear if the record locations were definitely in Hamburg Cove, or from the Connecticut River close to the mouth of the Cove (Walden and Parasiewicz 2005; Whitworth et al. 1968).

Regarding the above-listed diadramous fish, the importance of Hamburg Cove, as a White Perch fishery and a staging area for their fall migration, has been emphasized by the CT-DEP. In the

fall, White Perch crowd into Hamburg Cove to feed in very large numbers, as they migrate up the Connecticut River. White Perch is a relatively abundant native fish in Connecticut, and thus has not been flagged by agencies or conservation entities as a species of special conservation concern, but the numbers supported by Hamburg Cove are considered exemplary and a bulwark of the currently healthy state population (Gephart pers. comm.)

VII. RIVER/WATERSHED ECOSYSTEM QUALITY: INDICATORS OF AN EXEMPLARY AND UNIQUE, INTACT AND FUNCTIONING WATERSHED ECOSYSTEM

Biological Indicators

Cerulean warbler

This forest-interior warbler is the most area-sensitive North American bird species (Askins pers. comm.). The Eightmile River watershed, which comprises the greater part of a localized southern New England concentration area for this species, has a relatively high proportion of large, unfragmented blocks of forested habitat. The Eightmile watershed appears to have the largest blocks of Appalachian-affinity forests that still exist this far south in New England (i.e., similarly large forested blocks farther to the southeast in Connecticut and southwestern RI, support either lower Cerulean densities or no Ceruleans, and are Coastal Plain forests of different types (Askins pers. comm.). The robust Cerulean Wabler populations in and about the Eightmile watershed are an indication that the Eightmile River watershed has a unique combination of forest size, type, and geographic position.

Spotted Salamander

Based on the author's field observations and reports of others, the Spotted Salamander is evidently abundant throughout all or much of the watershed. This is an indication of an abundance of functioning vernal pool breeding habitat, and especially of an abundance of functioning forested foraging habitat for adults (Gruner pers. comm.).

Wood Frog

Based on the author's field observations and reports of others, the Wood Frog is very abundant throughout all or most of the watershed. Research elsewhere in Connecticut has shown that this vernal-pool-dependent amphibian is sensitive to fragmentation of upland habitat blocks surrounding its vernal pool breeding sites (Klemens 2000). The robust population in the Eightmile watershed is an indication that such fragmentation has not occurred in the watershed.

Stream Macrobenthos

Assemblages of benthic macroinvertebrates have been sampled and monitored by the CT-DEP in many streams across Connecticut for more than 25 years. As part of this statewide biomonitoring program, macroinvertebrate data was collected for the Eightmile River [mainstem] and East Branch Eightmile River in 1998 and 1999. Macroinvertebrate community structures in these streams indicated that the Eightmile River [mainstem] was "un-impaired", while the East Branch was "slightly impaired", compared to a nearby "reference" stream (i.e., a site selected because it is believed to represent essentially pristine conditions). The CT-DEP

concluded that the Eightmile River [mainstem] could itself be used as a reference stream, while the East Branch Eighmile River ranks in the upper half of sampling sites statewide (Beauchene 2003).

Umbrella Species

Cerulean warbler

The term "umbrella species" has been applied to species whose habitat requirements are such that they may be considered surrogates for the ecosystem that they inhabit. In other words, if an ecosystem is managed in such a way that the "umbrella species" naturally prospers, then we may be confident that the rest of the ecosystem and the species associated with it have been secured as. Since the Cerulean Warbler is the species in the watershed most sensitive to forest fragmentation, it may be considered an umbrella species for this system. Management for its success will undoubtedly ensure the success of many other species in the watershed known or suspected to be sensitive to forest fragmentation.

Habitat Intactness

One indicator of habitat intactness is the ratio of cumulative road length per unit area of watershed. For this investigation, road miles per square mile of total watershed area (road mi/mi^2) in Connecticut has been calculated from GIS data available from CT-DEP-EGIC. Based on this data, the Eightmile watershed, with 2.65 road mi/mi^2, has the third lowest road mi/ mi^2 of the 44 regional watersheds in CT (range: 1.57 to 16.5 road mi/mi^2). The two watersheds in Connecticut that have fewer road mi/mi^2 than the Eightmile, the Hollenbeck and the Wood, are parts of systems that have the highest numbers of rare species in New England.

Another indicator of habitat intactness is the proportion of a watershed that is occupied by large roadless blocks. The Nature Conservancy has developed a GIS map of roadless blocks in Connecticut and neighboring portions of Massachusetts and Rhode Island. From this coverage, a breakdown was developed for the 44 regional watersheds in Connecticut wherein total areas were calculated in each watershed falling into different size ranges of roadless blocks (e.g., 0-50 ac, 50-100 ac, 100-250 ac, and so on up to 10,000+ ac). Based on this analysis, the Eightmile watershed ranks 2nd from the top in terms of percentage of watershed occupied by roadless blocks of 1000 ac or greater (72.2% for the Eightmile watershed). The only Connecticut regional watershed with a higher percentage occupied by roadless blocks ≥1000 ac is the Hollenbeck, in northwestern Connecticut.

The University of Connecticut Center for Land Use Education and Research (CLEAR) has developed several GIS land use coverages for Connecticut, using satellite imagery as recent as 2002. The CLEAR coverage potentially allows a comparison of the Eightmile watershed to the other regional watersheds in Connecticut, in terms of percentages of various broad habitat types

(e.g., percentages of deciduous forest). However, there has been only very limited field verification/testing of the CLEAR data to-date (Wilson, pers comm.). During the generation of this report, the author developed a vegetation/habitat coverage for the Eightmile watershed, using a combination of low altitude aerial photo analysis, ground-truthing, and fixed-wing airplane reconnaissance. The habitat coverage developed for this investigation was developed independently of the CLEAR data, and was thus effectively a test of the accuracy of the CLEAR data, for the Eightmile watershed. Total areal percentages for certain important habitat/land cover units developed by the author for the Eightmile watershed have been compared to comparable units in the CLEAR coverage. For example, the percentage of total forested habitat derived from the author's work is 75.5%, which compares to 81% based on CLEAR data. The percentage of developed land in the watershed, based on the author's work, is 8.9%, which compares with 6.7% based on CLEAR data. These differences are smaller than differences derived from CLEAR data between the Eightmile watershed and most other regional watersheds. This supports using the CLEAR data to compare certain paramenters of the Eightmile watershed to other watersheds.

In Table 8, the Eightmile River watershed is compared to other regional watersheds in Connecticut, with respect to percent of each watershed occupied by developed area and forested area, based on the 2002 CLEAR GIS land cover data. Watersheds highlighted in blue are the other near-coastal watersheds in Connecticut (i.e., those the greater part of which are within the same distance from the coast as the Eightmile watershed). The regional watersheds are listed in order of increasing percentage of developed area. From Table 8, it is evident the Eightmile watershed, with 6.74% developed land, has a lower percentage of developed area than all except four of Connecticut's 44 regional watersheds, and a lower percentage of developed land than all 15 other near-coastal watersheds. For all except one of these other near-coastal watershed, this difference is greater than the above-mentioned difference between the author's habitat-map-derived developed area percentage and the CLEAR data for the Eightmile watershed. In terms of forested area, Table 8 shows that only two of Connecticut's 44 regional watersheds have a greater percentage of forested area than the Eightmile watershed. It exceeds all other near-coastal watersheds in percentage forested area, by 9 to 81 percentage points. In this case, all differences are greater than the disparity between the author's habitat-map-derived forested area percentage and the CLEAR data percentage.

Table 8. Comparison of Eightmile River watershed to other Connecticut regional drainage basins, in terms of percentages of developed land and forested land, using University of Connecticut CLEAR data (other near-coastal watersheds are highlighted in blue).

Regional Drainage Basin/watershed (per CT-DEP hierarchy)	Total area of regional basin (sq mi)	Total sq mi covered by CLEAR	developed % of basin (covered by CLEAR 2002)	forested % of basin (covered by CLEAR 2002)	Total acres covered by CLEAR
Hollenbeck	42.896	42.896	3.54%	84.5%	27453.627
Wood	34.189	11.764	5.17%	81.3%	7528.926
Tenmile	206.506	64.756	5.50%	56.3%	41443.985
Blackberry	46.573	46.515	6.68%	73.8%	29769.284
Eightmile	62.400	62.400	6.74%	80.5%	39935.721
Shepaug	155.438	155.438	7.71%	69.0%	99480.487
Pachaug	63.009	63.007	8.68%	71.6%	40324.610
Natchaug	175.840	175.840	8.91%	76.1%	112537.420
Aspetuck	50.740	50.740	8.93%	69.0%	32473.600
Fivemile	76.386	76.372	9.24%	75.0%	48878.329
Moosup	71.414	58.570	9.63%	73.6%	37484.848
Shetucket	124.957	124.957	10.20%	68.2%	79972.222
Quinebaug	398.538	398.538	10.34%	67.8%	255064.509
Yantic	97.809	97.809	10.84%	62.2%	62597.567
Pomperaug	88.999	88.999	11.37%	62.5%	56959.596
Willimantic	225.494	225.494	11.43%	72.1%	144315.886
Scantic	113.743	113.635	11.91%	52.6%	72726.584
Stony Brook	44.597	44.558	12.49%	42.7%	28516.988
Salmon	148.983	148.983	12.83%	70.6%	95349.174
Croton	95.043	44.923	13.64%	65.7%	28750.459
Farmington	607.173	478.437	13.95%	69.0%	306199.495
Candlewood	40.517	40.486	14.10%	56.0%	25910.927
Pawcatuck Main Stem	81.616	61.038	14.35%	62.8%	39064.279
Housatonic Main Stem	689.167	417.973	14.40%	65.1%	267502.525
Southeast Eastern Complex	62.404	62.404	15.27%	63.4%	39938.705
Southeast Western Complex	58.204	58.204	16.19%	63.2%	37250.459

Table 8. Comparison of Eightmile River watershed to other Connecticut regional drainage basins, in terms of percentages of developed land and forested land, using University of Connecticut CLEAR data (other near-coastal watersheds are highlighted in blue).

Regional Drainage Basin/watershed (per CT-DEP hierarchy)	Total area of regional basin (sq mi)	Total sq mi covered by CLEAR	developed % of basin (covered by CLEAR 2002)	forested % of basin (covered by CLEAR 2002)	Total acres covered by CLEAR
French	112.079	112.076	16.59%	61.0%	71728.880
Saugatuck	89.479	89.479	17.42%	67.7%	57266.299
South Central Eastern Complex	182.742	182.742	17.45%	65.1%	116954.775
Thames Main Stem	107.697	107.697	19.88%	60.4%	68926.309
Naugatuck	311.166	311.166	21.23%	61.1%	199146.006
Connecticut Main Stem	423.747	401.482	22.67%	48.4%	256948.577
Mattabesset	108.920	108.920	25.13%	44.0%	69708.907
Southeast Shoreline	42.788	42.788	28.53%	46.3%	27384.068
Southwest Western Complex	157.467	157.215	30.02%	44.3%	100617.769
Still	71.337	71.313	31.36%	46.9%	45640.496
Norwalk	62.407	62.407	31.62%	51.8%	39940.312
Hockanum	77.131	77.131	32.90%	42.3%	49364.096
South Central Western Complex	105.066	105.066	33.03%	45.5%	67241.965
Quinnipiac	165.548	165.548	34.48%	37.5%	105950.872
Southwest Eastern	98.619	98.619	42.48%	34.7%	63116.391
Park	77.221	77.221	46.38%	27.8%	49421.488
South Central Shoreline	58.978	58.978	48.75%	23.9%	37746.097
Southwest Shoreline	41.412	41.402	63.91%	9.4%	26497.245

Naturally functioning hydrologic system. One over-arching component of a functioning watershed ecosystem is a naturally functioning hydrologic cycle. Un-natural perturbations of a watershed's hydrology include dams, water diversions, stream channel encroachment and channelization, point source and non-point source discharges, and many other human actions. The Eightmile River watershed has determined to have an essentially natural intact flow, few and minor impediments, and a single known consumptive water diversion, the impact of which is considered insignificant (CT DEP diversion permit DIV 97-20). In the Eightmile watershed, there is a low cumulative percentage of impervious surfaces (2.97%), a low percentage of developed area (8.9%), and a high percentage of forested land (75.5%). These values for these

parameters are in the ranges that are correlated empirically with high ground and surface water quality. Available chemical and biotic data indicate that surface water quality is high in streams in the watershed. Biotic data collected by the CT-DEP 1998-1999 indicate "exemplary ecological conditions" for the Eightmile River [mainstem] and very good conditions for the East Branch Eightmile River (Beauchene 2003). In the context of Connecticut, and especially in the context of coastal Connecticut, a high percentage of the watershed, 75.5%, is forested. This is doubtless the primary reason for the high surface water quality and high ecological integrity of these rivers.

Presence of large unfragmented forest blocks. The high percentage of forested habitat in the Eightmile River (75.5%) is comparable in Connecticut only to watersheds in the northwest corner of Connecticut and the southeast border of Connecticut with Rhode Island, both areas that are recognized as having the highest known biodiversity in New England (as indicated by these areas having the highest numbers of extant rare species in New England [NatureServe 2004]). Similarly, in a Connecticut context, a low percentage of Eightmile watershed is developed (8.8%), and it has a low density of roads (2.65 road mi/mi^2), and percentage of watershed occupied by large roadless blocks (72% occupied by roadless blocks greater than 1000 ac). All three parameters are strong indicators of the level of habitat connectivity and intactness, and the Eightmile watersheds values are in Connecticut comparable to, and exceeded only by, watersheds in the two areas of highest biodiversity in New England.

A large portion of the Eightmile watershed's forested portion occurs as large, unfragmented blocks (e.g., 33% in blocks greater than 1000 ac, 17% in blocks greater than 500 ac). The Eightmile watershed also comprises the greatest part of a major New England concentration of the Cerulean Warbler, a forest interior species that is considered to be the most area-sensitive bird in North America, and which is experiencing a rapid rangewide decline. The high densities of the Cerulean Warbler centered in the Eightmile watershed are attributed to the combination of the Eightmile watershed's near-coastal position (and therefore warmer climate), its high proportion of large forest blocks, and the type and maturity of its forests. The Cerulean Warbler, besides being identified by multiple conservation organizations as a continental conservation priority, is both an indicator species and an umbrella species in the Eightmile watershed ecosystem. Its high densities indicate that the system has adequate resources, in this case forest blocks of adequate quantity and quality, to support a species with high sensitivity to both parameters. The Cerulean Warbler is an umbrella species in this system, because if habitat quality is such that there are high densities of Cerulean Warblers, we can expect that a large number of other area-sensitive forest species should thrive as well.

Relatively high proportion of watershed protected as conservation land. As of May 2005, based on research done by The Nature Conservancy, approximately 11,000 acres, or ~28%, of the Eightmile River watershed was protected by conservation ownership or easement (Geisler

and Frohling 2005). The largest portion of this protected portion (nearly ¾) is CT-DEP-owned State Forest, State Park, and other types of conservation land. The remainder (~¼) of protected parcels is owned, or easements held, by such entities as The Nature Conservancy, local land trusts, and towns (Geisler and Frohling 2005). Existing state-wide data does not allow a precise or up-to-date comparison of the Eightmile River watershed to other regional watersheds in the state, but available data suggests that the Eightmile watershed ranks very high. Digital GIS data, available from CT-DEP-EGIC, provides a coverage of parcels classified as "open space", which includes such entities as golf courses, campgrounds, and schools, and is 10 years or more out of date, especially with respect to conservation acquisitions by non-governmental organizations. Based on this coverage, 21% of the Eightmile River watershed is open space, and in this percentage is exceeded by only 4 of the 44 Connecticut regional watersheds (these being the Hollenbeck, Pachaug, Wood, and Natchaug). Another comparison, which may reasonably be said to be in a southern New England regional context, is possible using state-wide Massachusetts GIS data that was last updated in February 2006 (MassGIS 2006), and strictly represents permanently protected open space parcels (i.e., the same kind of entities that comprise the 28% figure for the Eightmile watershed). Using the Massachusetts data, the author calculated percentages for the 27 so-called "major drainage basins" in Massachusetts (MassGIS 2003). Percentages of permanently protected open space in the major Massachusetts drainage basins range from 6.4% to 33.4%, with the median being 18.8%. In this comparison, the Eightmile River watershed's 28% represents a relatively high percentage of protected land, compared with most watersheds.

Permanent protection of a relatively large portion of the Eightmile River watershed secures the sustainability of a significant portion of the existing ecological and biodiversity values that have been identified in the watershed. In addition, there exists a great deal of undeveloped open space with high natural value that may still be protected. For example, protected parcels in the Eightmile watershed have to-date "captured" only about 36% of the total acreage (~17,400 ac) of forest that occurs in large unbroken blocks (i.e., greater than 300 ac).

Nutrient cycling. Excessive leaching of nutrients in terrestrial ecosystems and excessive loading of nutrients in aquatic ecosystems are widely accepted as among the indicators of "ecosystem disease", and intact, well functioning nutrient cycling processes are essential to preventing these types of disfunction and maintaining ecosystem health (Gallicott et al. 1999). The conditions of nutrient cycling processes are difficult to measure directly for an area the size of the Eightmile River watershed, but surface water quality is a strong indicator of well-functioning nutrient cycling processes in an ecosystem. The author has not been able to find stream water chemistry data more recent than several decades old, but recent (1998-2003) bio-assays of water quality, using sampling and analysis of benthic macro-invertebrate communities, have been conducted in the Eightmile River [mainstem], East Branch Eightmile River, their two largest tributaries, Beaver Brook and Harris Brook, and two lesser tributaries, Burnham Brook

and Pleasant Valley Brook. Benthic macro-invertebrate community parameters are widely used as indictors of nutrient enrichment in streams.

Macroinvertebrates in the Eightmile River [mainstem] and East Branch Eightmile River was sampled by professional biologists with the CT-DEP as recently as 1998 and 1999. These data indicated that the Eightmile River [mainstem] was "un-impaired", while the East Branch was "slightly impaired", compared to a nearby "reference" stream (i.e., a site selected because it is believed to represent essentially pristine conditions). The CT-DEP concluded that the Eightmile River [mainstem] could itself be used as a reference stream, while the East Branch Eighmile River ranks in the upper half of sampling sites statewide (Beauchene 2003).

The most recent macro-invertebrate data for the Eightmile River [mainstem] and East Branch Eightmile River was collected in 2001 and 2002 by trained non-professional Connecticut River Watch Program volunteers, and the program volunteers sampled the one major tributary to the East Branch Eightmile River (Harris Brook) and three tributaries (including the largest, Beaver Brook) to the Eightmile River [mainstem]. In these studies, volunteers assessed representation in macro-invertebrate samples of easily recognized invertebrate organisms that are least pollution-tolerant versus organisms that are more pollution-tolerant. The studies found good representation of the least pollution-tolerant organisms and low representation of the most pollution-tolerant organisms in all streams sampled, with the possible exception of Harris Brook. The studies concluded from these data the water quality was very good in all streams sampled, with the possible exception of Harris Brook. According to the study report, it is not clear whether this reflects actual lower water quality in Harris Brook or sampling error (Brawerman 2002; 2003; 2004).

Another important component of surface water quality in the watershed is that of lentic habitats. Water quality data sets exists for the three largest ponds/lakes in the watershed: Lake Hayward, Uncas Pond, and Norwich Pond. Lake Hayward has a highly developed shoreline, and its watershed is 25% developed (nearly all residential) and 56% forested. Uncas Pond and Norwich Pond both have lightly developed shorelines, mostly forested shorelines, and very lightly developed (3% and 2%, respectively) and highly forested (91% and 82%, respectively) watersheds (Moorhead vegetation/habitat map 2006). The most comprehensive water quality data on these lakes was collected in 1979-1980, and this study classified Lake Hayward and Norwich Pond as mesotrophic, and Uncas Pond as oligotrophic (Frink and Norvell 1984). Less comprehensive water quality surveys of all three waterbodies were conducted in the early 1990s, and based on these data all three waterbodies were classified as mesotrophic (Canavan and Siver 1995). There are unpublished water quality survey data sets for Lake Hayward in 2003 and 2005, and for Uncus Pond in 2006 (CT-DEP 2006). Though there are some problems in comparing the 1979-1980 data sets with the more recent data sets (not all parameters were measured in the same way in each survey), it may reasonably be concluded that water quality in

the three lakes has remained stable between 1979-1980 and the present (Lee, pers. comm.; Wahle, pers. comm.). The apparent change of Uncas Pond from oligo- to mesotrophic is not real, because the pond would have been classified as mesotrophic, by modern standards, based on Frink and Norvell's actual data (Frink and Norvell 1984; Lee pers. comm., Wahle pers. comm.). Based on existing direct measurement data sets, there is no evidence of significant nutrient level increases in the three largest waterbodies in the watershed over the last 26 years. Consistent with this, there are associated with all three waterbodies robust occurrences of rare plant species and/or plant communities that occur only in low nutrient environments (Moorhead 2003).

These studies and observations demonstrate very good to excellent surface water quality throughout all, or at least most, of the watershed (see above discussions of Harris Brook and East Branch Eightmile River), and this is a strong indication of intact, well functioning nutrient cycling processes throughout all or most of the Eightmile watershed.

Level of impairment due to invasives species. One parameter often used to assess ecosystem integrity, function, and stress is the relative abundance of non-native and/or invasive species. Extensive displacement of native species by invasive species, and loss especially of the rarer, more sensitive native species are considered indicators of an impaired, stressed ecosystem. Regarding the relative importance of invasive species in the Eightmile watershed, inadequate scientific data precludes a rigorous comparison of this watershed to others, but in the opinion of many naturalists and scientists familiar with this region, the Eightmile watershed has relatively low levels of invasive species. This author's field observations (2003-2005) support this view, especially considering the vast acreage of dry to mesic, relatively acidic forest in the watershed, which is invasive-free or nearly so, and naturally inhospitable to all or most invasive plants. If one uses the presence/abundance of extant rare species as an indicator of ecosystem impairment due to invasives, the Eightmile watershed ecosystem's integrity appears rather high. The density of extant rare species in the Eightmile watershed (.08 spp./mi^2) is substantially higher than all other regional watersheds in Connecticut except for those in the northwest corner and along the Rhode Island border that have the highest numbers of extant rare species in New England. Thus, both subjective professional impressions and data on extant rare species indicate that the Eightmile watershed ecosystem is currently relatively unimpaired by invasives. However, a number of invasive plant species are established in the watershed, and a number of these are perceptibly increasing (See Table 9). They may be expected to increasing stress on at least certain elements of the Eightmile ecosystem. Among these in particular are the less common and rare habitats and species that occupy a relatively small portion of the watershed, but represent a large portion of the biodiversity.

Disturbance regimes. Among the many important intact natural disturbance regimes in the Eightmile watershed is the seasonal high flow-low flow cycle, overlaid by the lower frequency

very high flows associated with catastrophic storms, of the larger streams in the system. In the opinion of CT-DEP Inland Fisheries biologist Peter Aarrestad, the Eightmile streams are relatively free of flood control structures, and the larger streams, especially, have relatively little bank stabilization. Thus, there exist in abundance along the streams various riparian communities that are maintained by and dependent upon periodic flooding and mechanical scouring, and natural changes in channel configuration. In Aarrestad's opinion, the Eightmile River system is exceptional in the extent to which riparian landowners have generally "allowed the river to misbehave", and this has led to an exceptionally natural system in which natural disturbance regimes are prevalent at a watershed scale (Aarrestad pers. comm.)

VIII. MANAGEMENT ISSUES

Large unfragmented Forest blocks and the Cerulean Warbler

Though it is not the rarest species known to occur in the Eightmile watershed, the Cerulean Warbler is the arguably the highest-profile management issue for the Eightmile watershed. The Eightmile watershed appears to have among the highest breeding-seeding densities of this bird in New England. It is perhaps the most area-sensitive of all North American birds, and is experiencing rapid range-wide decline. It has been listed as a species of high global conservation concern by several international bird conservation organizations. Research on Cerulean Warblers suggests that they require continuous forest blocks of at least 1000 ac if they are to maintain stable populations (Askins pers. comm.). As shown in Figure 8, the Eightmile River watershed has a number of unbroken forest blocks that exceed that size, but not by much. Maintenance of the watersheds robust Cerulean Warbler population likely depends on the successful preservation of these large forest blocks as intact.

Deer management

High densities of deer and consequent impacts on biodiversity have been well documented in at least one part of the Eightmile watershed (Goodwin 1991b; Kilpatrick pers. comm.), though the author is not aware of any systematic evaluation of the entire watershed. During the author's 2003-2005 rare plant and natural community survey work, he developed a subjective impression that levels of deer herbivory impacts vary widely throughout the watershed. In the Burnham Brook area, in particular, long term monitoring has documented the link between loss of plant species and high deer densities (Goodwin 1991b). Monitoring and control of deer densities in the watershed is essential to maintenance and enhancement of the watershed's biodiversity.

Biological and ecological inventory

This study has for the most part drawn on existing information on the occurrence and distribution of animal and plant species (including rare species) and natural communities in the Eightmile watershed. None of the studies that generated these data can be said to be

comprehensive for the Eightmile watershed. The author's limited-scope 2003 survey for rare plants and natural communities resulted in the discoveries of a rather high number of previously unknown rare plant and natural community occurrences, and he continued to stumble upon new rare plant occurrences during 2004 and 2005 field work whose focus was not rare plant and natural community inventory. During the same period, a number of previously unknown occurrences of rare animals have been discovered by both professional and amateur scientists during various limited scope surveys and recreational activities. Such a high rate of discovery of new rare species populations strongly suggests that we are not yet approaching comprehensive knowledge of the Eightmile watershed's complement of rare species.

It is also true that relatively few of the known rare species and natural community occurrences in the Eightmile watershed have been judged to be secure and unthreatened, without some form of active protection and/or focused management. It is reasonable to expect that what is true for most of the known occurrences is also like true for the undiscovered occurrences. Continuing inventory is required if we are to approach comprehensive knowledge of Eightmile watershed's rarest and most vulnerable species, and thus be able to wisely allocate resources to manage them.

Minimally managed open and semi-open habitats

The majority of extant State-listed Endangered, Threatened, and Special Concern species of plants and animals known in the Eightmile watershed occur in, or are in some measure dependent on, non-forested open and semi-open habitats that with few exceptions cannot exist without certain some form of periodic disturbance by man that prevents development of closed-canopy forest and/or shrub thicket. Such habitats include former agricultural row-crop fields, hayfields, and pastures on various soil types, power line and highway rights-of-way, roadsides, old sand and gravel pits, forest clearings, and cemeteries, potentially (the author is unaware of rare species having yet been found in any cemeteries in the Eightmile watershed, but a number of other cemeteries in southeastern New England support State-, regionally, and globally rare plant species, and several of the Eightmile watershed's cemeteries support native-species-dominated grassland communities of high integrity). Rare species and natural community occurrences in these habitats are among the most imminently threatened elements of biodiversity in the Eightmile watershed. They are threatened both by a lack of protection and by a lack of management, or the wrong kind of management. The greatest number of these threatened elements are associated with glaciofluvial sand and gravel deposits that are either xeric or have a seasonally fluctuating water table. A lesser but significant number occur on so-called Thick Till (i.e., basal till) deposits.

There are a very large number of these minimally managed open and semi-open habitats in the Eightmile watershed, and only a small fraction were field- surveyed by the author during his 2003 rare plant and natural community survey. Additional survey is needed to identify those with the highest biodiversity values. For those that are already known to be of higher

biodiversity significance, management needs and threats should be assessed within the next 5 years (in some cases, more urgency is required), resources allocated, and management actions begun.

A special and very significant case is the Northeast Utilities (NU) transmission right-of-way that transects the Eightmile watershed at about its "waist". This right-of-way is both habitat for some of the rarest and significant species in the watershed, due to past ROW management practices that have maintained open-canopy conditions juxtaposed with certain bedrock formations and surficial deposit types. The ROW is also an area with some of the largest infestations of invasive species such as *Phragmites australis* subsp. *australis* and *Elaeagnus umbellata*. The ROW is subject to periodic ROW management practices, which include the use of herbicides and heavy equipment, whose purpose is to maintain electric power delivery infrastructure, rather than biodiversity values. These management actions in certain instances can be inferred to have clearly been beneficial to rare plant populations and habitats in ROWs, but in other instances have just as clearly been harmful. One of the latter instances occurred recently at one site in the Eightmile watershed, where in 2004 and 2005 a regional stronghold population of a regionally rare plant was impacted and may have been in largest part destroyed by a combination of management actions, involving both herbicide applications and earth-moving. This incident occurred in spite of an existing review process in which NU's planned ROW maintenance actions state-wide are reviewed by CT-DEP and potential impacts to rare species populations already in the CT-DEP-NDDB's database are identified and resolved. The obvious weakness in this system are that it involves no active *de novo* rare species survey by either NU or the CT-DEP-NDDB, and it thus affords no protection to rare species populations not yet databased by the CT-DEP-NDDB (both because the populations have not been found and reported to the state, and because recently found and reported populations require processing time).

Little scientific data is available from which to judge what proportion of NU's ROW management actions have harmed versus benefited rare species populations. The author and other naturalists have in recent years observed numerous instances of at least short term impacts to known rare species populations and natural communities, throughout Connecticut. However, there is little if any adequate long-term monitoring data by which to judge long-term impacts, and especially whether short term impacts to populations are followed by recovery and perhaps expansion because of habitat enhancement caused by the management actions. In the absence of strong evidence to the contrary, however, it is at least a reasonable conclusion that the higher intensity and frequency of ROW management actions in recent years may result in more destruction of rare species populations than did the lower intensity maintenance practices of the 1970s and 1980s (Johnson pers. comm.).

In light of this, it is clear that the NU transmission ROW in the Eightmile watershed hosts multiple recently discovered populations of important rare species, and there has been at least

one significant failure in the existing system by which the CT-DEP and NU resolved conflicts between ROW maintenance needs and protection of the rare species. Several reasons for this failing have been cited. According to NU, a heavy herbicide application by a vegetation management subcontractor that heavily impacted the herbaceous vegetation, including the rare plant, was not within NU's performance specifications for the work, and was the fault of subcontractor. In addition, NU was not informed of the existence of any rare species in the area (4 rare species occur in the area) during the review which occurred in advance of the herbicide treatment (this was likely due to the timing of the review in relation to the first reports CT-DEP-NDDB received on the 4 rare species populations – all were reported in early 2004, and the herbicide work was likely reviewed before they were reported or databased). After the herbiciding in 2004, a local naturalist contacted NU's vegetation management section and CT-DEP to alert them both to the impacts to the rare species. And finally, while coordination of the NU ROW vegetation management division with CT-DEP-NDDB was being practiced, the NU ROW *infrastructure* maintenance division was not, as of summer 2005, coordinating with CT-DEP-NDDB (Johnson pers. comm.). Significant avoidable impacts to rare plants and rare plant habitat occurred as a result of ROW infrastructure maintenance actions, such as service road widening and cut-and-fill.

Given the recently demonstrated biodiversity significance of the NU transmission ROW and the evident potential and actual impacts of ROW maintenance that may occur/have occurred in the absence of adequate coordination between NU, CT-DEP, and other stake-holders, one or more of the following actions are recommended. Existing information on known occurrences of rare species and natural communities in the ROW should be conveyed as soon as possible to NU and the CT-DEP-NDDB. The two most important reasons for the recent impacts to known rare species populations in the NU ROW are 1) the lag time between discovery of new populations and their being revealed to NU during their annual review process with CT-DEP-NDDB, and 2) absence of a system of review of proposed ROW infrastructure maintenance actions by the CT-DEP-NDDB. Obviously, this underscores the importance of reporting of rare species discoveries to the CT-DEP-NDDB as soon as possible, but given limitations of state government staff and time, the author suggests that there should also be a frequent direct dialogue between NU and local knowledgeable naturalists, consulting scientists, and others developing new information on rare species in the Eightmile watershed. Most importantly, however, NU should also recognize the necessity for, and take on the responsibility for, systematic rare species inventories in sections of ROW in which vegetation and infrastructure maintenance actions are planned, given the abundant evidence that there rare species occurrences in powerline ROWs not yet known to the CT-DEP-NDDB.

Obviously, the above measure would provide protection only to known populations of rare species, and to the author's knowledge only a relatively small proportion of the NU transmission ROW in the Eightmile watershed has been comprehensively surveyed for rare species. Given

the need for on-going maintenance activities, the need for *de novo* inventory of the entire ROW within the Eightmile watershed as soon as possible is a critical first step to providing a reasonable high level of protection to the many of the most vulnerable elements of biodiversity on the watershed.

A review and assessment of current NU ROW maintenance practices, and maintenance contracting practices, should be initiated by a multidisciplinary panel of experts on rare species plant and animal groups. The committees charge should be determine if there are ways in which overall risk to rare species could be reduced by standard procedure (i.e., ways in which risks might be reduced by NU standard protocol, regardless of whether the rare species population is known). This process would culminate with a presentation of recommendations to NU, and NU should be invited to participate from the outset.

It has been recognized for some time that both purposes may be achieved, with certain modifications of practices (William Niering of nearby Connecticut College was among the first to effectively campaign for this, in the late 1950s and 1960s).

Inventory, Monitoring, and Control of Invasive Species.

A comprehensive inventory of invasive species in the Eightmile watershed has not yet been performed, to the author's knowledge. The following comments on invasive plants in the Eightmile watershed draw in largest part upon author's incidental observations collected during 2003-2005 field work during the rare plant/ natural community survey, and field verification during the development of the habitat map of the watershed. Also, The Nature Conservancy commissioned a 2002 survey of invasive plants in the watershed, which involed the collection of plot data from ca. 200 sites in the watershed, using IPANE sampling methodology in 2002 (Horning & Pfeiffer 2002) (. Invasive plants documented in the watershed to-date by the author and/or Horning and Pfeiffer are presented in Table 9. Also presented in the table are non-native species whose status as invasives is, or has been, under consideration.

Though at least 23 invasive plant species are have been documented by the author's field work and others in the Eightmile watershed, invasives are probably either absent or occur in very low abundance throughout the greater part of the forested portion of the watershed (~75.5%). This is because the greater part of the existing forest are oak-dominated types occupying acidic, lower-fertility sites, and these communities are evidently naturally inhospitable to the majority of invasive species.

However, many natural communities and habitats in the Eightmile watershed are threatened, sooner or later, by invasive plants species (See Table 9). Some of these, like *Froelichia gracilis* (Slender Snake Cotton), *Cynanchum rossicum* (Pale Swallow-wort), and *Euphorbea esula* (Leafy Spurge), appear to be barely established and occasional on roadsides. Others, such as

Phragmites australis subsp. *australis* (introduced Common Reed), *Berberis thunbergii* (Japanese Barberry), *Elaeagnus umbellata* (Autumn Olive), *Celastrus orbiculatus* (Oriental Bittersweet), *Rosa multiflora* (Multiflora Rose), *Microstegium vimineum* (Japanese Stilt Grass), and *Robinia pseudo-acacia* (Black Locust), are well-established and locally abundant in certain habitats.

It is the author's subjective impression, based on his 2003-2005 field work in the Eightmile watershed, that the invasive species experiencing the most rapid increase in the Eightmile watershed are *Microstegium vimineum* (Japanese Stiltgrass) and *Elaeagnus umbellatus* (Autumn Olive). Both species are threatening existing rare species and their associated special natural communities.

Effective, on-going control of invasive species in the Eightmile watershed is essential to the preservation and enhancement of the Eightmile watershed's existing biodiversity. The most evident and immediate threat is to open-canopy and semi-open-canopy habitats and their associated rare and uncommon species. In most cases, these communities and species are also threatened by succession to forest or scrub, and a similar approach will control both threats.

Table 9. Invasive plant species (including both those species already accepted as invasives and non-natives that may be suspected of being invasive, at least in this system) documented in the Eightmile River watershed, with comments on status.

Taxon	Common name	CT status, acc. to Mehrhoff et al. 2003	CT legal status (Public Acts 03-136 and 04-203)	Comments
Acorus calamus	Sweetflag	not listed	none	This non-native species has not been identified as an invasive species in Connecticut, in part because only recently has it been recognized that we have two similar species of *Acorus*, the native *A. americanus* and the non-native *A. calamus*. The author's survey work in the Eightmile watershed has documented freshwater intertidal marshes in Hamburg Cove dominated by *A. calamus*. The ecological and management implications of these stands require study.
Ailanthus altissima	Tree-of-heaven	Widespread and invasive	Banned	
Alliaria petiolata	Garlic Mustard	Widespread and invasive	Banned	Observed primarily along roadsides
Amorpha fruticosa	False Indigo	Potentially invasive	Banned	Restricted to intertidal wetlands and intertidal shores
Berberis thunbergii	Japanese Barberry	Widespread and invasive	none	Serious and occasionally large-scale infestations occur locally in the Eightmile watershed, most often associated with mesic to seasonally wet soils and land relatively recently in agricultural use. Most widespread invasive species in watershed, according to Horning & Pfeiffer (2002)
Celastrus orbiculatus	Oriental Bittersweet	Widespread and	Banned	Among the three most widely distributed invasive

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Taxon	Common name	CT status, acc. to Mehrhoff et al. 2003	CT legal status (Public Acts 03-136 and 04-203)	Comments
		invasive		species in the watershed (Horning & Pfeiffer 2002)
Centaurea bierbersteinii	Spotted Knapweed	Widespread and invasive	Banned	Noted by the author in several sandy open habitats in the Salem area
Clematis terniflora	Yam-leaved Clematis	not listed		Frequent as showing low-climbing vine at forest and shrubland edge along north shore of Hamburg Cove
Cynanchum rossicum	Pale Swallow-wort	Widespread and invasive	Banned	At least one small population along Rte. 82 in Salem
Elaeagnus umbellata	Autumn Olive	Widespread and invasive	Banned	Locally abundant, and fifth most widespread invasive species in the watershed, according to Horning & Pfeiffer (2002). Vigorous invader of old fields, sand barrens, highway and transmission ROW habitat. Several extensive infestations in the watershed. Probably most serious of invasive threats to dry grasslands and barrens.
Euonymus alatus	Winged Euonymus	Widespread and invasive	none	Author has noted several moderate established infestations in mesic, higher-fertility forests, near roads and development. Fourth most widespread invasive species in the watershed, according to Horning & Pfeiffer (2002).
Euphorbia esula	Leafy Spurge		Banned	Author has observed the occasional roadside colony

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Taxon	Common name	CT status, acc. to Mehrhoff et al. 2003	CT legal status (Public Acts 03-136 and 04-203)	Comments
Fallopia japonica	Japanese Knotweed	Widespread and invasive	Banned	
Froelichia gracilis	Slender Snake Cotton	Widespread and invasive	Banned	Author has observed a single colony along Route 11. This route appears to be a corridor of southward dispersal into the watershed. This species is a potential threat especially to sand barren communities.
Glossostigma cleistanthum	Mud Mat	not listed	none	Vast numbers of this tiny plant occupying fresh [and perhaps oligohaline] intertidal flat habitat. It is not clear whether it is impacting the co-occurring native species, which include globally rare species.
Iris pseudacorus	Yellow Iris	Widespread and invasive	Banned	
Lonicera japonica	Japanese Honeysuckle	Widespread and invasive	Banned	
Lonicera morrowii	Morrow Honeysuckle	Widespread and invasive	Banned	
Lythrum salicaria	Purple Loosestrife	Widespread and invasive	Banned	
Microstegium vimineum	Japanese Stilt-grass	Widespread and invasive	Banned	Particularly abundant in the Hamburg Cove area, where it occurs immediately adjacent to, and just

Table 9. Invasive plant species (including both those species already accepted as invasives and non-natives that may be suspected of being invasive, at least in this system) documented in the Eightmile River watershed, with comments on status.

Taxon	Common name	CT status, acc. to Mehrhoff et al. 2003	CT legal status (Public Acts 03-136 and 04-203)	Comments
				above, the intertidal zone. Common along roadsides in the same vicinity, and by all appearances rapidly increasing.
Myriophyllum spicatum	European Water-milfoil	Restricted and invasive	Banned	Abundant in parts of Hamburg Cove
Phalaris arundinacea	Reed Canary-grass	Potentially invasive	none	Extensive in stands in open-canopy wetlands along East Branch in Salem, and Eightmile [main stem] at Pleasant Valley, and in some hay fields. Doubtless originally planted for hay in some, perhaps all, locations.
Phragmites australis var. *australis*	Common Reed (non-native var.)	Widespread and invasive	Banned	Occurring in wetlands at scattered locations in the watershed. Most patches are of modest size, but a few large/multi-acre stands are known. Perhaps most frequent in the electrical transmission ROW.
Poa compressa	Canada Blue-grass	Potentially invasive	Banned	Occurring especially in dry grasslands, sand barrens, and rocky outcrops
Robinia pseudoacacia	Black Locust	Widespread and invasive	none	Frequent along the shores of Hamburg Cove. Encountered at relatively few sites by Horning & Pfeiffer (2002).
Rosa multiflora	Multiflora Rose	Widespread and invasive	Banned	Second most widespread and abundant invasive species in watershed, according to Horning & Pfeiffer (2002)

Table 9. Invasive plant species (including both those species already accepted as invasives and non-natives that may be suspected of being invasive, at least in this system) documented in the Eightmile River watershed, with comments on status.				
Taxon	Common name	CT status, acc. to Mehrhoff et al. 2003	CT legal status (Public Acts 03-136 and 04-203)	Comments
Rumex acetosella	Sheep Sorrel	Potentially invasive	Banned	
Solanum dulcamara	Climbing Nightshade	Potentially invasive	Banned	
Trapa natans	Water chestnut	Restricted and invasive	Banned	Discovered in Hamburg Covein 2004, by the author. Population evidently consisting of a single individual (which was removed).

Beaver management.

Beaver, whose activities determine the hydrology, structure, and plant composition of at least several hundred acres of the Eightmile watershed's wetlands and watercourses, are one of the three "keystone species" of the watershed (the other two being deer and humans). The cyclic disturbances of wetlands, watercourses, and surrounding habitat is a natural ecological process in North America, and such disturbances create much diversity of habitat upon which many other species depend. Thus, widespread beaver activity in the watershed is an intact native ecological process.

In certain habitats, however, the activity of beaver may threaten the existence of certain of the rare plants and associated communities on which they depend. One such instance is an occurrence of a floating lake-shore peat flat community which supports a major concentration of rare plants. Beaver in this case may be destroying the peat flat habitat by burrowing in the peat, perhaps for food. At the same lake, recent raising of water levels by the beaver have caused high mortality of trees in an adjacent *Chamaecyparis thyoides* Atlantic White Cedar swamp. Other significant communities that exist in the Eightmile watershed that could be threatened by beaver include freshwater intertidal communities and medium fens (these communities have been degraded by beaver activity elsewhere in Connecticut, but not yet in the Eightmile watershed, to the author's knowledge).

Beaver control is often controversial, because they are charismatic and their activities are considered "natural". However, in the rare cases when populations of rare species and natural communities are evidently threatened by beaver activities, and that threat can be removed with no significant impact to the greater beaver population, the cause of biodiversity conservation should take precedence. To this end, those habitats and rare species occurrences that are vulnerable to beaver impacts should be identified and monitored, and the appropriate measures taken when beaver activity is reasonably concluded to be a threat.

IX. REFERENCES

1. Personal communication references

Aarrestad, Peter
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2. Literature references

Askins, R. A. 2000. Restoring North America's birds: lessons from landscape ecology. Yale University Press, New Haven, CT, USA. 320 p.

Barrett, N. E. 1994. Vegetation patch dynamics in freshwater tidal wetlands. Ph. D. dissertation. 278 pp.

Beauchene, M. 2003. Letter dated 11/13/03 from CT-DEP Bureau of Water Management, Planning and Standards Division, to Kevin Case.

Bell, M. 1985. The face of Connecticut: people, geology, and the land. Connecticut Dept. of Environmental Protection. State Geological and Natural History Survey Bull. 110. Hartford, CT, USA. 196 pp.

Bell, M. M. 1989. Did New England go downhill? Geographical Review 79(4): 450-466.

Bevier, L. R., ed. 1994. The atlas of breeding birds of Connecticut. State Geological and Natural History Survey of Connecticut Bull. 113. Hartford, CT, USA. 459 p.

Bonneau, L. 1997(?). Forestry landcover classification report. Unpublished technical report, available from the author. 3 pp.

Brawerman, J. 2002. Eightmile River rapid bioassessment summary report. Connecticut River Watch Program, Middlesex County Soil and Water Conservation District, deKoven House – 27 Washington Street, Middletown, Connecticut 06457. Technical report (digital ADOBE Acrobat

7.0 document). 15 pp.

Brawerman, J. 2003. Eightmile River rapid bioassessment summary report. Connecticut River Watch Program, Middlesex County Soil and Water Conservation District, deKoven House – 27 Washington Street, Middletown, Connecticut 06457. Technical report. 18 pp.

Brawerman, J. 2004. Eightmile River rapid bioassessment summary report. Connecticut River Watch Program, Middlesex County Soil and Water Conservation District, deKoven House – 27 Washington Street, Middletown, Connecticut 06457. Technical report. 17 pp.

Brumback W. E., L. J. Mehrhoff, R. W. Enser, S. C. Gawler, R. G. Popp, P. Somers, D. D. Sperduto, W. D. Countryman, and C. B. Hellquist. 1996. *Flora Conservanda*: New England. The New England Plant Conservation Program (NEPCoP) list of plants in need of conservation. *Rhodora* 98: 233-361.

Canavan, R. W. IV, and P A. Siver. 1995. Connecticut lakes: a study of the chemical and physical properties of fifty-six Connecticut lakes. Connecticut College Arboretum, New London, CT. 299 pp.

Carey, G. C., A. B. Carey, A. J. Main, W. L. Krinsky, and H. E. Sprance. 1981. *Ixodes dammini* (Acari: Ixodidae) in forests in Connecticut. J. Med. Entomology 18(2): 175-176.

Chyinski, R., and D. Bingham. 2004. Eightmile River watershed: an oasis for butterflies. Connecticut Butterfly Association Newsletter 5-6.

Collins, Joseph T. & Travis W. Taggart. 2002. Standard Common and Current Scientific Names for North American Amphibians, Turtles, Reptiles, and Crocodilians. Fifth Edition. The Center for North American Herpetology, Lawrence, Kansas. Pp. iv + 44 pp. (PDF web publication)

Connecticut Dept. of Environmental Protection. 2003. Wildlife restoration: performance reports, October 1, 2002 – September 30, 2003. Wildlife Division. Technical report.

Connecticut Dept. of Environmental Protection. 2005. Connecticut's comprehensive wildlife conservation strategy. Current status. http://dep.state.ct.us/burnatr/wildlife/geninfo/fedaid/cwcs/status.asp Accessed 6/4/2006.

Connecticut Dept. of Environmental Protection. 1998. Soil catenas of Connecticut, the relationships between soils, landscapes, geology, and parent material. Connecticut Dept. of Environmental Protection and U.S. Dept. of Agriculture Natural Resources Conservation Service. Connecticut Dept. of Environmental Protection, Hartford, CT. 1 p. pamphlet.

Connecticut, State of. 1992, amended 2004. Regulations of Connecticut State Agencies. Sec. 26-306-1 through 6.

Connecticut, State of. 1997. General Statutes of Connecticut. Chapter 495. Sec. 26 - Endangered species. 1126-1132.

Connecticut Dept. of Environmental Protection. 2006. Unpublished water quality survey data for Lake Hayward and Uncas Pond. Digital Microsoft EXCEL files transmitted by Lisa Wahle. Bureau of Water Management and Land Re-use, Planning and Standards Division, Monitoring and Assessment Program. Two digital EXCEL files.

Craig, R. J., M. Atshul, and K. G. Beal. 2003. Forest birds of the last green valley: the density, distribution, habitat ecology, and conservation of the forest birds of eastern Connecticut. Bird Conservation Research, Inc. Putnam, CT, USA. iv + 196 p.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U. S. Dept. of the Interior, Fish and Wildlife Service, Office of Biological Services. Washington, D.C. 131 pp.

Diedrich, J., and C. Thomas. 1999. The Wild & Scenic River study process. U. S. Forest Service and the National Park Service. Microsoft WORD document entitled "Eligibility Brief.doc". 5 pp.

Dowhan, J. J., and R. J. Craig. 1976. Rare and endangered species of Connecticut and their habitats. Connecticut Dept. of Environmental Protection. State Geological and Natural History. Report of Investigations No. 6. 137 pp.

Frink, C. R., and Norvell, W. A. 1984. Chemical and physical properties of Connecticut lakes. Bulletin 817. The Connecticut Agricultural Experiment Station, New Haven, CT. 10 pp. + 5 appendices.

Gallicott, J. B., L. B. Crowder, and K. Mumford. Current normative concepts in conservation. Conservation Biology 13(1): 22-35.

Geisler, K., and N. Frohling. 2005. Unpublished GIS data. ESRI ARCVIEW 3.2a shape file entitled "protected 8mileparcels.shp" and associated .dbf, .shp, .sbn, .sbx, and .shx files, last modified 5/3/2005.

Goodwin, R. H. 1991a. Vertebrates of the Burnham Brook Preserve of The Nature Conservancy. Studies in Human Ecology No. 14a, 2nd ed. Connecticut College, New London, CT. 21 pp.

Goodwin, R. H. 1991b. The flora of the Burnham Brook Preserve of The Nature Conservancy. Studies in Human Ecology No. 13b, 3rd Ed. Connecticut College, New London, CT.

Grossman, D.H., D. Faber-Langendoen, A.S. Weakley, M. Anderson, P.Bourgeron, R. Crawford,

K. Gooden, S. Landaal, K. Metzler, K. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. *International Classification of Ecological Communities: Terrestrial Vegetation of the United States.* Vol. I. *The National Vegetation Classification System: Development, Status, and Applications.* The Nature Conservancy, Arlington, Virginia.

Gruner, H., and M. W. Klemens. 2004. GIS database of records of reptile and amphibian collections, photographs, and reliable observations in and near Eightmile river watershed. Unpublished digital ESRI ARCVIEW files.

Harvey, R., ed. 2006. CT Bird reports for May and June 2006. http://www.virtualbirder.com/bmail/ctbird [accessed 6/26/2006].

Horning, O. 2002. A study of the distribution and ecology of non-native invasive species in the Eightmile River watershed in southeastern CT. Unpublished technical report commissioned by and submiited to The Nature Conservancy, Middletown, CT. 18 pp.

IUCN 2004. *2004 IUCN Red List of Threatened Species.* <www.redlist.org>. Downloaded on 14 March 2005.

Jacobs, R. P., and E. B. O'Donnell. 2002. A fisheries guide to lakes and ponds of Connecticut, including the Connecticut River and its coves. Connecticut Dept. of Environmental Protection Bulletin 35. Connecticut Dept. of Environmental Protection, Hartford, CT. 354 pp.

Main, A. J., Carey, G. C., A. B. Carey, W. L. Krinsky, and R. H. Goodwin. 1982. Immature *Ixodes dammini* (Acari: Ixodidae) on small animals in Connecticut, USA. J. Med. Entomology 19(6): 655-664.

Klemens, M. W. 1993. Amphibians and reptiles in Connecticut and adjacent regions. State Geological and Natural History Survey. Bulletin No. 112. Connecticut Dept. of Environmental Protection, Hartford, CT. 318 pp.

Klemens, M. W. 2000. Amphibians and reptiles in Connecticut: a checklist with notes on conservation status, identification, and distribution. Connecticut Dept. of Environmental Protection Bulletin 32. Hartford, CT. 96 pp.

MassGIS. 2003. Major drainage basins – March 2003. Digital ESRI shapefiles and associated files, downloaded from Massachusetts Office of Geographic and Environmental Information "MassGIS" website. URL: http://www.mass.gov/mgis/osp.htm. Accessed 11/6/2006.

MassGIS. 2006. Protected and recreational open space - February 2006. Digital ESRI shapefiles and associated files, downloaded from Massachusetts Office of Geographic and Environmental Information "MassGIS" website. URL: http://www.mass.gov/mgis/osp.htm. Accessed 11/6/2006.

Mehrhoff, L. J. 1997. Non-native invasive plant species occurring in Connecticut. Revised edition.

http://www.eeb.uconn.edu/bioconctr/publications/publication-1.html

Mehrhoff, L. J. 2000. "No new invasions". A provisional list of non-native and potentially invasive plants in New England. Draft 18 Oct 2000. http://www.eeb.uconn.edu/invasives/web_archive/NE_invasives.htm [accessed 14 Mar 2005]

Mehrhoff, L.J., K.J. Metzler, and E.E. Corrigan. 2003. Non-native and potentially invasive plants in Connecticut. Center for Conservation and Biodiversity, Univ. of Conn., Storrs. 4-p. pamphlet.

Metzler, K.J. 1990. Connecticut natural community classification. Working draft, revised to 2001. Connecticut Dept. of Environmental Protection. Environmental and Geographic Information Center. Connecticut Geological and Natural History Survey. Connecticut Natural Diversity Data Base. 8 pp.

Metzler, K.J. and J.P. Barrett. 2006. Vegetation classification for Connecticut. Connecticut Dept. of Environmental Protection. Environmental and Geographic Information Center. Connecticut Geological and Natural History Survey. Connecticut Natural Diversity Data Base. 150 pp. In press.

Metzler, K.J. and N.E. Barrett. 1982. Connecticut final report, National Wetlands Inventory, U. S. Fish and Wildlife Service. Technical report. 33 pp.

The Nature Conservancy. 2001. Ecoregions of the United States of America. Based on Bailey, 1994. Western Conservation Science Center. Jpeg image of single sheet map. URL: http//gis.tnc.org.

NatureServe. 2006. NatureServe conservation status. NatureServe Version 5.0. URL: http://www.natureserve.org/explorer/ranking.htm. Accessed 20 Aug 2006.

USDA, Natural Resources Conservation Service, 1995, and Connecticut Dept. of Environmental Protection, Environmental and Geographic Information Center, 2001. Digitized soils mapping on CD-ROM.

USDA, Natural Resources Conservation Service, National Soil Information System, 2003. State of Connecticut: detailed soil map legend. Non-MLRA soil survey area. Download of NASIS data communicated to author by Donald Parizek, USDA-NRCS soil scientist with Windsor, CT, USDA-NRCS Service Center. 56 pp.

Stone, J.R., Schafer, J.P., London, E.H. and Thompson, W.B., 1992. U.S. Geological Survey

special map, 2 sheets, scale 1:125,000. U.S. Geological Survey and Connecticut Geological and Natural History Survey, 1995. Connecticut Dept. of Environmental Protection, Environmental and Geographic Information Center, 2001. Digitized version of map on CD-ROM.

Walden, D. L., and Parasiewicz, P. 2005. Integrative assessment of biological and physical attributes of the Eightmile River – a component of the Wild and Scenic River Study – Phase 1 final report. Northeast Instream Habitat Program, Dept. of Natural Resources Conservation, University of Massachusetts, Amherst, MA. 65 pp. + appendices.

Westveld, M., *et al*. 1956. Natural forest vegetation zones of New England. Journal of Forestry 54: 332-338.

APPENDIX A

Explanation of global and state conservation ranks (NatureServe 2006)

NatureServe Global Conservation Status Ranks	
GX	Presumed Extinct (species)— Not located despite intensive searches and virtually no likelihood of rediscovery. Eliminated (ecological communities)—Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species.
GH	Possibly Extinct (species)— Missing; known from only historical occurrences but still some hope of rediscovery. Presumed Eliminated— (Historic, ecological communities)-Presumed eliminated throughout its range, with no or virtually no likelihood that it will be rediscovered, but with the potential for restoration, for example, American Chestnut Forest.
G1	Critically Imperiled—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
G2	Imperiled—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
G3	Vulnerable—At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
G4	Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
G5	Secure—Common; widespread and abundant.
G#G#	Range Rank—A numeric range rank (e.g., G2G3) is used to indicate the range of uncertainty in the status of a species or community. A G2G3 rank would indicate that there is a roughly equal chance of G2 or G3 and other ranks are much less likely. Ranges cannot skip more than one rank (e.g., GU should be used rather than G1G4).
GU	Unrankable—-Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. Whenever possible, the most likely rank is assigned and a question mark qualifier may be added (e.g., G2?) to express minor uncertainty, or a range rank (e.g., G2G3) may be used to delineate the limits (range) of uncertainty.
GNR	Unranked—Global rank not yet assessed.
GNA	Not Applicable—A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

NatureServe State Conservation Status Ranks	
SX	Presumed Extirpated—Species or community is believed to be extirpated from the nation or state/province. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
SH	Possibly Extirpated (Historical)—Species or community occurred historically in the nation or state/province, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or community could become NH or SH without such a 20-40 year delay if the only known occurrences in a nation or state/province were destroyed or if it had been extensively and unsuccessfully looked for. The NH or SH rank is reserved for species or communities for which some effort has been made to relocate occurrences, rather than simply using this status for all elements not known from verified extant occurrences.
S1	Critically Imperiled—Critically imperiled in the nation or state/province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province.
S2	Imperiled—Imperiled in the nation or state/province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province.
S3	Vulnerable—Vulnerable in the nation or state/province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
S4	Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
S5	Secure—Common, widespread, and abundant in the state/province.
S#S#	Range Rank —A numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4).
SNR	Unranked—Nation or state/province conservation status not yet assessed.
SU	Unrankable—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
SNA	Not Applicable —A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

NatureServe Rank Qualifiers	
?	Inexact Numeric Rank—Denotes some uncertainty about the numeric rank (e.g. G3? - Believed most likely a G3, but some chance of either G2 or G4).

Q	Questionable taxonomy—Taxonomic distinctiveness of this entity at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or the inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority conservation priority.
C	Captive or Cultivated Only—At present extant only in captivity or cultivation, or as a reintroduced population not yet established.
T#	Infraspecific Taxon (trinomial)—The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T-ranks follow the same principles outlined above for global conservation status ranks. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T-rank cannot imply the subspecies or variety is more abundant than the species as a whole-for example, a G1T2 cannot occur. A vertebrate animal population, such as those listed as distinct population segments under under the U.S. Endangered Species Act, may be considered an infraspecific taxon and assigned a T-rank; in such cases a Q is used after the T-rank to denote the taxon's informal taxonomic status.
B	Breeding—Conservation status refers to the breeding population of the species in the state/province (not applicable to global ranks).
N	Nonbreeding—Conservation status refers to the non-breeding population of the species in the state/province (not applicable to global ranks).
M	Migrant—Migrant species occurring regularly on migration at particular staging areas or concentration spots where the species might warrant conservation attention. Conservation status refers to the aggregating transient population of the species in the nation or state/province.