MASSACHUSETTS FOREST RESERVES
LONG TERM ECOLOGICAL MONITORING PROGRAM
EAST BRANCH FOREST RESERVE

A report on the baseline characteristics of the Forest Reserve areas located on the in Gilbert A. Bliss State Forest and Hiram H. Fox Wildlife Management Area on the East Branch of the Westfield River

Prepared for the
Massachusetts Executive Office of Energy and Environmental Affairs

June 2009

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Cover: The Westfield River, northern portion of the East Branch Forest Reserve (photo by Lena Fletcher).

PREFACE

The Commonwealth of Massachusetts has established two Forest Reserve properties along the eastern branch of the Westfield River in the towns of Cummington, Chesterfield, and Huntington. These two properties constitute the East Branch Forest Reserve, one of eight large Forest Reserves in the Commonwealth (Fig. 1). The Forest Reserves were established by the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA) to create areas where forest development is the product primarily of natural succession and natural disturbance. The Forest Reserve management goal is to increase the area of late seral forest and to protect and conserve species that depend on this habitat, while allowing the effects of natural disturbances to create variation in successional trends in some areas. Only passive management is used in the Forest Reserves, mainly focusing on restoring native habitat by removing invasive species. Sustainable forest management, including timber harvesting, will be implemented on state lands outside the Forest Reserve system (EOEEA 2009).

This report describes the physical features, disturbance history, land use history, and forest communities of the East Branch Forest Reserve. Following this, baseline data on tree density, size distribution, and species composition from Continuous Forest Inventory (CFI) data are summarized and discussed.

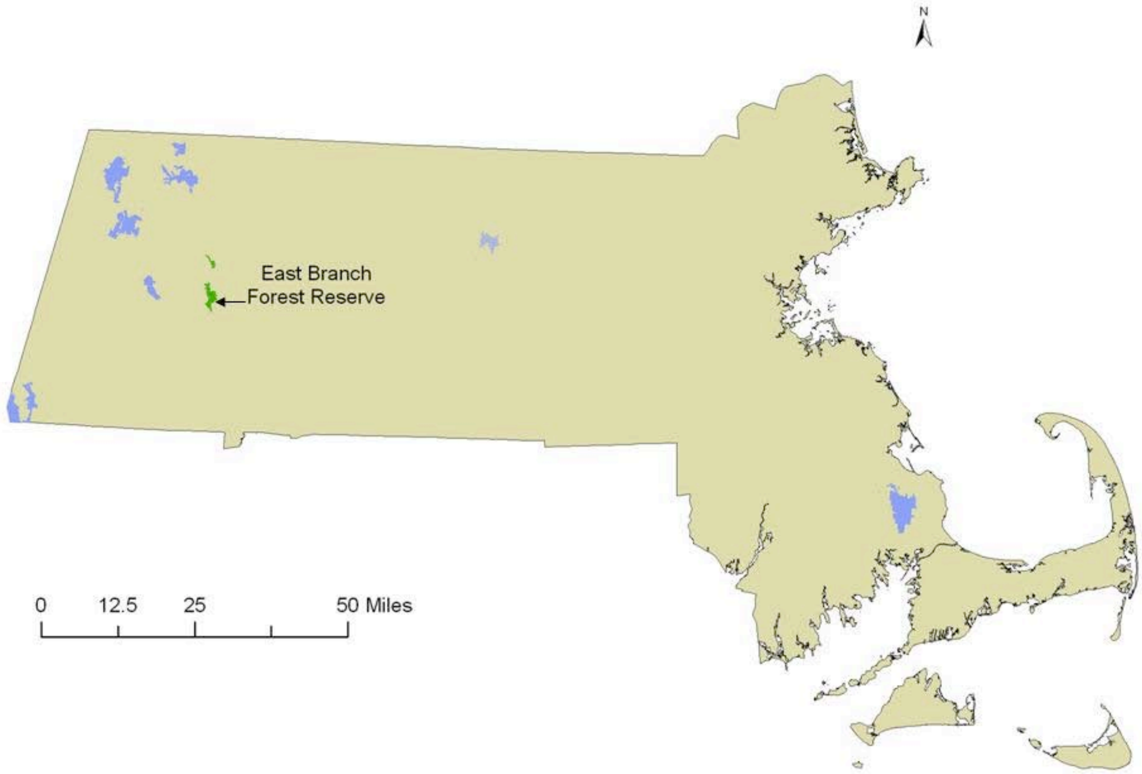

Fig. 1. The East Branch Forest Reserve (green). Other large Forest Reserves are shown in blue (DCR 2008). All GIS analyses were performed using ArcGIS 9.3 (ESRI 2008).

THE EAST BRANCH FOREST RESERVE

INTRODUCTION

Description

The East Branch Forest Reserve consists of four parcels of state-owned land located in the towns of Cummington, Chesterfield, and Huntington and bordering the East Branch of the Westfield River (Fig. 2). Three of these parcels are within the Gilbert A. Bliss State Forest and are managed by the Massachusetts Department of Conservation and Recreation-Division of State Parks and Recreation (DCR). The fourth parcel, located in the southwestern section of the Forest Reserve is a portion of the Hiram Fox Wildlife Management Area (WMA) and is managed by the Massachusetts Department of Fish and Game-Division of Fisheries and Wildlife (DFW). Together, these four parcels cover 2,620 acres. Acreage of individual parcels is shown in Table 1.

Table 1. East Branch Forest Reserve (areas based on GIS analyses) (DCR 2008).

Name	Location	Forest Reserve Acres
Gilbert A. Bliss State Forest	Northern Forest Reserve	390
Gilbert A. Bliss State Forest	West bank, Westfield River	1,020
Gilbert A. Bliss State Forest	East bank, Westfield River	520
Hiram H. Fox WMA	Southwestern Forest Reserve	690
	Total	2,620

The East Branch Forest Reserve is located in the Berkshire foothills in the Hudson Highlands Subsection, an ecoregion classification of the U.S. Forest Service and the basis for the Massachusetts state ecoregions (Keys and Carpenter 1995). Land Type Associations (LTAs) represent ecological mapping at a finer scale, within subsections. The Forest Reserve covers parts of three LTAs: the Lowlands of the Westfield River Valley, the Southern Berkshire Foothills Calcareous Bedrock LTA to the west of the river, and the Southern Berkshire Foothills Acidic Bedrock LTA to the east (Fig. 3) (de la Cretaz and Kelty 2008). Lowlands sites contain riparian and floodplain areas with enriched soils and riparian/floodplain vegetation. The two upland LTAs differ in bedrock composition. Upland bedrock to the west of the river contains calcareous granofels that can increase nutrient concentrations in forest soils.

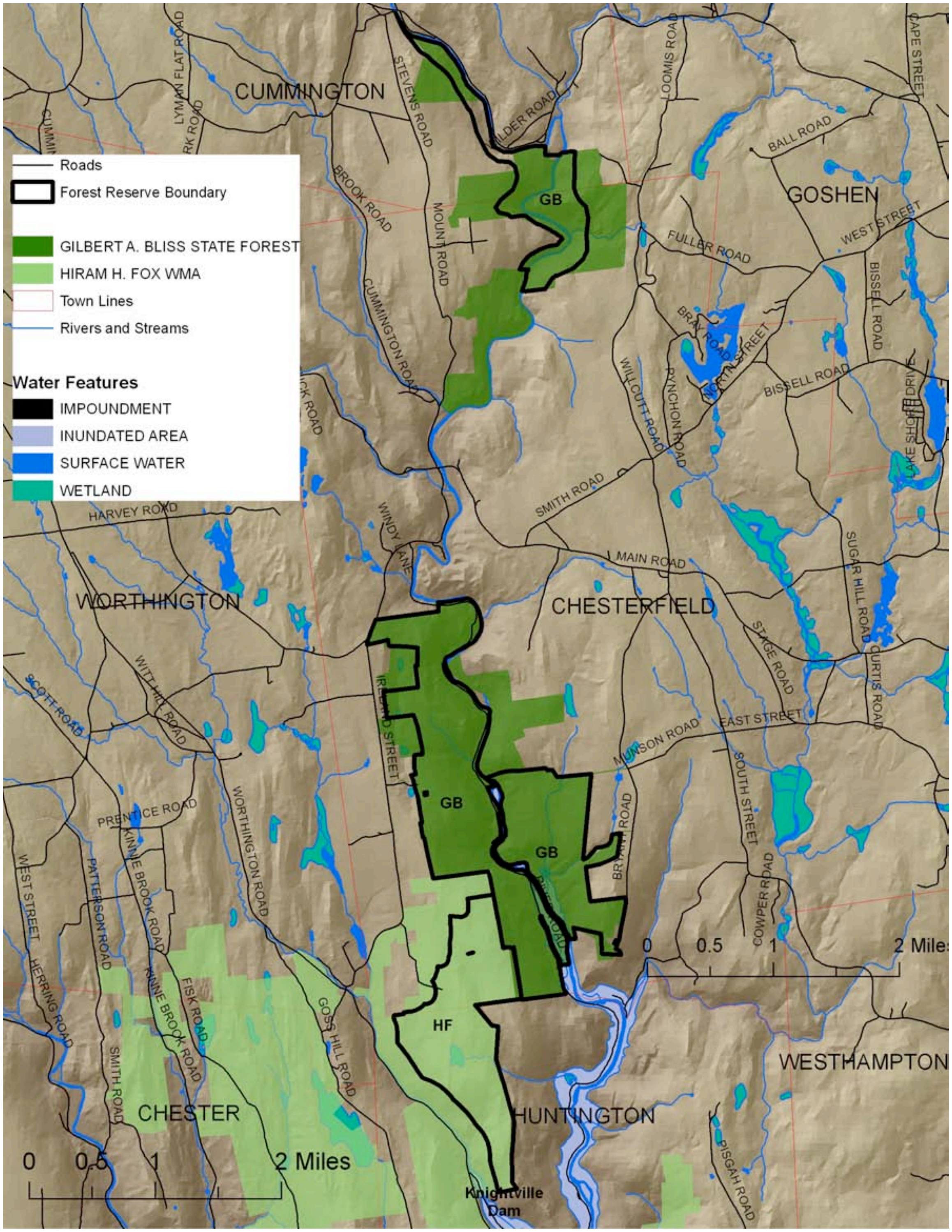

Fig. 2. The East Branch Forest Reserve consisting of sections of Gilbert A. Bliss State Forest (GB) and of the Hiram H. Fox Wildlife Management Area (HF) (DFW 2007, DCR 2008, MassGIS 2000).

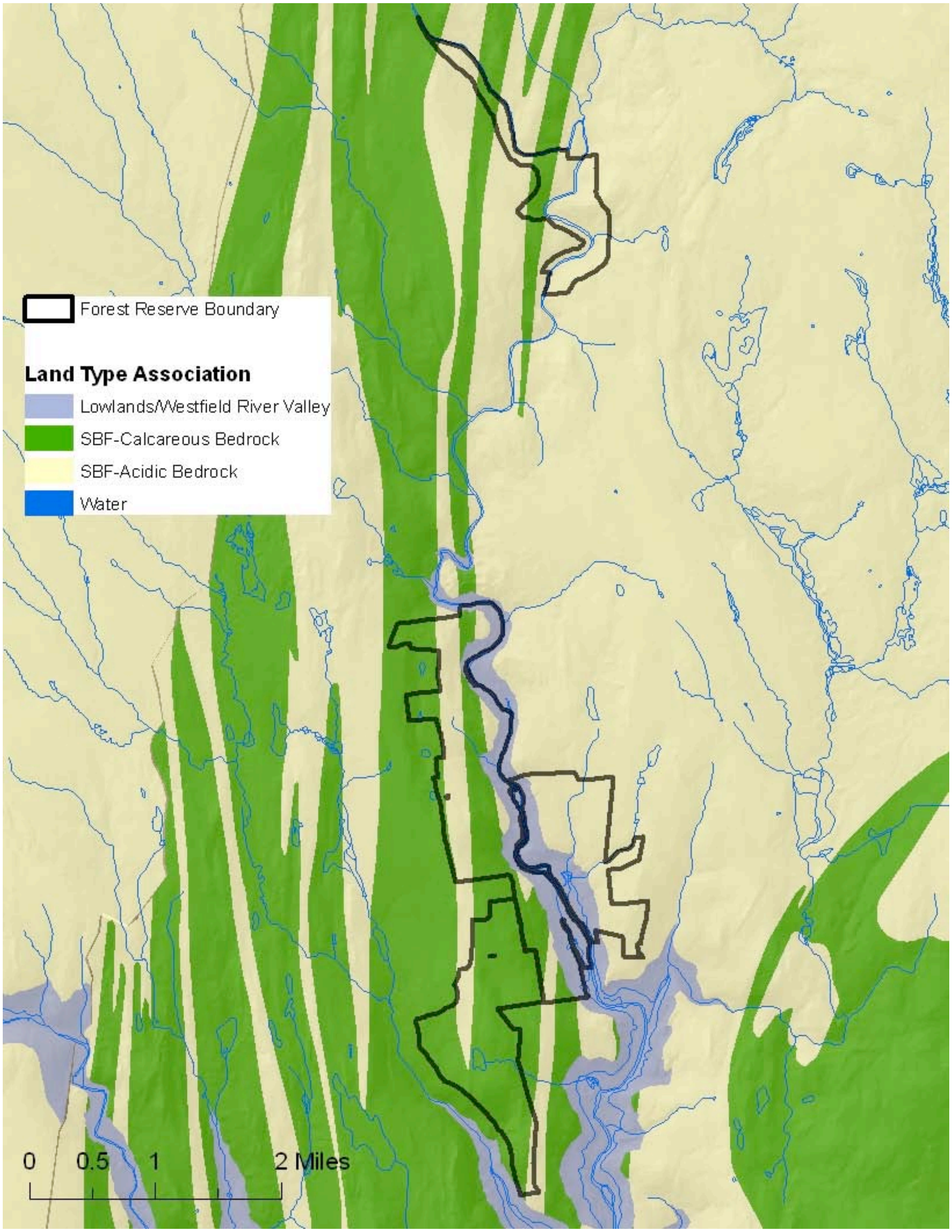

Fig. 3. Land Type Associations of the East Branch Forest Reserve. SBF = Southern Berkshire Foothills (de la Cretaz and Kelty 2008).

Associated Open Space

In 1993, the National Park Service designated 43.3 miles of the Westfield River's East, Middle and West Branches in the towns of Becket, Chester, Chesterfield, Cummington, Middlefield and Worthington as the first National Wild and Scenic River in Massachusetts. An additional 34.8 river miles were added in 2004 for a total of 78.1 miles. The Westfield is the only Wild and Scenic River in western Massachusetts with 2.6 miles classified as wild; 42.9 as scenic and 32.6 miles as recreational (National Wild and Scenic Westfield River, no date given). The watershed is the focus of conservation efforts by a number of State agencies and NGOs and there are many protected properties in the vicinity of the Forest Reserve (Fig. 4). GIS analysis of a 2-mile buffer extending from the Forest Reserve boundaries shows that approximately 28% of the land within the buffer is permanently protected open space (MassGIS 2009(a)).

Chesterfield Gorge is a spectacular section of the river channel just to the north of the Forest Reserve, owned by The Trustees of Reservations (TTOR), a Massachusetts conservation NGO. In this area, torrents of glacial meltwater carved a deep river valley, creating steep cliffs on either side of the current river channel. TTOR property covers 166 acres. The Division of Fisheries and Wildlife oversees many properties in the watershed in addition to the section of the Hiram Fox WMA that is included in the Reserve. The Nature Conservancy (TNC) has made the Westfield River Watershed a particular focus of its conservation efforts, conducting a forest and wetlands inventory, and an analysis of freshwater species in the river in 2003. In addition, TNC submitted a successful proposal to the U.S. Forest Service to designate 380,000 acres of central and western Massachusetts including the Westfield River Valley as a Forest Legacy Area. Forest Legacy status allows federal funds to be used to purchase development rights (conservation easements) from willing private property owners (TNC 2009). The Army Corp of Engineers operates the Knightville Dam at the southern end of the Forest Reserve. The dam was completed in 1941, following floods in 1936 and 1938 that caused massive destruction in Huntington and elsewhere throughout New England. At present, the Army Corps oversees the management of 2,430 acres of flood control lands that includes miles of rivers and streams and about 250 acres of old fields and wetlands in addition to the surrounding forest. The state leases 300 acres, which are managed by the DFW as a Wildlife Management Area (U.S. Army Corps of Engineers 2009).

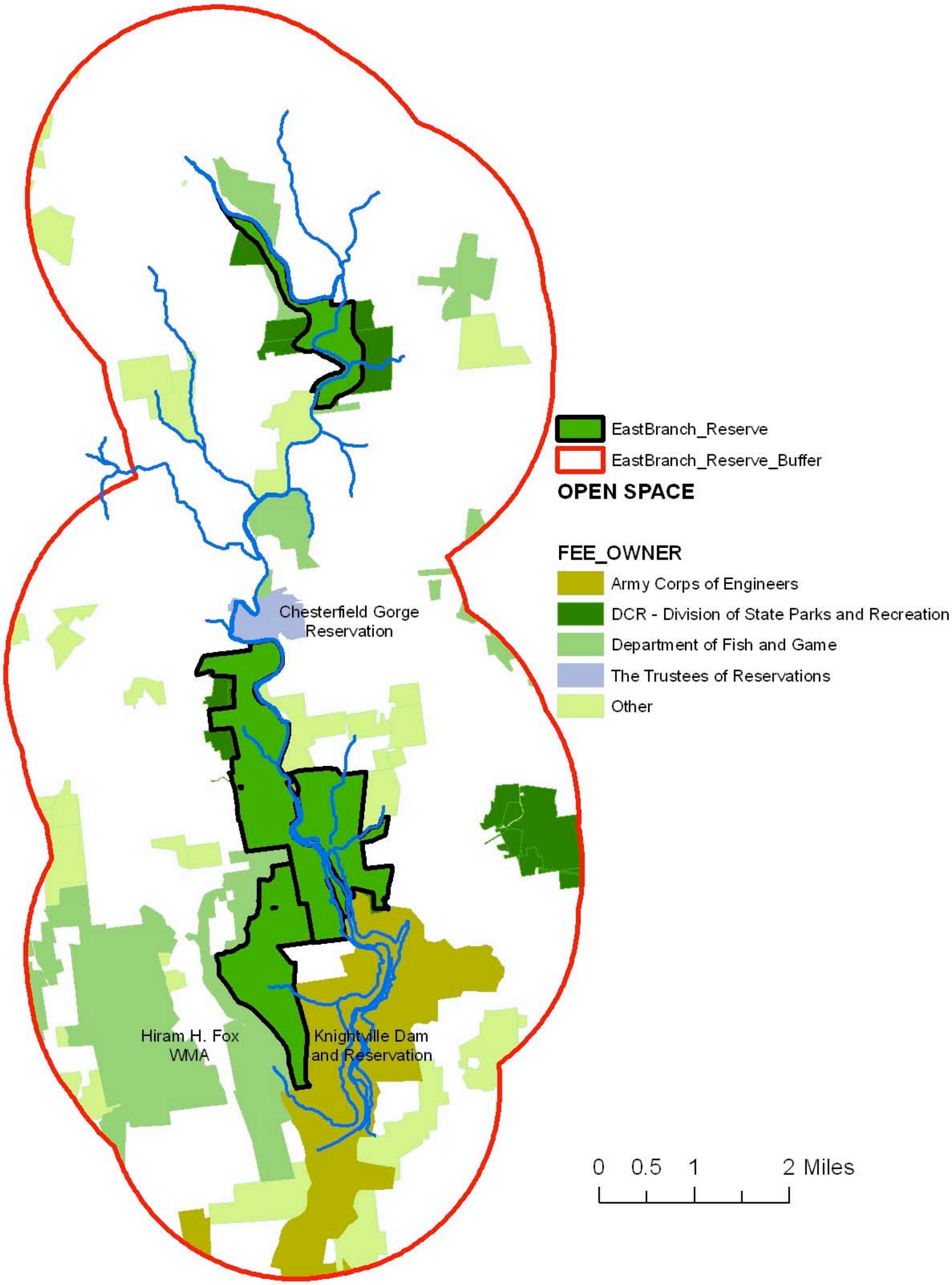

Fig. 4. Permanently protected open space within a buffer area extending 2 miles from East Branch Forest Reserve boundaries (MassGIS 2009 (a)).

PHYSICAL FEATURES

Topography

Elevations in the East Branch Forest Reserve range from 574 to 1,391 ft. The steepest slopes form cliffs that border the East Branch of the Westfield River in the northern portion of the Reserve. The river valley widens and slopes become more moderate as the river flows to the south (Fig. 5, Fig. 6). Slopes on the east side of the River have a west aspect, those on the west side have an east aspect (Fig. 5).

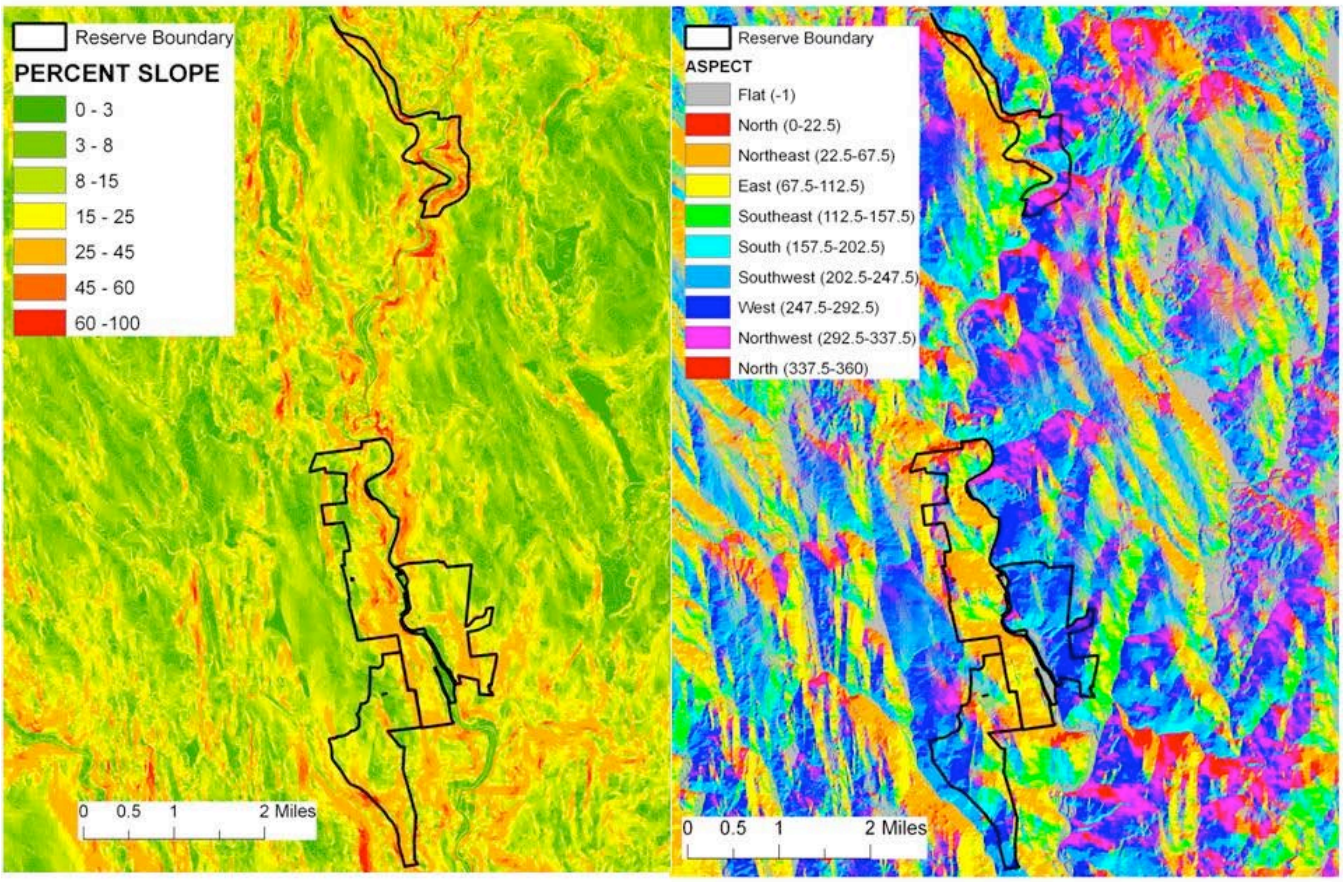

Fig. 5. Percent slopes (left) and aspect (right) East Branch Forest Reserve.

Fig. 6. The Westfield River Valley in the southern portion of the East Branch Forest Reserve (photo by Avril de la Cretaz).

Bedrock Geology

Bedrock in the area of the Westfield River is part of the Goshen Formation and was formed during the Devonian Period, between 360 and 400 million years ago during the Acadian Mountain Building Event (orogeny) (Fig. 7). This was the fourth major continental collision between Laurentia, the North American continental core, and other tectonic plates. A zone of “intense deformation, several tens of miles wide” from western Maine south to Long Island Sound provides evidence of this collision. During the Acadian orogeny, a thick blanket of sediments from the edge of the supercontinent of Gondwana, slide over the older rocks of the Shelburne Falls volcanic island chain. These volcanic islands had collided with Laurentia 50 million years earlier during the Taconic Mountain Building event and volcanic material had been welded on to the North American continent in the process. The Goshen Dome, to the east of the Forest Reserve, is a remnant of these ancient volcanoes and has had a major effect on the pathway of the Westfield River channel . The erosion resistant gneiss of the dome created a barrier, forcing the Westfield River to flow south to Huntington, before resuming its otherwise southeasterly path towards the Connecticut River (Skehan 2001).

Rock types in the Goshen Formation include micaceous schist and quartz-schist (Fig. 8, Table 2). Isolated strips of bedrock within the Goshen Formation also contain scattered beds of calcareous granofels within the quartz and schist. When calcium-rich material is located close to surface, it can create areas of high nutrient forest soils that favor the growth of rich mesic tree species such as sugar maple, white ash, basswood, and bitternut hickory. A diverse community of understory plants, including maidenhair fern, bloodroot, and blue cohosh among many others, is typically found in these enriched areas. These trees, shrubs, and herbaceous plants form a unique assemblage of species that constitute the Rich Mesic Forest Community (Zen et al.1983, Bellemare et al. 2005).

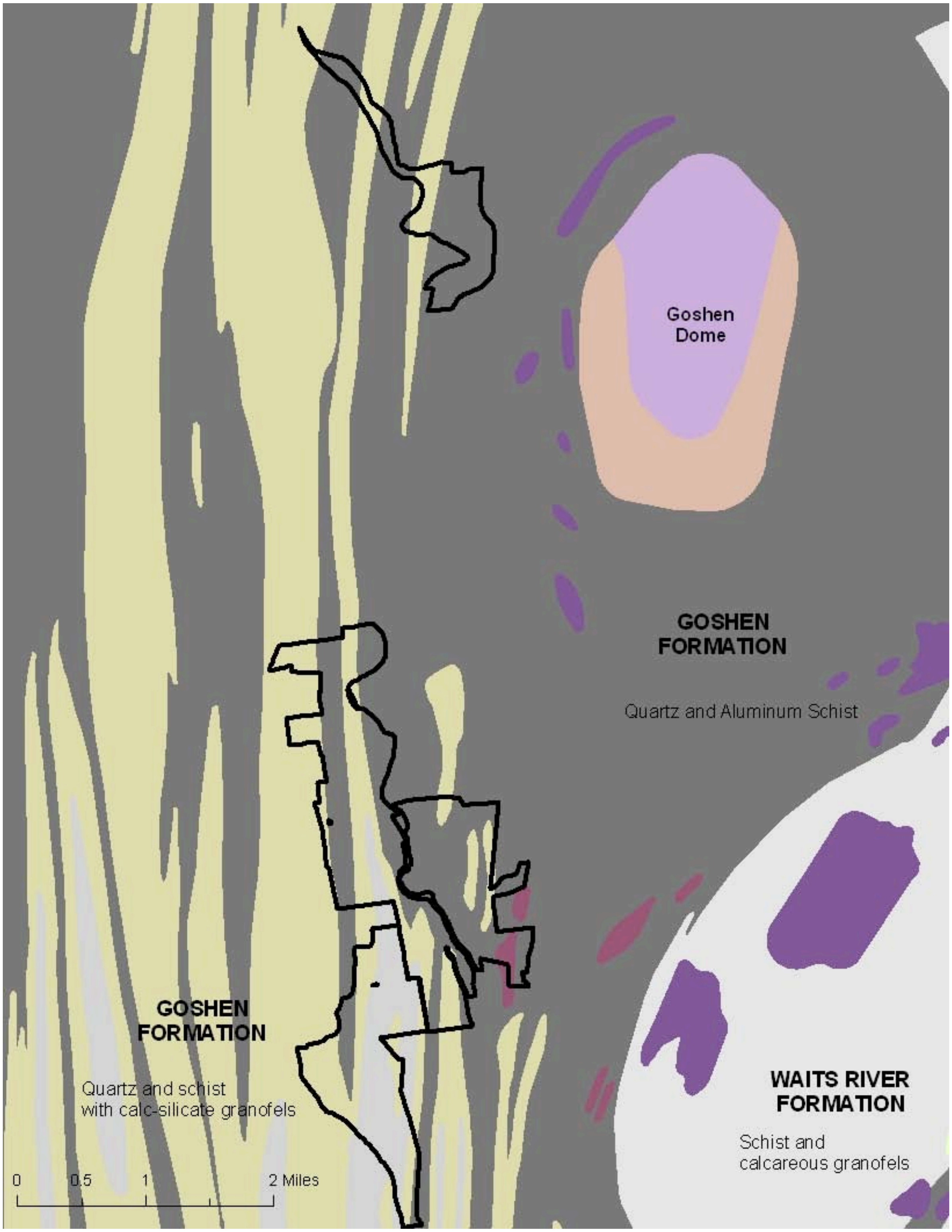

Fig. 7. Bedrock Formations in the East Branch Forest Reserve Area (Zen et al. 1983).

Fig. 8. Bedrock types within the East Branch Forest Reserve (Zen et al. 1983).

Table 2. Bedrock description, East Branch Forest Reserve (Zen et al. 1983).

Map Code	Description	Area (%)	Formation	Rock Type
Dg	Quartzite, quartz schist, carbonaceous aluminum schist	53	Goshen	Sedimentary
Dgq	Quartzite, quartz-garnet-mica schist, and calc-silicate granofels	31	Goshen	Sedimentary
Dgu	Quartzite, schist, scattered beds of calcareous granofels	15	Goshen	Sedimentary
Dpe	Pegmatite	1	Feldspar-quartz muscovite pegmatite	Igneous

Surficial Geology and Soils

There have been repeated episodes of glaciation in New England during the past one million years. Mountains of ice have advanced from the north, scraping away existing material and retreated, leaving massive amounts of debris behind (glacial drift). During the last glaciation, the Hudson Valley lobe, an extension of the Wisconsinan ice sheet, moved south into Massachusetts, covering the Berkshire Hills to a depth of more than 1,000 feet. At its greatest extent, 23,000 to 22,000 years ago, the southern border of the ice sheet reached Northern New Jersey and Long Island, NY. The glacial lobe moved in a southeasterly direction and melted back in the opposite direction. Current river drainages in the Berkshires and the Berkshire foothills flow generally to the southeast following the path of glacial advance and recession (Skehan 2001).

The recession of the glaciers, which continued until about 12,000 years ago, exposed a landscape covered with thick deposits of rocks, sand, and gravel left behind by the melting ice. Glacial drift can be divided into different types, based on the size and range of sizes of the particles. Glacial till, created by the grinding movement of the glaciers over bedrock, consists of poorly-sorted material, particles of many different sizes, including clay, sand, gravel, rocks and boulders. Glacial outwash is deposited by fast-flowing meltwater and consists of well-sorted sand and gravel of fairly uniform size. In addition to till and outwash, the East Branch Reserve has substantial areas of floodplain alluvium. Alluvium consists of small clay-sized particles of sedimentary material deposited and moved by the periodic flooding of the Westfield River (Fig. 9).

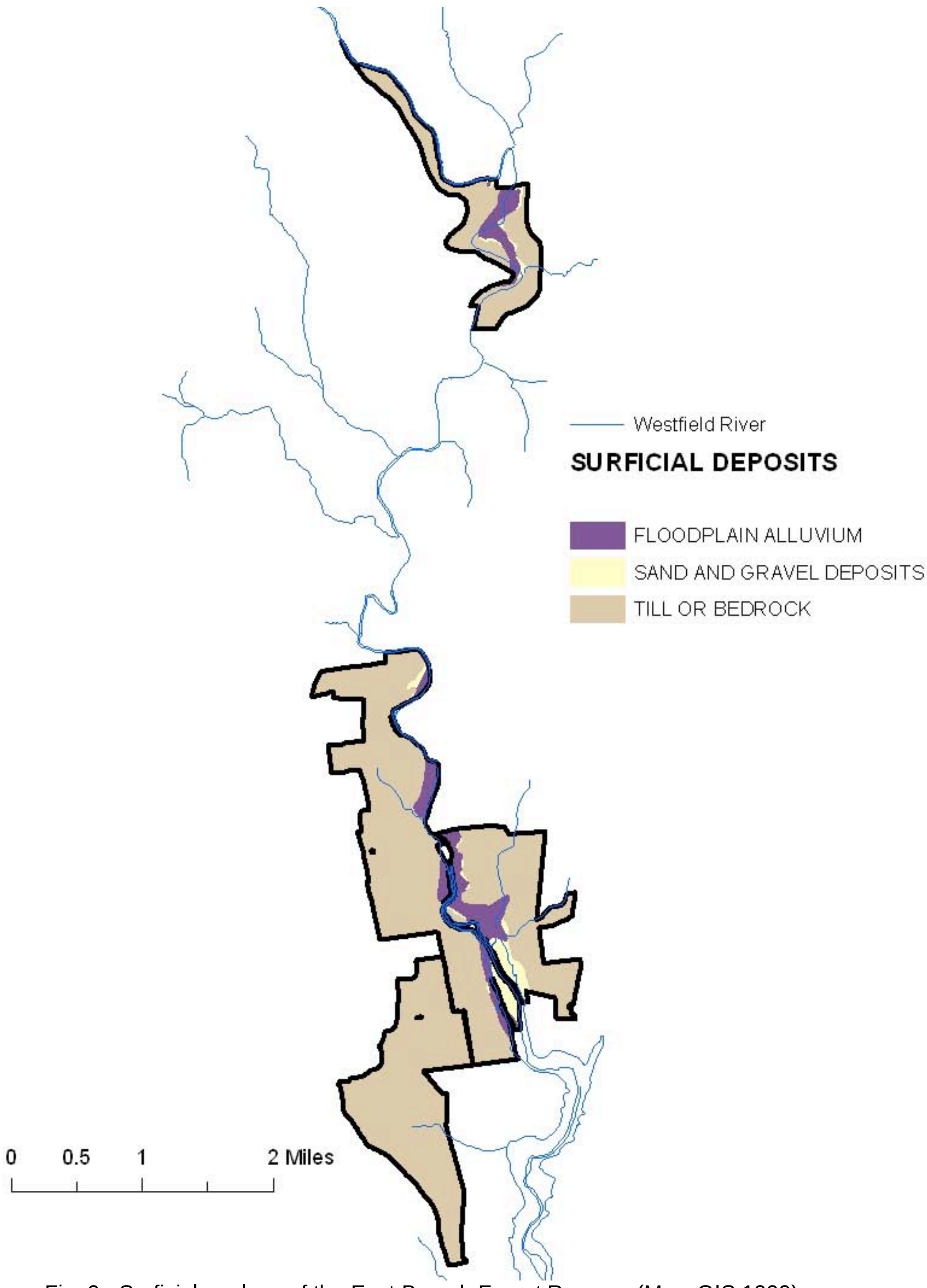

Fig. 9. Surficial geology of the East Branch Forest Reserve (MassGIS 1999).

There are 13 soil series found in the East Branch Reserve. For purposes of display, these have been grouped by drainage category (Fig. 10). All the soil series are listed in Table 3. The three most common soil series in the Reserve are the Westminster, Hollis, and Chatfield series, which collectively cover 80% of the total Forest Reserve area. The Westminster series (39% of the area) are upland soils and consist of shallow, somewhat excessively drained soils formed in a thin mantle of glacial till derived mainly from schist. These soils are displayed in Fig. 10 as “thin excessively drained till”. Depth to bedrock ranges from 10 to 20 inches (NCSS 2004). The Hollis series (31% of the area) are also upland soils and consists of shallow, well-drained and somewhat excessively well drained soils formed in a thin mantle of glacial till formed from gneiss, schist, and granite. Depth to bedrock ranges from 10 to 20 inches (NCSS 2007). The Hollis series also are included in the “thin excessively drained till” category. The Chatfield series, upland soils as well, cover 10% of the total area. This series consists of moderately deep, well drained, and somewhat excessively drained soils formed in till on glaciated plains, hills, and ridges with a depth to bedrock of 20 to 40 inches (NCSS 2006). They are displayed in the “thick well drained till” group. Upland soils in this area are inceptisols, soils that are at the “inception of soil development and just beginning to show signs of a soil profile (Brady and Weil 2002).

Soils formed in outwash cover a little more than 2% of the area and include the Merrimac and Hinckley soil series. Hinckley soils are described as very deep, excessively drained soils formed in water-sorted material on terraces, outwash plains, deltas, kames, and eskers (NRCS 2007). Merrimac soils consist of “very deep, somewhat excessively drained soils formed in glacial outwash on outwash terraces and plains and other glaciofluvial landforms.” Outwash soils are entisols with little evidence of soil profile development (Brady and Weil 2002). Alluvial soils belong to the Rippowam soil series. “The Rippowam series consists of very deep, poorly drained loamy soils formed in alluvial sediments. They are nearly level soils on flood plains subject to frequent flooding” (NCSS 2005).

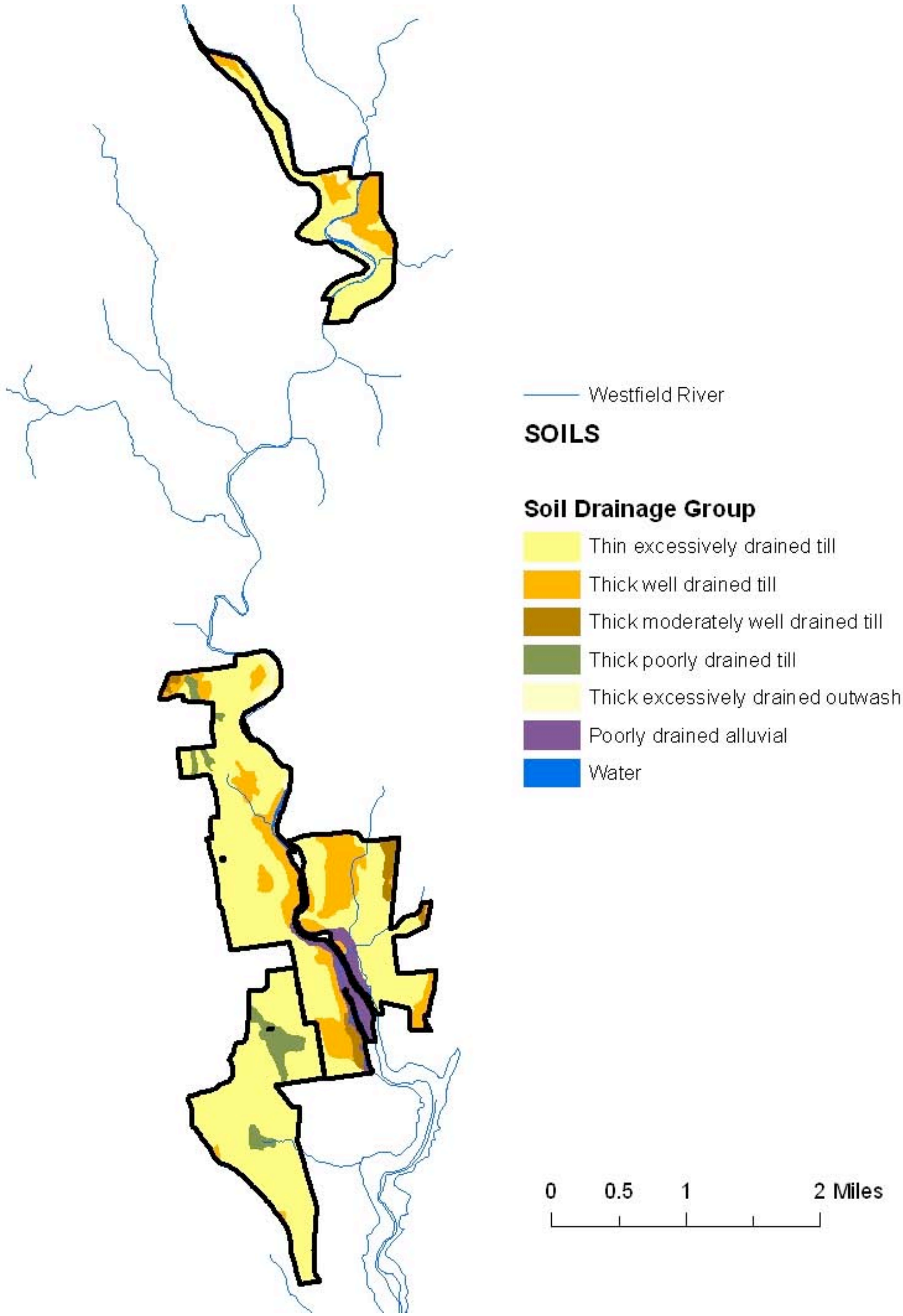

Fig. 10. Soil types in the East Branch Forest Reserve (Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture 2004).

Table 3. Soil Series, East Branch Forest Reserve (NCSS 2004, 2007, 2007, 2006, 2004, 2001, 2008, 2004, 2000, 1997, 2005, 2007, 2005).

Series Name	Soil Characteristics	Area (%)
Thin excessively drained till		
Westminster	Shallow, somewhat excessively drained	39
Hollis	Shallow, well drained and somewhat excessively drained	31
Lyman	Shallow, somewhat excessively drained	<1
Thick well drained till		
Chatfield	Moderately deep, well drained, and somewhat excessively drained.	10
Paxton	Deep, well drained	3
Shelburne	Very deep, well drained	2
Tunbridge	Moderately deep, well drained	2
Thick moderately well drained till		
Ashfield	Very deep, moderately well drained	1
Scituate	Very deep, moderately well drained	1
Thick poorly drained till		
Pillsbury	Very deep, poorly and somewhat poorly drained	3
Thick excessively drained outwash		
Merrimac	Very deep, somewhat excessively drained	2
Hinckley	Very deep, excessively drained	<1
Poorly drained alluvial		
Rippowam	Very deep, poorly drained	4

Climate

In the area of the East Branch Reserve, winters are cold and summers are moderately warm, with occasional hot spells. Annual precipitation is evenly distributed throughout the year (Scanu 1995). There is a weather station located at the Knightville Dam (elevation 629 ft.) near the southern boundary of the East Branch Forest Reserve in Huntington.

Table 4. Mean 24-hour temperature and mean total monthly precipitation, Knightville Dam, Huntington MA (World Climate 1996).

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
[1]Temp.˚F	20.1	22.1	32.2	43.9	55.0	63.9	68.5	66.6	58.5	47.8	37.9	25.7	45.1
[2]Precip. Inches	3.5	3.3	3.9	4.0	3.8	3.5	3.6	4.0	3.3	3.9	4.4	4.0	45.3

[1]Temperature derived from National Climatic Data Center, NCDC TD 9641 Clim 81 1961-1990 Normals. 30 years between 1961 and 1990.
[2]Precipitation from NCDC Cooperative Stations.35 complete years between 1948 and 1995.

Disturbance History

The most common natural disturbances in this area are windstorms (hurricanes and microbursts associated with severe thunderstorms), floods, pests, and pathogens (insects, and disease) (Bisbee 1876, Caron 1955, O'Keefe and Foster 1998). State foresters have recorded evidence of tree damage from wind (1998) and disease (1996) (DCR 2000). Aerial photo surveys (MassGIS 1997) show defoliation from gypsy moths primarily in the southern section of the Forest Reserve in lowland areas, including the wildlife management area, in 1981. Flooding, generally occurring in conjunction with either spring snowmelt or hurricanes is the primary disturbance affecting the riparian area and floodplain of the Westfield River. Early records (Bisbee 1876) describe a spring flood in 1819 that swept away nearly every bridge in the town, while houses and mills floated off in the floodwaters of the Westfield River and a similar event in 1879 (Caron 1955). During the 20th century, major floods occurred in 1936 and in 1938 in association with the infamous Hurricane of September 21, 1938. In response to these floods, the U.S. Army Corps of Engineers constructed the Knightville Dam as part of a network of flood damage reduction dams on tributaries of the Connecticut River (U.S. Army Corps of Engineers 2009). The dam was completed in 1941. The Knightville Dam detains upstream floodwaters, then releases the water gradually in order to protect downstream communities from flood damage. Following construction of the dam, major flooding occurred in 1955 during Hurricane Diane and again in 1987 during a spring rain-on-snow event. During the 1987 flood, the capacity of the dry reservoir behind the dam was exceeded and flood water flowed over the spillway scouring a channel down to bedrock (Connecticut River Valley Flood Control Commission 2007, U.S. Army Corps of Engineers 2009, Westfield River Watershed Association 2009 (a), 2009(b)). Hurricane-related flooding also occurred in October 2005 (Connecticut River Valley Flood Control Commission 2007). A recent study (Magilligan and Nislow 2005) found that there has been no significant change in monthly flow regime in the Westfield River following construction of this relatively small flood control dam.

State foresters have noted tree damage resulting from the activities of deer, birds, and porcupines, beech bark disease, heartrot, nectria, and white pine weevil (DCR 2000).

Pest and Pathogen Information

Nectria canker is the most common canker of hardwood trees. There are several species of Nectria fungus including *Nectria galligena* (the most widespread) *N. magnoliae,* which attacks tulip trees, and *N. coccinea* (see beech bark disease below). The fungus is found on red and sugar maple, black, yellow, and white birch, and beech trees. Hickory and ash species are generally not affected. Nectria fungus infections often are not fatal to the host tree; birch species are the most susceptible to death by girdling (Brandt 1964).

Beech bark disease results when bark, attacked and altered by the beech scale insect (*Cryptococcus fagisuga*), is invaded and killed by fungi, primarily *Nectria coccinea* and sometimes *Nectria galligena*. Beech bark disease causes significant mortality (Houston and O'Brien 1983).

White pine weevil (*Pissodes strobi*) is a native insect attacking eastern white pine. Adults hibernate in the duff underneath host trees, emerge in early spring, and crawl up the trunk of the host tree, where males and females begin feeding just below the terminal bud cluster. Females lay their eggs in egg cavities starting just below the terminal bud cluster and extending down the upper half of the terminal shoot. After the eggs hatch, larvae burrow under the bark of the terminal shoot where they continue feeding. Following metamorphosis, the adult beetles emerge from the pupae and continue feeding on the buds and bark tissue of stems and branches. Weevil attacks result in growth reduction (each weevil attack reduces tree height growth by 40 to 60% in that year), stem deformation, increased susceptibility to wood decay organisms, and tree mortality, although mortality is rare and usually occurs only in small trees (less than 4 ft tall) (Hamid et al. 1995).

Gypsy moth (*Lymantria dispar*) caterpillars have caused widespread forest defoliation throughout Massachusetts. The most severe recent outbreak occurred from 1980-1982. Gypsy moth caterpillars prefer hardwoods, especially oaks, basswood, gray and white birch, and poplar. Older larvae feed on several species of hardwoods plus hemlock, pines and spruces. They tend to avoid ash, butternut, balsam fir and mountain laurel, but will feed on almost anything during a population outbreak. Outbreak populations return to low levels that do not visibly affect the forest canopy after 2 to 3 years. Wasps, flies, ground beetles, and ants; many species of spiders, birds, and many small woodland mammals (mice, shrews, chipmunks, squirrels, and raccoons) all prey on gypsy moth larvae when population density is low, but this predation does not prevent outbreaks (McManus et al. 1989, Elkinton et al. 2004). Population outbreaks are eventually controlled by density-dependent mortality. A virus (*Nucleopolyhedrovirus*) usually causes outbreak population collapse. Recently an entomopathogenic fungus species (*Entomophaga maimaiga*) has prevented population outbreaks. The fungus has spread rapidly since it was first observed in 1989, partially the result of intentional introduction into gypsy moth infested areas as a biological control (Hajek et al. 1996, Liebhold 2003).

Hemlock Woolly Adelgid (*Adelges tsugae*) is a small aphid-like insect native to Japan that has caused considerable mortality to eastern hemlock trees from North Carolina to Connecticut (Orwig et al. 2002). Hemlock woolly adelgid is not, at this point, a problem within the East Branch forest. It is, however, present in Hampshire County and poses a potential threat since hemlock is one of the more common species in the Forest Reserve.

LAND USE HISTORY

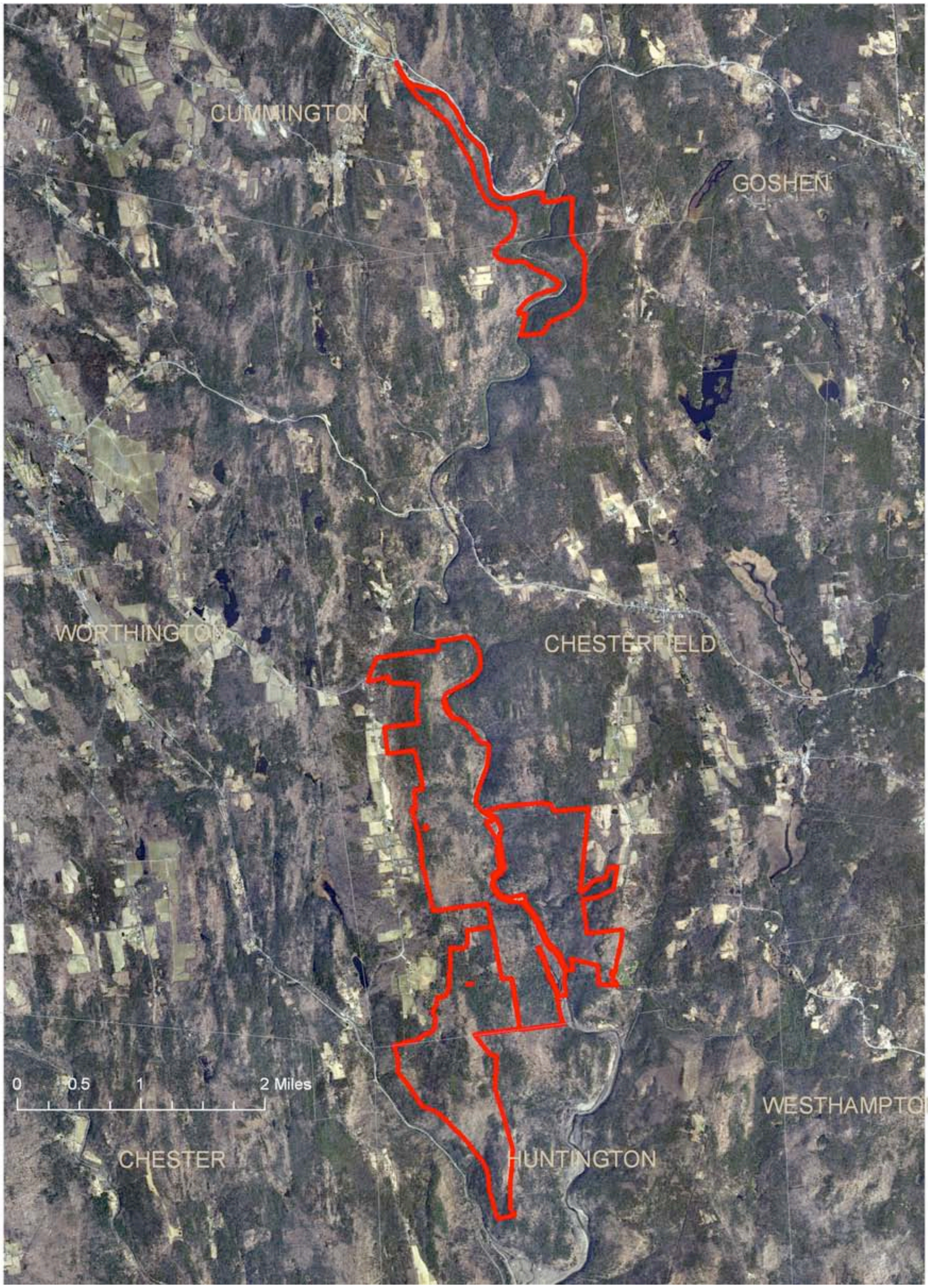

Fig. 11. Orthophotos of Cummington, Chesterfield, Huntington and neighboring towns (MassGIS 2005).

There were probably no permanent indigenous settlements outside of the major river valleys (Connecticut, Hoosic, and Housatonic) in western Massachusetts prior to European colonization, although the existence of well-established trails crossing the Berkshire Plateau indicates that native peoples regularly traveled through upland areas (Brown 1920, Buncich 1976). The Berkshire region was the last area in Massachusetts to be settled by European colonists. In 1725, Massachusetts began using land grants to pay off debts for military service. This encouraged the settlement of the hilltowns (Sayer et al. 1964, O'Keefe and Foster 1998).

The towns of Chesterfield, Cummington, and Huntington were all settled in the second half of the 18th Century. The town of Chesterfield was originally laid out in 1739 with much of the land granted to the veterans (or their descendents) of King Philip's War, a conflict with the Narragansett Indians in Plymouth County in 1675, and King William's War, a Canadian expedition of 1690. Initial settlement of the town did not begin until 1755. Chesterfield was incorporated in 1762. In that same year, a committee appointed by the General Court of Massachusetts was charged with selling 9 townships and 10,000 acres of Province land "to such as would give the most for the same". Colonel John Cummings purchased Lot #5 (Cummington) for £1,800 and William Williams bought Plantation #9, the land that was to become Huntington, for £1,500 (Bisbee 1876, Howes and Thayer 1964).

According to a 19th century history (Bisbee 1876), the territory was, at the time of initial settlement, covered with a dense forest where valuable timber species were found in abundance. Bisbee mentions beech, birch, maple, chestnut, pine, and oak. The early settlers cleared forest, erected dwellings and built roads. In Cummington, free land was offered to anyone who would settle and build a sawmill. In 1771, lot No. 20 was given to Deacon Barrett on the condition that he build a gristmill. In order to "prove up" or establish claim to a homesite on public land, a settler was required to build a house at least 18 ft square, with seven 100-foot studs within two years and to "improve" 10 acres of land within four years. Cummington was incorporated in 1779 (Howes and Thayer 1964).

Huntington was originally part of the Murrayfield Plantation, incorporated in 1765 and renamed Chester in 1783. Legend has it that William Miller, one of the earliest settlers, spent his first night in the area on an island in the Knightville section trying "to avoid the wolves, which were then numerous" (Bisbee 1876). In 1773, the eastern part of the territory was incorporated as a separate district with the name of Norwich. The legislature granted the community of Norwich all the rights and privileges of a town, but not representation in the General Court. This was a strategy by the British Colonial government designed to limit popular representation in the colonial government. Norwich was authorized to unite with the neighboring community of Chester, for purposes of representation. The restriction on the number of representatives was withdrawn in 1786, following the American Revolution; however, the line of demarcation between Norwich and Chester remained ill-defined. By the 1840s, a large community had grown up along the railroad line at the point where the towns of Norwich, Chester, and Blandford came together. The boundary line in the middle of this settlement separated both towns and counties and led to confusion about law enforcement, postal services, and school districts. In 1853, sections of Chester and Blandford included in this community were annexed to Norwich. In 1855, Norwich was incorporated and given the new name of Huntington in honor of the Hon. Charles P. Huntington of Northampton (Bisbee 1876).

Agriculture was the primary industry throughout much of the history of this area. The forest in the uplands was cleared for cropland and pastureland with land that was too steep or too wet for agriculture maintained as permanent woodlots (O'Keefe and Foster 1998). Local agricultural products included beef, pork, mutton, wool, and flax, vegetables, apples, and maple syrup. The colonial economy of the late 18^{th} Century was based on subsistence agriculture. Agriculture expanded in the 19^{th} Century. The establishment of local woolen mills made sheep raising more profitable; sheep herds grew requiring additional forest clearing for pasture (Howes and Thayer 1964)

Industrial and commercial activity, and population growth accelerated after 1800, with the development of new technologies and improved transportation. Population and economic development in the hill towns peaked between 1820 and 1860, following a pattern similar to that of the rest of western Massachusetts. Dams were built on rivers and streams to provide waterpower for sawmills and gristmills. All three towns along the East Branch of the Westfield River developed a variety of local industries. People moved from upland farms to the valleys as industries, dependent on waterpower from dams on the river, increased in number and size (O'Keefe and Foster 1998). In Huntington, this trend was augmented by the arrival of the Western Railroad. The railroad began daily trips from Springfield directly to Huntington in 1841 (Bisbee 1876, Caron et al. 1964).

In Cummington in the 1830s, there were three sawmills, two gristmills, two mills making broom handles, a tannery, a blacksmith shop, a wheelwright, and a whetstone mill. By 1840 there were fourteen mills in all and four tanneries (Howe and Thayer 1964). Between 1835 and the end of the Civil War, factories in Chesterfield made wagons, button molds, mop, broom, and tool handles, spools and bobbins for the silk industry, scythes, stoves, stove pipes, plows, and cultivators. Other local products included whetstones, palm leaf hats, and grandfather clocks. In 1845 in Chesterfield, the total income from agriculture was $28,476, while the total income from manufactured goods was $26,387 (Sayre et al. 1964). Huntington (Chester or Norwich until 1855) thrived and local industry survived for a longer period of time, due to the presence of the railroad. In 1929, 60 trains were passing through Huntington each day. Cummington suffered a more severe and earlier economic decline in large part due to the greater distance from the town to the railroad (Howes and Thayer 1964). Textile manufacturing began in Huntington in 1868. A succession of 4 textile mills processing flannel and then cotton yarn operated for several years before burning to the ground. A woolen mill was built after 1870. This became the Huntington Textile Company, which closed in 1952 (Caron et al. 1964).

Paper manufacturing began in Huntington in 1853 and in Cummington in 1856. In Cummington the paper mill was powered both by water and by steam engines. Paper manufacturing shifted from Cummington to Adams in 1908 and from Huntington to Holyoke in 1924. By 1964, the only industry in Huntington was "Smith's Saw Mill, employing only a small number of workers but those that remained were working steadily (Caron et al. 1964, Howes and Thayer 1964).

Industrial development placed additional demands on local forests. Wood was required for fuel and construction. Residents and industries burned wood for heat. O'Keefe and Foster (1998) estimated that each household would have used about 15 cords of wood per years for heating. Hemlock was used in tanneries and tanneries were forced to close when the local supply of hemlock bark was depleted. Wood was also required for charcoal and used as fuel for local industries. Beginning in the 1860s, new technology allowed paper mills to make paper from wood pulp instead of rags. Spruce and fir trees, used for paper production, were quickly depleted in the surrounding forests (Gordon 1998). Paper mills moved to Holyoke, as mentioned earlier, because it was located on the Connecticut River was able to make use of wood that was floated downstream from forests in northern New England.

Local agriculture declined and farms were abandoned as improved transportation brought competing farm products from the Midwest. Local industry declined, as resources were depleted and economic competition from larger industrial cities in the Northeast and Midwest increased due to technological innovation and improved transportation. In 1830, the population in Cummington was 1,261. The population of Chesterfield peaked in 1820 at 1,447. Population in the hilltowns fell from the 1820s onward as people left upland farms and jobs in local industries for opportunities in the West and in larger cities. In Chesterfield, the population fell by 50 to 100 people per decade from 1820 to 1900 and was down to 496 people in 1950 (Sayre et al. 1964). The population of Cummington was 550 in 1961. Manufacturing was to some extent replaced by tourism. Summer tourists have supplemented year-round populations and contributed to the local economy since the 1880s (Howes and Thayer 1964, Sayer et al. 1964). More recently there has been growth in population due to new residents who commute to employment in larger towns. Permanent populations of the three towns remain small Cummington 978, Chesterfield 1,201, Huntington 2,174. Populations of the three towns collectively increased 16% between 1980 and 2000 (MassGIS 2009(b), U.S. Census 2000) (Fig. 11).

Forests regrew as farms were abandoned and factories closed. The state began to acquire forestland in this area in 1955 with the purchase of 340 acres from the American Telephone and Telegraph Company (AT&T). Purchases and acquisitions continued through the 1990s adding 1,422 acres to the State Forest. An additional 88 acres has been acquired since 2000 (DCR Deed Database 2008).

In all, a total of 215 acres in 10 parcels have been harvested within the Forest Reserve since 1985 (Fig. 12). One 39-acre parcel in the northern section of the Forest Reserve was harvested in 1985. In the southern portion, a 25-acre parcel was harvested in 1985 and two areas (58 and 47 acres) were harvested in 1997. All timber harvesting in the southern portion occurred prior to State acquisition of the land. The DFW has harvested timber on 46 acres (3 parcels) within the Hiram H. Fox WMA portion of the Reserve (McDonald et al. 2006).

FOREST TYPES

In 2003, the DCR completed the "Land Cover Classification Project", including forest type mapping of all Massachusetts State Forests. GIS digital forest-type data were derived from 1:12,000 scale, leaves-on color infrared aerial photographs. The digital data and aerial photography were provided by the James W. Sewall Company of Old Town, Maine (DCR 2003). A similar dataset was completed by DFW in 2002 using color orthophotos provided by MassGIS, scale 1" = 2,500'. Polygons were delineated by Landmark Systems (Warner Robins, Georgia). Both companies used minimum mapping units of 5 acres. Because different forest type categories were used for State Forest and Wildlife Management Area land, the forest type analysis for each of these is presented separately in the figure legend and in the summary tables (Table 5, Table 6).

Approximately 53% of the entire Forest Reserve (State Forest and Wildlife Management Area combined) is dominated by northern hardwoods (Fig. 12). The remaining area is covered by a mixture of hemlock, white pine, and hardwoods. There are only small areas of oak and other central hardwoods, accounting for about 3% of the total area. Hemlocks are predominant in riparian/floodplain areas. Although Rich Mesic Forest Communities are too small to be observed at the scale of the digital forest type data, the presence of these communities has been noted by Massachusetts Natural Heritage (Fig. 13, Appendix C).

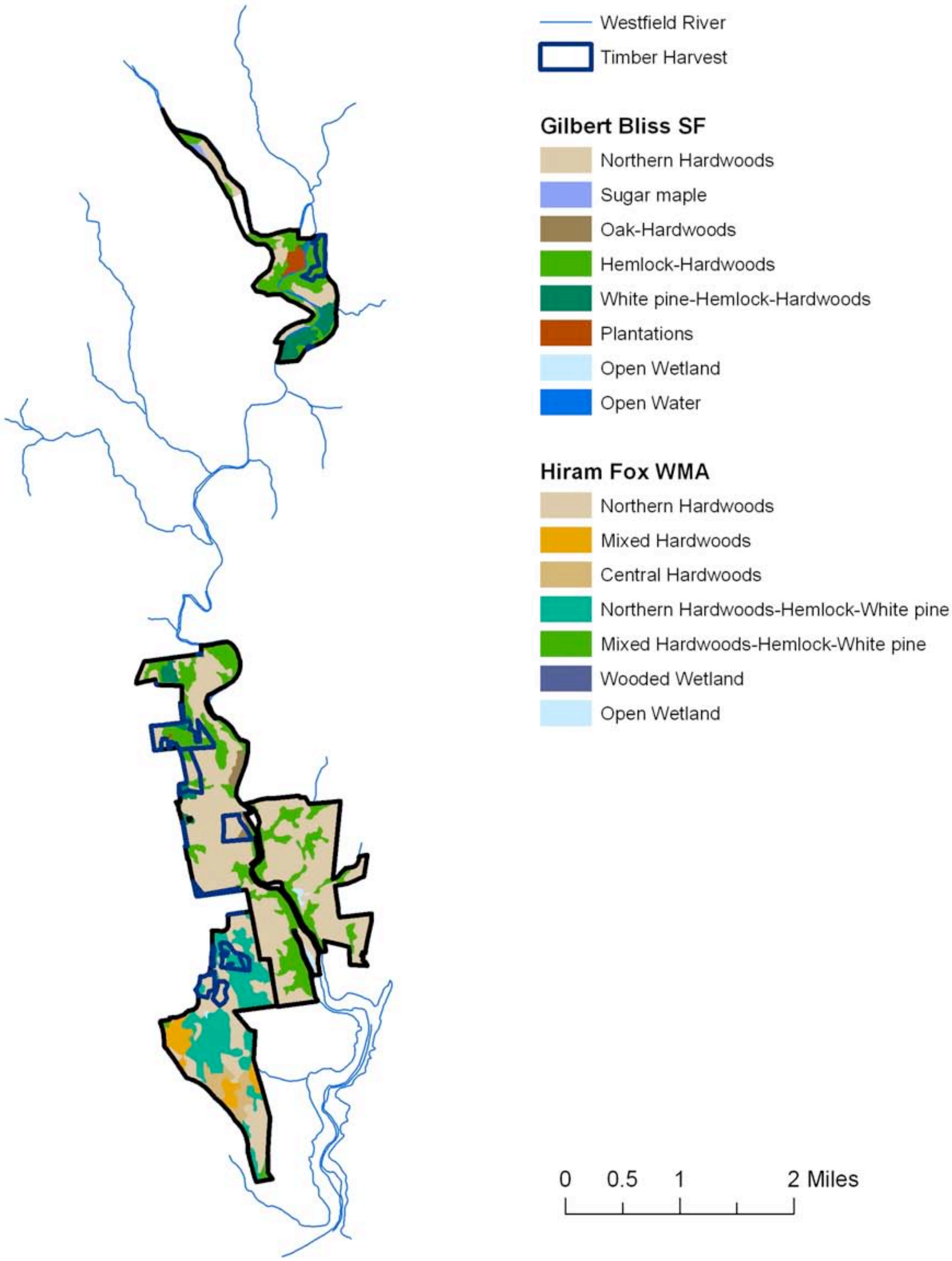

Fig. 12. Forest types, East Branch Forest Reserve, indicating predominant overstory species and timber harvests 1984-2003 (DFW 2002, DCR 2003, McDonald et al. 2006).

Table 5. Forest types, East Branch Forest Reserve, Gilbert A. Bliss State Forest (DCR 2003) (1,935 acres).

Forest Type	**Area (%)**
Northern Hardwoods	58
Sugar maple	<1
Oak-Hardwoods	1
Hemlock-Hardwoods	32
White pine-Hemlock-Hardwoods	5
Plantations	1
Open Wetland	1
Open Water	1

Table 6. Forest types, East Branch Reserve, Hiram H. Fox WMA (DFW 2002) (685 acres).

Forest Type	Area (%)
Northern Hardwoods	36
Mixed Hardwoods	11
Central Hardwoods	8
Northern Hardwoods-Hemlock-White pine	43
Mixed Hardwoods-Hemlock-White pine	2
Wooded Wetland	0
Open Wetland	0


Fig. 13. Maidenhair fern, a rich-site indicator, Huntington, MA (photo by Lena Fletcher).

CONTINUOUS FOREST INVENTORY (CFI) DATA

The Continuous Forest Inventory (CFI) plots were established by Massachusetts state forestry agencies in the late 1950s. These are permanent 0.20-acre plots, laid out on a 0.5-mile square grid on all state forests and most state watershed protection land (Rivers 1998) (Fig. 14). Plot measurements were completed in 1960, 1965, 1980, and 2000. Data include plot descriptors and measurements of all trees ≥5.0 inches dbh (diameter at breast height). Deadwood and understory sampling were added in 2000 (Rivers 1998). Future sampling is planned at 10-year intervals. All analyses are based the 2000 CFI dataset (DCR 2000). The CFI data were analyzed using SAS 9.1.3 Statistical Software (SAS Institute Inc. 2004).

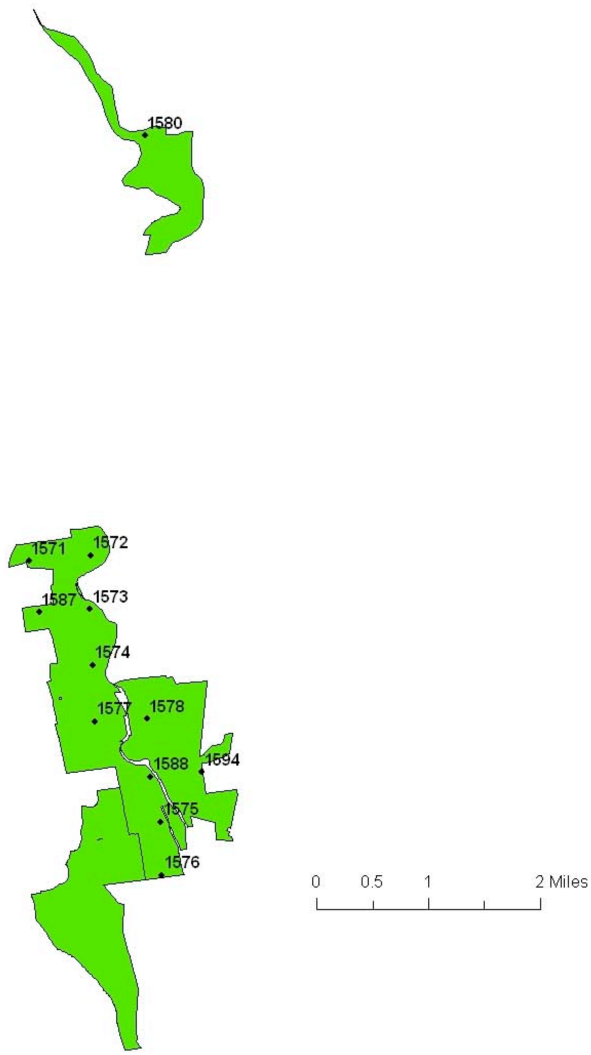

Fig. 14. Continuous Forest Inventory (CFI) plots, East Branch Forest Reserve. There are 12 plots that fall within the boundary of the Forest Reserve (DCR 2000). There are no permanent plots in the Wildlife Management Area.

Forest Age and Disturbance History

CFI plot ages are determined by coring 1-3 overstory trees located just outside the boundaries of each plot (Table 7). CFI plots in the East Branch Forest Reserve are between 45 and 98 years old.

Table 7. Plot age, East Branch Forest Reserve (DCR 2000).

CFI Plot Age		
Age (years)		**# Plots**
41-50		1
51-60		1
61-70		1
71-80		3
81-90		1
91-100		4
Listed as 0		1
	Total Plots	12
	Age Range	45-98

The CFI methods allow only one disturbance to be entered for each plot at each measurement date. The disturbance recorded may be the most recent disturbance or the most important disturbance to have affected the plot (e.g., if a plot was damaged by a windstorm in 1970 and then harvested in 1990, the recorded disturbance would have been changed from "wind" to "harvest cut" in the 2000 sampling). Therefore, the data do not represent a complete disturbance history of the plot. A completely disturbance record by plot can be found in Appendix B. One plot in the Reserve is noted as damaged by wind in 1998. Five plots were pastured between 1930 and 1960 and one plot was harvested in 1991 (Table 8).

Table 8. Summary of disturbances, East Branch Forest Reserve (DCR 2000).

CFI Plot Disturbance		
Disturbance Type		
Code	**Description**	**# Plots**
0	None	3
1	Fire	0
2	Wind	2
3	Snow & Ice	0
4	Other use, cleared	0
5	Other use, pastured	5
6	Insects	0
7	Disease	1
8	Timber stand improvement	0
9	Harvest cut	1
	Total	12

Live Trees

Size distribution in the East Branch Forest Reserve follows a typical inverse J-curve with larger numbers of trees in the smaller size classes (Fig. 15). The number of trees/acre declines progressively as dbh increases. Mean stand density based on data from 12 plots for the East Branch Forest Reserve for trees ≥ 5 inches dbh is 222.9 ± 24.8 stems/acre (95% confidence interval). Mean stand density for large trees (≥ 20 inches dbh) is 7.1 ± 8.3 stems/acre.

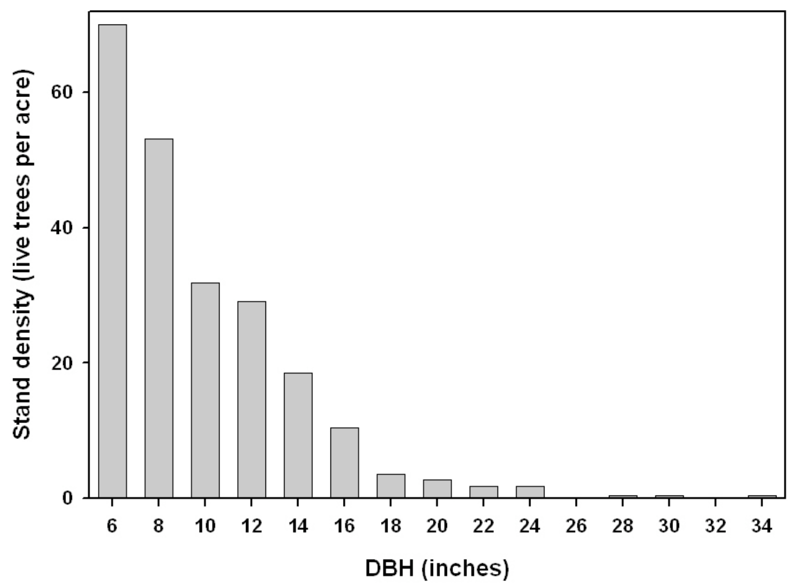

Fig. 15. Mean stand density (trees/acre) by 2-inch dbh classes (DCR 2000), East Branch Forest Reserve (N=12 plots).

Data from the 2000 CFI dataset indicate that the primary species in the East Branch Forest Reserve are hemlock, northern hardwoods, red maple, and white pine (Fig. 16). Hemlocks account for 26% of the total basal area. Northern hardwoods (beech, birch, sugar maple) and northern hardwood associates (white ash and black cherry) account for 21% of the total basal area. Red maple constitutes 19% of the basal area, while white pine makes up 16%. Live-tree biomass in 2000 was 90.1 ± 29.0 tons/acre (N = 12 plots).

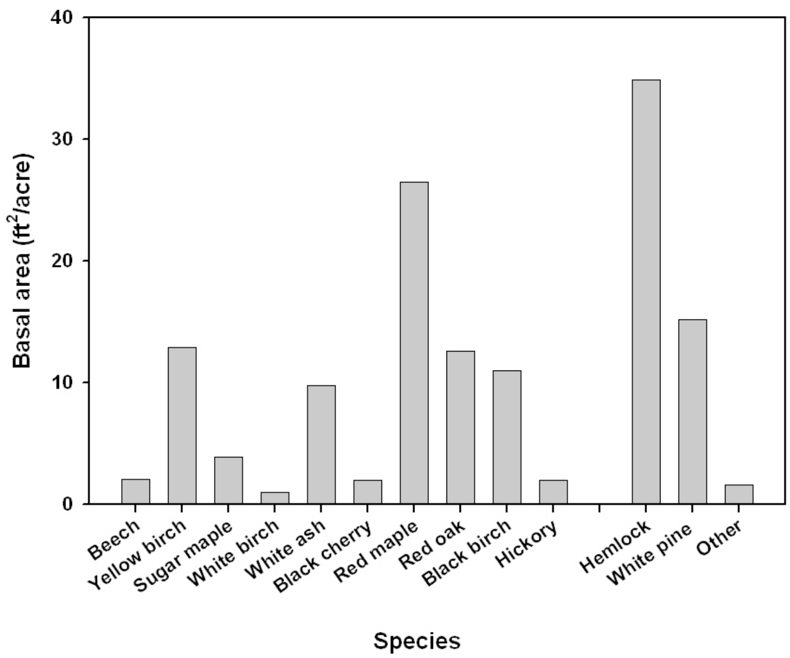

Fig. 16. Mean basal area (ft^2/acre) by species (DCR 2000), East Branch Forest Reserve (N=12 plots). “Other” includes basswood, poplar, other spruce, and unidentified species.

Deadwood

Biomass of standing deadwood (snags) and down deadwood (coarse woody debris) was estimated from volume calculations using specific gravity estimates by species, reduced for stages of decay (Tyrrell and Crow 1994, Chojnacky and Heath 2002, Woodall and Williams 2007). N=12 plots for all statistical analyses. The biomass estimate for standing deadwood was 3.1 ± 3.3 tons/acre. The down deadwood biomass estimate was 5.0 ± 10.7 tons/acre. Standing deadwood was primarily composed of red maple (45%) and hemlock (22%) (Fig. 17). Down deadwood was composed of northern hardwoods (primarily beech) (50%), hemlock (14%), black birch (6%), red maple (4%) with the remaining 26% composed primary of hickory with minor amounts of poplar, gray birch, basswood, elm, and unidentified species.

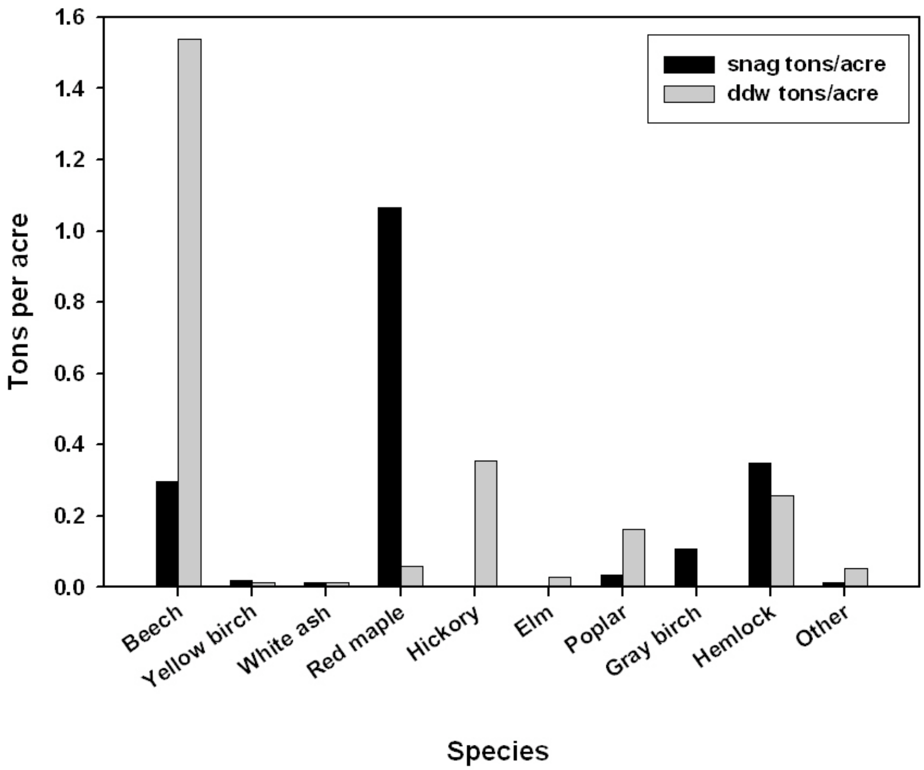

Fig. 17. Species composition of standing and down deadwood (DCR 2000), East Branch Forest Reserve, (N=12 plots). “Other” includes only unidentified species.

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Appendix A. East Branch Forest Reserve Species List

Trees and Shrubs

Ash	*Fraxinus* spp.
Balsam fir	*Abies balsamea*
Basswood	*Tilia americana*
Beech (American beech)	*Fagus grandifolia*
Bitternut hickory	*Carya cordiformis*
Black birch	*Betula lenta*
Black cherry	*Prunus serotina*
Butternut	*Juglans cinerea*
Chestnut	*Castanea dentata*
Elm	*Ulmus* spp.
Gray birch	*Betula populifolia*
Hemlock	*Tsuga canadensis*
Hickory	*Carya* spp.
Mountain laurel	*Kalmia latifolia*
Oaks	*Quercus* spp.
Poplar	*Populus spp.*
Red maple	*Acer rubrum*
Red oak (northern red oak)	*Quercus rubra*
Spruce	*Picea* spp.
Sugar maple	*Acer saccharum*
Tulip Tree	*Liriodendron tulipifera*
White ash	*Fraxinus americana*
White birch	*Betula papyrifera*
White oak	*Quercus alba*
White pine	*Pinus strobus*
Yellow birch	*Betula alleghaniensis*

Herbaceous Species

Bloodroot	*Sanguinaria canadensis*
Blue cohosh	*Caulophyllum thalictroides*
Maidenhair fern	*Adiantum pedatum*

Appendix B: CFI Plot Disturbance History

Plot #	State Forest	Description	Year
1571	Gilbert A. Bliss	None	0
1572	Gilbert A. Bliss	Disease	1996
1573	Gilbert A. Bliss	Wind	1998
1574	Gilbert A. Bliss	None	0
1575	Gilbert A. Bliss	Other use, pastured	1940
1576	Gilbert A. Bliss	None	0
1577	Gilbert A. Bliss	Other use, pastured	1930
1578	Gilbert A. Bliss	Wind	0
1579	Gilbert A. Bliss	Other use, pastured	1960
1580	Gilbert A. Bliss	Other use, pastured	1930
1587	Gilbert A. Bliss	Harvest cut	1991
1588	Gilbert A. Bliss	Other use, pastured	1955

Appendix C: Massachusetts Natural Heritage and Endangered Species Program, BioMap and Living Waters 2004.

The East Branch Forest Reserve protects substantial portions of 2 areas identified as core habitats by Massachusetts Natural Heritage. In the northern portion of the Reserve in the towns of Cummington and Chesterfield, this includes Core Habitat BM665. In the southern portion of the Reserve, in the town of Huntington, the Natural Heritage Core Habitat is BM744. In general, most of the Westfield River, its riparian and floodplain areas and associated forest uplands have been given priority status for biodiversity conservation.

Core Habitat BM665 (Cummington, Chesterfield)

This Core Habitat encompasses a section of the Westfield River, its tributaries, and adjacent forests. Highlights include a diverse Riverside Seep community, the presence of two Endangered plant species, and high-gradient streams that support Spring Salamanders. This Core Habitat also supports rare species of dragonflies, including the Riffle Snaketail that was first documented here over 100 years ago.

Natural Communities

This Core Habitat contains a moderate-sized Riverside Seep along a narrow section of riverbank on the Westfield River. Riverside Seeps are a mixed herbaceous community that occurs at the base of steep riverbanks where groundwater seeps out of the bottom of the upland slope. This enrichment leads to high species diversity. Although not well-buffered by forested upland, the seep here does contain good species diversity.

Plants

The only current Massachusetts population of the Endangered Spurred Gentian, a slender perennial with purplish-green flowers, grows along cool, mossy shores of the Westfield River. Another Endangered plant species, Muskflower, grows in springy areas and seeps around the river.

Invertebrates

In its northeast portion, this Core Habitat includes a 5-km stretch of the Westfield River, its tributaries, and surrounding forested uplands that are habitat for rare species of dragonflies such as the Riffle Snaketail, which has been known to inhabit this stretch of the Westfield River for well over 100 years! This Core Habitat is within dispersal distance of Core Habitats in Cummington, which allows for movement of Riffle Snaketails between these areas. Most of this Core Habitat is within the protected land of the Gilbert A. Bliss State Forest (now Forest Reserve) *and the Division of Fisheries and Wildlife's Westfield River Access Area.*

Vertebrates

This Core Habitat contains over 7 miles of connected high-gradient river and brook habitats that support populations of Spring Salamanders along the Westfield River and Tower, Oak Hill, and Jewel Brooks in Chesterfield. Over half of this Core Habitat is already protected as conservation land within the Chesterfield State Forest.

Natural Communities

Common Name	Scientific Name	Status
Riverside Seep		Imperiled

Plants

Common Name	Scientific Name	Status
Barren Strawberry	*Waldsteinia fragarioides*	Special Concern
Muskflower	*Mimulus moschatus*	Endangered
Spurred Gentian	*Halenia deflexa*	Endangered

Invertebrates

Common Name	Scientific Name	Status
Riffle Snaketail	*Ophiogomphus carolus*	Threatened

Vertebrates

Common Name	Scientific Name	Status
Spring Salamander	*Gyrinophilus porphyriticus*	Special Concern

Core Habitat BM744 (Huntington)

This Core Habitat includes portions of the Westfield and Little Rivers, as well as their surrounding forest uplands, which together support a diversity of plants and animals. Included are high-quality habitats for rare species of moths, dragonflies, tiger beetles, and plants, and also for Water Shrews and Four-toed Salamanders. This Core Habitat contains several patches of Rich, Mesic Forest within which the moist and nutrient-rich soils support a variety of springtime plants. Much of this Core Habitat is protected as conservation land.

Natural Communities

This Core Habitat contains numerous upland forest communities of good quality, including a series of Rich, Mesic Forest patches occurring along several miles of the Westfield River. Rich, Mesic Forests are a variant of northern hardwood forests dominated by Sugar Maple with a diverse herbaceous layer and many spring ephemerals, unusual plants that appear only in the spring, in a moist nutrient-rich environment. Here the patches are well-buffered by a large Northern Hardwoods-Hemlock-White Pine Forest that occupies much of the rolling terrain within this Core Habitat.

Plants

Two rare species of sedge inhabit areas of this Core Habitat, as does the Endangered Wild Senna, which grows in only two places in all of Massachusetts.

Invertebrates

This Core Habitat includes an 11-km stretch of the East Branch of the Westfield River and surrounding forested, unfragmented uplands in Huntington and Chesterfield that are critical habitat for many rare insect species. These species include river dragonflies such as the Ocellated Darner, Riffle Snaketail, and Ski-tailed Emerald; the Twelve-spotted Tiger Beetle, which inhabits the riverbanks; and the Ostrich Fern Borer moth, an inhabitant of the floodplain along the river. Many of these species also inhabit another Core Habitat, located less than 5 km to the southwest along the Middle Branch of the Westfield River, which probably allows for occasional dispersal between these two areas. Much of this Core Habitat is within the Knightville Dam & the Gilbert A. Bliss State Forest (now Forest Reserve) *; conservation of the remaining areas of unprotected land within this Core Habitat is desirable to increase the amount of contiguous protected habitat and to help ensure the long-term viability of rare species inhabiting the area…..*

Vertebrates

This Core Habitat contains habitat for Water Shrews along the Westfield River within the Knightville Wildlife Mangement Area. Habitat for Four-toed Salamanders is also present here in sphagnum pools in small, forested wetlands.

Natural Communities

Common Name	Scientific Name	Status
Circumneutral Talus Forest/Woodland		Vulnerable
Hemlock-Hardwood Swamp		Secure
Hickory-Hop Hornbeam Forest/Woodland		Imperiled
High-Energy Riverbank		Vulnerable
High-Terrace Floodplain Forest		Imperiled
Northern Hardwoods-Hemlock-White Pine Forest		Secure
Rich, Mesic Forest Community		Vulnerable

Plants

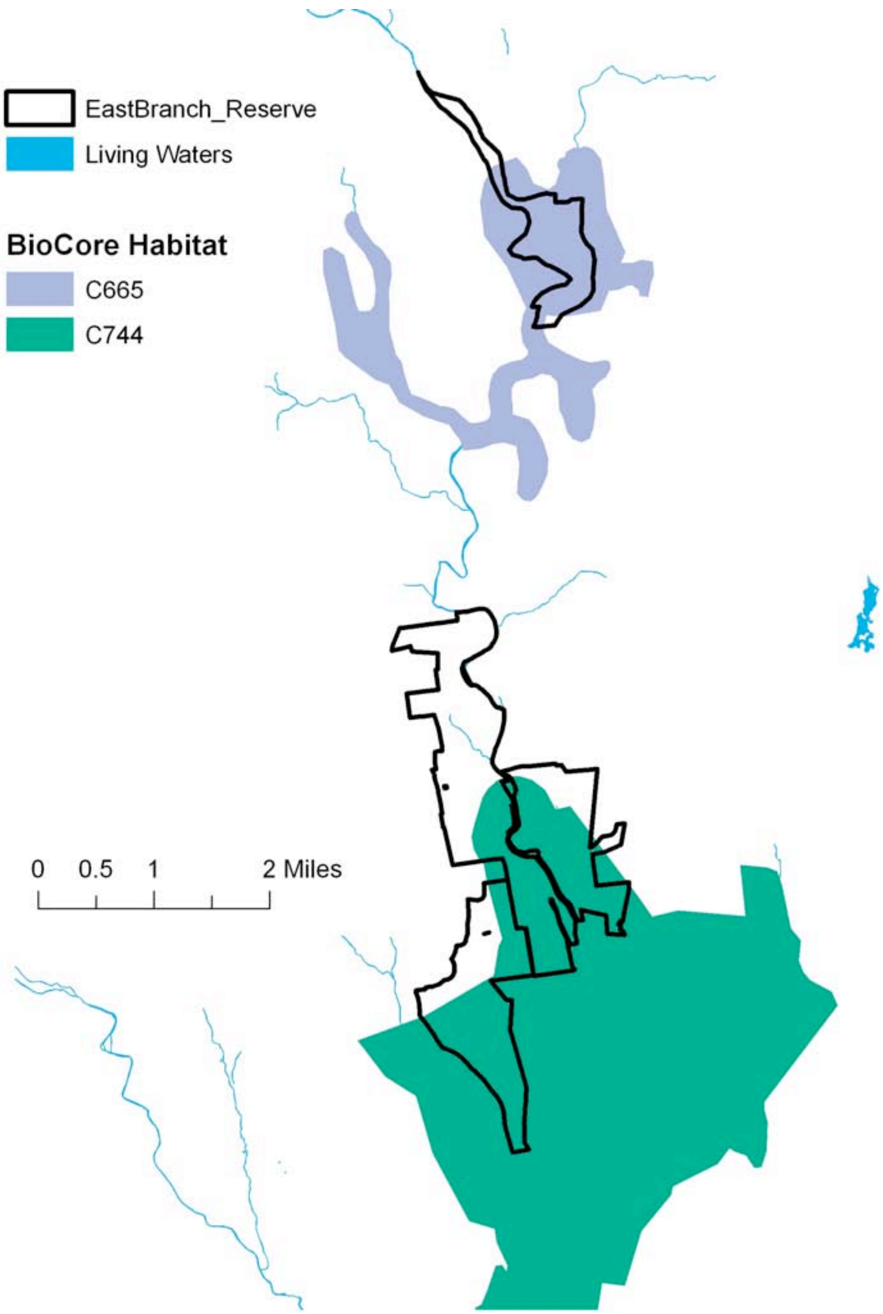
Common Name	Scientific Name	Status
Foxtail Sedge	*Carex alopecoidea*	Threatened
Hitchcock’s Sedge	*Carex hitchcockiana*	Special Concern
Muskflower	*Mimulus moshchatus*	Endangered
Wild Senna	*Senna hebecarpa*	Endangered

Invertebrates

Common Name	Scientific Name	Status
Ocellated Darner	*Boyeria grafiana*	Special Concern
Osrich Fern Borer Moth	*Papaipema sp. 2 near pterisii*	Special Concern
Riffle Snaketail	*Ophiogomphus carolus*	Threatened
Ski-Tailed Emerald	*Somatochlora elongata*	Special Concern
Twelve-Spotted Tiger Beetle	*Cicindela duodecimguttata*	Special Concern

Vertebrates

Common Name	Scientific Name	Status
Four-toed Salamander	*Hemidactylium scutatum*	Special Concern
Water Shrew	*Sorex palustris*	Special Concern



Appendix C. Fig. 1. Core Habitat designations within the East Branch Forest Reserve (NHESP 2004).