AN ASSESSMENT OF THE FOREST RESOURCES OF MASSACHUSETTS

APPENDIX

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Prepared for the
USDA Forest Service

June 2010

An Assessment of the Forest Resources of Massachusetts - Appendix

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The development and publication of this document were facilitated by grants from the Massachusetts Department of Conservation and Recreation and the National Association of State Foresters, and in-kind support from the University of Massachusetts Amherst, Department of Natural Resources Conservation.

Cover photographs by: Michael Jones (salamander), Lena Fletcher (children and canopy), and the Department of Conservation and Recreation.

Cover art by Jim Taylor.


Appendix

I.A. INTRODUCTION

PRIMARY DATA SOURCES

US Forest Service Forest Inventory Analysis (FIA)
FIA summary

The USDA Forest Service monitoring program is the Forest Inventory and Analysis (FIA). This nation-wide monitoring program conducts a three stage systematic sample of sites across all forested lands of the United States. Phase 1 involves remote sensing to identify where the forested land is. Plots are located on both forested and open land. Phase 2 is on the ground plot sampling, with one plot for every 6,000 acres of forest. On phase 2 plots field crews collect data on forest type, site attributes, and individual tree attributes. The Phase 3 sample involves a subset of the Phase 2 plots, with 1 plot per 96,000 acres, a much coarser sample. Phase 3, or Forest Health Monitoring (FHM) plots are measured for a variety of forest health attributes including crown conditions, lichen communities, understory vegetation, woody debris, and soil characteristics. There are 596 FIA phase 2 plots in Massachusetts. Their distribution across major land use and counties are shown below. The exact locations of the FIA plots are kept confidential (FIADB, 2009).

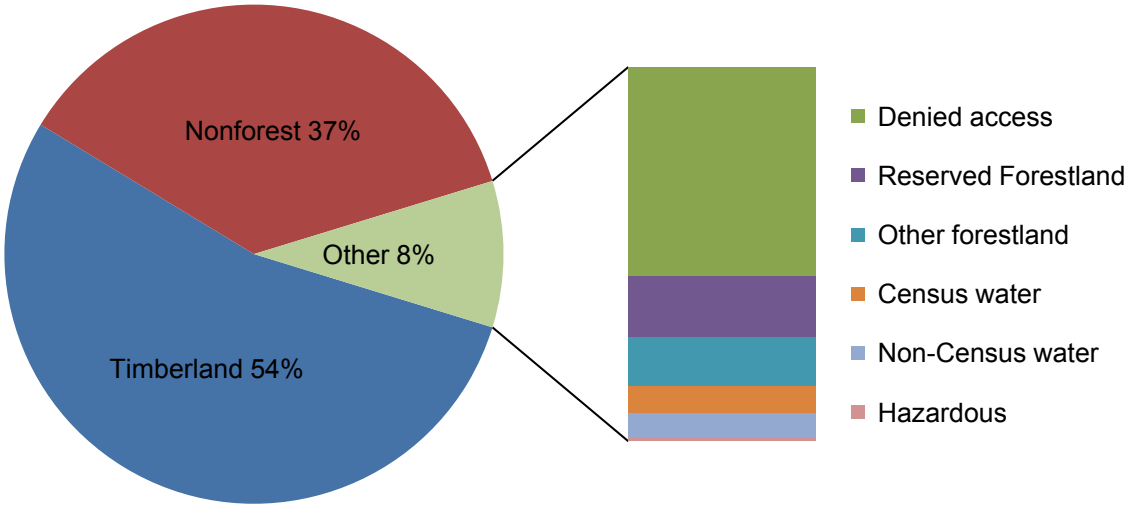

Fig. IA.1. Location of FIA plots in Massachusetts (U.S. Forest Service FIA, 2008).

Table IA.1. Distribution of FIA plots by land type and county (US Forest Service FIA, 2008).

County	*Total*	*Timberland (%)*	*Reserved forestland (%)*	*Other forestland (%)*	*Nonforest (%)*	*Non-Census water (%)*	*Census water (%)*	*Denied access (%)*	*Hazardous (%)*
Barnstable	29	6.3	3	1	15.9	0	1.1	1.8	0
Berkshire	70	49.7	1	0	14.8	0.2	0.3	4	0
Bristol	41	23	1	0	14.5	0	0.5	2	0
Dukes	6	2.3	1	0	2.6	0	0	0	0
Essex	40	13.3	0.3	1.8	23.3	0	0	1	0.4
Franklin	55	39.3	0	0	12.4	0	0.3	3	0
Hampden	50	33.3	0	0	13.9	0.4	0.1	2.3	0
Hampshire	41	31.4	0	0	7.6	0	0	2	0
Middlesex	60	21.1	1	0.3	35.1	0	0.3	2.3	0
Nantucket	3	1.4	0	0	1.3	0	0	0.3	0
Norfolk	30	10.3	1	2.8	15.9	0	0	0	0
Plymouth	48	21.3	0	0.9	24.8	0.7	0.3	0	0
Suffolk	4	0	0	0	4	0	0	0	0
Worcester	119	68.8	1	0.7	31.8	2.5	1.3	13	0
Total	596								

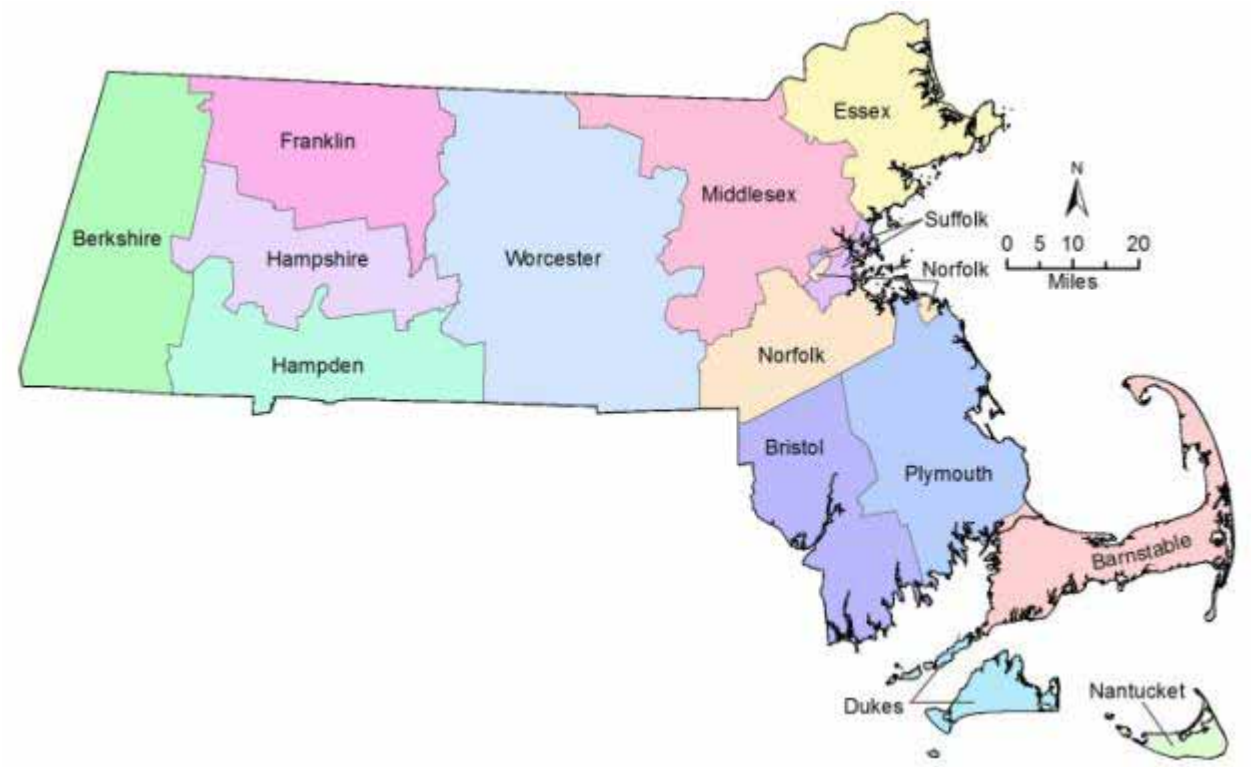

Figure IA.1. Counties of Massachusetts.

MassGIS

MassGIS is the Commonwealth's Office of Geographic and Environmental Information, within the Massachusetts Executive Office of Energy and Environmental Affairs (EEA). Through MassGIS, the Commonwealth has created a comprehensive, statewide database of spatial information for environmental planning and management. The state legislature has established MassGIS as the official state agency assigned to the collection, storage and dissemination of geographic data. In addition, the legistlative mandate includes coordinating GIS activity within the Commonwealth and setting standards for geographic data to ensure universal compatibility. MassGIS has implemented several ways of coordinating GIS activity in the Commonwealth. MassGIS staff are advised by the Massachusetts Geographic Information Council (MGIC). MGIC includes representatives from federal, state, regional, and local government agencies, GIS consultants, utilities, non-profit organizations, and academia (MassGIS, 2010).

Forest Conditions and Trends
C1.A. CONSERVATION OF BIOLOGICAL DIVERSITY

MASSACHUSETTS FOREST ASSOCIATED RARE SPECIES

Table C1.A1. Massachusetts forest associated rare species (Jacob Kubel, NHESP, 2010; NHESP, 2010).

Scientific Name	*Common Name*	*Taxonomic Group*	*MESA Status: 11 Jan 2010*
Invertebrates			
Acronicta albarufa	Barrens Daggermoth	Invertebrate Animal	T
Aeshna subarctica	Subarctic Darner	Invertebrate Animal	T
Anax longipes	Comet Darner	Invertebrate Animal	SC
Bagisara rectifascia	Straight Lined Mallow Moth	Invertebrate Animal	SC
Boyeria grafiana	Ocellated Darner	Invertebrate Animal	SC
Callophrys hesseli	Hessel's Hairstreak	Invertebrate Animal	SC
Callophrys lanoraieensis	Bog Elfin	Invertebrate Animal	T
Catocala herodias gerhardi	Gerhard's Underwing Moth	Invertebrate Animal	SC
Catocala pretiosa pretiosa	Precious Underwing Moth	Invertebrate Animal	E
Eacles imperialis	Imperial Moth	Invertebrate Animal	T
Enallagma carunculatum	Tule Bluet	Invertebrate Animal	SC
Enallagma daeckii	Attenuated Bluet	Invertebrate Animal	SC
Enallagma laterale	New England Bluet	Invertebrate Animal	SC
Enallagma pictum	Scarlet Bluet	Invertebrate Animal	T
Enallagma recurvatum	Pine Barrens Bluet	Invertebrate Animal	T
Erora laeta	Early Hairstreak	Invertebrate Animal	T
Gomphus abbreviatus	Spine-crowned Clubtail	Invertebrate Animal	E
Gomphus descriptus	Harpoon Clubtail	Invertebrate Animal	E
Gomphus fraternus	Midland Clubtail	Invertebrate Animal	E
Gomphus quadricolor	Rapids Clubtail	Invertebrate Animal	T
Gomphus vastus	Cobra Clubtail	Invertebrate Animal	SC
Gomphus ventricosus	Skillet Clubtail	Invertebrate Animal	SC
Lithophane viridipallens	Pale Green Pinion Moth	Invertebrate Animal	SC
Lycia rachelae	Twilight Moth	Invertebrate Animal	E
Neurocordulia obsoleta	Umber Shadowdragon	Invertebrate Animal	SC
Neurocordulia yamaskanensis	Stygian Shadowdragon	Invertebrate Animal	SC
Ophiogomphus aspersus	Brook Snaketail	Invertebrate Animal	SC
Ophiogomphus carolus	Riffle Snaketail	Invertebrate Animal	T
Papaipema sp. 2 nr. pterisii	Ostrich Fern Borer Moth	Invertebrate Animal	SC
Pieris oleracea	Mustard White	Invertebrate Animal	T
Pomatiopsis lapidaria	Slender Walker	Invertebrate Animal	E
Rhionaeschna mutata	Spatterdock Darner	Invertebrate Animal	SC
Rhodoecia aurantiago	Orange Sallow Moth	Invertebrate Animal	T
Satyrium favonius	Oak Hairstreak	Invertebrate Animal	SC
Somatochlora elongata	Ski-tipped Emerald	Invertebrate Animal	SC
Somatochlora forcipata	Forcipate Emerald	Invertebrate Animal	SC
Somatochlora georgiana	Coppery Emerald	Invertebrate Animal	E
Somatochlora incurvata	Incurvate Emerald	Invertebrate Animal	T
Somatochlora kennedyi	Kennedy's Emerald	Invertebrate Animal	E
Somatochlora linearis	Mocha Emerald	Invertebrate Animal	SC
Stenoporpia polygrammaria	Faded Gray Geometer	Invertebrate Animal	T
Stylurus amnicola	Riverine Clubtail	Invertebrate Animal	E
Stylurus scudderi	Zebra Clubtail	Invertebrate Animal	SC
Stylurus spiniceps	Arrow Clubtail	Invertebrate Animal	T

Scientific Name	*Common Name*	*Taxonomic Group*	*MESA Status: 11 Jan 2010*
Williamsonia fletcheri	Ebony Boghaunter	Invertebrate Animal	E
Williamsonia lintneri	Ringed Boghaunter (Banded Bog Skimmer)	Invertebrate Animal	E
Zale sp. 1 nr. lunifera	Pine Barrens Zale	Invertebrate Animal	SC
Zanclognatha martha	Pine Barrens Zanclognatha	Invertebrate Animal	T
Plants			
Acer nigrum	Black Maple	Vascular Plant	SC
Actaea racemosa	Black Cohosh	Vascular Plant	E
Adlumia fungosa	Climbing Fumitory	Vascular Plant	SC
Agastache scrophulariifolia	Purple Giant Hyssop	Vascular Plant	E
Ageratina aromatica	Lesser Snakeroot	Vascular Plant	E
Agrimonia pubescens	Hairy Agrimony	Vascular Plant	T
Amelanchier bartramiana	Bartram's Shadbush	Vascular Plant	T
Aplectrum hyemale	Putty-root	Vascular Plant	E
Arceuthobium pusillum	Dwarf Mistletoe	Vascular Plant	SC
Arisaema dracontium	Green Dragon	Vascular Plant	T
Asplenium montanum	Mountain Spleenwort	Vascular Plant	E
Asplenium ruta-muraria	Wall-rue Spleenwort	Vascular Plant	T
Betula pumila	Swamp Birch	Vascular Plant	E
Blephilia hirsuta	Hairy Wood-mint	Vascular Plant	E
Boechera laevigata	Smooth Rock-cress	Vascular Plant	T
Boechera missouriensis	Green Rock-cress	Vascular Plant	T
Cardamine douglassii	Purple Cress	Vascular Plant	E
Cardamine pratensis var. palustris	Fen Cuckoo Flower	Vascular Plant	T
Carex backii	Back's Sedge	Vascular Plant	E
Carex baileyi	Bailey's Sedge	Vascular Plant	T
Carex castanea	Chestnut-colored Sedge	Vascular Plant	E
Carex davisii	Davis's Sedge	Vascular Plant	E
Carex formosa	Handsome Sedge	Vascular Plant	T
Carex glaucodea	Glaucescent Sedge	Vascular Plant	E
Carex grayi	Gray's Sedge	Vascular Plant	T
Carex hitchcockiana	Hitchcock's Sedge	Vascular Plant	SC
Carex lupuliformis	False Hop-sedge	Vascular Plant	E
Carex mitchelliana	Mitchell's Sedge	Vascular Plant	T
Carex polymorpha	Variable Sedge	Vascular Plant	E
Carex tuckermanii	Tuckerman's Sedge	Vascular Plant	E
Carex typhina	Cat-tail Sedge	Vascular Plant	T
Cerastium nutans	Nodding Chickweed	Vascular Plant	E
Chamaelirium luteum	Devil's-bit	Vascular Plant	E
Claytonia virginica	Narrow-leaved Spring Beauty	Vascular Plant	E
Clematis occidentalis	Purple Clematis	Vascular Plant	SC
Conioselinum chinense	Hemlock Parsley	Vascular Plant	SC
Corallorhiza odontorhiza	Autumn Coralroot	Vascular Plant	SC
Cryptogramma stelleri	Fragile Rock-brake	Vascular Plant	E
Cynoglossum virginianum var. boreale	Northern Wild Comfrey	Vascular Plant	E
Cypripedium arietinum	Ram's-head Lady's-slipper	Vascular Plant	E
Cypripedium parviflorum var. makasin	Small Yellow Lady's-slipper	Vascular Plant	E
Cypripedium reginae	Showy Lady's-slipper	Vascular Plant	SC
Desmodium cuspidatum	Large-bracted Tick-trefoil	Vascular Plant	T

Scientific Name	Common Name	Taxonomic Group	MESA Status: 11 Jan 2010
Dichanthelium ovale ssp. pseudopubescens	Commons's Panic-grass	Vascular Plant	SC
Doellingeria infirma	Cornel-leaved Aster	Vascular Plant	E
Elymus villosus	Hairy Wild Rye	Vascular Plant	E
Equisetum scirpoides	Dwarf Scouring-rush	Vascular Plant	SC
Goodyera repens	Dwarf Rattlesnake-plantain	Vascular Plant	E
Huperzia selago	Mountain Firmoss	Vascular Plant	E
Hydrastis canadensis	Golden Seal	Vascular Plant	E
Hydrophyllum canadense	Broad Waterleaf	Vascular Plant	E
Ilex montana	Mountain Winterberry	Vascular Plant	E
Isotria medeoloides	Small Whorled Pogonia	Vascular Plant	E
Liparis liliifolia	Lily-leaf Twayblade	Vascular Plant	T
Listera cordata	Heartleaf Twayblade	Vascular Plant	E
Lonicera hirsuta	Hairy Honeysuckle	Vascular Plant	E
Luzula parviflora ssp. melanocarpa	Black-fruited Woodrush	Vascular Plant	E
Lycopus rubellus	Gypsywort	Vascular Plant	E
Lygodium palmatum	Climbing Fern	Vascular Plant	SC
Magnolia virginiana	Sweetbay Magnolia	Vascular Plant	E
Malaxis monophyllos var. brachypoda	White Adder's-mouth	Vascular Plant	E
Milium effusum	Woodland Millet	Vascular Plant	T
Mimulus alatus	Winged Monkey-flower	Vascular Plant	E
Moehringia macrophylla	Large-leaved Sandwort	Vascular Plant	E
Morus rubra	Red Mulberry	Vascular Plant	E
Oxalis violacea	Violet Wood-sorrel	Vascular Plant	E
Panax quinquefolius	Ginseng	Vascular Plant	SC
Penstemon hirsutus	Hairy Beardtongue	Vascular Plant	E
Petasites frigidus var. palmatus	Sweet Coltsfoot	Vascular Plant	E
Platanthera flava var. herbiola	Pale Green Orchis	Vascular Plant	T
Polystichum braunii	Braun's Holly-fern	Vascular Plant	E
Populus heterophylla	Swamp Cottonwood	Vascular Plant	E
Pyrola asarifolia ssp. asarifolia	Pink Pyrola	Vascular Plant	E
Quercus macrocarpa	Bur Oak	Vascular Plant	SC
Quercus muehlenbergii	Yellow Oak	Vascular Plant	T
Ranunculus micranthus	Tiny-flowered Buttercup	Vascular Plant	E
Rhododendron maximum	Great Laurel	Vascular Plant	T
Ribes lacustre	Bristly Black Currant	Vascular Plant	SC
Rosa acicularis ssp. sayi	Northern Prickly Rose	Vascular Plant	E
Sanicula canadensis	Canadian Sanicle	Vascular Plant	T
Sanicula odorata	Long-styled Sanicle	Vascular Plant	T
Solidago macrophylla	Large-leaved Goldenrod	Vascular Plant	T
Solidago simplex ssp. randii var. monticola	Rand's Goldenrod	Vascular Plant	E
Sorbus decora	Northern Mountain-ash	Vascular Plant	E
Sphenopholis nitida	Shining Wedgegrass	Vascular Plant	T
Sphenopholis pensylvanica	Swamp Oats	Vascular Plant	T
Symphyotrichum prenanthoides	Crooked-stem Aster	Vascular Plant	T
Thuja occidentalis	Arborvitae	Vascular Plant	E
Tipularia discolor	Cranefly Orchid	Vascular Plant	E
Trichomanes intricatum	Weft Bristle-fern	Vascular Plant	E
Triphora trianthophora	Nodding Pogonia	Vascular Plant	E
Viburnum rafinesquianum	Downy Arrowwood	Vascular Plant	E

Scientific Name	*Common Name*	*Taxonomic Group*	*MESA Status: 11 Jan 2010*
Waldsteinia fragarioides	Barren Strawberry	Vascular Plant	SC
Woodsia glabella	Smooth Woodsia	Vascular Plant	E
Vertebrates			
Accipiter striatus	Sharp-shinned Hawk	Vertebrate Animal	SC
Agkistrodon contortrix	Copperhead	Vertebrate Animal	E
Ambystoma jeffersonianum	Jefferson Salamander	Vertebrate Animal	SC
Ambystoma laterale	Blue-spotted Salamander	Vertebrate Animal	SC
Ambystoma opacum	Marbled Salamander	Vertebrate Animal	T
Asio otus	Long-eared Owl	Vertebrate Animal	SC
Carphophis amoenus	Eastern Worm Snake	Vertebrate Animal	T
Crotalus horridus	Timber Rattlesnake	Vertebrate Animal	E
Dendroica striata	Blackpoll Warbler	Vertebrate Animal	SC
Emydoidea blandingii	Blanding's Turtle	Vertebrate Animal	T
Glyptemys insculpta	Wood Turtle	Vertebrate Animal	SC
Haliaeetus leucocephalus	Bald Eagle	Vertebrate Animal	E
Myotis leibii	Small-footed Myotis	Vertebrate Animal	SC
Oporornis philadelphia	Mourning Warbler	Vertebrate Animal	SC
Pantherophis alleghaniensis	Eastern Rat Snake	Vertebrate Animal	E
Parula americana	Northern Parula	Vertebrate Animal	T
Scaphiopus holbrookii	Eastern Spadefoot	Vertebrate Animal	T
Sorex dispar	Rock Shrew	Vertebrate Animal	SC
Sorex palustris	Water Shrew	Vertebrate Animal	SC
Terrapene carolina	Eastern Box Turtle	Vertebrate Animal	SC
Vermivora chrysoptera	Golden-winged Warbler	Vertebrate Animal	E

Note: This is not an official list. Generally, this list includes Massachusetts Endangered Species Act (MESA)-listed species that (a) depend on forested conditions to meet some component of their life histories, (b) prefer forested conditions, or (c) commonly persist/occur in forested conditions, although other habitats may be preferred. "Forested conditions" are defined as forest communities (upland forest, floodplain forest, and forested swamps) consisting of moderate to substantial (~25-100%) overstory canopy cover, where the overstory consists predominantly of trees >20 ft tall.

Excluded from the list are species that are associated primarily with (a) aquatic habitats like lakes/ponds, rivers/streams, vernal pools, and/or the ocean (fish, clams, some plants, some snails, etc.), (b) open, disturbed features of water bodies (river bars/cobbles, banks, pond shores, beaches, etc.), (c) open balds, cliffs, and/or ledges, (d) meadows, fields, grasslands, (e) open wetlands (marshes, etc.), (f) shrublands/brushlands, and (g) open barrens.

The most difficult species to categorize were those associated with barrens, floodplain forests, and ledges. Generally, barrens species were considered forest associates only if they preferred the more heavily wooded/shaded parts of the barrens. Floodplain forest species were considered forest associates as long as they did not reside exclusively in inundated microhabitats (e.g., oxbows). Ledge species were classified as forest associates when they were dependent on or most common in shaded conditions.

"*Endangered*" (E) species are native species which are in danger of extinction throughout all or part of their range, or which are in danger of extirpation from Massachusetts, as documented by biological research and inventory.

"*Threatened*" (T) species are native species which are likely to become endangered in the forseeable future, or which are declining or rare as determined by biological research and inventory.

"*Special concern*" (SC) species are native species which have been documented by biological research or inventory to have suffered a decline that could threaten the species if allowed to continue unchecked, or which occur in such small numbers or with such restricted distribution or specialized habitat requirements that they could easily become threatened within Massachusetts.

Any native species listed as endangered or threatened by the U.S. Fish and Wildlife Service is also included on the state list. The rules and regulations and precise definitions relative to the establishment of the Commonwealth's list of endangered, threatened, and special concern species are set forth in 321 CMR 10.00 et seq.

C2.A. MAINTENANCE OF PRODUCTIVE CAPACITY OF FOREST ECOSYSTEMS

VARYING ESTIMATES OF FORESTLAND IN MASSACHUSETTS

U.S. Forest Service FIA

Table C2. A1. Estimates of forestland classifications for Massachusetts 1953-2008; 1953 and 1972 (Peters and Bowers, 1977), 1985 – 2008 (US Forest Service FIA, 2008).

	1953 (acres)	***1972 (acres)***	***1985 (acres)***	***1998 (acres)***	***2008 (acres)***
Total forestland	3,288,000	2,952,000	3,264,000	3,126,000	3,020,000
Timberland	3,259,000	2,798,000	2,965,000	2,632,000	2,895,000
Noncommercial forestland	29,000	154,000	299,000	495,000	125,000
Percent forested	65%	59%	64%	62%	57%

FIA identifies forestland as all land with at least 10% stocking, on at least one acre in area.

To some extent variations in timberland and noncommercial forestland estimates result from the US Forest Service working to refine definitions and methods to produce the most precise possible estimates. Specifically, timberland area appears to decrease in 1998 and increase in 2008. This does not reflect actual trends in the amount of timberland, but results from The Forest Service refining their definitions and methods used to identify the major land classes "Timberland", "Other forestland", "Noncommercial forestland" and "Water" during these inventories (Table C2.A1).

Table C2.A2. All major land uses for 1985, 1998, and 2008 (U.S. Forest Service FIA, 2008). Note that the temporary drop in "Timberlands" coincides with an increase in both "Other" and "Noncommercial" forestlands.

	1985 (acres)	***1998 (acres)***	***2008 (acres)***
Timberland	2,965,000	2,632,000	2,895,000
Reserved Forestland	208,000	126,000	65,000
Other forestland	90,000	368,000	60,000
Noncommercial forestland	299,000	495,000	125,000
Total forestland	3,264,000	3,126,000	3,020,000
Nonforest	1,752,000	1,890,000	1,931,000
Water	0	0	339,000
Total land	**5,016,000**	**5,010,000**	**5,289,000***

*including water (differences relate to definitions and mapping techniques).

MassGIS

Table C2.A3. Estimates of 2005 forestlands* in Massachusetts. (MassGIS, 2009 a,b)

	Total (acres)	***Permanently protected (acres)***
Forest	2,902,000	860,000
Forested Wetlands	285,000	83,000
Total	3,187,000	943,000

*Definition of forestland – tree cover covers at least 50% of the land.

U.S. FOREST SERVICE FIA DEFINITIONS

Growing-stock trees: Live trees of commercial species classified as sawtimber, poletimber, saplings, or seedlings; that is, all live trees of commercial species except rough and rotten trees.

Growing-stock volume: Net volume, in cubic feet, of growing-stock trees 5.0 inches diameter dbh. and larger from a 1-foot stump to a minimum 4.0-inch top diameter outside bark of the central stem, or to the point where the central stem breaks into limbs. Net volume equals gross volume less deduction for cull.

NonCommercial or Reserved Forestland: Forestland that does not meet the definition of "timberland" (see below).

Sawtimber tree: A live tree of commercial species at least 9.0 inches dbh. for softwoods or 11.0 inches for hardwoods, containing at least one 12-foot sawlog or two noncontiguous 8-foot sawlogs, and meeting regional specifications for freedom from defect.

Sawtimber volume: Net volume in board feet, by the International 1/4-inch rule, of sawlogs in sawtimber trees. Net volume equals gross volume less deductions for rot, sweep, and other defects that affect use for lumber.

Timberland: Forestland producing or capable of producing crops of industrial wood (more than 20 cubic feet per acre per year) and not withdrawn from timber utilization (formerly known as commercial forestland).

ADDITIONAL GRAPHS AND TABLES

Table C2.A4. Forest cutting plan summary data 2003 – 2009 (DCR, 2009a).

	Parcel size (acres)	*Forest cutting plans per year*	*Harvest Intensity (ft^3/acre)*	*Volume harvested (ft^3/year)*
2004	42.0	633	460	3,743,200
2005	41.8	633	480	4,183,800
2006	42.3	662	550	6,107,800
2007	47.9	640	550	5,059,000
2008	45.4	544	540	4,768,000
2009	44.7	443	570	3,462,300
Average 2004-2009	44.0	593	530	4,554,000
Standard deviation	2.4	84	45	969,700

Table C2. A5. Management on State Forest land, 2004 to 2008, (DCR, 2009b).

Fiscal Year	*Foresters*	*Acres*	*Revenue ($)*	*Improvements value ($)*	*Volume MBF**	*Volume cords***	*Volume tons****
2004	13	1,370	620,685	159,882	4,867	2,995	3,153
2005	9	1,716	530,336	171,309	4,657	6,627	2,130
2006	9	1,702	715,015	143,808	4,939	5,198	2,205
2007	9	1,734	896,526	140,171	5,498	4,400	3,189
2008	10	1,874	1,112,050	131,380	7,498	5,717	5,118

* saw logs
** fuelwood
*** pulpwood

C3.A. MAINTENANCE OF FOREST ECOSYSTEM HEALTH AND VITALITY

INVASIVE PLANT SPECIES IDENTIFIED BY THE MASSACHUSETTS INVASIVE PLANT ADVISORY GROUP (MIPAG)

Invasive (33)
"Invasive plants" are non-native species that have spread into native or minimally managed plant systems in Massachusetts. These plants cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems.

Acer platanoides L. (Norway maple)
Acer pseudoplatanus L. (Sycamore maple)
Aegopodium podagraria L. (Bishop's goutweed; bishop's weed; goutweed)
Ailanthus altissima (P. Miller) Swingle (Tree of heaven)
Alliaria petiolata (Bieb.) Cavara & Grande (Garlic mustard)
Berberis thunbergii DC. (Japanese barberry)
Cabomba caroliniana A.Gray (Carolina fanwort; fanwort)
Celastrus orbiculatus Thunb. (Oriental bittersweet; Asian or Asiatic bittersweet)
Cynanchum louiseae Kartesz & Gandhi (Black swallow-wort, Louise's swallow-wort)
Elaeagnus umbellata Thunb. (Autumn olive)
Euonymus alatus (Thunb.) Sieb. (Winged euonymus; Burning bush)
Euphorbia esula L. (Leafy spurge; wolf's milk)
Frangula alnus P. Mill. (European buckthorn; glossy buckthorn)
Glaucium flavum Crantz (Sea or horned poppy; yellow hornpoppy)
Hesperis matronalis L. (Dame's rocket)
Iris pseudacorus L. (Yellow iris)
Lepidium latifolium L. (Broad-leaved pepperweed; tall pepperweed)
Lonicera japonica Thunb. (Japanese honeysuckle)
Lonicera morrowii A.Gray (Morrow's honeysuckle)
Lonicera x bella Zabel [*morrowii* x *tatarica*] (Bell's honeysuckle)
Lysimachia nummularia L. (Creeping jenny; moneywort)
Lythrum salicaria L. (Purple loosestrife)
Myriophyllum heterophyllum Michx. (Variable water-milfoil; Two-leaved water-milfoil)
Myriophyllum spicatum L. (Eurasian or European water-milfoil; spike water-milfoil)
Phalaris arundinacea L. (Reed canary-grass)
Phragmites australis (Cav.) Trin. ex Steud. subsp. australis (Common reed)
Polygonum cuspidatum Sieb. & Zucc. (Japanese knotweed; Japanese or Mexican Bamboo)
Potamogeton crispus L. (Crisped pondweed; curly pondweed)
Ranunculus ficaria L. (Lesser celandine; fig buttercup)
Rhamnus cathartica L. (Common buckthorn)
Robinia pseudoacacia L. (Black locust)
Rosa multiflora Thunb. (Multiflora rose).
Trapa natans L. (Water-chestnut)

Likely Invasive (29)
"Likely Invasive plants" are non-native species that are naturalized in Massachusetts but do not meet the full criteria that would trigger an "Invasive plant" designation

Ampelopsis brevipedunculata (Maxim.) Trautv. (Porcelain-berry; Amur peppervine)
Anthriscus sylvestris (L.) Hoffmann (Wild chervil)
Berberis vulgaris L. (Common barberry; European barberry)
Cardamine impatiens L. (Bushy rock-cress; narrowleaf bittercress)
Centaurea biebersteinii DC. (Spotted knapweed)
Cynanchum rossicum (Kleopov) Borhidi (European swallow-wort; pale swallow-wort)
Egeria densa Planchon (Brazilian waterweed; Brazilian elodea)
Epilobium hirsutum L. (Hairy willow-herb; Codlins and cream)
Euphorbia cyparissias L. (Cypress spurge)
Festuca filiformis Pourret (Hair fescue; fineleaf sheep fescue)

Glyceria maxima (Hartman) Holmburg (Tall mannagrass; reed mannagrass)
Heracleum mantegazzianum Sommier & Levier (Giant hogweed)
Humulus japonicus Sieb. & Zucc. (Japanese hops)
Hydrilla verticillata (L.f.) Royle (Hydrilla; water-thyme; Florida elodea)
Ligustrum obtusifolium Sieb. & Zucc. (Border privet)
Lonicera tatarica L. (Tatarian honeysuckle)
Microstegium vimineum (Trin.) A. Camus (Japanese stilt grass; Nepalese browntop)
Miscanthus sacchariflorus (Maxim.) Franch. (Plume grass; Amur silvergrass)
Myosotis scorpioides L. (Forget-me-not)
Myriophyllum aquaticum (Vell.) Verdc. (Parrot-feather; water-feather; Brazilian watermilfoil)
Najas minor All. (Brittle water-nymph; lesser naiad)
Nymphoides peltata (Gmel.) Kuntze (Yellow floating heart)
Phellodendron amurense Rupr. (sensu lato) (Amur cork-tree)
Pueraria montana (Lour.) Merrill (Kudzu; Japanese arrowroot)
Ranunculus repens L. (Creeping buttercup)
Rorippa amphibia (L.) Bess. (Water yellowcress; great yellowcress)
Rubus phoenicolasius Maxim. (Wineberry; Japanese wineberry; wine raspberry)
Senecio jacobaea L. (Tansy ragwort; stinking Willie)
Tussilago farfara L. (Coltsfoot)

Potentially Invasive (4)
"Potentially invasive plants" are non-native species not currently known to be naturalized in Massachusetts, but that can be expected to become invasive within minimally managed habitats within the Commonwealth.

Arthraxon hispidus (Thunb.) Makino (Hairy joint grass; jointhead; small carpetgrass)
Carex kobomugi Ohwi (Japanese sedge; Asiatic sand sedge)
Lonicera maackii (Rupr.) Herder (Amur honeysuckle)
Polygonum perfoliatum L. (Mile-a-minute vine or weed; Asiatic tearthumb)

Table C3.A1. Insects and Disease: 1999 – 2008 (Massachusetts DCR Forest Health Program, 2009).
*Forest tent caterpillar, winter moth, and gypsy moth accounted for 85% of the annual defoliation 1999 – 2008 (Table C3.A3).

Agent or observation	*Preferred Host*
Anthracnose	Many hosts
Armillaria root disease	Many spp. of woody plants, specifically damaging or killing already stressed individuals
Ash decline/yellows	Ash
Bark beetles	Many conifers and deciduous tree spp.
Beech bark disease	American beech
Birch leafminer	Birch spp.
Black turpentine beetle	Eastern white pine, pitch pine, and red spruce
Browntail moth	Oaks, shadbush, apple, cherry, beach plum, and rugosa rose
Diplodia blight	Exotic and native pine spp., particularly red pine in Mass.
Eastern tent caterpillar	Primarily cherry, apple, crabapple, also hawthorn and maple.
Fall cankerworm	Apple and elm, also hickory, maple, ash, yellow birch, beech, basswood, boxelder, cherry, oak
Foliage discoloration	
Forest tent caterpillar*	Sugar maple, aspen
Gypsy moth*	Oaks
Hardwood anthracnose	hardwood species, including ash, basswood, birch, catalpa, elm, hickory, horsechestnut, maple, oak, sycamore, tulip tree, and walnut
Hemlock looper	Eastern hemlock
Hemlock woolly adelgid	Eastern hemlock
Japanese beetle	
June beetle	
Leaf blister of oak	Oaks
Leaf spots	Numerous hardwood spp.
Leafcutting bees	
Locust borer	Black locust
Locust leafminer	Black locust
Looper	Pitch pine
Maple leafcutter	Maple spp.
Maple trumpet skeletonizer	Sugar and red maple
Nantucket pine tip moth	All pine species except eastern white pine
Oak decline	Oaks
Oak skeletonizer	Oaks
Pear thrips	Maple, birch, ash, black cherry, beech
Periodical cicada	Deciduous trees
Pine needleminer	Eastern white pine
Red pine scale	Red pine
Spruce aphid	Spruce
White pine sawfly	White pine
Winter moth*	Oaks, maples, basswood, ash, crabapples, apple, blueberry,

Table C3.A2. Other forest pests (Abiotic, human, mammal).

Agent or observation
Drought
Flooding/high water
Logging damage
Human caused fire
Fire
Beaver
Wind-tornado
Winter injury
Human activities
Land use conversion
Wild-fire
Road salt
Harvest
Land clearing
Abiotic damage
Suppression
Broken top
Improper planting technique

Table C3.A2. Top 3 defoliation agents 1999-2008* (Massachusetts DCR Forest Health Program, 2009).

Year	*Total Acres*	*Agent 1*	*Acres*	*(%)*	*Agent 2*	*Acres*	*(%)*	*Agent 3*	*Acres*	*(%)*
1999	74,095	pear thrips	40,737	55	unknown	11,098	15	gypsy moth	9,823	13
2000	44,926	gypsy moth	44,656	99	hwa	260	1	beech bark disease	9	0
2001	49,325	gypsy moth	48,021	97	beech bark disease	1,293	3	hwa	20	0
2002	18,139	fall cankerworm	5,261	29	gypsy moth	4,744	26	drought	2,612	14
2003	77,791	winter moth	33,332	43	forest tent caterpillar	6,857	9	beech bark disease	4,859	6
2004	154,217	forest tent caterpillar	44,787	29	gypsy moth	34,761	23	winter moth	34,125	22
2005	293,116	forest tent caterpillar	204,616	70	gypsy moth	35,433	12	pine needle miner	22,624	8
2006	570,055	forest tent caterpillar	405,557	71	gypsy moth	118,935	21	Nantucket pine tip moth	30,024	5
2007	126,208	winter moth	42,987	34	gypsy moth	27,031	21	forest tent caterpillar	21,809	17
2008	59,830	winter moth	27,875	47	gypsy moth	15,323	26	periodical cicada	8,551	14

*Totals for the ten year period were omitted because the same area may be defoliated repeatedly; thus, the total area defoliated is probably considerably less than the sum of the yearly total acres.

Table C3.A4. Towns infested with hemlock woolly adelgid (Forest Health Monitoring Program, 2009).

Year reported	*Town*	*Year reported*	*Town*
1989	SPRINGFIELD	**2000**	GREAT BARRINGTON
1990	WALTHAM		NORTHBRIDGE
1991	STOUGHTON		DUXBURY
1992	SOUTHWICK		WARE
	AGAWAM		BELCHERTOWN
	LONGMEADOW		CANTON
	PLYMOUTH		CLINTON
	MASHPEE		MELROSE
	MANCHESTER		QUINCY
	NEWTON		GRANVILLE
	BROOKLINE		HOLLAND
	MILTON		GREENFIELD
1993	LAKEVILLE		GRAFTON
	CHICOPEE		HADLEY
	SANDWICH		SOUTH HADLEY
	BRIMFIELD		PETERSHAM
	TAUNTON		HOPEDALE
	WAREHAM		NORTHBORO
	CAMBRIDGE		ROCHESTER
	WESTPORT		MATTAPOISETT
	REHOBOTH	**2001**	CARLISLE
	BARNSTABLE (OSTERVILLE)		BILLERICA
	RUSSELL		BREWSTER
1994	NORTHAMPTON		ROCKPORT
	SEEKONK		NORTHFIELD
1995	HOLYOKE		WEST BROOKFIELD
	WESTHAMPTON		MILLBURY
	YARMOUTH		EDGARTOWN
	DENNIS		CHESTERFIELD
	SHEWSBURY		WILLIAMSBURG
	LEICESTER		CHARLTON
	AMHERST	**2002**	HOPKINTON
	DOUGLAS		ASHLAND
	BOYLSTON		HOLLISTON
1996	GLOUCESTER (MAGNOLIA)		HUDSON
	HINGHAM		MARLBORO
	WILBRAHAM		WATERTOWN
	FALL RIVER		BELMONT

Year reported	Town	Year reported	Town
	SUTTON		MEDFORD
1997	COHASSET		SOMERVILLE
	NORWELL		LEXINGTON
	ATTLEBORO		WINCHESTER
	NORTH ATTLEBORO		BURLINGTON
	WORCESTER		MARBLEHEAD
	SHERBORN		DANVERS
	DARTMOUTH		EASTHAMPTON
	BOURNE		WHATELY
	EASTON		EAST LONGMEADOW
	EAST BRIDGEWATER		GRANBY
	BLACKSTONE		WENDELL
	NEW BEDFORD		BRAINTREE
	SWAMPSCOTT		AMESBURY
	STURBRIDGE		MILFORD
	FOXBORO		HANSON
	MONTAGUE		HAMILTON
	LINCOLN		EGREMONT
1998	NORTON		SHEFFIELD
	BEVERLY		HARVARD
	WEST TISBURY		NORTH ANDOVER
	DOVER		NORTH READING
	HALIFAX		GEORGETOWN
	FAIRHAVEN		UXBRIDGE
	SOUTH DEERFIELD		HAVERHILL
	WEST SPRINGFIELD		LANCASTER
	WARREN		READING
	PELHAM		STOCKBRIDGE
	SOUTHAMPTON		EAST BROOKFIELD
	BOSTON		FALMOUTH
	WESTFIELD		CONWAY
1999	HAMPDEN		MONSON
	ARLINGTON	2003	HANOVER
	NATICK		GILL
	WALPOLE		NORFOLK
	NEWBURYPORT		WESTWOOD
	WESTBORO		MARSHFIELD
	WELLESLEY		AUBURN
	LEVERETT		BROCKTON
	CONCORD	2004	HYANNIS
	SOUTHBORO		EASTHAM

Appendix

Year reported	Town	Year reported	Town
	WOBURN		SCITUATE
	MIDDLEBORO		ORLEANS
	SUNDERLAND		FALMOUTH (COTUIT)
	ACTON		NORFOLK
	PALMER	**2005**	BERNARDSTON
	MARION		COLRAIN
	SHARON		CHARLEMONT
	NEEDHAM		LYDEN
	FREETOWN		CHESTER
	WESTON		BLANDFORD
	ACUSHNET		MT. WASHINGTON
	HARDWICK	**2006**	SHELBURNE
	NEW SALEM	**2007**	BOXBORO
	FRAMINGHAM		CHELMSFORD
	SOUTHBRIDGE		LITTLETON
			PRINCETON
			WESTMINISTER
			LYNN
		2008	TOWNSEND
		2009	ERVING

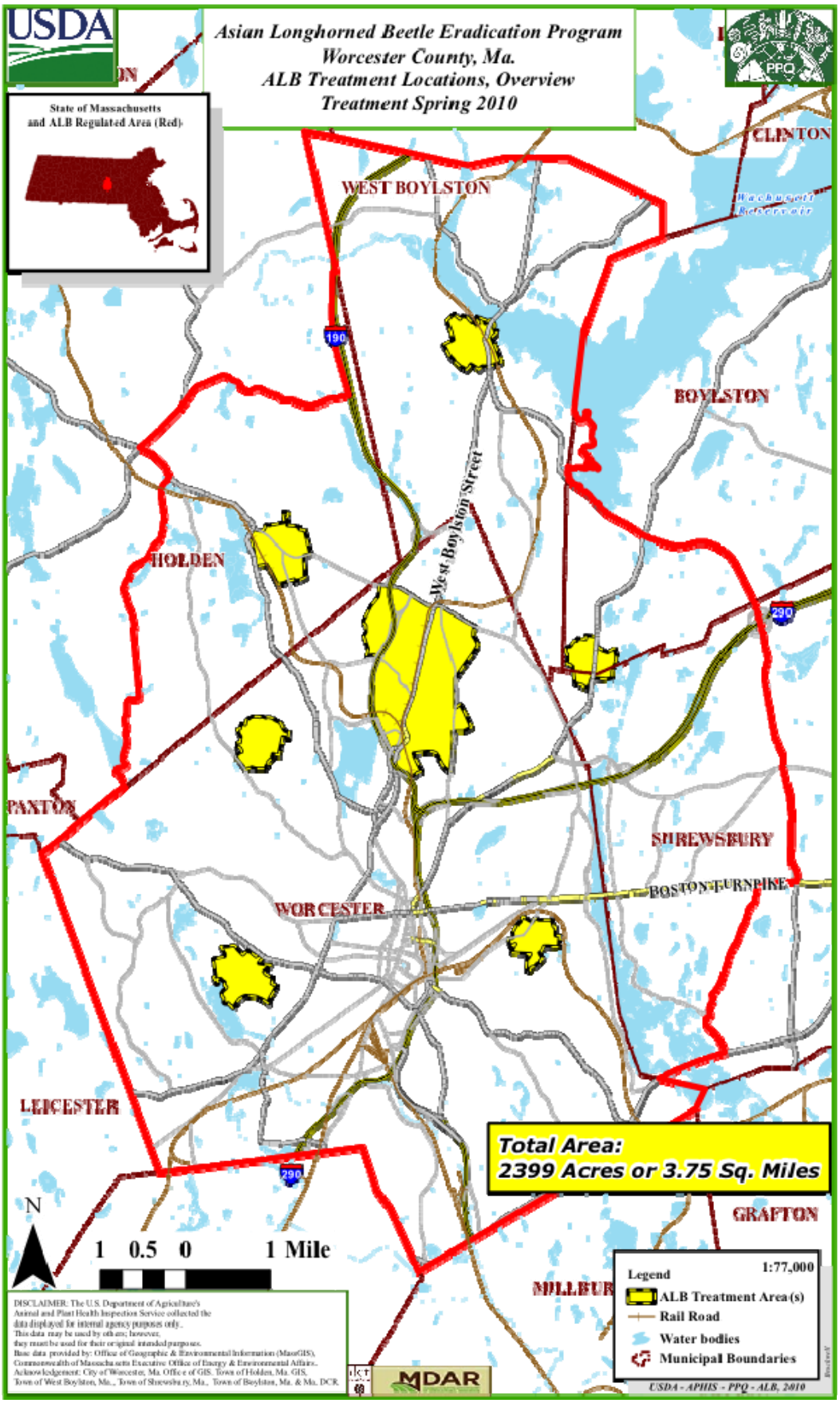

Figure C3.A1. Asian Longhorned Beetle in Worcester, treatment locations.

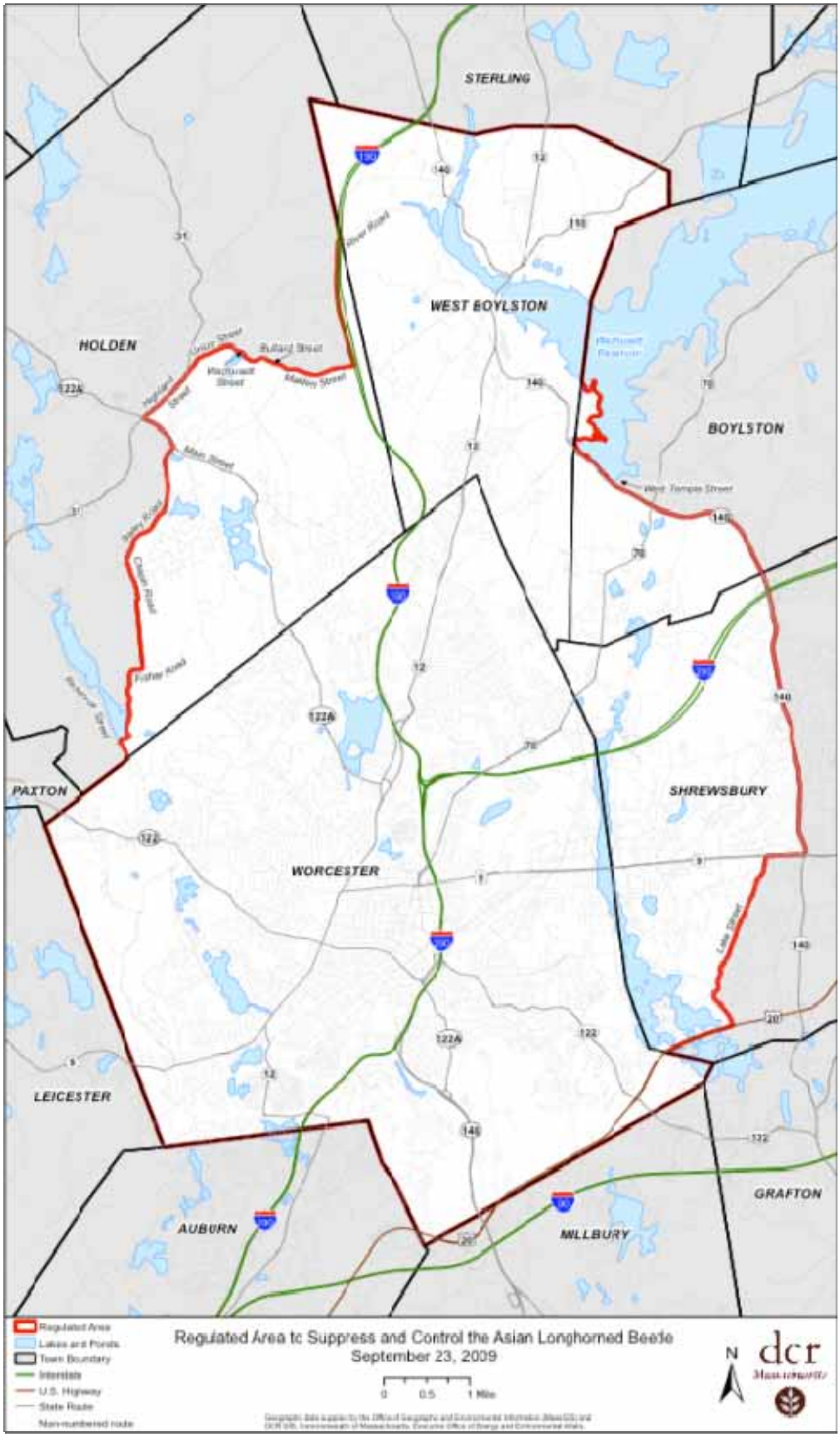

Figure C3.A2. Asian Longhorned Beetle in Worcester, regulated area.

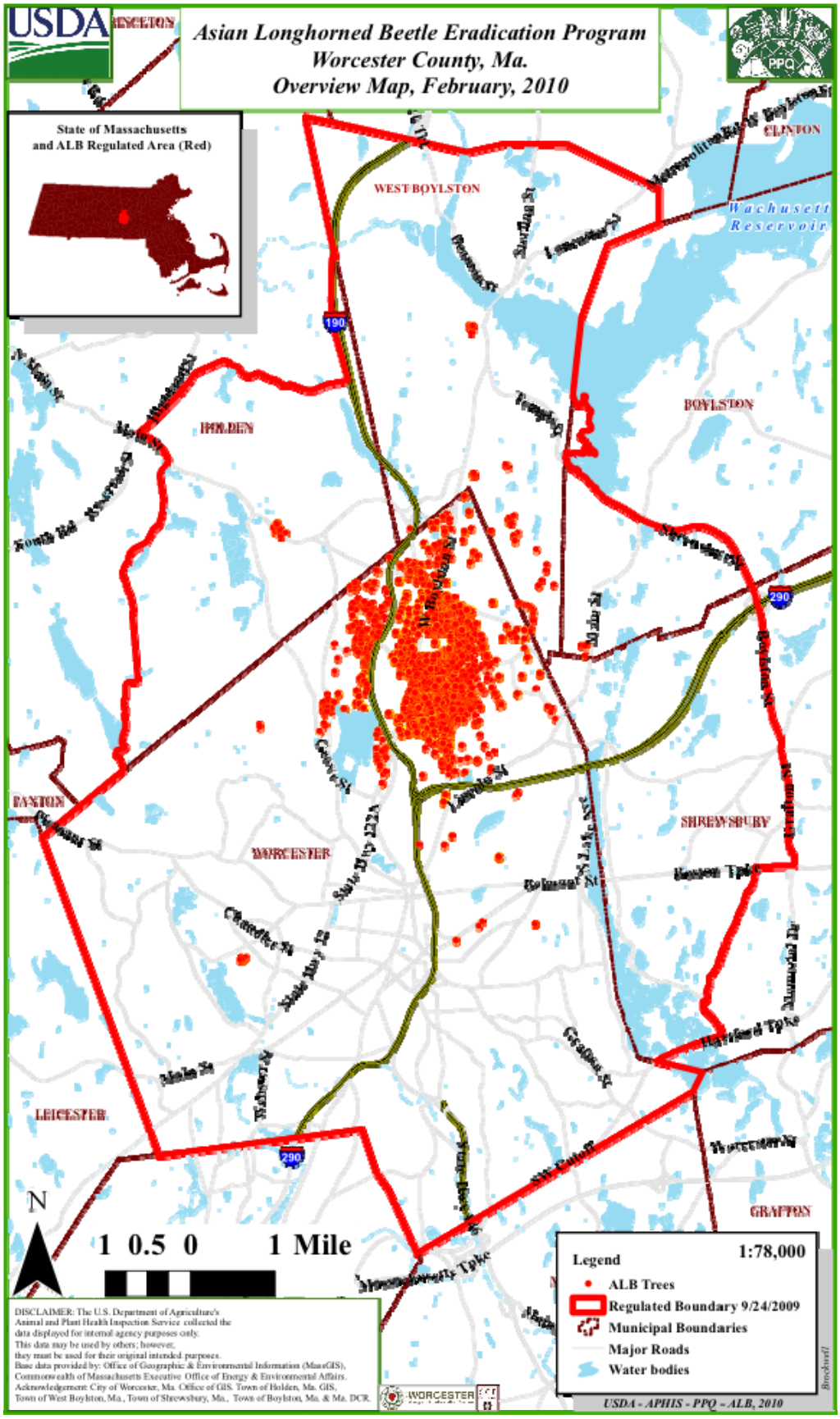

Figure C3.A3. Asian Longhorned Beetle in Worcester, infested tree locations.

C4.A. CONSERVATION AND MAINTENANCE OF SOIL AND WATER RESOURCES

Table C4.A1. Massachusetts HUC 8 Subbasins, identification.

HUC 8 subbasin	*States*	*HUC 8 number*
Blackstone	MA, RI	01090003
Cape Cod	MA, RI	01090002
Charles	MA	01090001
Chicopee	MA	01080204
Concord	MA	01070005
Deerfield	MA,VT	01080203
Farmington	CT, MA	01080207
Housatonic	CT, MA, NY	01100005
Hudson-Hoosic	MA, NY, VT	02020003
Lower Connecticut	CT, MA	01080205
Merrimack	MA, NH	01070002
Middle Connecticut	MA, NH, VT	01080201
Middle Hudson	CT, MA, NY	02020006
Miller	MA, NH	01080202
Narraganset	MA, RI	01090004
Nashua	MA, NH	01070004
Piscataqua-Salmon Falls	ME, NH, MA	01060003
Quinebaug	CT, MA, RI	01100001
Shetucket	CT, MA	01100002
Westfield	MA, VT	01080206

Table C4.A2. Massachusetts HUC 8 Subbasins, Area (Ability to Produce Clean Water (APCW, 2009).

HUC 8 Subbasin	*States*	*Total area (acres)*	*Land area (acres)*	*Water area (acres)*
Blackstone	MA RI	305,565	297,729	7,836
Cape Cod	MA RI	1,432,824	927,990	504,834
Charles	MA	726,122	637,449	88,673
Chicopee	MA	461,485	429,602	31,883
Concord	MA	260,670	252,571	8,099
Deerfield	MA, VT	423,689	417,758	5,931
Farmington	CT, MA	387,122	375,392	11,730
Housatonic	CT, MA, NY	1,237,723	1,206,389	31,334
Hudson-Hoosic	MA, NY, VT	1,210,994	1,193,104	17,891
Lower Connecticut	CT, MA	708,177	685,154	23,023
Merrimack	MA, NH	1,486,995	1,393,216	93,779
Middle Connecticut	MA, NH, VT	644,612	630,250	14,362
Middle Hudson	CT, MA, NY	1,555,210	1,518,189	37,021
Miller	MA, NH	247,185	240,827	6,358
Narragansett	MA, RI	857,519	738,853	118,666
Nashua	MA, NH	341,751	330,526	11,225
Piscataqua-Salmon Falls	ME	900,238	867,270	32,968
Quinebaug	CT, MA, RI	468,982	456,789	12,193
Shetucket	CT, MA	336,088	330,351	5,737
Westfield	CT, MA	332,115	327,058	5,057

Table C4.A3. Massachusetts HUC 8 Subbasins, Land Use (APCW, internal data, 2009).

HUC 8 subbasin	*Land area (acres)*	*Forest area (acres)*	*Forested area (%)*	*Agricultural area (acres)*	*Agricultural area (%)*
Blackstone	297,729	191,641	64	21,074	7
Cape Cod	927,990	395,055	43	62,771	7
Charles	637,449	261,100	41	30,404	5
Chicopee	429,602	347,368	81	34,074	8
Concord	252,571	133,776	53	19,928	8
Deerfield	417,758	365,561	88	28,468	7
Farmington	375,392	291,177	78	24,521	7
Housatonic	1,206,389	865,861	72	155,840	13
Hudson-Hoosic	1,193,104	817,514	69	266,159	22
Lower Connecticut	685,154	389,957	57	72,383	11
Merrimack	1,393,216	994,148	71	100,061	7
Middle Connecticut	630,250	496,731	79	58,694	9
Middle Hudson	1,518,189	1,061,956	70	281,512	19
Miller	240,827	204,480	85	9,300	4
Narragansett	738,853	396,544	54	63,022	9
Nashua	330,526	235,126	71	31,306	9
Piscataqua-Salmon Falls	867,270	638,783	74	72,665	8
Quinebaug	456,789	350,587	77	49,825	11
Shetucket	330,351	265,530	80	29,170	9
Westfield	327,058	273,117	84	20,944	6

Table C4.A4. Massachusetts HUC 8 Subbasins, Forest (APCW, 2009).

HUC 8 subbasin	*Total forest area (acres)*	*Public forest area (acres)*	*Public forest area (%)*	*Private forest area (acres)*	*Private forest area (%)*
Blackstone	191,641	11,621	6	180,020	94
Cape Cod	395,055	75,300	19	319,754	81
Charles	261,100	62,546	24	198,553	76
Chicopee	347,368	59,141	17	288,226	83
Concord	133,776	20,249	15	113,527	85
Deerfield	365,561	101,473	28	264,088	72
Farmington	291,177	47,722	16	243,455	84
Housatonic	865,861	102,778	12	763,083	88
Hudson-Hoosic	817,514	130,883	16	686,631	84
Lower Connecticut	389,957	43,320	11	346,636	89
Merrimack	994,148	80,929	8	913,219	92
Middle Connecticut	496,731	78,483	16	418,247	84
Middle Hudson	1,061,956	140,441	13	921,515	87
Miller	204,480	43,815	21	160,665	79
Narragansett	396,544	30,979	8	365,565	92
Nashua	235,126	35,919	15	199,207	85
Piscataqua-Salmon Falls	638,783	27,045	4	611,738	96
Quinebaug	350,587	37,834	11	312,753	89
Shetucket	265,530	31,433	12	234,098	88
Westfield	273,117	53,454	20	219,663	80

Table C4.A5. Massachusetts HUC 8 Subbasins, Riparian Zones (APCW, internal data, 2009).

HUC 8 subbasin	*Total land area (acres)*	*Riparian zone area (acres)*	*Riparian forest area (acres)*	*Riparian forest area (%)*
Blackstone	297,729	15,249	10,716	70
Cape Cod	927,990	34,693	16,991	49
Charles	637,449	34,877	18,220	52
Chicopee	429,602	25,987	18,643	72
Concord	252,571	13,328	8,324	62
Deerfield	417,758	16,368	12,863	79
Farmington	375,392	16,078	11,257	70
Housatonic	1,206,389	61,286	41,155	67
Hudson-Hoosic	1,193,104	33,534	22,767	68
Lower Connecticut	685,154	34,211	20,732	61
Merrimack	1,393,216	72,432	51,236	71
Middle Connecticut	630,250	35,930	26,708	74
Middle Hudson	1,518,189	51,901	39,080	75
Miller	240,827	11,456	8,594	75
Narragansett	738,853	39,130	25,585	65
Nashua	330,526	18,658	12,924	69
Piscataqua-Salmon	867,270	50,715	39,660	78
Quinebaug	456,789	25,221	18,366	73
Shetucket	330,351	13,464	9,741	72
Westfield	327,058	17,210	13,742	80

Table C4.A6. Massachusetts HUC 8 Subbasins, rankings for roads, soil erodibility, housing density, drinking water consumers (APCW, 2009; Barnes et al., 2009).

HUC 8 subbasin	*Road density[1]*	*Soil erodibility[2]*	*Housing density[3]*	*Drinking water consumers[4]*
Blackstone	1.61	3.51	2.83	10.00
Cape Cod	2.61	3.77	3.43	9.00
Charles	1.58	3.85	2.72	10.00
Chicopee	2.21	3.60	3.55	10.00
Concord	1.40	3.68	2.70	9.00
Deerfield	2.75	2.26	3.84	6.00
Farmington	2.12	3.00	3.34	10.00
Housatonic	2.11	2.95	3.33	9.00
Hudson-Hoosic	2.50	2.29	3.66	8.00
Lower Connecticut	1.72	3.04	2.92	9.00
Merrimack	2.05	3.35	3.25	9.00
Middle Connecticut	2.44	3.14	3.56	8.00
Middle Hudson	2.27	2.15	3.54	10.00
Miller	2.23	3.32	3.63	8.00
Narragansett	1.81	3.49	2.91	10.00
Nashua	1.88	3.29	3.24	10.00
Piscataqua-Salmon Falls	2.25	3.33	3.34	8.00
Quinebaug	2.05	3.15	3.34	7.00
Shetucket	2.06	3.01	3.30	7.00
Westfield	2.40	3.10	3.71	10.00

Metric	*Low (1 point)*	*Moderate (2 points)*	*High (3 points)*	*Very high (4 points)*
[1]Road density (D, quartiles)	75th -100th percentile	50th – 74th percentile	25th – 49th percentile	0 – 24th percentile
[2]Soil erodibility (S,k factor)	>0.34	0.28 – 0.34	0.2 – 0.28	0 – 0.2
[3]Housing density (acres per housing unit in 2000)	<0.6 acres/unit	0.6 – 5.0 acres/unit	5.0 – 20.0 acres/unit (east)	> 20 acres/unit (east)
	Low (1 point)	*Moderate/High (2-9 points)*		*Very high (10 points)*
[4]Drinking water consumers	10th quantile	2nd – 9th quantile		1st quantile

(Barnes et al., 2009)

C5.A. MAINTENANCE OF FOREST CONTRIBUTION TO GLOBAL CARBON CYCLES

Table C5.1. Carbon stocks by forest type for Massachusetts. All forest pool estimates are in tons per acre, n = sample size (COLE, 2009).

Forest type	*Live tree*	*Dead tree*	*Under-story*	*Down dead wood*	*Forest floor*	*Soil*	*Total nonsoil*	*n*
Silver maple/American elm	59.0	3.5	1.1	4.2	13.3	49.8	81.1	1
Sugar maple/beech/yellow birch	47.1	3.3	1.0	3.5	12.8	31.0	67.7	79
Eastern white pine	50.5	2.3	1.4	3.3	6.4	34.5	63.9	43
Norway spruce	46.0	4.5	1.3	3.1	7.6	29.4	62.5	1
Eastern hemlock	47.1	3.0	0.8	2.8	6.8	34.7	60.5	15
Eastern white pine/northern red oak/white ash	37.6	1.7	1.6	3.1	13.0	30.6	56.9	44
Northern red oak	45.5	2.3	1.1	3.3	4.1	23.7	56.2	25
Sweetbay/swamp tupelo/red maple	36.8	3.2	0.8	2.9	12.2	44.9	55.8	7
Eastern white pine/eastern hemlock	41.9	2.5	1.2	2.5	6.7	34.8	54.8	5
Cottonwood/willow	38.5	0.7	1.5	2.9	10.2	46.0	53.7	1
Scarlet oak	42.5	0.9	2.1	3.3	3.6	23.7	52.4	5
Chestnut oak/black oak/scarlet oak	41.3	1.7	0.9	3.1	3.8	23.7	50.7	16
Cherry/white ash/yellow poplar	38.9	1.9	1.5	3.7	3.8	23.9	49.8	12
Paper birch	38.2	1.4	2.3	2.5	4.6	39.0	48.9	2
White oak/red oak/hickory	39.0	1.5	1.2	2.9	4.0	24.0	48.7	49
Red maple/upland	29.8	1.9	1.7	2.5	11.9	31.0	47.7	23
Sycamore/pecan/American elm	29.5	2.1	1.4	2.2	11.7	49.8	46.9	4
Red pine	29.8	1.0	3.1	3.0	7.5	33.0	44.5	1
Black cherry	23.6	2.1	2.3	6.6	8.6	30.2	43.3	4
Red mapl/oak	29.2	0.7	1.6	7.8	3.7	23.7	42.9	11
Red spruce	21.9	2.3	0.6	2.8	14.7	43.7	42.2	2
Sugarberry/hackberry/elm/green ash	23.9	0.3	0.8	1.7	13.3	49.8	40.1	1
Other pine/hardwood	21.0	0.8	1.7	2.7	12.4	29.8	38.7	10
Black ash/American elm/red maple	15.4	5.2	3.3	1.1	12.6	49.8	37.7	1
Red maple/lowland	21.9	1.0	1.4	1.8	11.4	49.5	37.5	15
Hard maple/basswood	18.4	0.2	1.1	2.4	9.6	31.0	31.8	1
Pitch pine	16.0	1.1	2.0	1.6	5.8	34.6	26.4	8
Mixed upland hardwoods	15.8	0.0	2.8	3.1	3.2	23.7	24.8	2
White oak	15.7	0.2	2.2	1.5	3.4	23.7	23.0	2
River birch/sycamore	9.4	1.2	0.8	1.0	9.6	49.8	22.1	1
Grey birch	12.8	0.0	3.8	2.4	3.1	39.0	22.0	2
Aspen	13.7	1.8	1.3	1.2	4.0	39.0	22.0	3
Willow	7.9	0.4	1.1	1.7	8.5	49.8	19.7	2
Nonstocked	1.0	0.6	2.1	0.0	2.1	44.2	5.8	2

C6.A. MAINTENANCE AND ENHANCEMENT OF LONG-TERM MULTIPLE SOCIOECONOMIC BENEFITS TO MEET THE NEEDS OF SOCIETIES

ROUND WOOD PRODUCTION

Table C6A.1. Round Wood production by ownership 2006 (US Forest Service, TPO, 2006).
MBF = thousand board feet; MCF = thousand cubic feet.

Ownership	*Species group*	*Saw logs*		*Pulpwood*		*Fuelwood*		*Other products*	*All products*
		MBF	**MCF**	**Cords**	**MCF**	**Cords**	**MCF**	**MCF**	**MCF**
Public	**Softwood**	620	95	34	3	0	0	1	98
	Hardwood	18	3	133	11	0	0	1	16
	Total	638	97	167	14	0	0	2	114
Forest industry	**Softwood**	2,115	323	214	18	0	0	0	341
	Hardwood	1,412	224	51	4	0	0	1	228
	Total	3,528	546	265	22	0	0	1	570
Other private	**Softwood**	25,733	3,927	11,516	979	208,405	16,672	98	21,676
	Hardwood	16,869	2,671	1,046	89	308,496	24,680	3	27,443
	Total	42,601	6,599	12,563	1,068	516,901	41,352	101	49,119
All ownerships	**Softwood**	28,468	4,345	11,764	1,000	208,405	16,672	99	22,116
	Hardwood	18,299	2,898	1,230	105	308,496	24,680	5	27,687
	Total	46,767	7,243	12,994	1,104	516,901	41,352	104	49,803

Table C6A.2. Lumber Production of Softwoods and Hardwoods in New England: 2004 and 2003 (mmbf = millions of board feet lumber tally) U.S. Census Bureau 2005, Lumber Production and Mill Stocks, 2004.

	Total		*Softwoods*		*Hardwoods*	
	2003 (MMBF)	**2004 (MMBF)**	**2003 (MMBF)**	**2004 (MMBF)**	**2003 (MMBF)**	**2004 (MMBF)**
United States	49,456	47,181	38,502	36,687	10,954	10,494
Connecticut	48	45	(D)	r/12	(D)	33
Maine	964	949	828	814	136	135
Massachusetts	60	59	24	26	36	33
New Hampshire	232	240	168	178	64	62
Rhode Island	6	r/6	3	3	3	r/3
Vermont	183	187	74	69	109	118

D Withheld to avoid disclosing data for individual companies;
r/Revised by 5 percent or more from previously published data;
Z Represents less than 500,000 board feet.

WOOD PRODUCTS MARKETING

Massachusetts Department of Conservation and Recreation – Division of State Parks and Recreation Marketing and Utilization Program Partners

- Biomass Energy Resource Center
- Coop Power
- Massachusetts Department of Environmental Protection
- Massachusetts Division of Energy Resources: Bioenergy Working Group
- Massachusetts Executive Office of Environmental Affairs
- Massachusetts Farm Bureau
- Massachusetts Forest Landowners Association
- Massachusetts Water Resources Authority: Renewable Energy
- Massachusetts Wood Producers Association
- Northeast Lumber Manufacturers Institute: Advisory Board Member
- Northeast Regional Biomass Program: Advisory Board Member
- Northeast Utilization & Marketing Council: Advisory Board Member
- Pioneer Valley Planning Commission
- University of Massachusetts Amherst Department of Natural Resources Conservation
- University of Massachusetts Amherst Department of Resource Economics
- US Department of Energy
- USDA Forest Service: Economic Action Program, State and Private Forestry Program and Forest Products Laboratory

BIOMASS

Additional details for ecological biomass harvests (Kelty et al., 2008)

Nutrient cycling

Major nutrients are nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), and magnesium (Mg). Tree boles (trunks) have low concentrations of nutrients, while fine branches and foliage have high concentrations of nutrients. The intensity and frequency of harvests determines the level of net nutrient output from forest ecosystems. Harvesting guidelines to leave fine branches and foliage on harvest sites would minimize nutrient export. A second output of nutrients is from the mobilization of nitrogen and base cation nutrients, most importantly calcium (Ca), from the site from reduced vegetation uptake and increased soil exposure and microbial activity.

Management recommendations (to maintain forest nutrients, especially calcium)

1. Do not combine whole-tree harvests with clearcutting
2. Only use whole-tree harvest in partially cut stands to mitigate nutrient losses
3. In oak stands, reduce harvest intensity (a high proportion of Ca in oak stems)
4. Establish advanced regeneration to reduce losses (shelterwood methods)
5. Harvest during the winter when foliage and associated nutrients are already on the forest floor

Soil physical properties

Harvesting equipment compacts soils, reducing pore sizes and increasing bulk densities decreasing long-term soil and site productivity. Biomass harvests may have increased harvesting equipment use, or reduced slash on skid trails to reduce compaction.

Management recommendations

1. Spread harvest slash on skid roads and trails to reduce compaction on roads.
2. Use equipment with low ground pressures and use "one-pass harvesting systems".
3. Harvest when the ground is frozen, particularly on sensitive soils.
4. Restore areas with excessive compaction in a way that fosters natural regeneration.

Streamflow and water quality

A commercial timber harvest of any size will allow more water to reach the forest floor because of reduced interception and transpiration. Harvests that remove greater than 20-30% of the basal area will yield measurable effects on stream flows.

Management recommendations: Follow Best Management Practices (BMPs)

1. Planning and constructing roads
2. Retaining riparian forest buffer strips
3. Reduce the amount of land and basal area harvested in a given watershed

Carbon cycling and storage

NEP, net ecosystem productivity, is the total photosynthesis minus total respiration. When NEP is positive the forest acts as a carbon sink. Intermediate aged and older forest stands show gradually declining carbon sequestration rates, but they do continue to act as both carbon sinks and as carbon stores.

The overall sizes of forest carbon pools have been found to generally increase with stand age in the Northeast. It is important to harvest after leaf-fall and to add nitrogen and other nutrients to the stand over time as the overall nutrient capital is reduced.

Thinning treatments are the primary management tool for harvesting biomass while managing stands on more traditional rotation lengths (80 to 100 years). Thinnings remove suppressed or intermediate trees that are likely to die from competition and decompose. This utilizes biomass that would have died and decomposed, releasing carbon dioxide. By harvesting these doomed trees as forest products they can be used as an energy source as an alternative to fossil fuels. There appear to be no trends between evergreen and deciduous species in terms of biomass production rates.

Management recommendations (to maximize carbon sequestration while removing biomass in harvest operations)

1. Practices that conserve nutrients and soil maintain site productivity and carbon sequestration rates should be encouraged.
2. Regenerating a stand structure of intolerant species above tolerant species will produce the highest rate of carbon sequestration in a given stand.
3. An agricultural-like system of woody biomass crops may be an economical option.
4. An unharvested stand will develop the most carbon on that site, however, thinning a stand and utilizing the yield for long-lived products (lumber) could sequester more carbon in total.

FUNDING

Table C6A.3. USDA Forest Service State and Private Forestry funding to Massachusetts Partners FY2009a, itemized list (USDA Forest Service NA S&PF, 2009).

	Grant funding 2009 ($)	***Subtotals by program ($)***
Forest Health Management:		**722,291**
Federal Lands		*316,440*
The Nature Conservancy- Firewood Website	86,500	
The Nature Conservancy- Firewood Website	83,500	
FHTET-Univ of Mass-Biocontrol of Ambermarked Birch Leafminer	25,000	
Univ. of MA Development of biocontrol resources and projects for forest pests in the US	12,000	
UMASS: Monitor and Assess HWA mortality factors in MA	45,440	
Harvard Univ: ALB dendrochronology project	15,000	
FHTET: Univ. of MA-"Dev. of Biocontrol Resources and Projects for Forest Pests	11,000	
FHTET: Univ. of MA - "Life Table Analysis to Measure the Impact of Introduced Parasitoids	38,000	
Cooperative Lands		*405,851*
Core Funding	50,600	
FHTET - "Gypchek Virus Production USDA APHIS	172,000	
FHTET - UMass "Biological Control of Ambermarked Birch Leafminer and other	36,200	
Off Plot FHM	19,000	
UMASS: Establish and Evaluate ID biotype of L. nigrinus	66,806	
UMASS: Evaluation of EHS natural enemies in Japan	29,245	
DCR: Phase 2 EAB biosurveillance	3,300	
DCR: Phase 2 EAB biosurveillance (Carryover)	9,700	
DCR: ALB detection surveys	15,000	
FHTET: Univ. of MA-"Dev. of Biocontrol	4,000	
Cooperative Fire Protection (CFP):		**410,466**
State Fire Assistance		*129,650*
Volunteer Fire Assistance		*39,200*
State Fire Assistance NFP		*192,395*
Core Funding	124,296	
Core Funding FY08	21,099	
Conservation Education Program	5,000	
MA Tree Wardens Urban Forestry Emergency Response Initiative	12,000	
NFP Haz Mit: Wildfire Mitigation on Town Owned Lands in Barnstable County	30,000	
Volunteer Fire Assistance NFP		*38,221*
Forest Health Management- Coop Lands NFP		*11,000*
FHTET - UMass "Biological Control of Ambermarked Birch Leafminer and other	11,000	
Cooperative Forestry (CF):		**4,291,365**
Forest Stewardship		*363,800*

	Grant funding 2009 ($)	Subtotals by program ($)
Core Funding	110,100	
Conservation Education Program	2,500	
Forest to Faucet Partnership UMASS	44,000	
S&PF- Redesign: Working with Municipalities, Foresters and Landowners to Increase Conservation	56,000	
S&PF: - Redesign: Working with Municipalities, Foresters and Landowners to Increase Conservation	57,000	
S&PF Redesign: Working with Municipalities, Foresters and Landowners to Increase Conservation	86,000	
Core Funding - Supplemental	8,200	
Forest Legacy		*3,638,200*
Core Funding	38,200	
Southern Monadnock Plateau II	2,200,000	
Metacomet-Monadnock Forest	1,400,000	
Urban and Community Forestry		*289,365*
Core Funding	253,865	
MA Tree Wardens Urban Forestry Emergency Response Initiative	10,000	
MKIW--Groundwork Lawrence Connections Urban Youth	25,500	
Miscellaneous		**3,026,500**
Reimbursable Programs: Worcester, MA. Asian Longhorned Beetle Mitigation	500,000	
Recreation, Heritage and Wilderness: MKIW--Groundwork Lawrence Connections Urban Youth	14,500	
Hazardous Fuels Reduction and Mitigation S&PF (ARRA): ARRA - SE MA Hazardous Fuels Mitigation and Ecosystem Restoration	1,974,000	
Forest Health Non-Federal Lands (ARRA): ARRA - MA Native Species (Invasive) Ecological Restoration	538,000	
Total		***8,450,622***

FOREST LEGACY

Table C6A.4. Forest Legacy completed projects in FY 2008 (USDA Forest Service, 2009b).

No.	Name	County	Acres	Interests value ($)	FLP payment ($)
1	Holich	Hampshire	113	220,000	220,000
2	Anciporch	Hampshire	106	198,000	165,000
3	Audubon	Berkshire	75	180,000	180,000
4	Hutchinson	Worcester	490	616,000	450,000
5	Pippin Tree	Middlesex	73	4,300,000	1,500,000
6	Boudreau	Hampshire	56	321,000	241,000
7	Johnson	Hampshire	47	59,000	48,000
8	Stockbridge Sportsman Club	Berkshire	67	60,000	60,000
9	Kripalu (BNRC)	Berkshire	225	280,000	280,000
10	Pumpkin Brook Link	Middlesex	174	750,000	250,000
11-12	Hatfield Watershed 1-2	Hampshire	145	681,000	512,000
13-15	Alford Springs 1-3	Berkshire	947	1,265,000	945,000
16	2-Mile Landbridge	Worcester	467	600,000	330,000
17	Williams	Berkshire	14	38,000	35,000
18	Mt. Washington-Camp Hi-Rock	Berkshire	665	2,100,000	1,097,000
19	Belmont Springs	Middlesex	255	2,600,000	1,383,000
20	Karner Brook Ridge	Berkshire	213	1,000,000	303,000
21-22	Prospect Hill 1-2	Worcester	167	438,000	302,000
23-26	Bush Hill 1-4	Worcester	340	598,000	243,000
27	Ballard Hill	Berkshire	33	265,000	90,000
28	Muschopauge Brook	Worcester	106	630,000	395,000
29	Eagleville Pines	Worcester	283	1,107,000	830,000
30-35	Quabbin Corridor Connection	Worcester	907	1,883,000	499,000
	Completed Project Totals (FY2008)		**5,968**	**20,189,000**	**10,358,000**

Funded Forest Legacy Tracts* (FY 2008)

No.	Name	County	Acres	Interests value ($)	FLP payment ($)
36-47	Quabbin Corridor Connection 7-18	Worcester	769	2,398,000	2,211,000
This project extends over a 9-mile expanse of rolling hills and intact forest lands, adding crucial links to 80,000 acres of protected lands.					
48-55	Southern Monadnock Plateau 1-8	Worcester	1,100	4,735,000	2,500,000
Today about 50 percent of the Mid-State Trail runs through private, unprotected property and along town roads. This large project would help connect tens of thousands of acres protected by the Commonwealth, land trusts and municipalities.					
	Proposed Project Totals		**1,869**	**7,133,000**	**4,711,000**

*The following FLP projects were completed between 10/1/2009 and 03/31/2010 (USDA Forest Service, Northeastern Area Forest Legacy Program, 2010)

Name	Acres	Total Value ($)	FLP payment ($)
Southern Monadnock Plateau 1	175	319,250	305,000
Southern Monadnock Plateau 3	303	950,000	890,240
Southern Monadnock Plateau 6	90	268,375	200,000
Southern Monadnock Plateau 7	78	356,000	308,000

State Proposed Forest Legacy Tracts that have cleared the Forest Stewardship or Forest Legacy Committee.

No.	Name	County	Acres	Estimated Value ($)
56-69	Southern Monadnock Plateau II 1-14	Worcester	1,825	4,430,000
70-81	Southern Monadnock Plateau III 1-12	Worcester and Middlesex	1,885	4,840,000
This project will build on Phase I to conserve working forests facing high threats of conversion due to increasing development pressures. This multi-year effort is creating corridors of protected working forests, linking more than 15,000 acres of protected lands in Massachusetts and New Hampshire				
82-92	Metacomet-Monadnock Forest 1-11	Franklin and Worcester	1,055	2,225,000
This project is the first of a three-phase strategy targeting 5,000 acres of institutional and private forest land centered in some of the largest unfragmented forest blocks in the Massachusetts and New Hampshire Quabbin to Cardigan Corridor				
93-98	Monson Forest Lands 1-6	Hamden	749	3,040,000
This project is a focused collaborative effort to conserve prime forest strategically located within a matrix of over 2,000 acres of conserved land stretching into Connecticut and will leverage support for a broad land conservation effort being developed through a bi-state regional partnership.				
		Proposed Projects Total	**5,514**	**14,535,000**

C7.A. LEGAL, INSTITUTIONAL, AND ECONOMIC FRAMEWORK FOR FOREST CONSERVATION AND SUSTAINABLE MANAGEMENT

Massachusetts State Agencies

Forestry Outline

I. Organizational Structure

A. The Divisions of State Parks, Urban Parks and Water Supply Protection

1. DCR is comprised of three operational divisions: the division of state parks and recreation, the division of urban parks and recreation, and the division of water supply protection. G. L. c. 21, § 1.

2. The division of urban parks and recreation has control over the state parks, forests, parkways, waterways, rinks, pools, beaches and other recreational lands and facilities of DCR within the urban parks district that is comprised of thirty-six municipalities within the Greater Boston area. G. L. c. 21, § 1.

3. The division of state parks and recreation has control over the state parks, forests, parkways, waterways, rinks, pools, beaches and other recreational lands and facilities outside of the geographic area defined as the urban parks district. G. L. c. 21, § 1, c. 92, § 33, and c. 132A, § 3.

4. The director of the division of state parks and recreation shall promote the perpetuation, extension and proper management of the public and private forest lands of the commonwealth, and perform such other duties as may be imposed upon him by the governor G. L. c. 132, § 1.

B. Bureaus of Forest Fire Control, Forestry and Recreation

1. Within DCR are three bureaus: forest fire control, forestry, and recreation. G. L. c. 132A, § 1C.

2. The bureau of forestry, with the commissioner's approval, is charged with performing such duties concerning forest management practices, reforestation, development of forest or wooded areas under DCR's control, making them in perpetuity income producing and improving such wooded areas. G. L. c.132A § 1F.

3. The bureau is also responsible for such other duties that were vested in the former bureau of shade tree management and pest control by the general laws or any special laws, and is responsible for shade tree management, arboricultural service, and suppression of insects defined as public nuisances in G. L. c. 132, § 11. See G. L. c. 132, § 1A.

4. The bureau, subject to the commissioner's approval, may promulgate rules and regulations to carry out its pest and nuisance control duties and powers. G. L. c. 132, § 11.

II. DCR Mission

A. Core Agency Duties; G. L. c. 21, § 1

It shall be the duty of the Department of Conservation and Recreation to exercise general care and oversight of the natural resources of the commonwealth and of its adjacent waters; to make investigations and to carry on research relative thereto; and to propose and carry out measures for the protection, conservation, control, use, increase, and development thereof. The words "natural resources", as used herein, shall be held to include ocean, shellfish and inland fisheries; wild birds, including song and insectivorous birds; wild mammals and game; sea and fresh water fish of every description; forests and all uncultivated flora, together with public shade and ornamental trees and shrubs; land, soil and soil resources, lakes, ponds, streams, coastal, underground and surface waters; minerals and natural deposits. The department shall also be concerned with

the development of public recreation as related to such natural resources; and shall have control and supervision of such parks, forests, and areas of recreational, scenic, or historic significance as may be from time to time committed to it.

B. Forest Cutting Practices Act; Declaration of Policy; G. L. c. 132, § 40.

It is hereby declared that the public welfare requires the rehabilitation, maintenance, and protection of forest lands for the purpose of conserving water, preventing floods and soil erosion, improving the conditions for wildlife and recreation, protecting and improving air and water quality, and providing a continuing and increasing supply of forest products for public consumption, farm use, and for the wood-using industries of the commonwealth.

C. Article 97 of the Articles of Amendment to the Constitution of the Commonwealth of Massachusetts

The people shall have the right to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and esthetic qualities of their environment; and the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources is hereby declared to be a public purpose. No land or interest in land acquired and held by DCR can be conveyed out or put to an inconsistent use unless the Legislature authorizes such conveyance or change in use by two-thirds roll-call vote.

D. Development of Resource Management Plans; G. L. c. 21 § 2F

1. The directors of the divisions of State Parks and Urban Parks shall work in cooperation with the director of the division of fisheries and wildlife within the Department of Fish and Game to establish coordinated management guidelines for sustainable forestry practices on public forest lands within DCR and on private forestlands. Said guidelines for public forest lands shall include agreements on equipment, personnel transfers, operational costs, and assignment of specific management responsibilities. DCR shall submit management plans to the Stewardship Council for the council's adoption with respect to all reservations, parks, and forests under the management of the Department, regardless of whether such reservations, parks, or forests lie within the urban parks district or outside the urban parks district. Said management plans shall include guidelines for the operation and land stewardship of the aforementioned reservations, parks and forests, shall provide for the protection and stewardship of natural and cultural resources, and shall ensure consistency between recreation, resource protection, and sustainable forest management. DCR shall be responsible for implementing said management plans, with due regard for the above requirement.

2. For land in the division of water supply protection, the commissioner shall adopt watershed management plans prepared with the participation of a professionally qualified forester and the appropriate watershed advisory committee. Watershed management plans shall provide for, but need not be limited to, forestry, water yield enhancement and recreational activities. All forestry activities shall be subject to the Forest Cutting Practices Act (G. L. c. 132, §§ 40-46). G. L. c. 92A ½ , § 16.

(Provided by DCR Office of the General Council, 2010)

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METHODOLOGY OF THE GEOSPATIAL ANALYSIS

INTRODUCTION

The goal of the Massachusetts Statewide Forest Resource Assessment Geospatial Analysis is to identify priority landscape areas across Massachusetts where federally –funded cooperative forestry program outreach and activity can be emphasized and coordinated. A separate geospatial analysis was conducted to identify priority areas for each of the national themes: 1. Conserve and Manage Working Forest Landscapes for Multiple Values and Uses; 2. Protect Forests from Threats; and 3. Enhance Public Benefits from Trees and Forests. In addition, we conducted an overall synthesis overlay to give a broad depiction of the state of the forest resource in Massachusetts. A separate Urban Forest overlay was conducted as well. The following GIS process descriptions were conducted using ESRI ArcGIS Desktop software.

MAJOR TRANSPORTATION ROUTES AND COUNTY SEATS OF MASSACHUSETTS

Circles scaled by population.

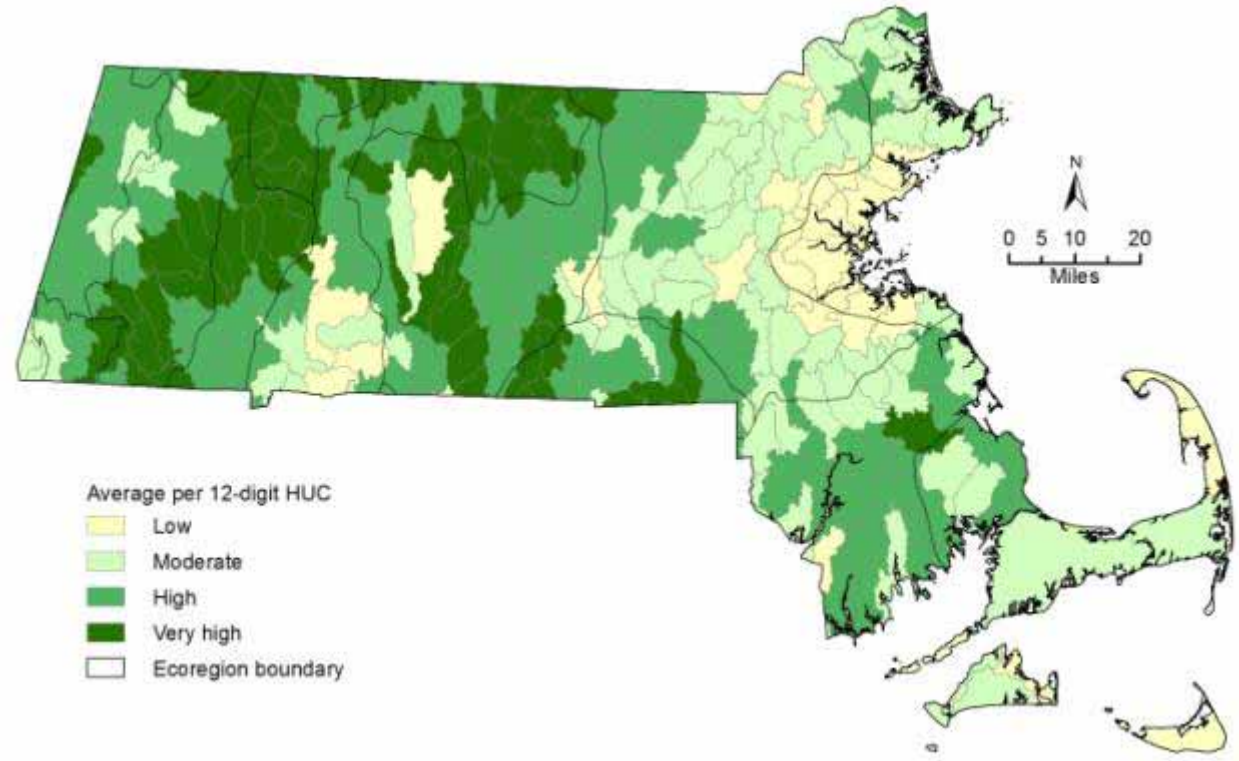
CONSERVE AND MANAGE WORKING FOREST LANDSCAPES FOR MULTIPLE VALUES AND USES OVERLAY

The following five datalayers were summed (Weighted Sum Tool) with the following weights:

- Non-Protected Private Forests 1
- Development Pressure 1
- Forest Cutting Plans (1984-2003) 0.5
- Forest Stewardship Plans 1
- Non-Reserve State Land 0.5

The resulting raster was aggregated to 12-digit watersheds (HUC) using the Zonal Statistics tool, with the mean statistic type selected. The final raster was classified into 4 natural breaks and labeled as Low, Moderate, High, and Very high.

Result: See following map.



Individual Datalayer Computations

Non-Protected Private Forests

Data Sources:

MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2009. Land Use (2005). *Available at* http://www.mass.gov/mgis/laylist.htm.

The Land Use (2005) datalayer is a Massachusetts statewide, seamless digital dataset of land cover / land use, created using semi-automated methods, and based on 0.5 meter resolution digital ortho imagery captured in April 2005.

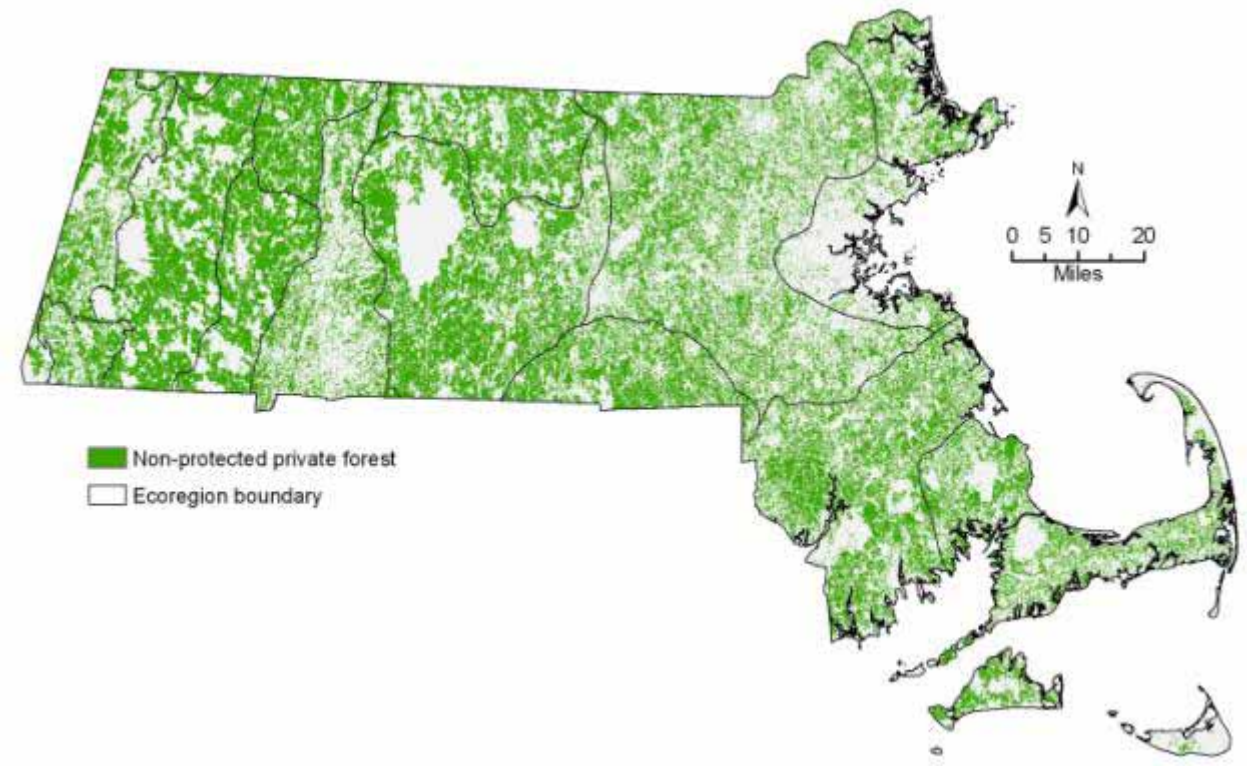
MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2010. Protected and Recreational Open Space - February 2010. *Available at* http://www.mass.gov/mgis/laylist.htm.

The Protected and Recreational Open Space datalayer contains the boundaries of conservation lands and outdoor recreational facilities in Massachusetts.

GIS process:

1. Forest and forested wetland land uses were selected from the 2005 MassGIS land Use datalayer.
2. Selected forest and forested wetland polygons were converted to a raster.
3. In Perpetuity level of protection code (P) from LEV_PROT field was selected from Protected and Recreational Open Space datalayer.
4. Selected permanently protected open space polygons were converted to a raster.
5. Using the Combine Tool, areas where forest and forested wetland selection were not concurrent with permanently protected open space were extracted.
6. Using the Reclassify Tool on the combine raster, non-protected private forests were classified with a value of 1.

Result: See following map.


N
0 5 10 20
Miles
Non-protected private forest
Ecoregion boundary

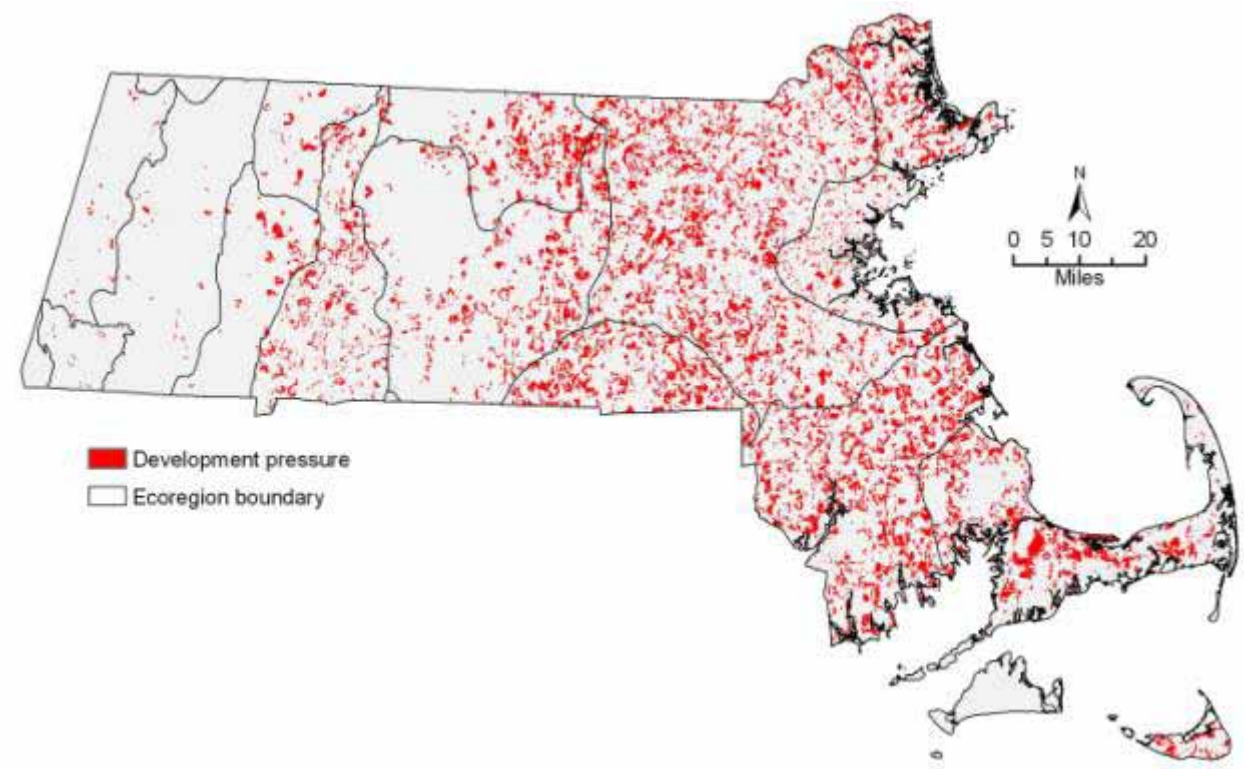
Development Pressure

Data Source:

Barnes, M.C., A.H. Todd, R.Whitney Lilja, and P.K. Barten. 2009. *Forests, Water, and People: Drinking water supply and forest lands in the Northeast and Midwest United States*. NA-FR-01-08, United States Department of Agriculture Forest Service, Northeastern Area State and Private Forestry, Newtown Square, PA 19073, 71 pp.

Development pressure is defined as areas that already have, or are likely to undergo conversion from forest to residential, commercial, or industrial land. Development pressure was calculated by subtracting the housing density in 2000 from the housing density in 2030. If housing density increased between 2000 and 2030, then development pressure was said to occur.

Result: See following map



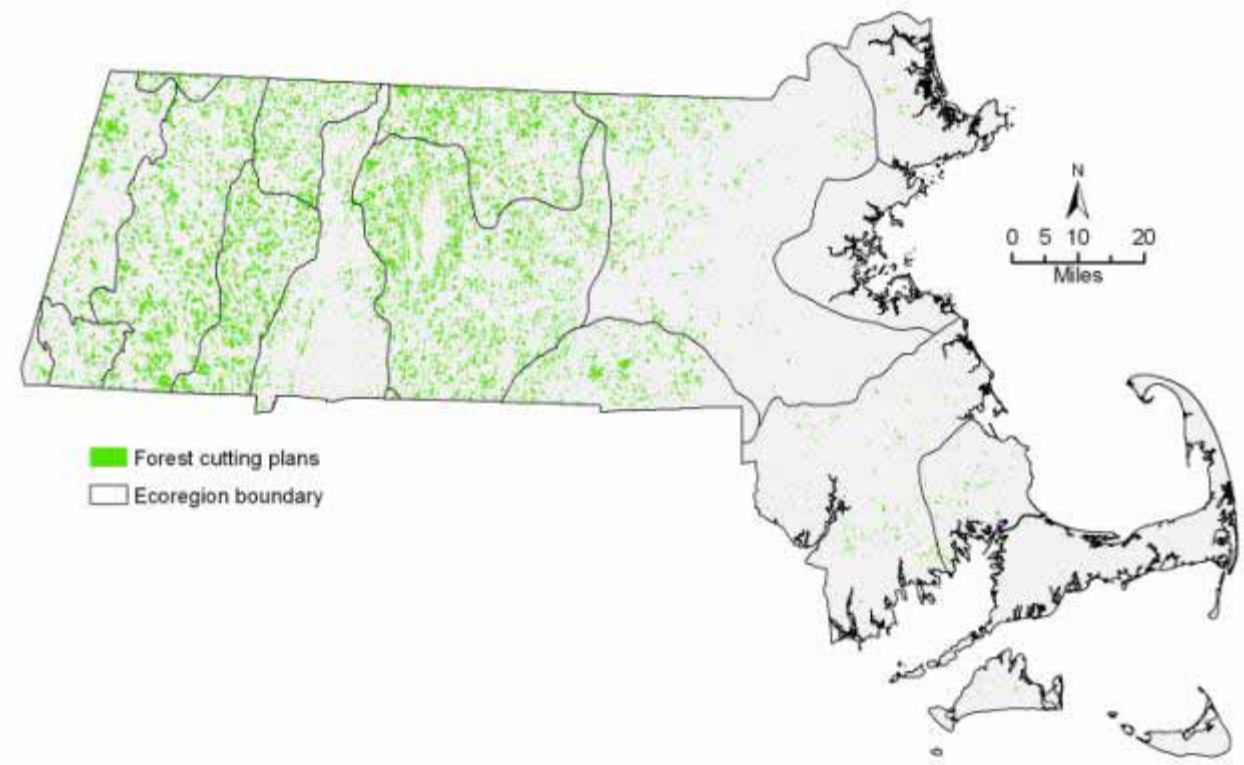
Forest Cutting Plans

Data Source:

McDonald, R.I., G. Motzkin, M.S. Bank, D.B. Kittredge, J. Burk, and D.R. Foster. 2006. Forest harvesting and land-use conversion over two decades in Massachusetts. *Forest Ecology and Management* 227:31-41.

A spatially explicit database of all harvest operations in Massachusetts from 1984 to 2003.

Result: See following map

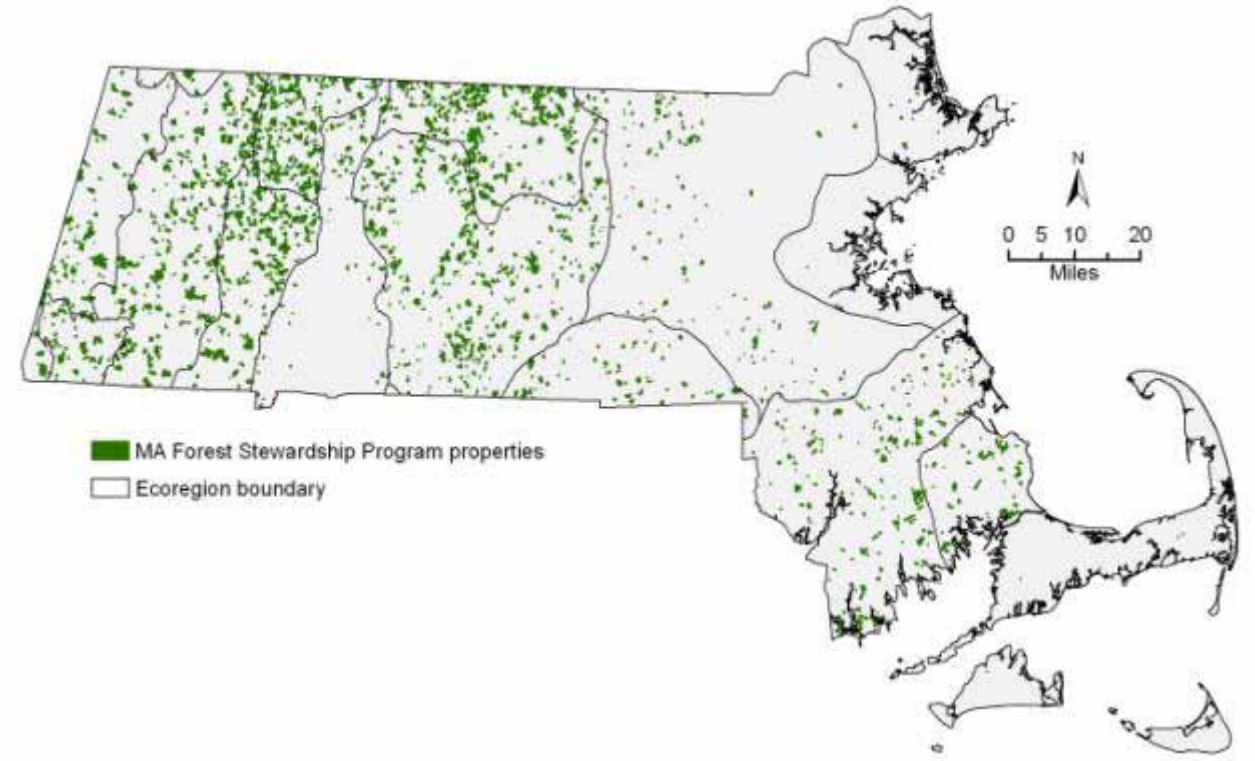


Forest Stewardship Plans
Data Source:

DCR (Massachusetts Department of Conservation and Recreation). 2010. Forest Stewardship Plans.

The Massachusetts Forest Stewardship Program Properties datalayer contains the boundaries of all properties which have plans under the Massachusetts Forest Stewardship Program.

Result: See following map.



Non-Reserve State Land

Data Sources:

EEA (Executive Office of Environmental and Energy Affairs). 2009. Forest Reserves. Boston, MA. February 2, 2009. *Available at* http://www.mass.gov/Eoeea/docs/eea/lf/whatare_forestreserves.pdf .

The Reserve datalayer contains those properties designated as forest reserves by the Massachusetts Executive Office of Environmental Affairs.

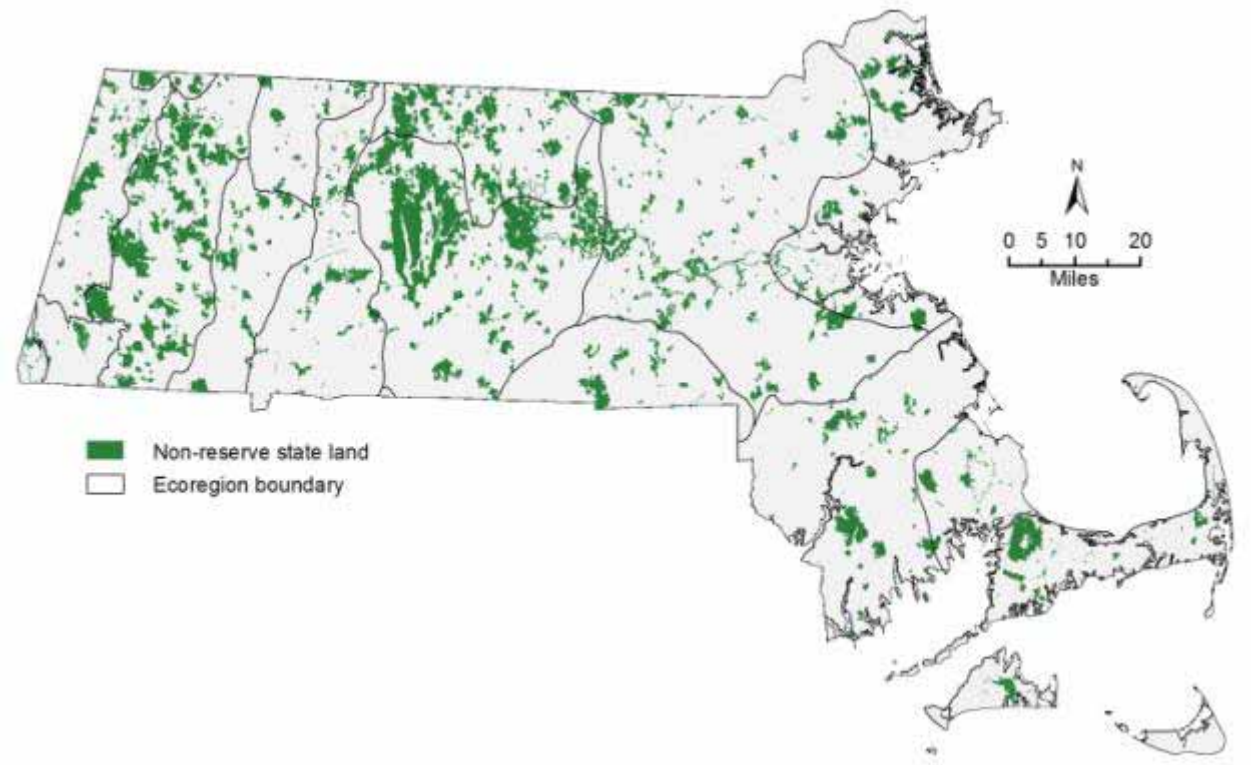
MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2010. Protected and Recreational Open Space - February 2010. *Available at* http://www.mass.gov/mgis/laylist.

The Protected and Recreational Open Space datalayer contains the boundaries of conservation lands and outdoor recreational facilities in Massachusetts.

GIS process:

1. State lands (polygons with OWNER_TYPE attribute of “S” or “1”) were unioned with the forest reserve datalayer.
2. State land not concurrent with reserves was extracted.

Result: See following map.



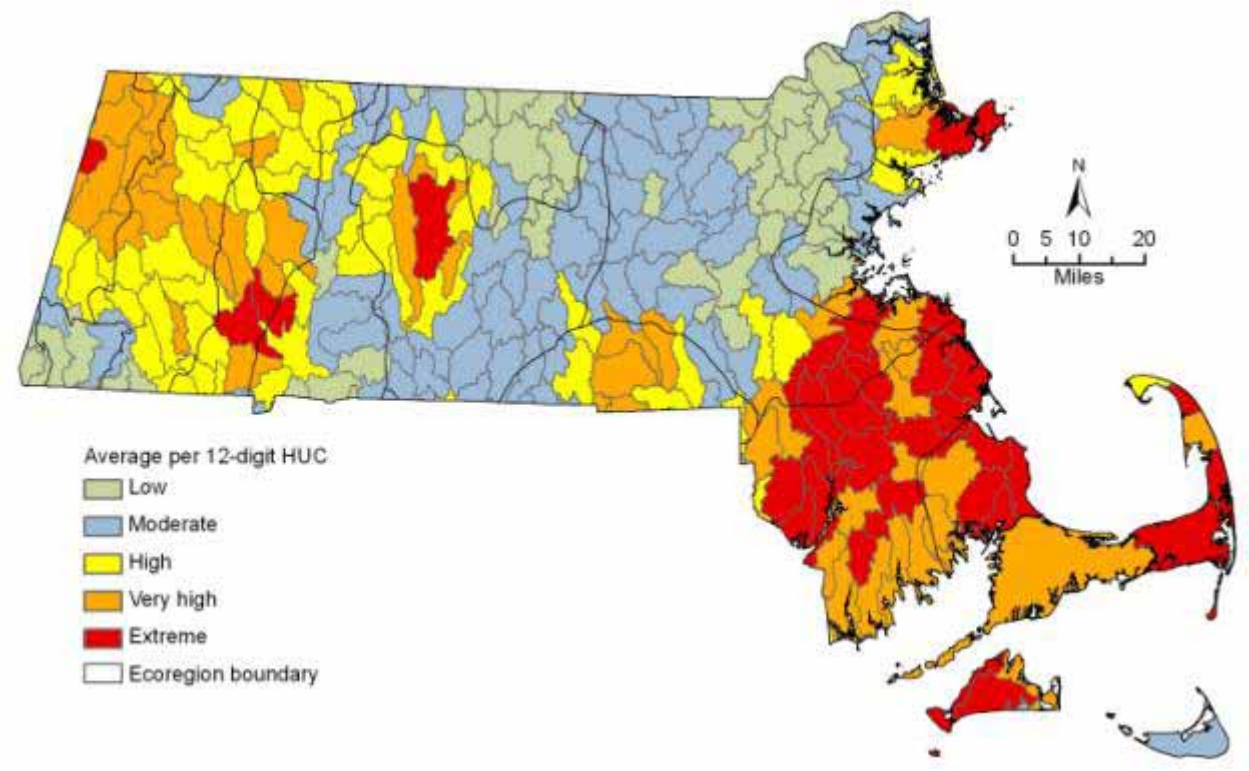
PROTECT FORESTS FROM THREATS OVERLAY

The following two datalayers were summed (Weighted Sum Tool) with equal weights:

- Wildfire Risk
- Forest Health Risk

The resulting raster was aggregated to 12-digit watersheds (HUC) using the Zonal Statistics tool, with the mean statistic type selected. The final raster was classified into 5 natural breaks and labeled as Low, Moderate, High, Very high, and Extreme.

Result: See following map.



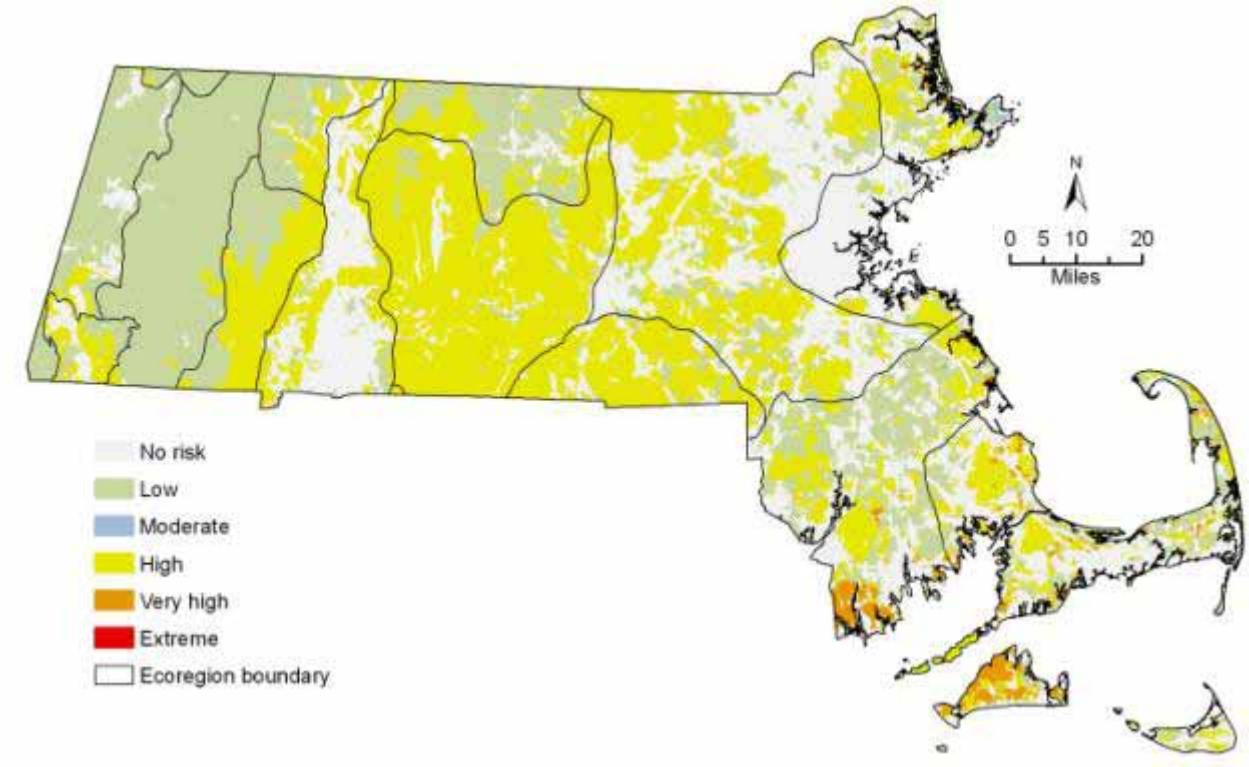
Individual Datalayer Computations

Wildfire Risk
Data Source:

Northeast Wildfire Risk Assessment Geospatial Work Group. 2009. Draft Area Assessment.

The assessment is a geospatial analysis of fire risk in the 20-state U.S. Forest Service Northeastern Area. The assessment is comprised of three components: (1) fuels, (2) wildland-urban interface, and (3) topography (slope and aspect) that are combined using a weighted overlay. These three characteristics are combined to identify wildfire prone areas where hazard mitigation practices would be most effective.

Result: See following map



Forest Health Risk

Data Source:

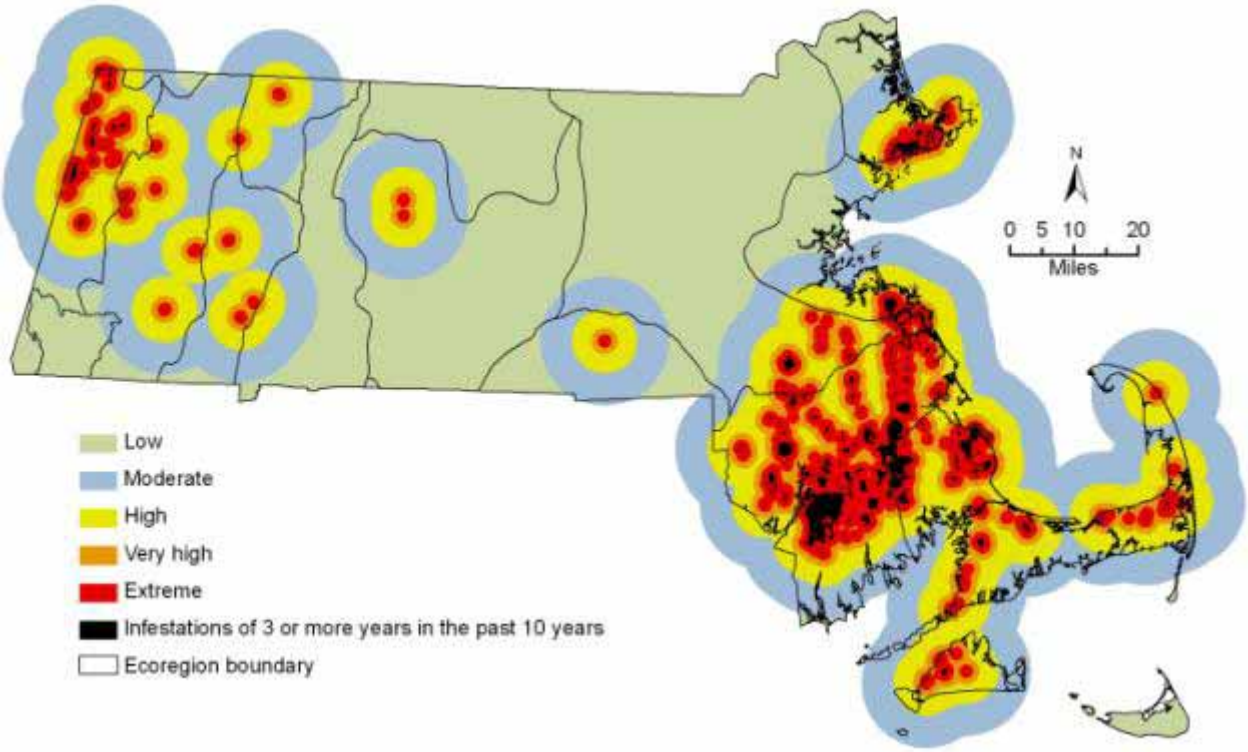
US Forest Service. Northeastern Area State and Private Forestry. Forest Health Monitoring Program. Forest Health Aerial Survey Damage 2000 to 2009.

This dataset is a compilation of forest insect, disease and abiotic damage mapped by aerial detection surveys on forested areas in the USDA Forest Service Northeastern Area.

GIS process:

1. 2000 to 2009 Aerial Survey Damage shapefiles were converted to rasters.
2. Using the Combine Tool, values of aerial survey damage data sets from 2000 to 2009 were combined.
3. Areas that had infestations of 3 or more years were extracted.
4. Using the Multiple Ring Buffer Tool, buffers around areas with 3 or more years of infestations with distances of 1, 2, 5, and 10 miles were created and converted to a raster.
5. Using the Reclassify Tool on the multiple-ring buffer raster, values were reclassified as follows: values of 1 mile = 5, values of 2 miles=4, values of 5 miles= 3, values of 10 miles = 2, and NoData = 1.
6. Values of 5, 4, 3, 2, and 1 correspond to risk levels of Extreme, Very high, High, Moderate, and Low, respectively.

Result: See following map



ENHANCE PUBLIC BENEFITS FROM TREES AND FORESTS OVERLAY

Water Resources and Biological Diversity

The following five datalayers were summed (Weighted Sum Tool) with the following weights:
Water Resources

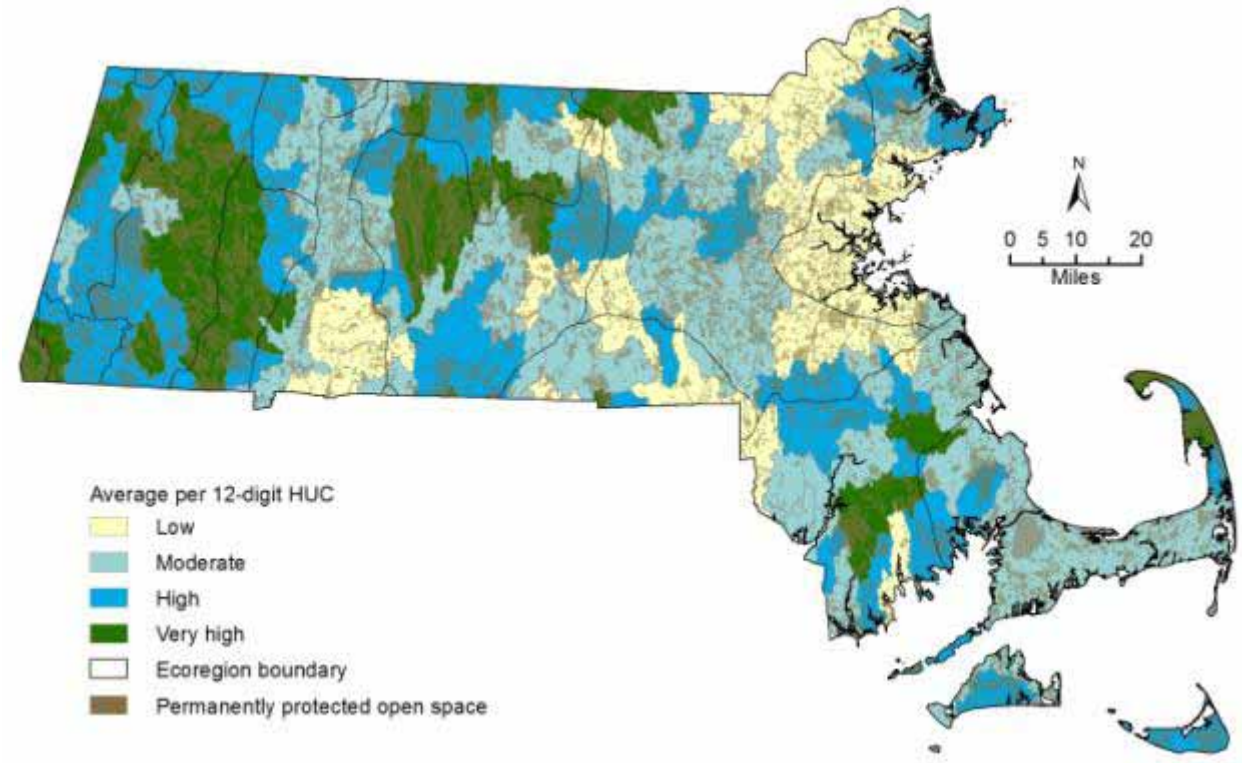
- Ability to Produce Clean Water 1
- Zone II & Interim Wellhead protection areas 1
- Outstanding Resource Waters and Wild & Scenic rivers (Federal) 0.5

Biodiversity

- Index of Ecological Integrity 1.25
- BioMap and Living Waters core habitats 1.25

The resulting raster was aggregated to 12-digit watersheds (HUC) using the Zonal Statistics tool, with the mean statistic type selected. The final raster was classified into 4 natural breaks and labeled as Low, Moderate, High, and Very high. Permanently protected open space was displayed as a transparent overlay on the final map.

Result: See following map.



Individual Datalayer Computations

Ability to Produce Clean Water

Data Source:

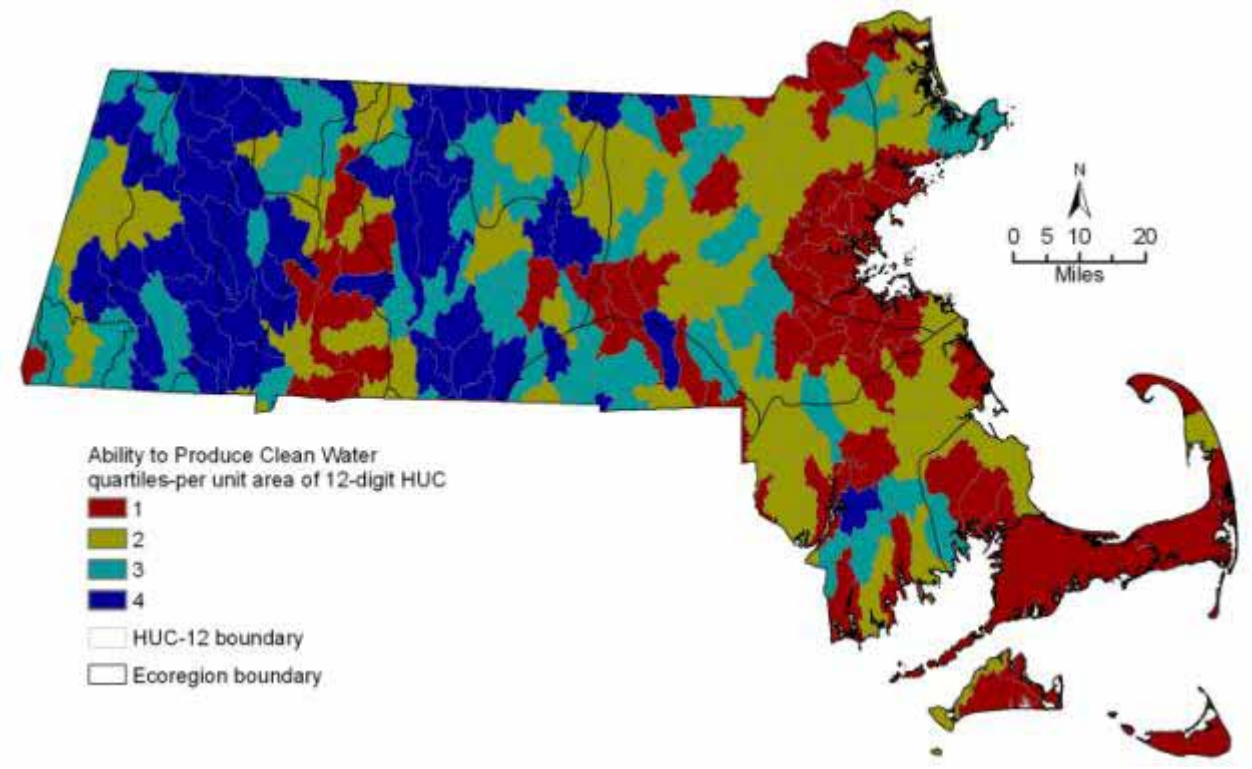
Barnes, M.C., A.H. Todd, R.Whitney Lilja, and P.K. Barten. 2009. *Forests, Water, and People: Drinking water supply and forest lands in the Northeast and Midwest United States*. NA-FR-01-08, United States Department of Agriculture Forest Service, Northeastern Area State and Private Forestry, Newtown Square, PA 19073, 71 pp.

The Ability to Produce Clean Water Index characterizes a variety of biophysical conditions in each watershed known to influence water quality. This index of water quality and watershed integrity uses six attributes: forest land, agricultural land, riparian forest cover, road density, soil erodibility, and housing density.

GIS process:

1. The Ability to Produce Clean Water Index 30-meter values were averaged per 12-digit watersheds (HUC) within Massachusetts.
2. The result was divided into 4 classes based on quartiles. The classes were given values of 1 through 4.

Result: See following map.



Zone II & Interim Wellhead protection areas

Data Source:

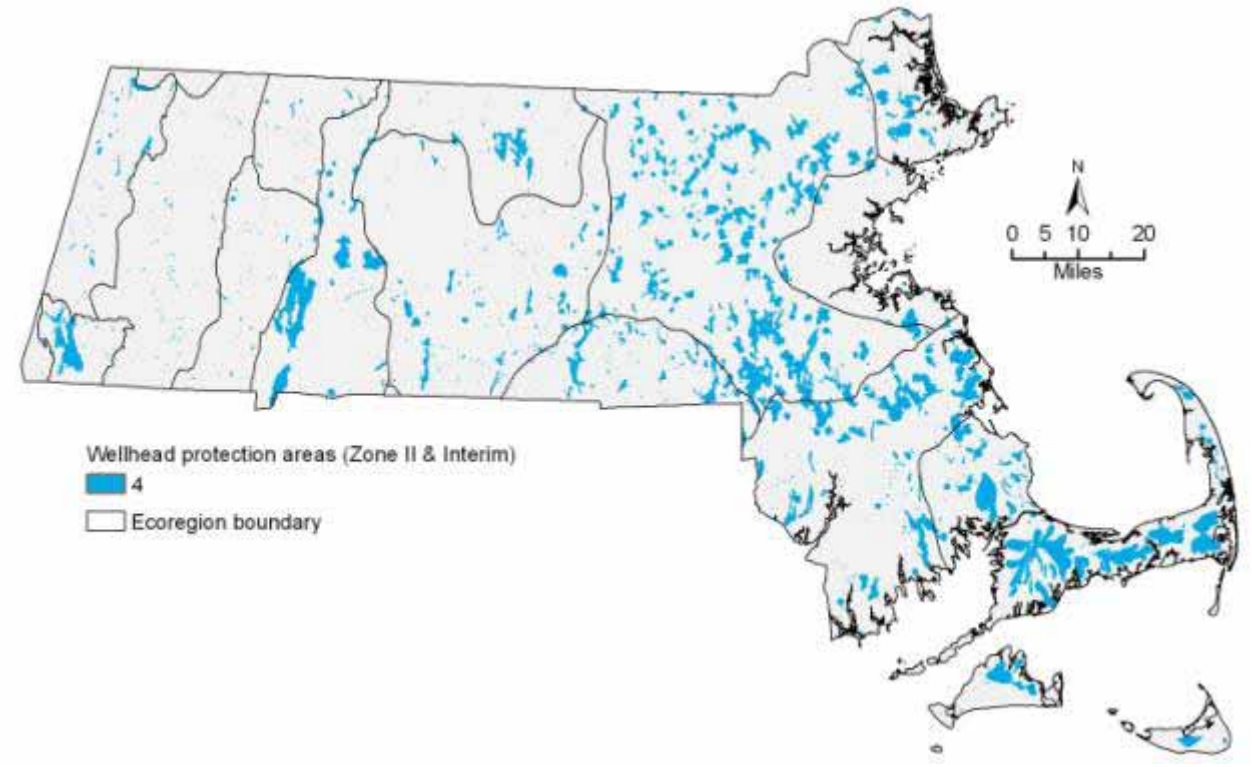
MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2009. DEP Wellhead Protection Areas (Zone II, IWPA). *Available at* http://www.mass.gov/mgis/laylist.htm.

A Zone II is a wellhead protection area that has been determined by hydro-geologic modeling and approved by the Department of Environmental Protection's (DEP) Drinking Water Program (DWP). In cases where hydro-geologic modeling studies have not been performed and there is no approved Zone II, an Interim Wellhead Protection Area (IWPA) is established based on DEP DWP well pumping rates or default values.

GIS process:

1. All Zone II & Interim Wellhead protection areas were merged, converted to a raster, and given a value of 4.

Result: See following map.



Outstanding Resource Waters and Wild & Scenic rivers (Federal)

Data Sources:

MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2009. Outstanding Resource Waters. *Available at* http://www.mass.gov/mgis/laylist.htm.

This datalayer delineates those watershed areas in which some resources may be afforded Outstanding Resource Waters classification under the Massachusetts Surface Water Quality Standards of 1995.

USDA-Forest Service Recreation Solutions. 2009. Wild and Scenic rivers. *Available at* http://www.rivers.gov/maps.html.

This data represents segments of the National Wild and Scenic River System.

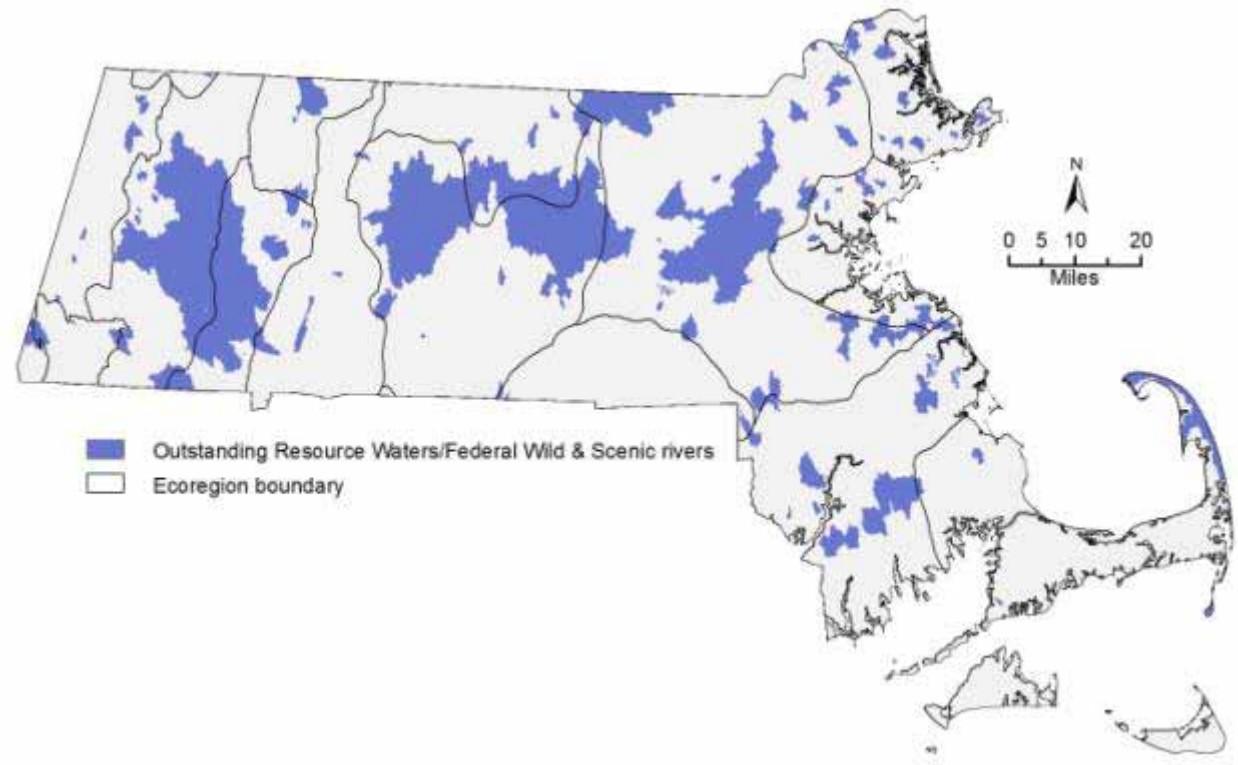
MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2005. NRCS HUC Basins (8,10,12). *Available at* http://www.mass.gov/mgis/nrcshuc.htm.

This dataset is a digital hydrologic unit boundary layer that is at the Subwatershed (12-digit) level. The layer also includes delineations at the Watershed (10-digit) and Subbasin (8-digit) levels. Each basin is identified by a unique Hydrologic Unit Code (HUC), as well a name, at each level. HUCs are identifiers as assigned to basin polygons by the U.S. Geological Survey (USGS).

GIS process:

1. Any HUC-12 that fed upstream of or into a reach of designated Wild & Scenic river was selected.
2. These HUC-12s were merged with all polygons in the Outstanding Resource Waters layer.
3. The resulting polygons were converted to a raster and given a value of 4.

Result: See following map.


N
0 5 10 20
Miles
Outstanding Resource Waters/Federal Wild & Scenic rivers
Ecoregion boundary

Index of Ecological Integrity

Data Source:

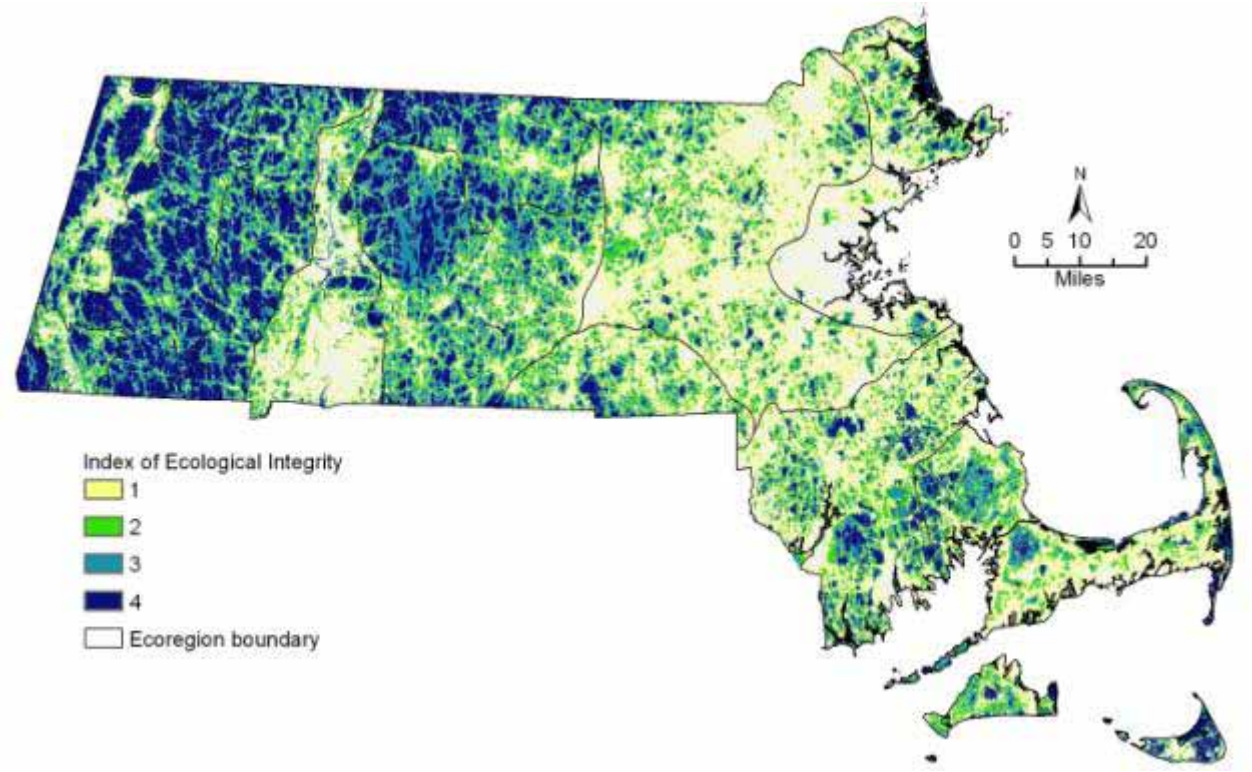
McGarigal, K., B. W. Compton, S. D. Jackson, and K. Rolih. 2009. Conservation Assessment and Prioritization System (CAPS) preliminary statewide Massachusetts assessment. June 2, 2009. Landscape Ecology Program, Department of Natural Resources Conservation, University of Massachusetts, Amherst.

The Index of Ecological Integrity (IEI) is the output from the Conservation Assessment and Prioritization System (CAPS). CAPS is a computer software program designed to assess the ecological integrity and biodiversity value of every location based on natural community-specific models, in order to help prioritize lands for conservation action based on their assessed ecological value.

GIS process:

1. The Index of Ecological Integrity was reclassified into 4 classes based on natural breaks. The classes were given the values of 1 through 4.

Result: See following map.



BioMap and Living Waters core habitats

Data Sources:

MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2002. NHESP BioMap Core Habitat. *Available at* http://www.mass.gov/mgis/laylist.htm.

The BioMap Core Habitat layer depicts the most viable habitat for rare species and natural communities in Massachusetts.

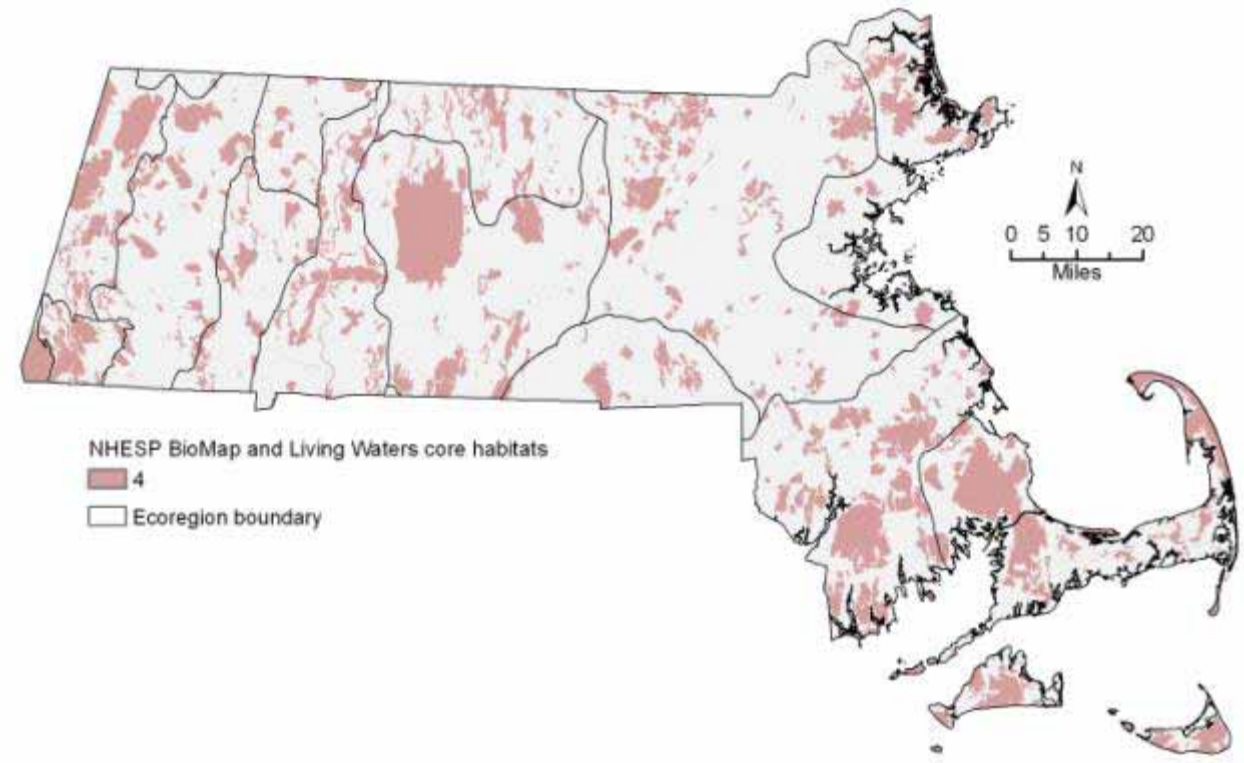
MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2003. NHESP Living Waters Core Habitats. *Available at* http://www.mass.gov/mgis/laylist.htm.

The Living Waters Core Habitats represent lakes, ponds, rivers, and streams that are important for the protection of freshwater biodiversity in Massachusetts.

GIS process:

1. All Core habitat areas were merged, converted to a raster and given a value of 4.

Result: See following map.



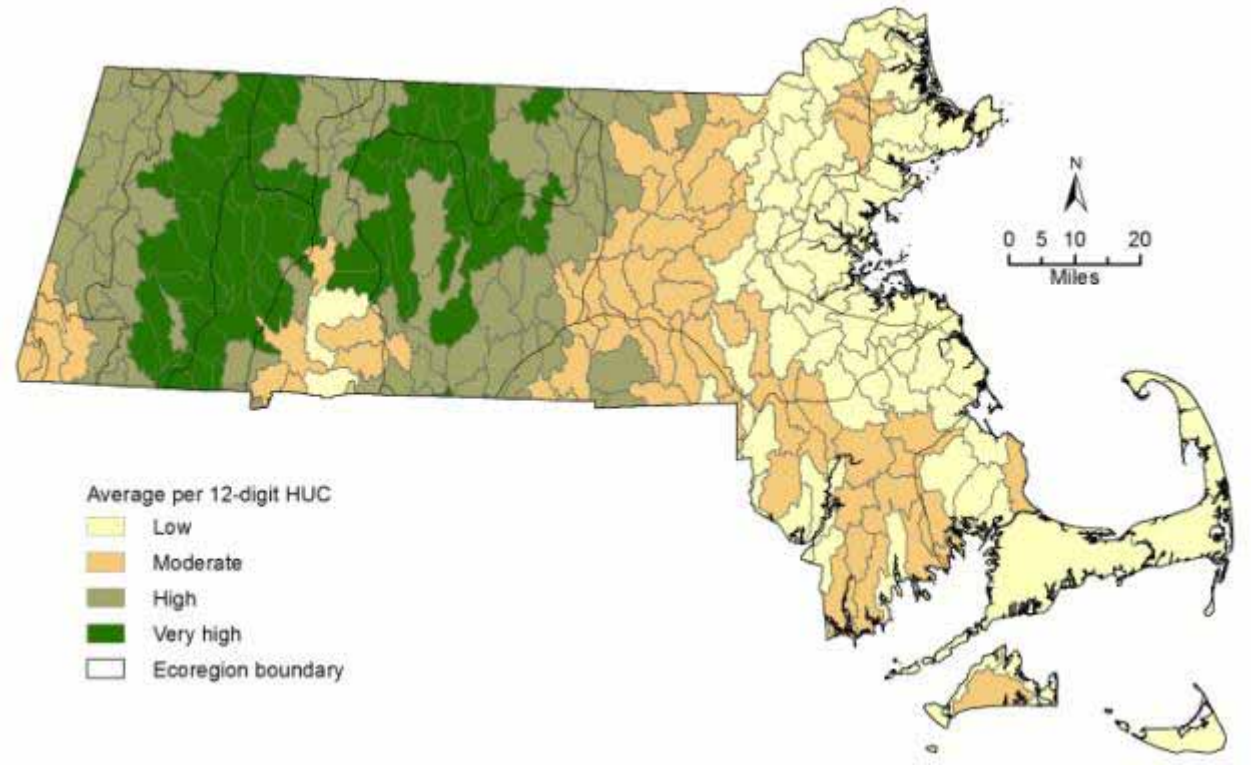
Local Wood Production and Forest Sector Employment

The following five datalayers were summed (Weighted Sum Tool) with the following weights:

- Sawmill woodshed index 0.25
- Licensed timber harvesters woodshed index 0.5
- Licensed foresters woodshed index 0.25
- Commercially viable forest block size: 2 classes: 25 to 100 acres; > 100 acres 1
- Cutting Plans (1984-2003) in non-reserved forest 0.5

The resulting raster was aggregated to 12-digit watersheds (HUC) using the Zonal Statistics tool, with the mean statistic type selected. The final raster was classified into 4 natural breaks and labeled as Low, Moderate, High, and Very high.

Result: See following map.



Individual Datalayer Computations

Sawmill woodshed index

Data Sources:

Damery, D.T., 2006. 2004 Massachusetts Sawmill Survey (TPO Roundwood). USDA Forest Service Project No. 04-CA-11242343-132-A1.

Damery, D.T. C. Bellemer, and G. Boyce. 2006. *Massachusetts Directory of Sawmills & Dry Kilns – 2006*. University of Massachusetts, Amherst, and Massachusetts Department of Conservation & Recreation.

New York State Department of Environmental Conservation Division of Lands and Forests, Bureau of Private Land Services, Forest Utilization Program, 2009. *Directory of Primary Wood-Using Industry in New York State.*

State of Connecticut Department of Environmental Protection, Division of Forestry, 2007. *Connecticut Primary Processor Directory June 2007.*

University of New Hampshire Cooperative Extension, 2010. *New Hampshire Directory of Sawmills & Lumber Wholesalers.*

Vermont Division of Forestry, 2009. Online directory of Vermont Sawmills and Veneer Mills and the directory of Vermont Wood Product Manufacturers and Crafters. *Available at* http://www.vtfpr.org/util/for_utilize_sawmill_search.cfm.

Description:

Sawmill directories for states adjacent to or within trucking distance of Massachusetts were obtained via the internet. Directories were not easily accessible for Rhode Island and Maine, nor were Canadian mills considered in the analysis, but they undoubtedly influence Massachusetts' forest industry.

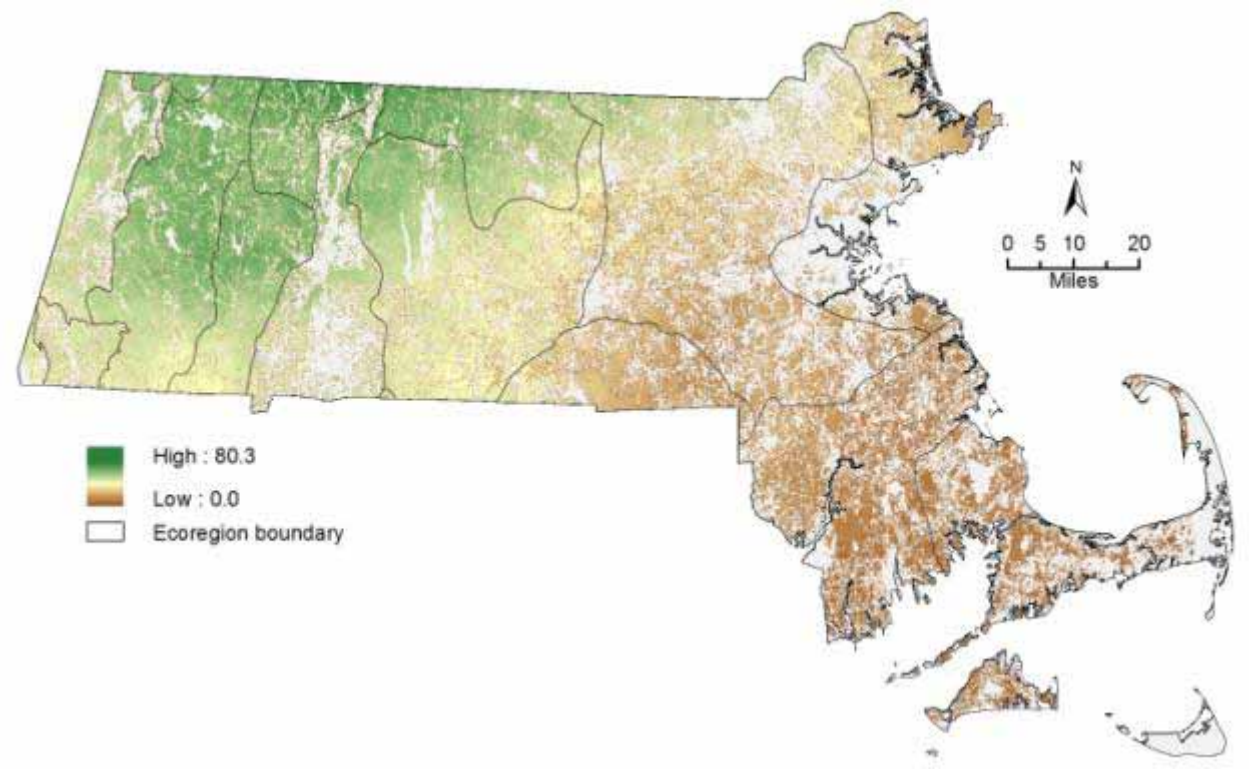
GIS process:

1. Address locations in the directories were geocoded. Street location information from the most recent US Census Tiger/LINE files (http://www.census.gov/geo/www/tiger/); where address information was not available or valid, Zip Code Tabulation Area (ZCTA) centroids were used (http://www.census.gov/geo/www/cob/z52000.html) to maintain consistency across state lines, rather than use state-specific data..
2. Woodsheds were defined as simple circles centered on the point location of the mill; radii were defined by analysis of usable data (n=32) returned from the survey (Damery, 2006) used to generate the 2006 Massachusetts Sawmill Directory (Bellemer et al., 2006). Woodshed radii are determined by annual procurement volume ranges as follows:

Annual procurement volume, MMBF	Normal one-way procurement radius, mi
<500	31.59
≥500 to <2000	38
>=2000 to <5000	46.67
≥5000	91.67

3. The proportion of each woodshed comprising commercially viable forestland (>5ac blocks) was calculated. The reciprocal of the proportions were calculated, and then rescaled such that the woodshed with the greatest amount of commercially viable forestland received a score of 1, and the other woodshed weights adjusted accordingly. The effect is to say the less commercially viable forestland within a given woodshed, the more important it becomes in sustaining local jobs, rural economies, and further management of forests in that area. The forestland within a sawmill's woodshed then receives that rescaled score. Since sawmill woodsheds can and do overlap, the weights become additive in woodsheds that overlap.

Result: See following map.



Licensed timber harvesters woodshed index

Data Sources:

Damery, D. T., L. Yadav, and Y. Zhao, 2008. Finding and removing barriers to sustainable harvest and primary processing of Massachusetts native woods. A USDA Federal State Market Improvement Grant Report.

A USDA Federal State Market Improvement Grant Report from the Massachusetts Department of Agricultural Resources, containing a summary and analysis of survey results of forest landowners, harvesters, foresters, sawmill owners, and lumber wholesalers in Massachusetts.

DCR (Massachusetts Department of Conservation and Recreation). 2010. Harvester License Report.

Directory of timber harvesters who have obtained a Massachusetts license to engaged in the business of harvesting timber or other forest products.

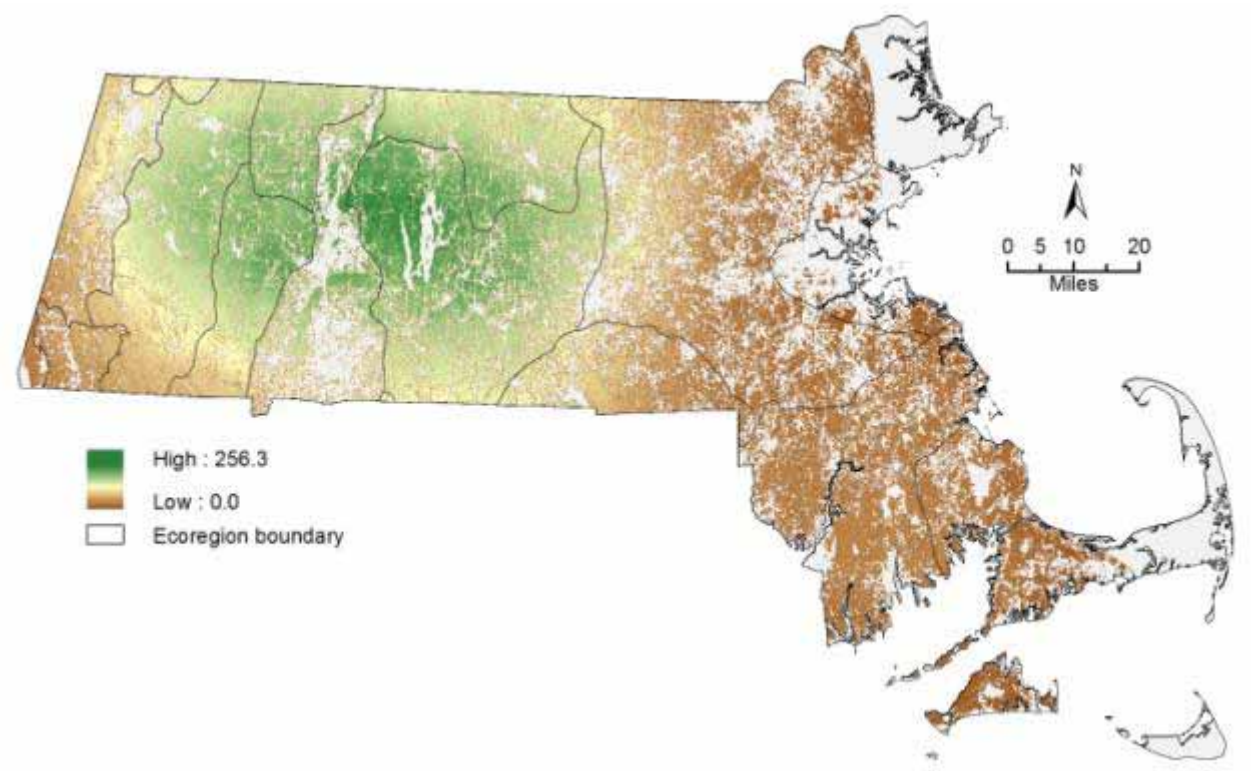
Kittredge, D. B., M. J. Mauri, and E. J. McGuire, 1996. Decreasing woodlot size and the future of timber sales in Massachusetts: When is an operation too small? *Northern Journal of Applied Forestry* 13(2):96-101.

GIS process:

1. Each license holder's address was geocoded using a similar procedure to step 1 of sawmills, above.
2. A 25 mile radius circle was created for each address, based on:
    a. Harvester survey responses summarized in Kittredge et al. (1996), indicating for lot sizes queried (1, 5, and 20 ac.), a majority of harvesters would be willing to travel 25, but not 50 mi. for lots 5 ac. and larger. In no cases would a majority of respondents bid on a 1 ac. timber sale.
    b. Damery et al (2008), indicating harvester survey respondents travel on average 28.27 mi.

The proportion of commercially viable forestland within each woodshed was calculated, and forestland weighted accordingly, similar to step 3 of sawmills, above.

Result: See following map.


N
0 5 10 20
Miles
High : 256.3
Low : 0.0
Ecoregion boundary

Licensed foresters woodshed index

Data Source:

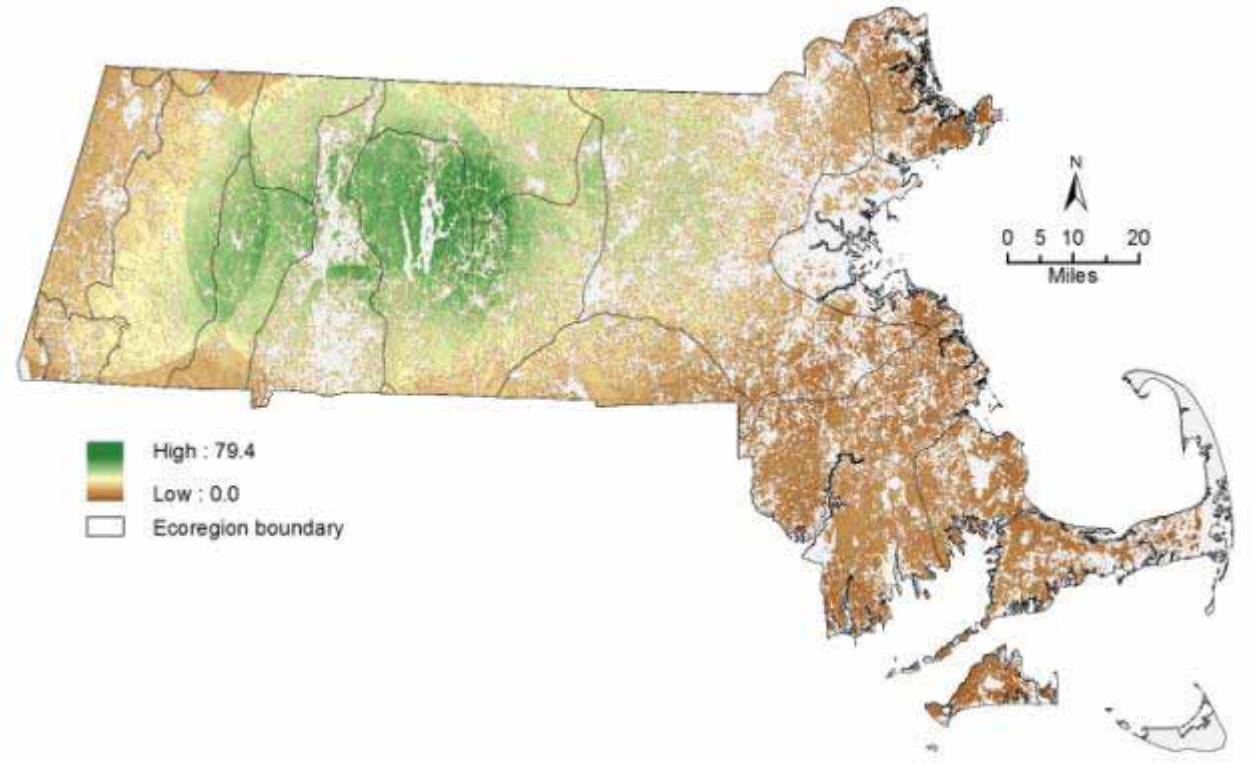
DCR (Massachusetts Department of Conservation and Recreation). 2010. Directory of Licensed Foresters.

Directory of foresters who have obtained a Massachusetts license to practice forestry.

GIS process:

1. Each license holder's address was geocoded using a similar procedure to step 1 of sawmills, above.
2. A 25 mile radius circle was created for each address, based on an assumption of relatively similar preferences to the harvester GIS process step 2.
3. The proportion of commercially viable forestland within each woodshed was calculated, and forestland weighted accordingly, similar to step 3 of sawmills, above.

Result: See following map.



Commercially viable forest block size: 2 classes: 25 to 100 acres; > 100 acres

Data Sources:

MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2009. Community Boundaries (Towns) from Survey Points. *Available at* http://www.mass.gov/mgis/laylist.

The Community Boundaries (Towns) from Survey Points is the political boundary datalayer of all communities in Massachusetts.

MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2007. Executive Office of Transportation - Office of Transportation Planning Roads. *Available at* http://www.mass.gov/mgis/laylist.htm.

The OTP Roads layer is the official state-maintained street transportation dataset available from MassGIS and represents local and major roadways, including designations for Interstate, U.S. and State highways.

EEA (Executive Office of Environmental and Energy Affairs). 2009. Forest Reserves. Boston, MA. February 2, 2009. *Available at* http://www.mass.gov/Eoeea/docs/eea/lf/whatare_forestreserves.pdf (University of Massachusetts Amherst, Department of Natural Resources Conservation GIS files).

The Reserve datalayer contains those properties designated as forest reserves by the Massachusetts Executive Office of Environmental Affairs.

MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2009. Land Use (2005). *Available at* http://www.mass.gov/mgis/laylist.htm.

The Land Use (2005) datalayer is a Massachusetts statewide, seamless digital dataset of land cover / land use, created using semi-automated methods, and based on 0.5 meter resolution digital ortho imagery captured in April 2005.

MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2008. Trains. *Available at* http://www.mass.gov/mgis/laylist.htm.

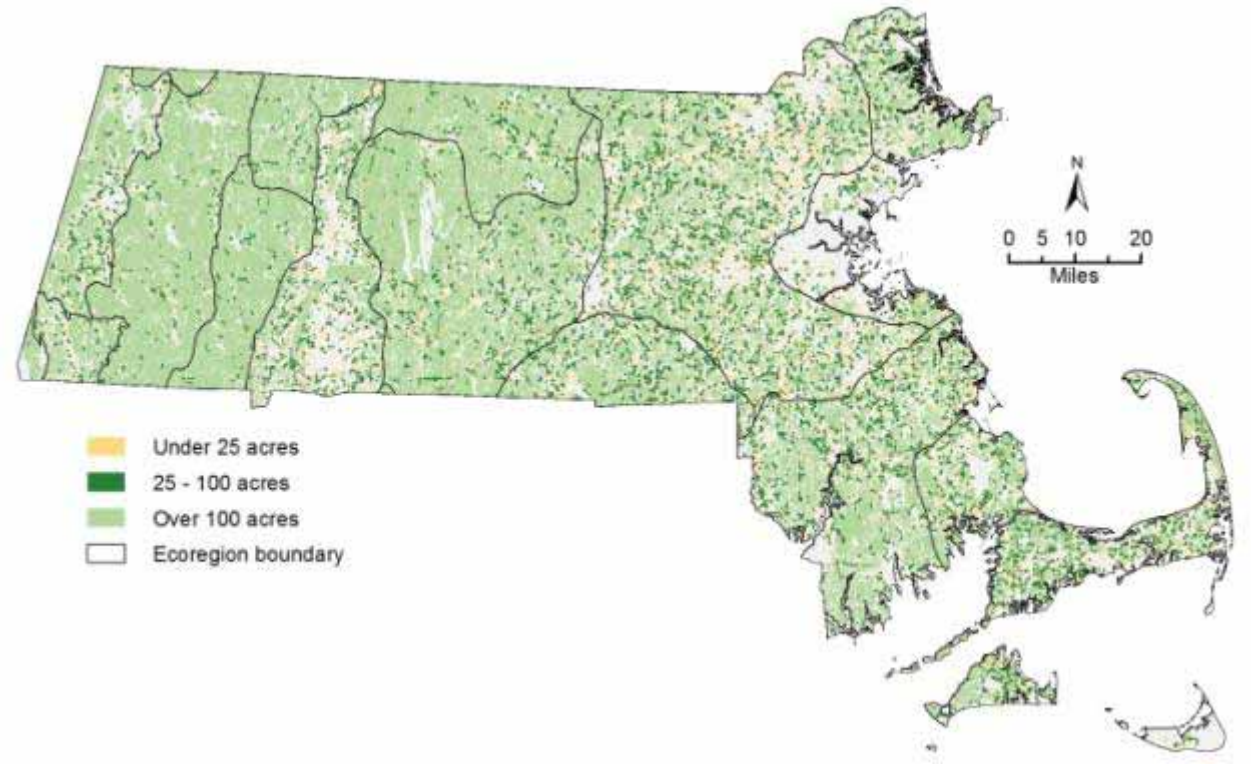
The Trains layer includes active passenger, freight, and MBTA Commuter Rail and Rapid Transit railways, along with abandoned rail lines.

GIS process:

1. The state outline was produced from the Community Boundaries layer and converted to a line feature.
2. The roads and trains layers (after being cleaned of features such as tunnels that do not interrupt forest ownership and having the geometry checked) were merged into a single transportation line layer.
3. The transportation line layer was merged with the state outline line layer, and the result converted to a polygon feature class.
4. Forest and forested wetland land uses (LUCODE = 3, 37) were selected from the 2005 MassGIS land Use datalayer to identify forestland.
5. Forestland not reserved from production was created by removing reserved forestland (using the forest reserve datalayer) from forestland.
6. The intersection of the transportation/state outline polygons and non-reserved forests was calculated to identify forest blocks.

7. The result was converted to a raster, and the Boundary Clean tool was used to remove irregular peninsulas of forestland not suitable for forest management. The result was converted back to a polygon layer and intersected with the original forest block layer to preserve islands of non-forest as well as the original blocks.
8. Blocks smaller than 5 ac or less than 100' wide were removed from the analysis, and the results visually inspected. Blocks 25-100 ac in size were scored 4; blocks over 100 ac in size were scored 2, and blocks under 25 ac in size were scored zero. The result was then converted to a raster.

Result: See following map.



Cutting Plans (1984-2003) in non-reserve forest

Data Source:

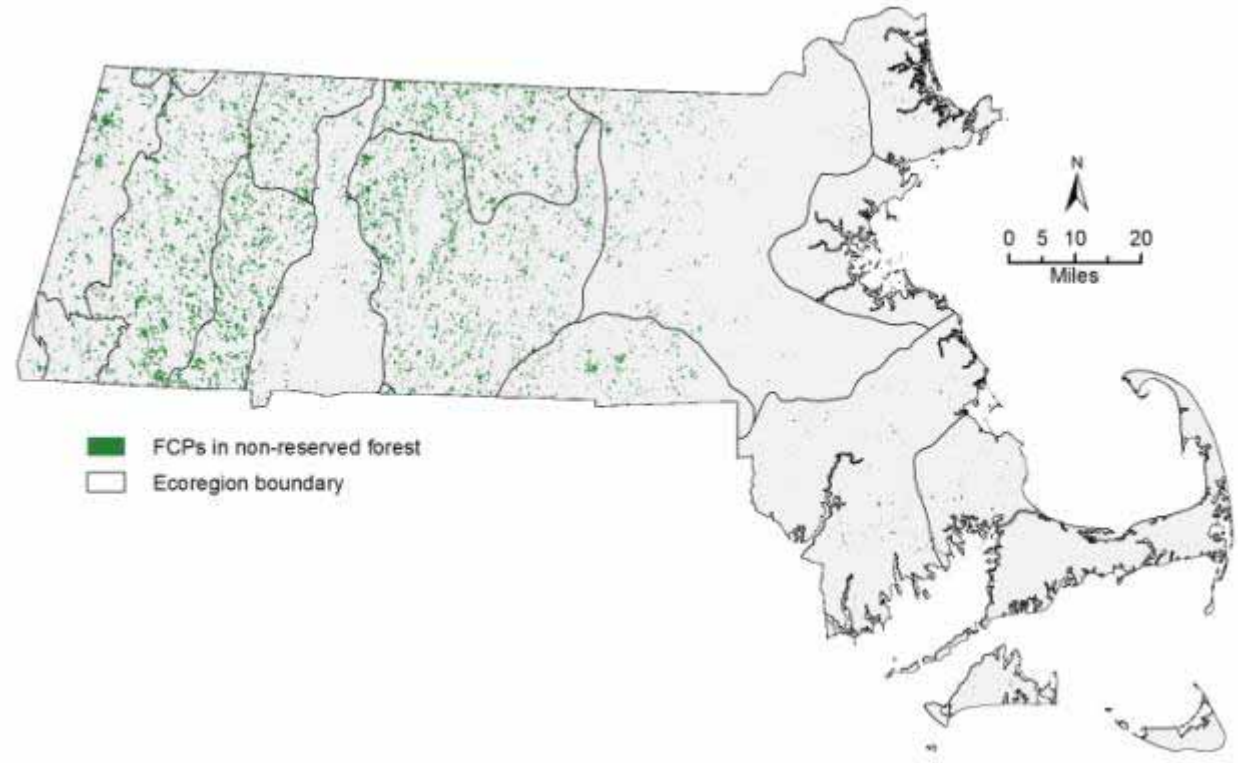
McDonald, R.I., G. Motzkin, M.S. Bank, D.B. Kittredge, J. Burk, and D.R. Foster. 2006. Forest harvesting and land-use conversion over two decades in Massachusetts. *Forest Ecology and Management* 227:31-41.

A spatially explicit database of all harvest operations in Massachusetts from 1984 to 2003.

GIS process:

1. Cutting plans in forest reserve areas were removed.

Result: See following map.



SYNTHESIS OVERLAY

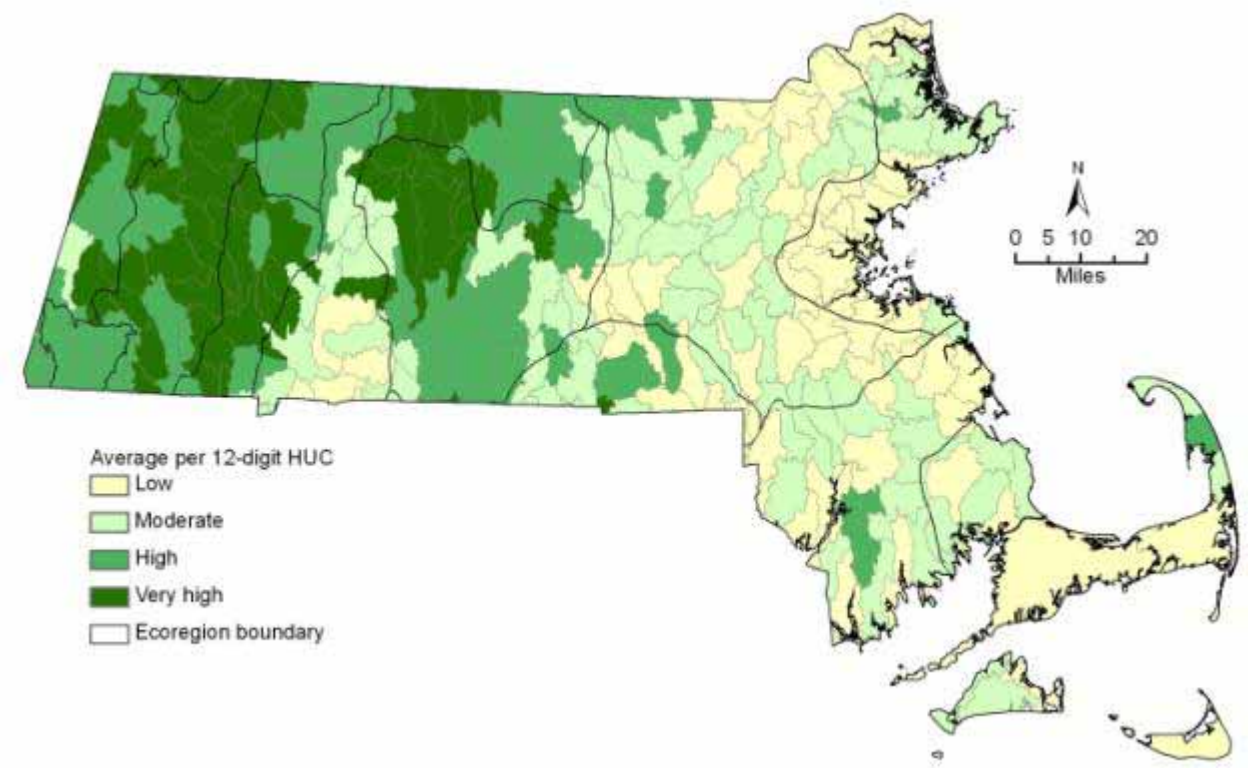
Forest Functions, Benefits and Values

The following six datalayers were summed (Weighted Sum Tool) with the following weights:

- Forest Landscape: Interior Forest Blocks 1
- Protection and Recreation: Protected and Recreational Open Space 0.5
- Soil &Water Conservation: APCW 1
- Biodiversity: BioMap and Living Water Core areas 0.5
- Stewardship: Forest Stewardship Plans 0.25
- Sustainable Forest Fiber Sources & Markets: 1
    - Cutting plans, sawmill index, licensed foresters index, & licensed timber harvesters index

The resulting raster was aggregated to 12-digit watersheds (HUC) using the Zonal Statistics tool, with the mean statistic type selected. The final raster was classified into 4 natural breaks and labeled as Low, Moderate, High, and Very High.

Result: See following map.



Individual datalayer computations

Forest Landscape: Interior Forest Blocks

Data Sources:

MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2009. Land Use (2005). *Available at* http://www.mass.gov/mgis/laylist.htm.

The Land Use (2005) datalayer is a Massachusetts statewide, seamless digital dataset of land cover / land use, created using semi-automated methods, and based on 0.5 meter resolution digital ortho imagery captured in April 2005.

MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2007. Executive Office of Transportation - Office of Transportation Planning Roads. *Available at* http://www.mass.gov/mgis/laylist.htm.

The OTP Roads layer is the official state-maintained street transportation dataset available from MassGIS and represents local and major roadways, including designations for Interstate, U.S. and State highways.

MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2008. Trains. *Available at* http://www.mass.gov/mgis/laylist.htm.

The Trains layer includes active passenger, freight, and MBTA Commuter Rail and Rapid Transit railways, along with abandoned rail lines.

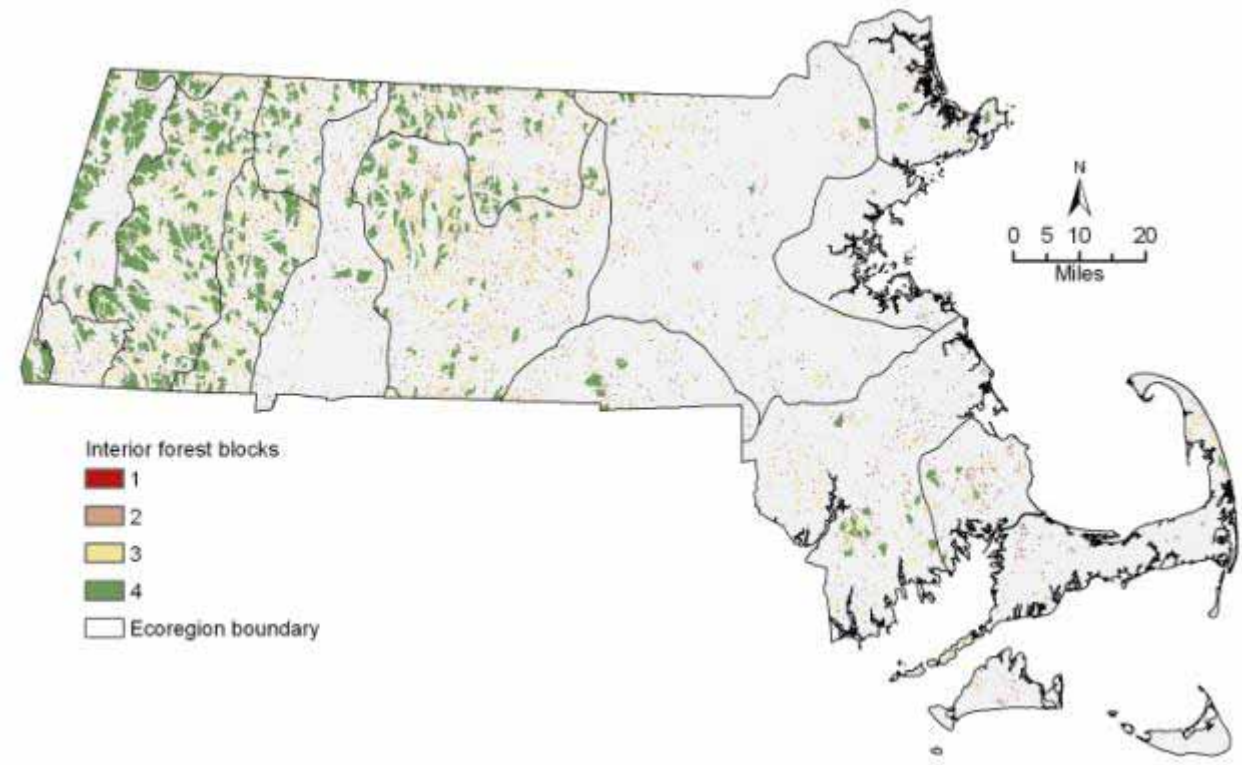
GIS process:

1. Forest and forested wetland land uses (LUCODE = 3, 37) from the 2005 MassGIS land Use datalayer were selected and converted to a raster.
2. Roads were buffered using to the following scheme:

Buffer size	Class
1000 meters	Limited Access Highway
300 meters	Multi-lane Highway, not limited access
300 meters	Other numbered route
300 meters	Major road - arterials and collectors
100 meters	Minor street or road

3. All road buffers were into one shapefile and converted to a raster.
4. All train lines were buffered 300 meters and converted to a raster.
5. All developed and open land uses (land use codes of 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 24, 26, 29, 31, 38, and 39) were buffered 300 meters and converted to a raster.
6. Using the Combine Tool, areas where forest and forested wetlands selection were not concurrent with road buffers, train buffers, and developed and open land buffers were extracted.
7. The reclassify tool was used on the resulting combine raster to have interior forests.
8. The interior forest raster was converted to a polygon feature class.
9. The size in acres of interior forest blocks was calculated.
10. The interior forest polygon datalayer was converted back to raster and scored such that 1 to 50 acres = 1, 50 to 100 acres = 2, 100 to 500 acres = 3, and >500 acres = 4.

Result: See following map.


N
0 5 10 20
Miles
Interior forest blocks
1
2
3
4
Ecoregion boundary

Protection and Recreation: Protected and Recreational Open Space

Data Source:

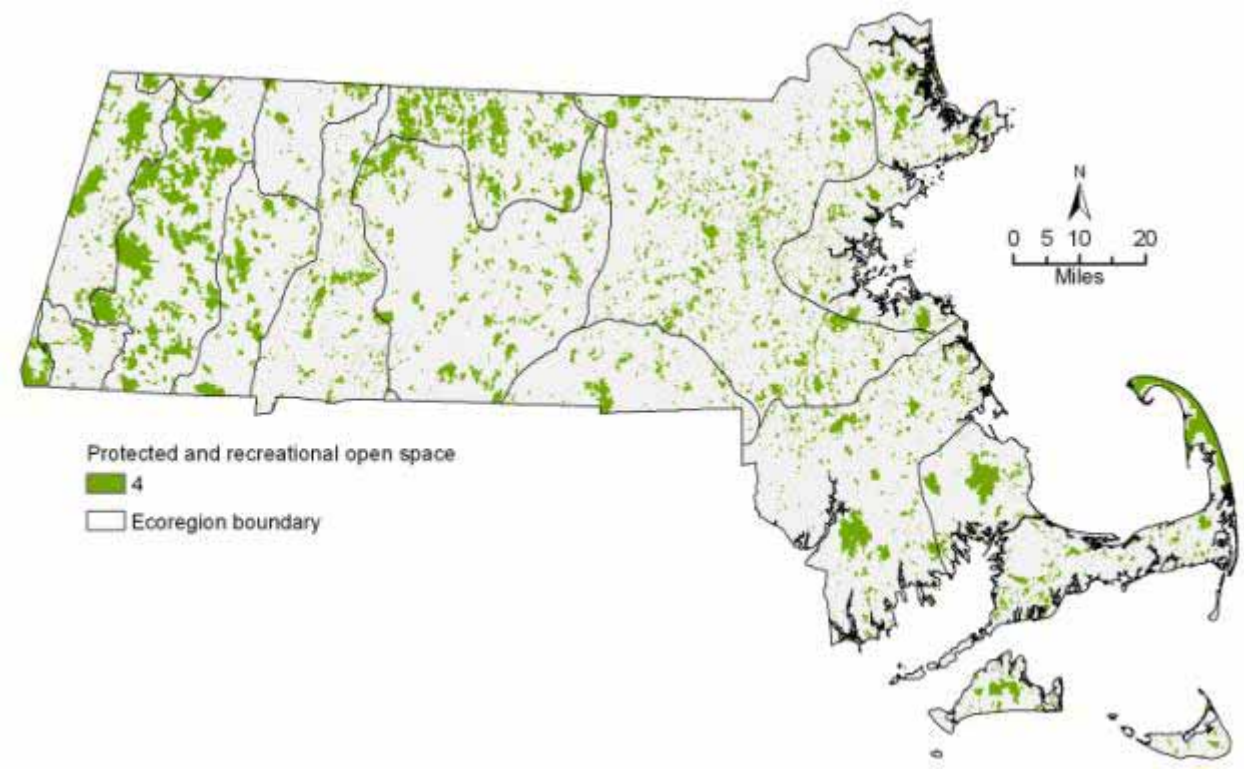
MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2010. Protected and Recreational Open Space - February 2010. *Available at* http://www.mass.gov/mgis/laylist.htm.

The Protected and Recreational Open Space datalayer contains the boundaries of conservation lands and outdoor recreational facilities in Massachusetts.

GIS process:

1. Polygons with protection from development in perpetuity (LEV_PROT = P) and public access (PUB_ACCESS = Y) were selected from the Protected and Recreational Open Space datalayer.
2. Selected protected and recreational open space polygons were converted to a raster, and assigned a value of 4.

Result: See following map.



Soil &Water Conservation: APCW
See data source, description, and GIS process under the Enhance Public Benefits from Trees and Forests overlay.
Result: See map under the Enhance Public Benefits from Trees and Forests Overlay *Water Resources and Biological Diversity*

Biodiversity: BioMap and Living Water Core areas
See data source, description, and GIS process under the Enhance Public Benefits from Trees and Forests overlay.
Result: See map under the Enhance Public Benefits from Trees and Forests Overlay *Water Resources and Biological Diversity*

Stewardship: Forest Stewardship Plans
See data source and description under the Conserve and Manage Working Forest landscapes for Multiple Values and Uses overlay.

GIS process:

1. The Forest Stewardship datalayer was converted to a raster, and given a value of 4.

Result: See map under the Conserve and Manage Working Forest landscapes for Multiple Values and Uses overlay.

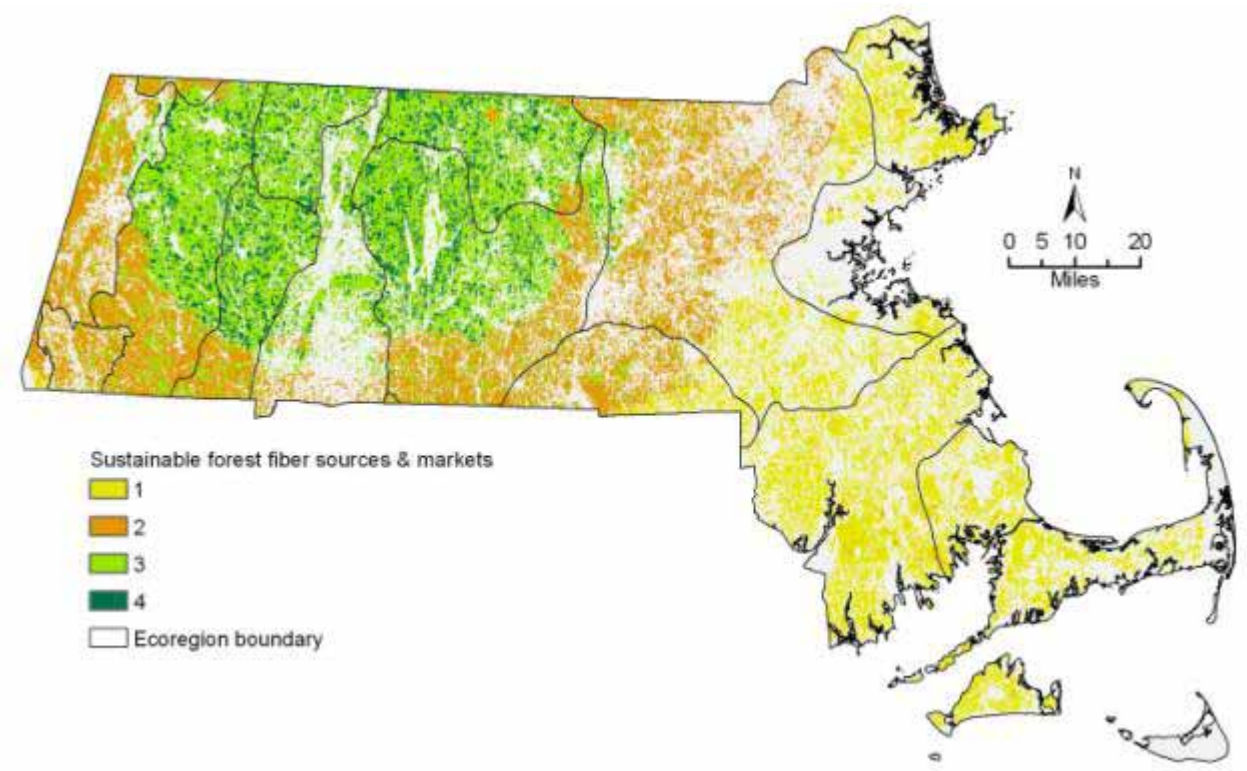
Sustainable Forest Fiber Sources & Markets: Forest cutting plans, sawmill index, licensed foresters index, & licensed timber harvesters index.

See data sources and descriptions under the Local Wood Production and Forest Sector Employment overlay.

GIS process:

1. Using the Weighted Sum Tool, the sawmill woodshed index, the licensed timber harvester woodshed index, licensed foresters woodshed index, and the non-reserve cutting plans were added together.
2. The raster was re-classified (Reclassify Tool) into 5 manual classes of 0, 0-4, 4-8, 8-12, and 12-16 and assigned values of 0, 1, 2, 3, and 4 respectively.

Result: See following map.


N
0 5 10 20
Miles
Sustainable forest fiber sources & markets
1
2
3
4
Ecoregion boundary

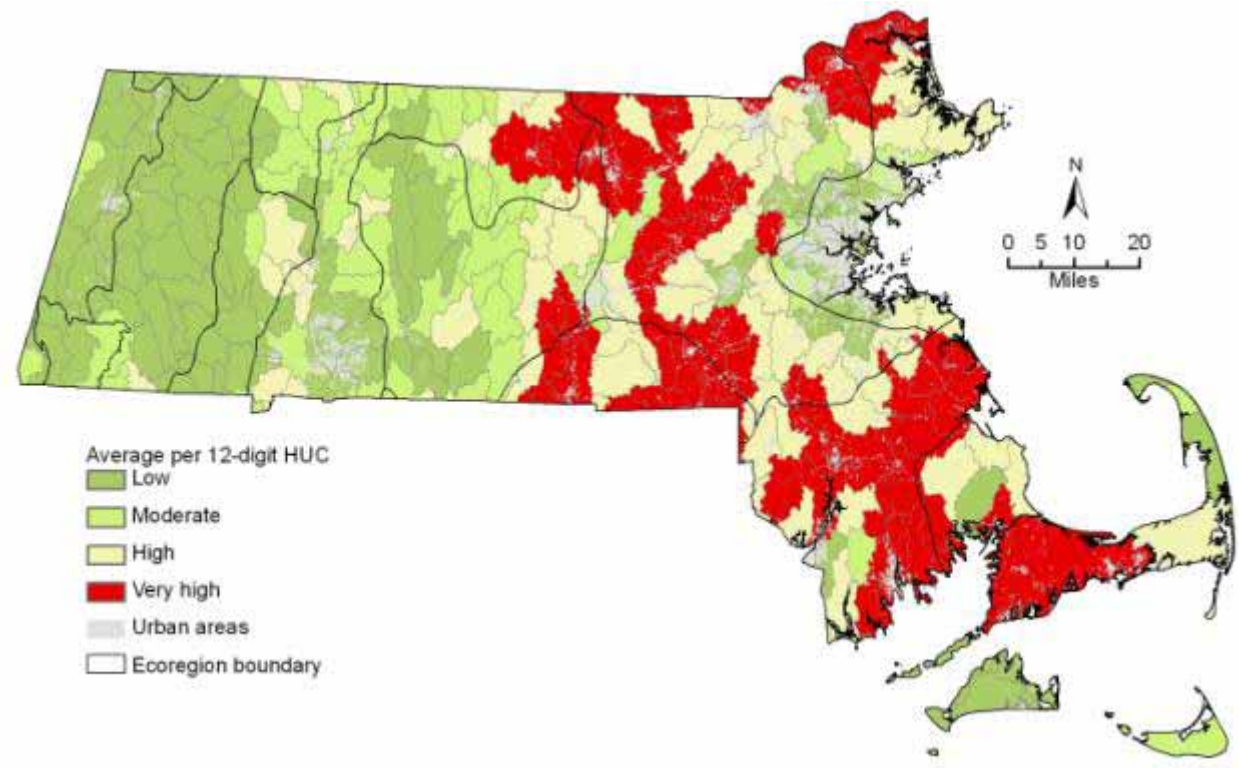
Forest Vulnerability

The following four datalayers were summed (Weighted Sum Tool) with the following weights:

- Wildfire and Forest Health Risk 0.25
- Development Pressure 1
- Non-Protected Private Forest 0.5
- Loss in the Index of Ecological Integrity, 1971 to 2005 0.25

The resulting raster was aggregated to 12-digit watersheds (HUC) using the Zonal Statistics tool, with the mean statistic type selected. The final raster was classified into 4 natural breaks and labeled as Low, Moderate, High, and Very high.

Result: See following map.



Individual Datalayer Computations

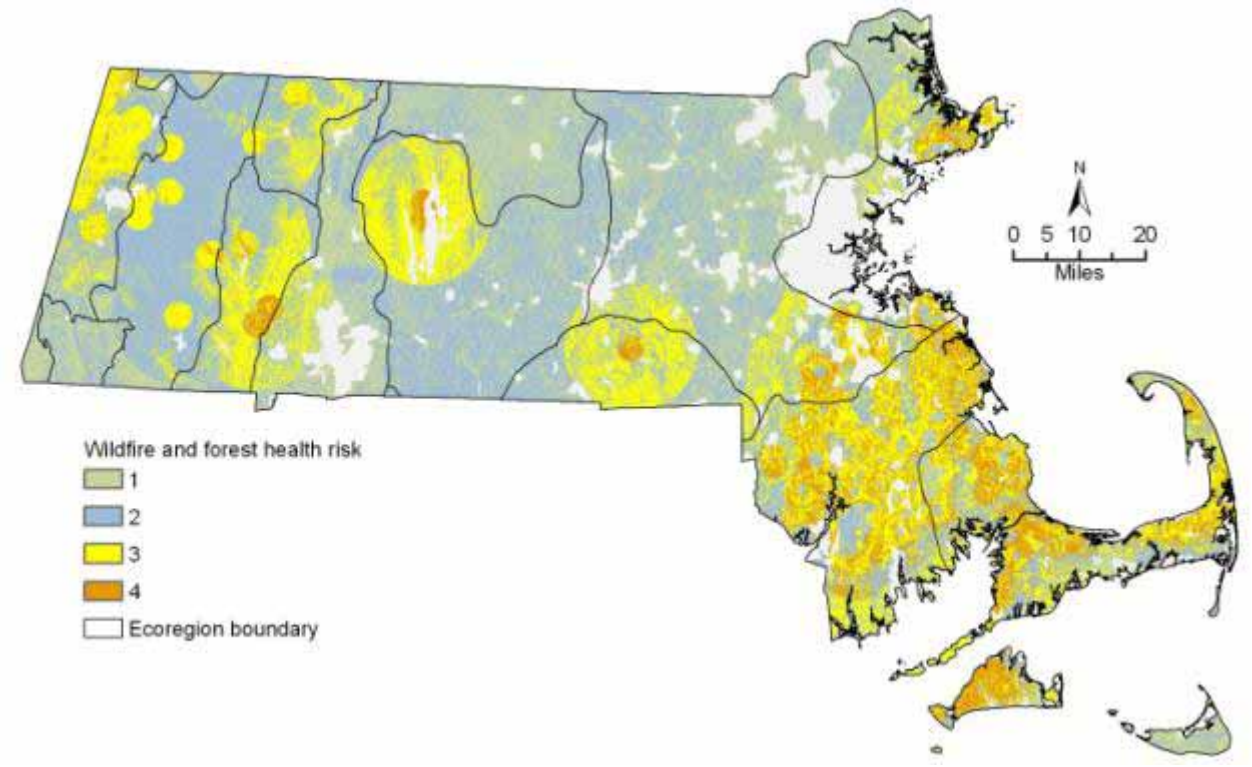
Wildfire and Forest Health Risk

See data sources and descriptions under the Protect Forest from Threats overlay.

GIS process:

1. Using the Reclassify Tool the Protect Forests from Threats overlay raster values of 4 and 5 were reclassified to 4, all other values remained the same.

Result: See following map.



Development Pressure, quartiles-per unit area of 12-digit HUC

See data source and description under the Conserve and Manage Working Forest landscapes for Multiple Values and Uses overlay.

Data source**:**

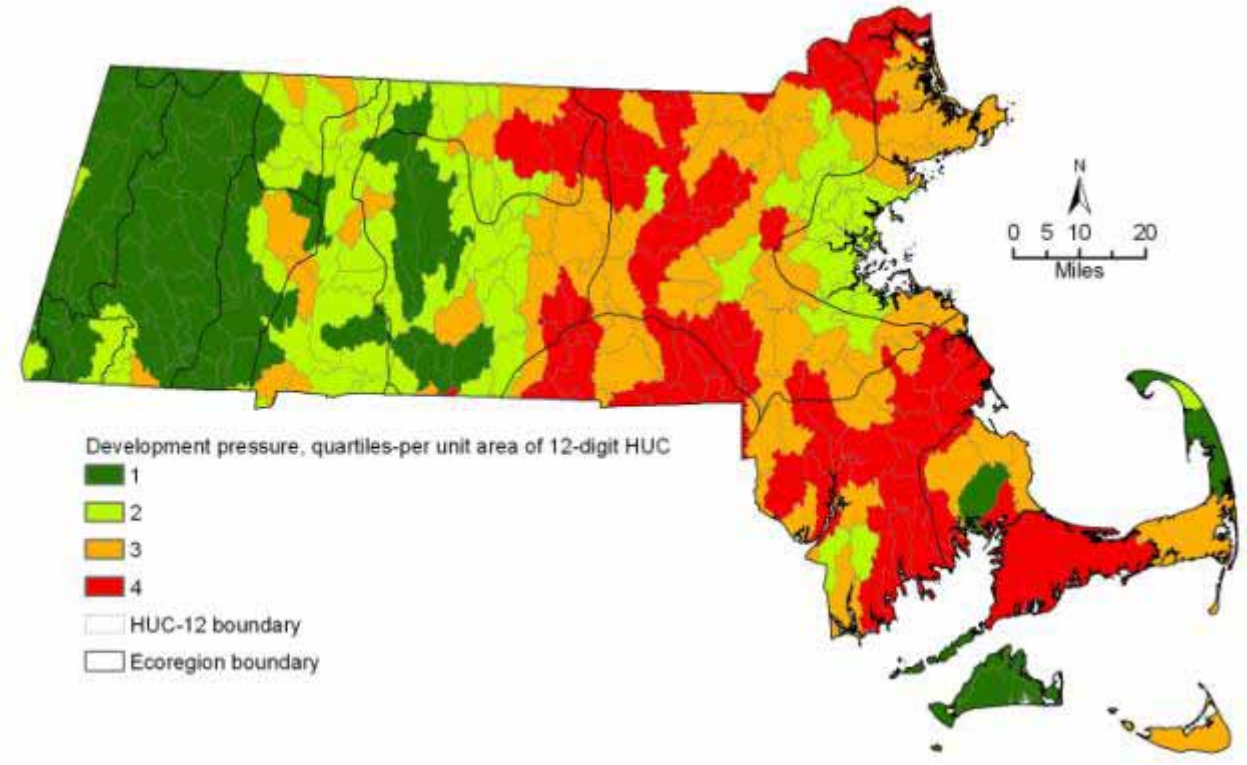
MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2005. NRCS HUC Basins (8,10,12). *Available at* http://www.mass.gov/mgis/laylist.htm.

The NRCS HUC Basins (8,10,12) dataset is a digital hydrologic unit boundary layer that is at the Subwatershed (12-digit) level. The layer also includes delineations at the Watershed (10-digit) and Subbasin (8-digit) levels. Each basin is identified by a unique Hydrologic Unit Code (HUC), as well a name, at each level. HUCs are identifiers as assigned to basin polygons by the U.S. Geological Survey (USGS).

GIS process:

1. Using the Zonal Statistics As Table Tool, area of development pressure per 12-digit watershed (HUC) was computed.
2. The resulting table was joined to the 12-digit watershed shapefile.
3. The percent of development pressure area per 12-digit watershed area was computed.
4. The shapefile was classified into quartiles based upon the per unit area of development pressure.
5. The shapefile was converted into a raster and assigned values of 1 through 4 based on the quartile classes.

Result: See following map.



Non-Protected Private Forest

See data source and description under the Conserve and Manage Working Forest landscapes for Multiple Values and Uses overlay.

GIS process:

1. Using the Reclassify tool, the Non-Protected Private Forest datalayer was given a value of 4.

Result: See map under the Conserve and Manage Working Forest landscapes for Multiple Values and Uses overlay.

Loss in the Index of Ecological Integrity, 1971 to 2005

Data Source:

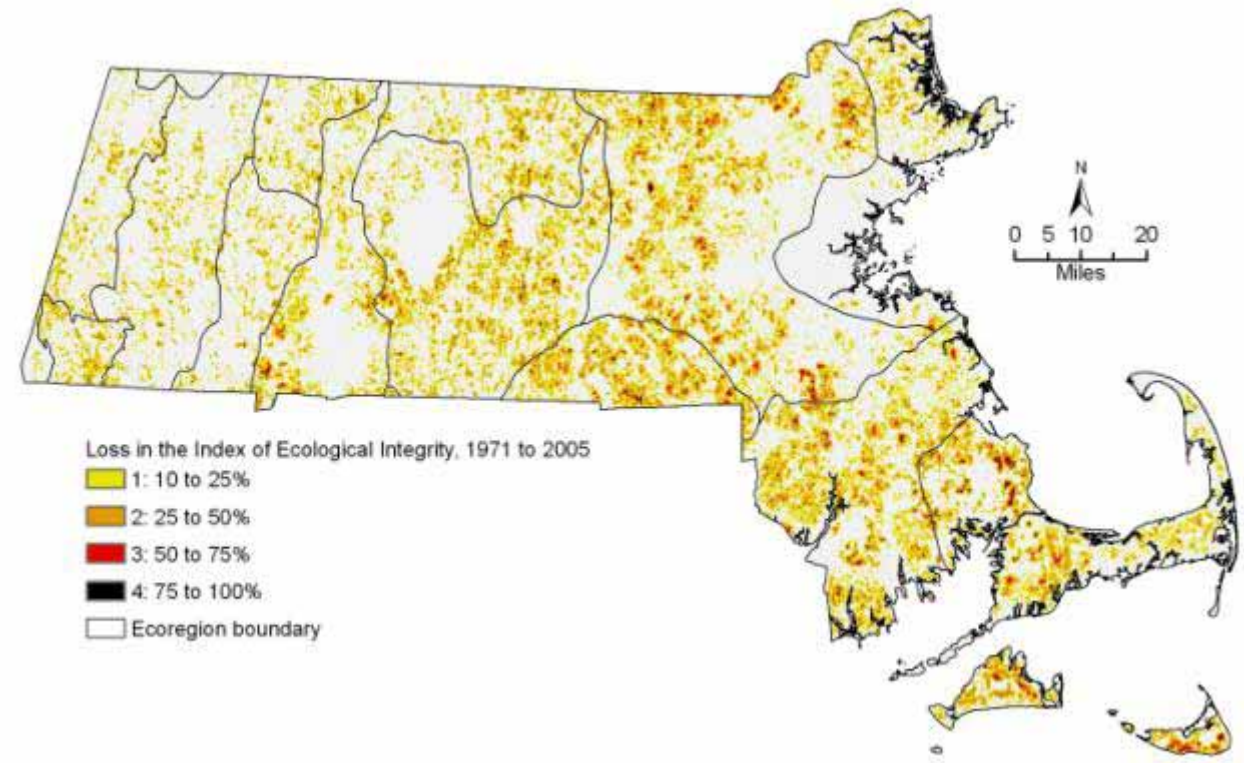
Massachusetts Audubon Society (J. DeNormandie). 2009. *Losing Ground – Beyond the Footprint: Patterns of development and their impact on the nature of Massachusetts* (fourth edition), 29 pp.

Differences in the Index of Ecological Integrity from 1971 to 2005.

GIS process:

1. Using the Reclassify Tool, the loss of ecological integrity raster was reclassified into 4 classes:
   1: 10 to 25%
   2: 25 to 50%
   3: 50 to 75%
   4: 75 to 100%

Result: See following map.



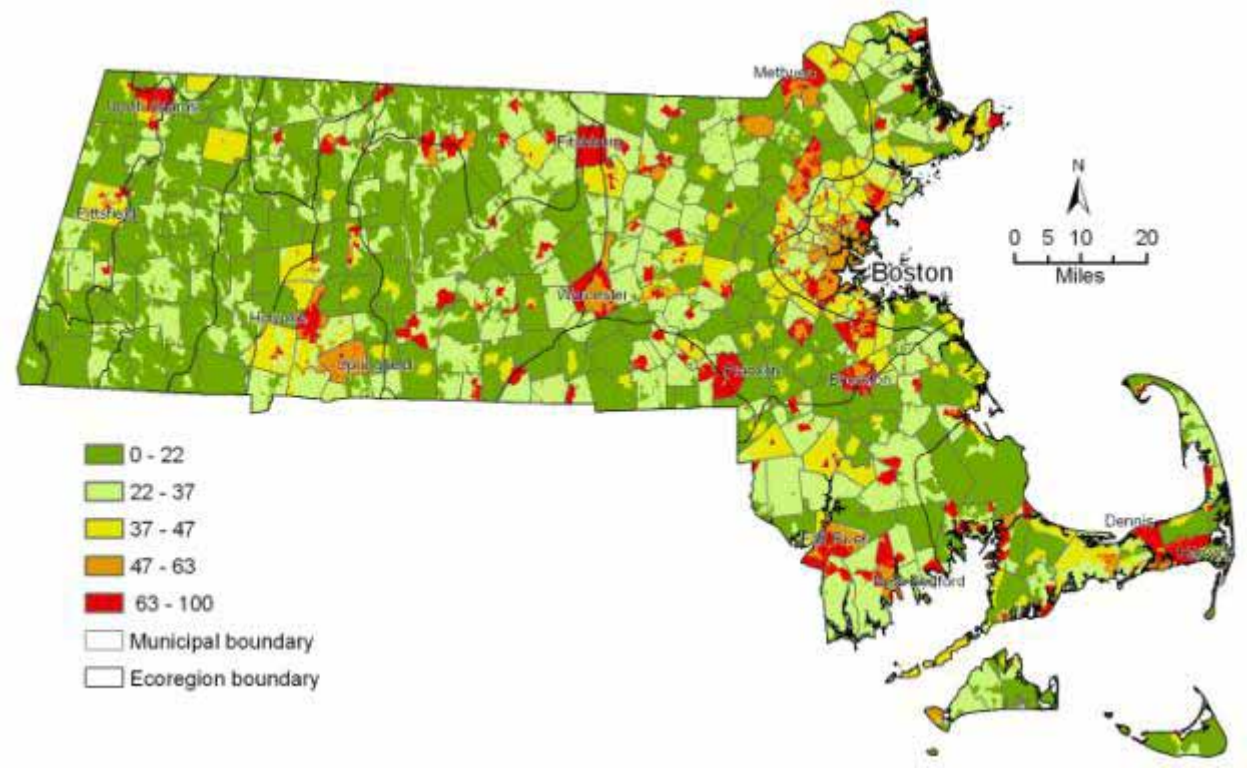
URBAN FOREST OVERLAY

The following five datalayers were summed (Weighted Sum Tool) with the following weights:

- "Maryland Method" 32
- MA Sustainable Community Score 22
- Percent of population below poverty level & environmental justice populations 24
- Wildland Urban Interface 13
- 303d (Clean Water Act) list of Impaired Waters 9

The resulting raster was classified into 5 natural breaks and labeled with their respective ranges.

Result: See following map.



Individual Datalayer Computations

"Maryland Method"
Data Source:

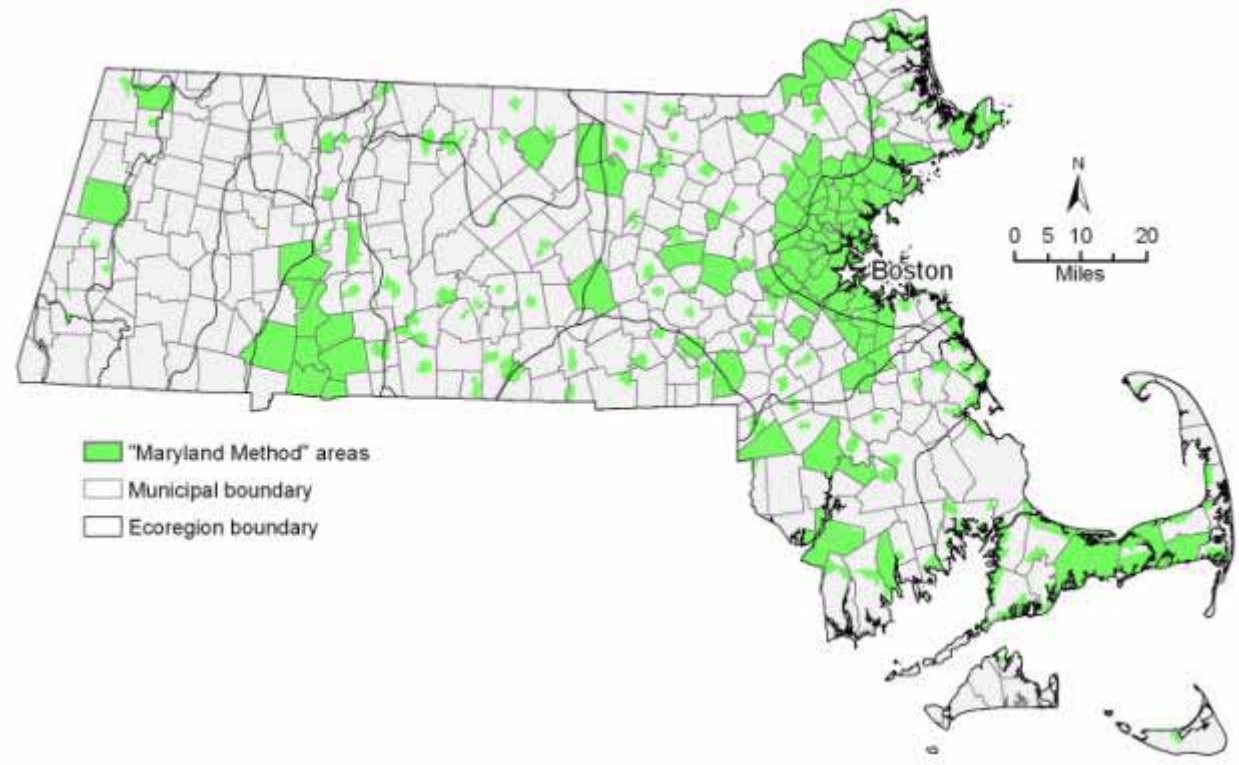
US Forest Service. Northeastern Research Station. Urban Forest Data for Massachusetts. Version 2/26/09. *Available at* http://www.nrs.fs.fed.us/data/urban/state/?state=MA.

A statewide spatial overlay analysis to identify priority urban areas using Census-defined places as the unit of analysis. This Maryland Method, developed by former Maryland Urban and Community Program Coordinator Mike Galvin identifies which communities to target for setting urban tree canopy goals. The process results in a list of communities that have less than average urban tree canopy and greater than average population, urbanized area, and impervious surface area.

GIS process:

1. Shapefile was converted to a raster.
2. Using the Reclassify Tool, all values were reclassified into a value of 1.

Result: See following map.



MA Sustainable Community Score

Data Sources:

DCR (Massachusetts Department of Conservation and Recreation). Massachusetts Urban & Community Forestry Information. 2009. *Available at* http://maps.massgis.state.ma.us/dcr/forestry/forestry23.html.

The Massachusetts Sustainable Community Score is based on six performance measures: 1. Securing or training professional staff; 2. Developing and implementing an urban forestry management plan; 3. Building and strengthening citizen advocacy and action organizations; 4. Developing and adopting tree and forest ordinances and policies; 5. Achieving Tree City USA® accreditation; and 6. Coordinating community tree and forest management decisions among municipal departments. The six criteria are used to measure community capacity to effectively manage forest resources. Each community receives a score of 0 through 6 based on the number of performance measures attained.

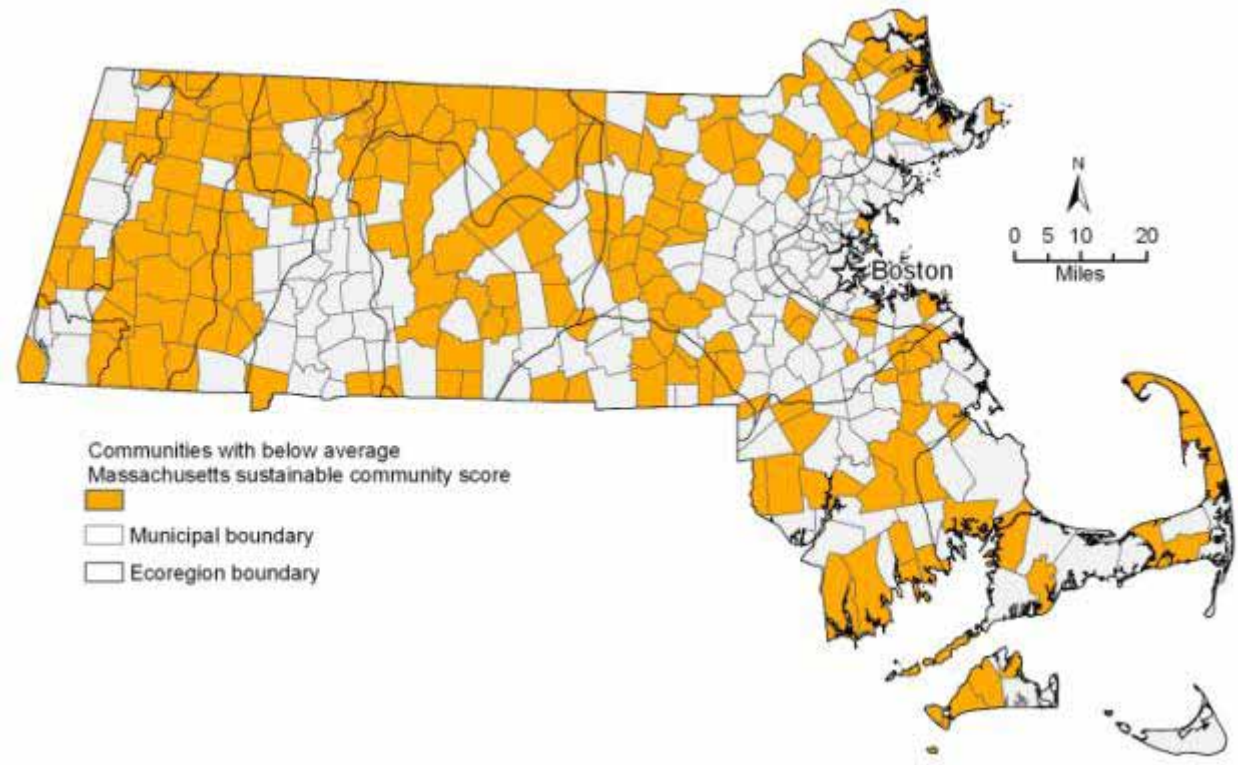
MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2009. Community Boundaries (Towns) from Survey Points. *Available at* http://www.mass.gov/mgis/laylist.

The Community Boundaries (Towns) from Survey Points is the political boundary datalayer of all communities in Massachusetts.

GIS process:

1. The MA Urban & Community Forestry Information spreadsheet was joined to the community boundary datalayer.
2. The community boundary shapefile was converted to a raster using the Sustainable Community Score field.
3. Using the Reclassify tool the raster was reclassified to have Sustainable Community Score's of 1 and 2 equal to 1, and 3,4,5,6 equal to 0. Sustainable Community Scores of 1 and 2 were below average scores.

Result: See following map.



Percent of population below poverty level & environmental justice populations

Data Sources:

DCR (Massachusetts Department of Conservation and Recreation). Massachusetts Urban & Community Forestry Information. 2009. *Available at* http://maps.massgis.state.ma.us/dcr/forestry/forestry23.html.

The percent of population below poverty level datalayer is made up of families from each Massachusetts community whose family income falls below the national poverty level based on US Census Bureau 2000 economic data.

MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2009. Community Boundaries (Towns) from Survey Points. *Available at* http://www.mass.gov/mgis/laylist.

The Community Boundaries (Towns) from Survey Points is the political boundary datalayer of all communities in Massachusetts.

MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2009. Datalayers from the 2000 U.S. Census, Environmental Justice Populations. 2003. *Available at* http://www.mass.gov/mgis/laylist.

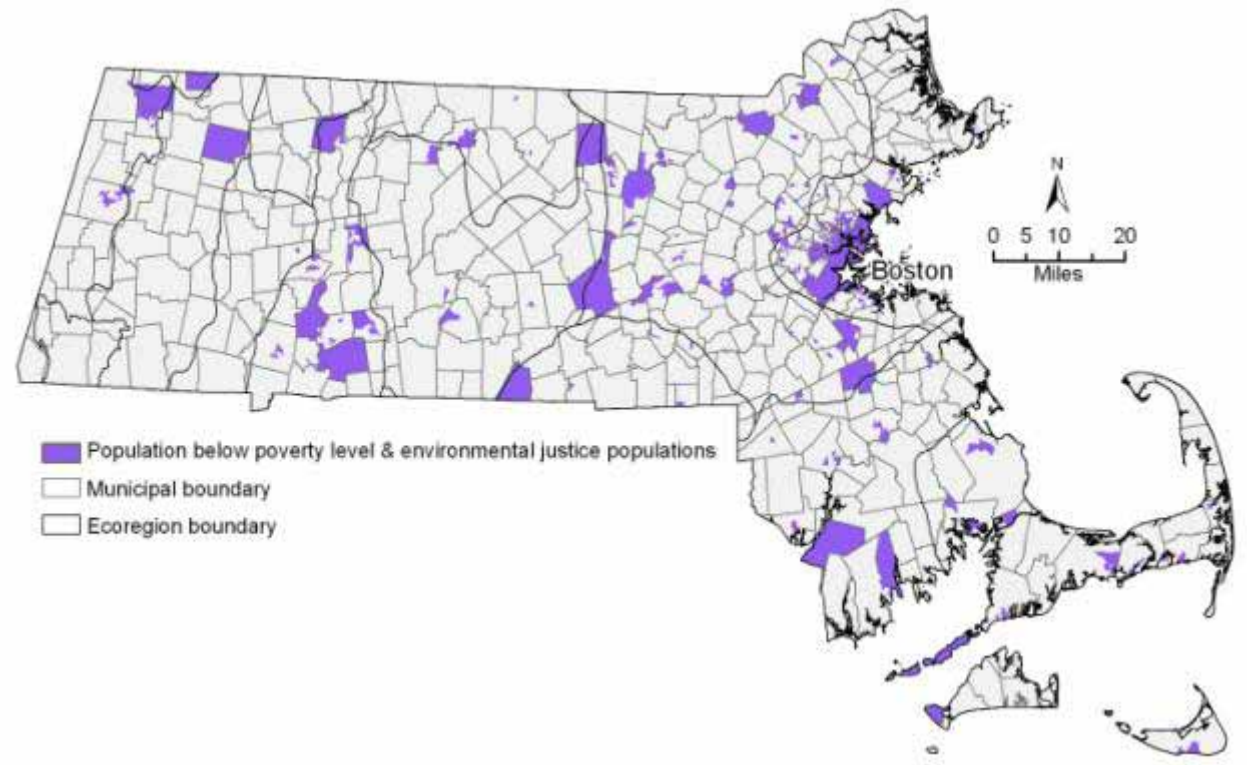
The Environmental Justice Populations datalayer represents neighborhoods across the state with high minority, non-English speaking, low-income, and foreign-born populations.

Appendix

GIS process:

1. The MA Urban & Community Forestry Information spreadsheet was joined to the community boundary datalayer.
2. Communities with poverty levels greater than 10% were merged with the environmental justice datalayer.
3. Converted the merged shapefile to a raster and assigned it a value of 1.

Result: See following map.



Wildland Urban Interface

Data Source:

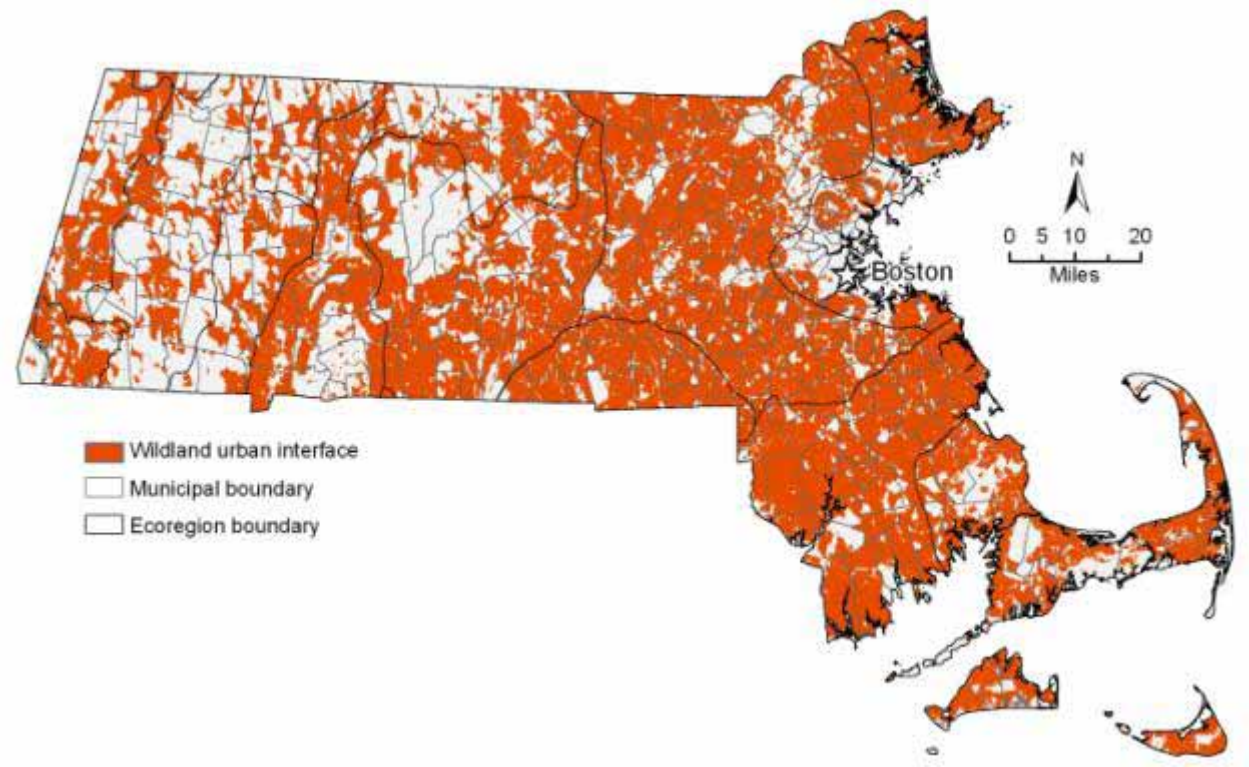
Radeloff, V.C., R.B. Hammer, S.I. Stewart, J.S. Fried, S.S. Holcomb, and J.F. McKeefry. 2005. The wildland urban interface in the United States. *Ecological Applications* 15:799-805.

Areas where structures and other human development meet or intermingle with undeveloped wildland.

GIS process:

1. Interface and intermix values within the WUIHDEN00 field were exported and converted to a raster with a value of 1.

Result: See following map.



303d (Clean Water Act) list of Impaired Waters

Data Source:

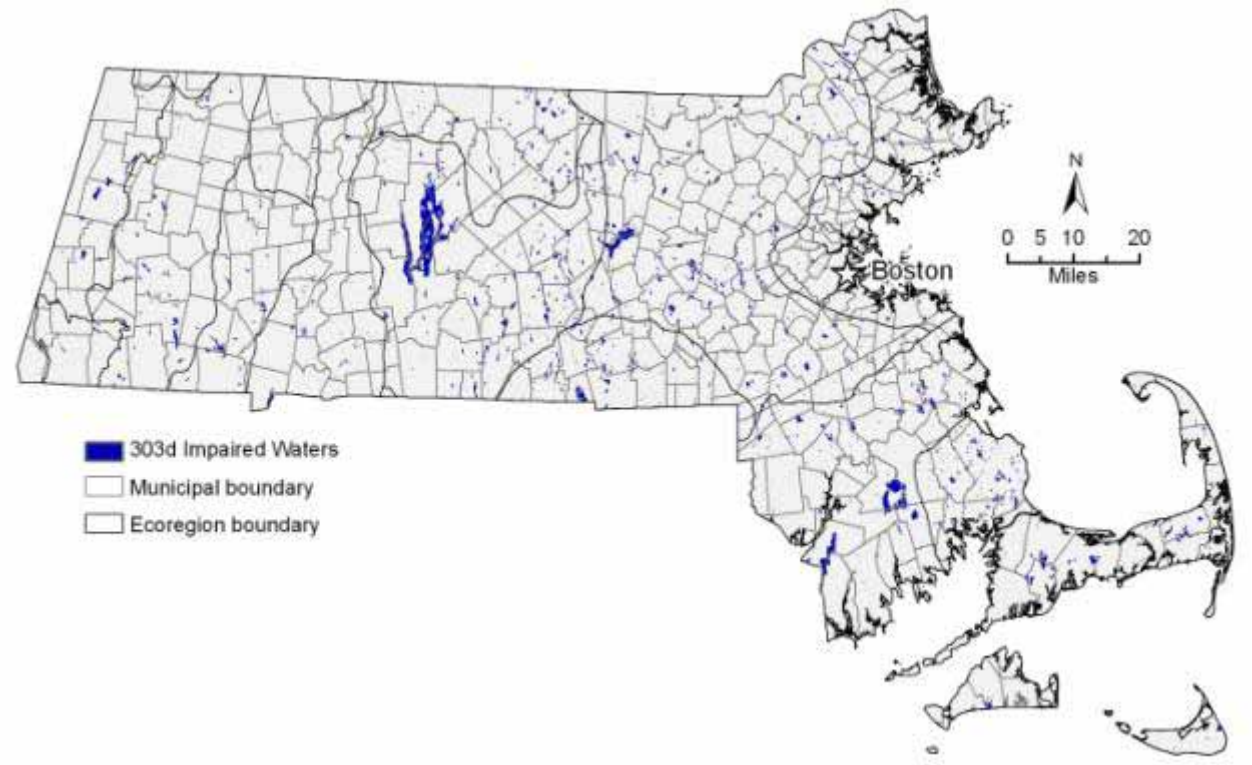
MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs). 2005. DEP 2002 Integrated List of Waters (305(b)/303(d)). *Available at* http://www.mass.gov/mgis/laylist.htm.

The Massachusetts Department of Environmental Protection's Division of Watershed Management (DWM), Watershed Planning Program (WPP) 2002 Integrated List data layer represents estuary, lake and river segments assessed and summarized in the 2002 Report to Congress made under sections 305(b) ("Water Quality Inventory") and 303(d) of the Federal Clean Water Act.

GIS process:

1. Shapefile was converted to a raster and assigned a value of 1.

Result: See following map.



DATA GAPS

We are fortunate in Massachusetts to have a wealth of available data. MassGIS provides an extensive array of high quality GIS data that is easily accessible, well organized, and updated on a regular basis. Research and educational institutions such as the Harvard Forest and University of Massachusetts Amherst provide scientific literature on local forests, forestry, and conservation. Conservation groups and state agencies such as the Natural Heritage and Endangered Species Program also have extensive data libraries. In researching and writing this report, we found only a few topics where want of data limited our analysis. The most notable of these was wood export. It appears to be common knowledge that much of the wood that is harvested in the state is exported for processing, however we were unable to find studies to support this.

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