Classification of the
Natural Communities
of
Massachusetts

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    Mixed Coniferous - Deciduous Forest/Woodland;
      mixed conifer trees 25-75% of the cover and deciduous 75-25% of the cover
      Forest Seep Community
      Maritime Forest/Woodland
      Coastal Forest/Woodland
      Oak – Hemlock - White Pine Forest
      Pitch Pine - Oak Forest /Woodland
      White Pine – Oak Forest
      Northern Hardwoods – Hemlock – White Pine Forest
      Spruce – Fir – Northern Hardwood Forest

  SHRUBLANDS; Shrubs (<~15 ft (~5m) tall) are dominant with >25% cover; trees <25%
    Maritime and coastal shrublands in the regular salt spray zone See also Estuarine Section
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      Maritime Pitch Pine Woodlands on Dunes
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      Scrub Oak Shrubland

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Sandplain Heathland - Inland Variant
        Acidic Rocky Summit/Rock Outcrop Community
        Circumneutral Rocky Summit / Rock Outcrop Community
        Calcareous Rocky Summit / Rock Outcrop Community

   HERBACEOUS and OPEN Vegetation communities: Not dominated by trees or tall shrubs: Cover of woody vegetation - trees <25%; tall shrubs <25%
Herbaceous and sparse vegetation in the regular salt spray zone, daily or storm See also Estuarine Section Maritime
        abutting ocean
        Rock Cliff Community
        Maritime Erosional Cliff Community
        Maritime Beach Strand Community
   Not usually abutting ocean but receiving regular storm winds with sand and salt, not directly affected by daily salt spray from tides
        Maritime Dune Community
        Sandplain Heathland
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        Cultural Grassland

Herbaceous and sparse vegetation inland from regular, including storm, salt spray
        Riverside Rock Outcrop Community
        Sandplain Heathland - Inland Variant
        Sandplain Grassland - Inland Variant
        Cultural Grassland
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        Acidic Rocky Summit/Rock Outcrop Community
        Circumneutral Rocky Summit / Rock Outcrop Community
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        Riverside Rock Outcrop Community
   Rock Cliff
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        Circumneutral Rock Cliff Community
        Calcareous Rock Cliff Community

PALUSTRINE COMMUNITIES
   FOREST/WOODLAND (Greater than about 25% tree cover) (Swamp)
   Deciduous Forest; broad leaved (generally deciduous) trees >75% of the cover
        Deciduous Forests/Swamps along rivers
        Alluvial Hardwood Flat Community
        Cobble Bar Forest
        Alluvial Red Maple Swamp
        High-terrace Floodplain Forest
        Major-river Floodplain Forest
        Transitional Floodplain Forest
        Small-river Floodplain Forest
        Deciduous Forests/Swamps not along rivers
        Black Gum - Pin Oak - Swamp White Oak Perched Swamp
        Red Maple - Black Gum Swamp
        Red Maple Swamp
        Red Maple - Black Ash Swamp
        Red Maple - Black Ash - Bur Oak Swamp
        Red Maple - Black Ash - Tamarack Calcareous Seepage Swamp
   Conifer and Mixed Forest; needle leaved (generally evergreen) trees >25% of the cover
        Alluvial Atlantic White Cedar Swamp
        Coastal Atlantic White Cedar Swamp
        Inland Atlantic White Cedar Swamp
        Northern Atlantic White Cedar Swamp
        Hemlock Swamp
        Spruce – Tamarack Bog
        Red Spruce Swamp
        Rich Conifer Swamp

SHRUBLANDS, wetlands dominated by shrubs (<~15 ft (~5m) tall); total woody cover >25%, trees <25%
        Shrub Swamp
        Highbush Blueberry Thicket
        Acidic Shrub Fen

OPEN: SPARSELY VEGETATED, HERBACEOUS or LOW SHRUB wetland communities
    Acidic Peatlands
        Level Bog
        Kettlehole Level Bog
        Atlantic White Cedar Bog
        Acidic Graminoid Fen
        Acidic Graminoid Fen - Spillway Fen
        Sea-level Fen
    Calcareous wetlands/ peatlands
        Calcareous Basin Fen
        Calcareous Seepage Marsh
        Calcareous Sloping Fen
        Calcareous Pondshore/Lakeshore Community

    Other sparse, herbaceous/graminoid, or low shrub wetland communities, neither acidic sphagnum peatlands nor calcareous fens
        Wet Meadow
        Kettlehole Wet Meadows
        Shallow Emergent Marsh
        Deep Emergent Marsh

      Open wetland vegetation associated with pond or lakes (not aquatic)
        Calcareous Pondshore/Lakeshore Community
        Coastal Plain Pondshore Community
        Coastal Plain Pondshores - Inland Variant
        Acidic Pondshore/Lakeshore Community
        Freshwater Mud Flat Communities
        River and Lake Drawdown Community

      Open wetland vegetation associated with river or streams (not aquatic)
        River and Lake Drawdown Community
        Low-energy Riverbank Community
        Riverine Pointbar and Beach Community
        High-energy Riverbank Community
        High-energy Rivershore Meadow
        Riverside Seep Community

ESTUARINE COMMUNITIES
FOREST/WOODLAND (Greater than about 25% tree cover) (Swamp)
        Fresh/Brackish Tidal Swamp

SHRUBLAND Shrub dominate (multiple trunks, <~15 ft (~5m) tall); total woody cover >25%, trees <25%)
        Fresh/Brackish Tidal Shrubland

OPEN: SPARSELY VEGETATED, HERBACEOUS or LOW SHRUB wetland communities
    Open vegetation along tidal rivers and streams in areas where fresh and salt water mix
        Freshwater Tidal Marsh
        Brackish Tidal Marsh

    Open vegetation covered twice daily in salt water by tides or submerged
        Seagrass Community
        Coastal Salt Pond Community
        Salt Marsh
        Marine Intertidal Rocky Shore Community
        Marine Intertidal Gravel/Sand Beach Community

Introduction

The main purpose of this classification is to provide a framework for describing, inventorying, and tracking natural communities for conservation in Massachusetts. The community types identified in the classification are intended to be recognizable in the field and meaningful to a broad conservation audience including writers of town open space plans, land managers, environmental reviewers and consultants, and ecologists doing field studies.

What is a Natural Community? Natural communities are defined as groups of species that recur together in (usually) particular environmental conditions. A community may have indicator species that occur primarily in a particular type of community. It has characteristic species and usual species that generally occur in the particular type of community, but also occur in other types of communities. In a particular type of community these species occur together in different locations in similar structures and proportions. Occurrences of a community type tend to be in sites with similar chemistry, soils, moisture, slopes, temperature ranges, and other physical conditions.

Communities have structural attributes that affect what plant and animal species are part of them. Vertical diversity is provided by different layers of vegetation and its density. Different types of trees have different shapes and shade the lower layers differently. Different tree species also affect nutrient movement differently which influences what other species will co-occur with them. Shrubs and tall herbaceous plants do the same especially when they are dominant. Communities have horizontal diversity produced by more or less sun, moisture, rock outcrops, soil exposure, and other physical and biological variables. Underlying it all is the physical environment, the geology of the land and the regional climate controlling what species can grow, what is present. Past disturbances, including glaciation thousands of years ago, and more recent hurricanes and human land use - particularly the extensive land clearing, cultivation, and reforestation that occurred after European settlement - influence the species mixes and community structure seen today.

Diversity is an attribute of communities: the numbers of species and their relative abundances affect communities in different ways. A particular species may be abundant and dominant in one type of community and barely present in another type where it would not exert control on what other species are present, resulting in a different community type. Not all natural community types have a wide diversity of species: appropriate native diversity may be low in certain, generally stressful, conditions (for example, a dry site on sand with low nutrient availability on acidic soils may support a naturally low diversity Pitch Pine - Scrub Oak Community).

For organizational purposes in this classification the community types are differentiated by ecological processes then structure (growth form of the dominant species), followed by species composition and physical substrate. System (Terrestrial (upland), Palustrine (wetlands but not aquatic), and Estuarine (affected by tides or ocean waters) is the first division in this classification. The Systems are then each subdivided into forest, and not forest but shrub dominated, and not forest or shrub dominated but dominated by herbaceous vegetation or sparsely vegetated - open.

Naming Conventions: The names of the natural communities in this classification are intended to be descriptive labels that highlight important species or features of the particular types of natural community. Sometimes a physical character such as in a rock outcrop or cliff or riverbank controls what species will be present: in those cases the name often includes that feature; examples include Calcareous Rock Cliff and Low-energy Riverbank Communities. Other community types are characterized by one or more dominant (or main) species and are named for them: Mixed Oak Forest and Hemlock Swamp are examples. When community name includes species names, the intent is to use the names of the most common and dominant species that affect or control what other species are present. Naming the dominant species may lead to inclusion of characteristic but not diagnostic species such as Red Maple: this version of the classification has changed the names of several forested wetlands to Red Maple - Other Species

Swamps to emphasize the importance of Red Maple in these community types (examples include Red Maple - Black Gum Swamp and Red Maple - Black Ash Swamp). *Cultural* is used in a community name or in its attributes to indicate that the community so attributed was overtly created by human management activities (River and Lake Drawdown Community and Cultural Grasslands) or that the community developed on a human created physical feature (Acidic Graminoid Fen - Spillway Fen). Each of these named cultural community types provides habitats for species of conservation interest, although the community itself is not a focus for conservation. Some community types of conservation focus may be managed to impede succession to forest, but are dominated by native rather than non-native species (Sandplain Grasslands and Sandplain Heathlands particularly the Inland Variants of both are examples). The focus on native species, along with the intent of the land management, is the main differentiating feature of natural vs. cultural communities in this classification. Some of the differentiation may, of course, be arbitrary.

Purpose of the Classification: This natural community classification is designed to describe vegetation at a scale that is meaningful for conservation and land protection. A classification provides a convenient mechanism for reducing the complexity of natural vegetation to a relatively small number -- 107 in this case -- of somewhat homogeneous and relatively easily understood, but abstract and artificial, groups. Any classification requires somewhat arbitrary categories and lines between types; classifications differ on where the lines are drawn. Vegetation classifications are influenced by their intended use – the use of this one is for conservation, and, indeed, focuses on the uncommon.

One way NHESP works to protect the components of biodiversity is to evaluate the conditions and distribution of natural communities across the state. Analyzing and evaluating natural communities requires knowing what they are. A first step in acquiring knowledge of natural communities is to classify them - to name and describe what is known and establish a common parlance for discussing them. The classification framework then identifies what is not well known and encourages the gathering of missing information.

The intent of this classification is to describe communities that can be identified in the field and to accurately (if arbitrarily) divide the vegetation of Massachusetts into identifiable and useful categories. Terrestrial, Palustrine, and Estuarine communities are included; Aquatic and Marine communities are NOT addressed in this classification.

Natural community types include variation that is part of the community description. In defining the composition and structure of the community types, variations within those community-types are often identified; further information on the variations may lead to further splitting or lumping of the identified types in later versions of the classification. Small patches of included variation is generally considered to be part of the prevailing community; occasionally large (mappable) patches of variation are considered to be different types of communities. For example, very small patches of rocky outcrops in a forest may be considered to be part of the expected structure of the forest, but outcrops large enough to have full sun or other distinct conditions would be considered to be communities separate from the surrounding forest. Age of communities (time since a major disturbance), its state of succession, also leads to variation. Some vegetation in early successional stages, generally in relatively open conditions that have a distinct species mix, are identified as community types in this classification. However, successional forests are generally lumped into very broadly defined community types, with successional patches included as part of the variation of the prevailing community type. Descriptions of types of cultural communities (plant communities planted and maintained by humans for direct use by humans or domesticated animals such as forest plantations, orchards, and pastures) could be expanded, but most are not of conservation focus, so will probably continue to be lumped into a few groups.

Many communities occur with others in mosaics that share conditions and processes, such as water flowing through a wetland complex with no one community-type independent of the others or the unifying conditions. Communities are most effective as units of conservation when the controlling ecological processes can be maintained or restored. Identifying communities in the functional systems of

which they are a part is a step in their conservation. In the classification, some of those ideas are addressed the Environmental Setting (Description in the fact sheets) part of the community description. (Functional systems are not the same as the hierarchy of the key - that is a rock cliff face may be found in the key under non-forested, open communities, but is found on the ground surrounded by forest.)

The community descriptions here are for occurrences in exemplary conditions, they are abstract: many community occurrences approach but do not meet the criteria of the abstract, but still qualify as that community type. Many actual communities are disturbed by nature or humans, some are in climatic, topographic, or geological conditions different from the idealized, and others occupy some middle ground between described communities. Because communities are made up of plant species that have individual responses to environmental variables, the communities described grade into other community types. In addition, the role of land use history is very important in the location and definitions of natural communities in Massachusetts. Over four hundred years of intense use of the land in the state appears to have had a homogenizing effect that overrides some of the influences of climate and landscape position (for example, see Foster et al. 1998, and other papers from the Harvard Forest). Some of this homogenization of communities is reflected in the difficulty of defining distinct community types and in the prevalence of mid-successional species in many of the community descriptions as well as in the actual community occurrences.

The community-types that are described here are parts of the habitat for the animal species that use them. Birds may nest in one type of community, feed in another, and then leave entirely. Other animals also move between community types for different needs. Generalist species might have individuals occurring in a variety of different community types.

Despite the problems of classifying vegetation in a working landscape, we do find recurrent groupings of plant species and associated animals that share responses to environmental conditions. Species that have restricted ranges and particular environmental requirements are often used as indicators of the communities in which they occur. Other species are found in a range of conditions and occur in a variety of community-types, so are less useful as indicators, although they may be characteristically present in a given community type. These natural groupings of species, or natural communities, tend to vary simultaneously in response to soil moisture gradients, temperature gradients, and nutrient gradients, in a multidimensional, rather than linear, way. Thus, there are southern and northern versions of dry to wet gradients, acidic to less acidic, and nutrient poor to nutrient rich communities, and all the other interactions as well. While not all the possible variations result in distinctly different communities, there is a lot of variation in the real world.

Relationship to other classifications

This classification focuses on the natural communities of Massachusetts, which are closely related to the natural communities of the region and particularly the surrounding states. All of the surrounding states have published classifications for their state's natural communities; most are available on line and all are cited in the reference list. Differences from other state's classifications are, of course, confounded by geographic differences in species distributions in the states, as well as issues of different levels of definitions. NatureServe (with the Ecological Society of America and the US Federal Geographic Vegetation Subcommittee) has developed the United States National Vegetation Classification (USNVC). The Massachusetts Classification descriptions include the USNVC/NatureServe synonyms for those who want more finely divided community-types – the USNVC Associations. The accuracy of the cross-walks made here to the USNVC synonyms is variable, which is at least partially a result of the lack of clear boundaries between or among community types.

Organization of the classification

This classification divides natural community **types** into three major systems: Terrestrial, Palustrine and Estuarine. Keys to assist in differentiating the community types are included for each system. Within the System, the structural dominance – growth form or physiognomy such as forest, shrubland,

herbaceous, and open or sparsely vegetated – is used as a division of types. The forested categories in the Terrestrial and Palustrine sections are subdivided into coniferous (evergreen), deciduous, and mixed.

A significant presence of water is used to define the Palustrine system, and the presence of water with some salinity or tide for inclusion in the Estuarine category. All tidally influenced communities are in the estuarine category whether the tidal water is saline or fresh. Upland salt spray communities not influenced by tides are treated as Terrestrial.

Terrestrial: The vegetation of terrestrial communities is not significantly influenced by standing or moving water. The forested community types have more than about 25% tree canopy, which includes woodlands of USNVC/NatureServe and other classifications. If mature trees are absent, and if shrubs are present forming more than about a 25% shrub layer cover overall, the community is considered to be a shrubland. Herbaceous communities are relatively open communities with neither forest nor shrub canopies. Many of the open herbaceous or sparsely vegetated communities are divided by their substrate type, rock or sand for convenience.

Palustrine: The palustrine section of the Massachusetts natural community classification includes all freshwater, non-tidal wetlands dominated by trees, shrubs, or persistent emergents, including mosses and lichens. This definition is slightly different from Cowardin (1979) who also included small, shallow aquatic beds with submersed and floating-leaved aquatics, and tidal wetlands where salinity due to ocean-derived salts was less than 0.5%. In this Massachusetts' classification, submersed and floating-leaved aquatics are not included (other organizations are working on aquatic classifications), and all tidal wetlands are included in the estuarine section. The palustrine section does include riverside communities that receive annual or semi-annual overbank flooding, e.g. floodplain forests. High-terrace floodplain forests are included in the palustrine section in order to group them with other floodplain forest communities. In this classification of natural communities, the term Wetlands is not used in the sense of a legally defined "jurisdictional wetland." The ideas certainly overlap, but the "jurisdictional wetlands" and their boundaries are determined by legally defined techniques not included in this classification.

Estuarine: Estuarine communities are subject to varying salinity, tidal actions, and wind. Estuaries include tidal habitats and adjacent tidal wetlands in which ocean water is at least occasionally diluted by freshwater from the land. Estuarine areas extend landward and up streams to where oceanic salts (formally defined as above 0.5 ppt salinity in an annual average low flow period) or tides (including freshwater tidal areas) have an influence on the vegetation. Hyper salinity (compared to the ocean) may occur temporarily in some areas from evaporation (such as in salt ponds). The estuarine area extends off-shore to areas with freshwater influence on the seawater, called subtidal communities that include seagrass beds. Many Estuarine and Marine (no freshwater influence) communities are outside of the jurisdiction of the Division of Fisheries and Wildlife and are not included in this classification which is generally limited to communities defined by vascular plants. As with the aquatic communities, other organizations have taken responsibility for developing regional or national marine classifications.

Species Nomenclature

The scientific and common names of organisms are intended to be consistent with the following:
Vascular plants:
> Cullina, Melissa Dow, Bryan Connolly, Bruce A. Sorrie, and Paul Somers. 2011. The vascular plants of Massachusetts: a County Checklist First Revision. Massachusetts Division of Fisheries and Wildlife, Natural Heritage & Endangered Species Program. Westborough, MA.

Mammals:
> Cardoza, James E., Gwilym S. Jones and Thomas W. French. nd. State Mammal List. 4th Edition. Available only from http://www.mass.gov/eea/agencies/dfg/dfw/fish-wildlife-plants/state-mammal-list.html downloaded 2016

Birds:

Blodget, B.G. 1998. Checklist of the birds of Massachusetts. Massachusetts Division of Fisheries and Wildlife. Westborough, MA. http://www.mass.gov/eea/docs/dfg/dfw/wildlife/wildlife-facts-pubs/bird-list.pdf The American Ornithologists Union Checklist of North American Birds incorporates the most up to date changes in bird classification and nomenclature: http://checklist.aou.org/

Reptiles and Amphibians:

Cardoza, James E. and Peter G. Mirick. revised 2009. State Reptiles & Amphibians List, 3rd edition. Massachusetts Division of Fisheries and Wildlife, Fauna of Massachusetts Series No. 3. Westborough, MA. http://www.mass.gov/eea/agencies/dfg/dfw/fish-wildlife-plants/state-reptiles-and-amphibians-list.html

Request for information

This classification identifies example sites where the community-types can be found on lands with public access in Massachusetts. The NHESP database includes sites on less accessible land. NHESP continues to incorporate records of good occurrences of all community-types into its database, with the most common (types generally categorized as Low Priority for conservation) being tracked only by exemplary occurrences (definitions of exemplary are being developed for each community type), and the rarest (Priority types) being tracked by all known occurrences. There is a sliding scale for inclusion in the NHESP database for the less rare types. Evaluation of the proportion of occurrences on conservation land and identification of which types need further protection have been incorporated into DFW's conservation planning projects as the natural community classification has been developed. NHESP is always interested in reports of additional locations of uncommon or exemplary community occurrences; this will not necessarily result in those locations becoming published information.

Management and restoration knowledge developed and collected on the various community types increases the protection of the biodiversity of Massachusetts. Management needs of communities are seldom well known. The descriptions of the community types in the Classification (not the fact sheets), include some of the management issues identified by field biologists who have been to occurrences of the communities described. Management needs of the described communities can always be improved and refined.

This classification of the natural communities of Massachusetts was written in order to provide a basis for discussing and conserving diversity of the types of vegetation in the state. The primary aim is to describe natural communities of conservation interest in Massachusetts, while including all the vegetation of the state. The overall tendency in this classification is to lump rather than to split. However, communities that have been well-studied (e.g. floodplain forests, acidic peatlands, Atlantic white cedar swamps) are usually more finely divided. Mostly, though, the many vegetation associations occurring within broadly defined communities are not described separately. Instead, the variation in vegetation is included within the vegetation description field. As more data are accumulated, more divisions and reorganization will undoubtedly occur.

This classification represents the best knowledge about Massachusetts' communities from the field data and literature compiled to date. It is by no means complete or absolute. Instead, it should be regarded as a framework that can be field-tested and revised. Communities can be added, deleted, divided, or combined with increased knowledge of Massachusetts' natural communities. There are inconsistencies, some fields are incomplete, some community descriptions overlap. Any assistance with refining those issues would be helpful. All comments, feedback, and community information are welcome and appreciated. Your help will greatly improve the result.

CLASSIFICATION PAGE GUIDE

Community Name:	Name used to describe the community in Massachusetts
Community Code:	Unique ten digit alphanumeric element code (ELCODE) assigned to the community.
State Rank:	Community state rank (SRANK) that reflects the community's rarity and threat within Massachusetts, with regard to its regional rarity and threat. The SRank system was developed for Natural Heritage programs by The Nature Conservancy. The SRANKs are as follows:

S1= Typically 5 or fewer occurrences, very few remaining acres or miles of stream, or especially vulnerable to extirpation in Massachusetts for other reasons.

S2= Typically 6-20 occurrences, few remaining acres or miles of stream, or very vulnerable to extirpation in Massachusetts for other reasons.

S3= Typically 21-100 occurrences, limited acreage or miles of stream in Massachusetts.

S4= Apparently secure in Massachusetts.

S5= Demonstrably secure in Massachusetts.

SU= Status unknown in Massachusetts.

Map of Ecoregions where the community is known, from the NHESP database:
See the discussion of the ecoregions in the Appendix

Each community description is accompanied by a line map showing the ecoregion boundaries used by DFW. Ecoregions in which the community type is known to occur (i.e., NHESP has field data for the community including vegetation descriptions and/or plot data) are shaded in gray.

The community ecoregion maps are intended to give the user an idea of where a certain community type might be encountered and also to identify ecoregions for which community data are needed.

Concept:	Brief general description or word-picture of the community.
Environmental setting:	Detailed description of the landscape setting, soils, water chemistry, and other physical characteristics of the community.
Vegetation Description:	Detailed description of the vegetation structure and characteristic plant species of the community.
Differentiating Occurrences:	Discussion that highlights distinct features of the community type with lists of related types that it might be confused with and brief notes on their distinctive features.
Habitat values for Associated Fauna:	Description of the habitat that the community provides for animals, including birds, small mammals, amphibians, reptiles, and invertebrates.
Examples with: Public Access	List of representative examples of the community in areas with public access. For particularly sensitive communities, specific examples are not listed.
Threats:	A description of known threats to the community.
Management needs:	A description of management activities that may be necessary to maintain community occurrences and the quality of those occurrences, when known.
USNVC/NatureServe:	Synonyms in the National Vegetation Classification. Crosswalk updated in 2015-2016 from USNVC.org. [Association codes are written in brackets.]

Community Distribution Maps: Ecoregions

Ecoregions (or ecological regions) are broad areas of relatively homogeneous vegetation, soils, climate, geology, and patterns of human use. Ecoregions have been developed for the United States to provide an ecological framework for inventorying and assessing environmental resources. Different agencies and organizations have developed somewhat different ecoregions and have called them by different names to indicate hierarchy of scale and to avoid confusion: the USDA US Forest Service (USFS) hierarchical framework of ecological units divides the United States into provinces, sections, and subsections. Massachusetts falls within three sections of two USFS Provinces of the United States— **Lower New England Section** (221A) of the **Eastern Broadleaf Forest Province** (221) and the **New England Piedmont Section (**M211B) and **Green, Taconic, Berkshire Mountains Section** (M211C) of **the Adirondack-New England Mixed Forest - Coniferous Forest - Alpine Meadow Province** (M211). USFS sub-sections are called Ecoregions of Massachusetts in this classification; they are particularly useful for statewide ecological inventory and assessment activities, including vegetation classification.

The USFS sections and sub-sections in Massachusetts are regional and extend into surrounding states: the apparently unconnected parts of 221Ag on the Connecticut border are actually connected in Connecticut as are the two parts 221Ae. However, in this Massachusetts classification of natural communities, the eastern and western parts of 221Ae are described separately and treated as separate ecoregions because the uncommon natural communities and rare species of the areas are distinct although the overall upland forest types are more similar to each other than to forests in the higher elevation M211Cc that occurs between them in Massachusetts.
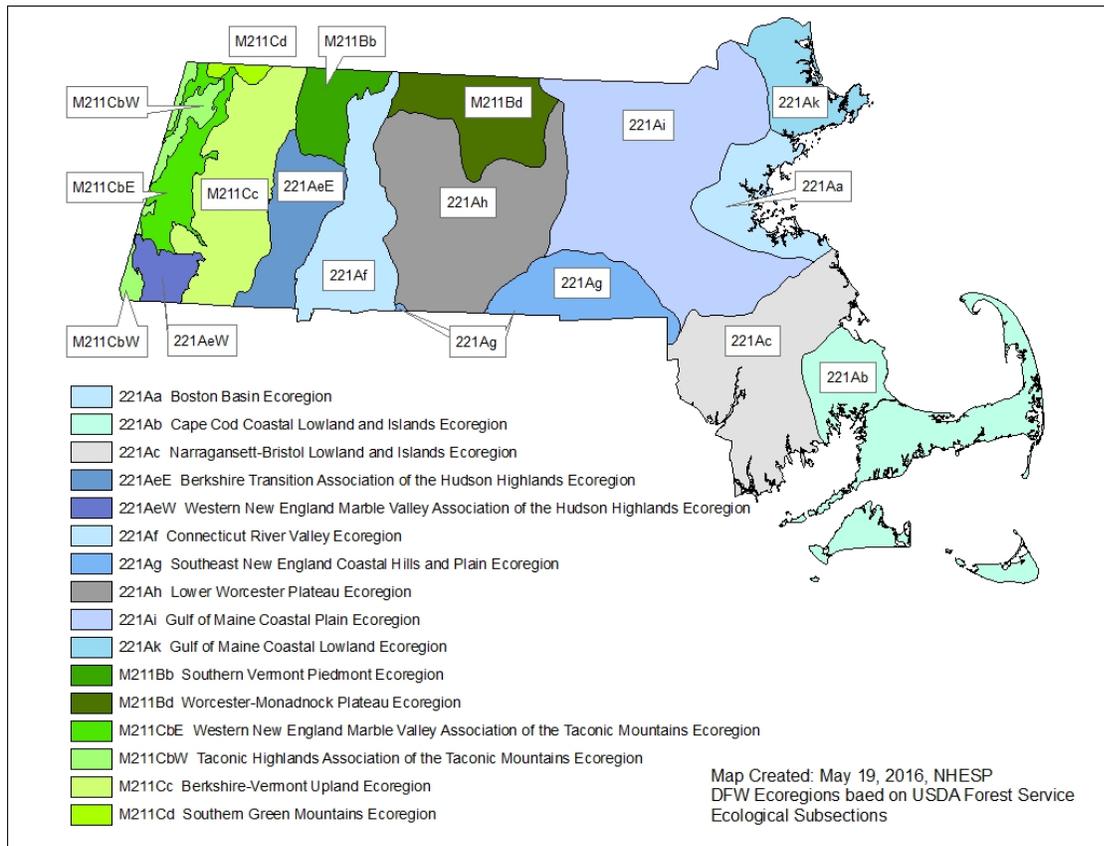

Fig. 1. DFW Ecoregions of Massachusetts: boundaries based on USDA Forest Service Ecological Subsections (Cleland et al 2007; McNab et al 2007), with refinements west of the Connecticut River (de la Cretaz & Kelty, 2008).

The USDA Forest Service (USFS) and the US Environmental Protection Agency (EPA) have each developed versions of ecoregions for New England that include Massachusetts. The core areas of both sets of ecological regions are similar although the boundaries vary in detail.

Earlier versions of *The Classification of Natural Communities of Massachusetts* used a now outdated map of the ecoregions of Massachusetts prepared by the EPA in 1994. Since then the EPA and the USFS have each produced updated maps showing variously named ecological regions that we call ecoregions (EPA Level IV – Griffith et al 2009; USFS – McNab et al. 2007). Additional finer descriptions and boundary adjustments for the USFS subsections west of the Connecticut River were put together for the USFS by a team at the University of Massachusetts-Amherst (de la Cretaz and Kelty, 2008). During the time that these ecoregion boundaries and descriptions were being revised, the Massachusetts Division of Fisheries & Wildlife's (DFW's) Forestry Project incorporated the USFS ecological regions (subsections) into planning for habitat management (Forest Management Planning webpage; (http://www.mass.gov/eea/agencies/dfg/dfw/wildlife-habitat-conservation/forest-management-planning.html). As a result of the past changes and agency use of the USFS based ecoregions, the USFS based ecoregions (USFS subsections) were used as the basis for the distribution maps of the natural communities in this classification. The USFS and US EPA Level IV (2009) ecoregions primarily differ in boundaries: the core areas of identified subsections / sub ecoregions are generally similar. The differences reflect both that different approaches were taken to delineating the ecoregional lines, and also that most changes in vegetation, climate, and geology are gradual and the actual boundaries among types are somewhat arbitrary and fuzzy (as shown in 'fuzzy boundaries' between types in the 1994 EPA ecoregions). The USFS has descriptions of their sections, but not of the subsections. West of the Connecticut Valley, there are descriptions of the subsections and Land Type Associations (LTAs) (more finely defined areas within the subsections) from de la Cretaz and Kelty (2008). The 2009 EPA descriptions of their ecoregions are at the scale used in this classification. Because the core areas described by the EPA are similar to the USFS areas, language from the EPA descriptions was incorporated as seemed useful. LTA language was also used where it clarified the description of the DFW ecoregion: however because the LTAs are more finely divided than the DFW ecoregions, those descriptions were combined and edited to inform the final DFW ecoregion description. In addition, the original 1994 EPA ecoregion descriptions as synopsized in the 2000 edition of the *Classification of Natural Communities of Massachusetts* continue to describe the core areas of the DFW ecoregions and informed many of the new descriptions. (The main differences between the DFW ecoregions and the 1994 EPA ecoregions used in the earlier versions of the natural community classifications, besides relatively minor differences in boundary locations are: the 1994 EPA ecoregions did not separate the coastal areas as distinctly as do the DFW, USFS, and the 2009 EPA maps so that the Worcester area extended to the ocean; 221Ag Southeast New England Coastal Hills and Plain, an area that extends through Rhode Island and Connecticut was not recognized in the original EPA ecoregions; the Berkshire Highlands were separated into two parts not separated in the DFW ecoregions, and the DFW ecoregions include Southern Green Mountain lobes not recognized in the EPA ecoregions; and the western New England Marble Valleys were seen as one unit.)

DFW Ecoregions:
Lower New England Section of the Eastern Broadleaf Forest Province (221A) (close to the EPA Level III Northeastern Coastal Zone (59)) covers most of southern New England and the coastal areas to the north, including most of eastern and central Massachusetts. Appalachian oak forests and northeastern oak-pine forests are the natural vegetation types, growing on relatively nutrient-poor soils. The **Boston Basin Ecoregion (221Aa)** has low, rolling topography that is dominated by urban and suburban land. Most natural vegetation has been removed leaving patches of oak and white pine-oak forests, maritime

shrubland and dunes, and salt marshes. Nearly half of the plant species in the ecoregion are non-native. The **Cape Cod Coastal Lowland and Islands Ecoregion (221Ab)** (EPA Level III Atlantic Coastal Pine Barren (84) is characterized by terminal moraines and outwash plains left by glaciers, and by coastal deposits. Much of the surface water is naturally acidic with limited available nutrients. This ecoregion is distinguished by moderate maritime climate, stunted pine and oak forests, numerous kettle ponds, salt and freshwater wetlands, and sand dunes. The **Narragansett-Bristol Lowland and Islands Ecoregion (221Ac)** has flat to gently rolling irregular plains where bedrock outcrops are uncommon, and thick glacial till and outwash deposits cover the area. There are low gradient streams and numerous wetlands. The vegetation is coastally influenced oak and oak-pine forests with various combinations of central hardwood species. Branches of the Westfield River join in the center of the **Berkshire Transition Ecoregion (Association) of the Hudson Highlands (221AeE)** and flow east to the Connecticut River. The vegetation is dominated by a mix of northern, transition, and oak-conifer forests, with oaks more common southwards. Soils are acidic although there is calcareous bedrock in the central area that supports species of rich forests that also occur in enriched alluvial sites. The floodplain and valley of the Housatonic River occupy a large portion of the **Western New England Marble Valley Ecoregion (Association) of the Hudson Highlands (221AeW)** with smaller areas of floodplain and outwash to the east. Low hills with limestone outcrops and soils formed in calcareous glacial till support species-rich communities in a prevailing transition hardwood forest. The **Connecticut River Valley Ecoregion (221Af)** is characterized by a mild climate, low rolling topography with some high hills and ridges, and rich soils. Central hardwoods (oak-hickory) and transition hardwoods are the major forest types. The **Southeast New England Coastal Hills and Plains Ecoregion (221Ag)** is on irregular plains with some low hills including numerous glacial drumlins. Wetlands, including red maple swamps, are abundant. Streams are low to moderate gradient. The prevailing central hardwoods forest has various combinations of oaks and pines with a few areas of transition and northern hardwoods species including sugar maple. The **Lower Worcester Plateau Ecoregion (221Ah)** is generally higher elevation than to the south and east but has relatively moderate relief compared to northern and western parts of the state. The soils developed primarily on glacial till. The major forest types are transition hardwoods (maple-beech-birch, oak-hickory) with some central hardwoods (oak-hickory). Lakes, ponds, and acidic wetlands are common. The large **Gulf of Maine Coastal Plain Ecoregion (221Ai)** has higher elevations and greater relief than the coastal area to its east but is less hilly and lower than to the west. Low and moderate gradient streams and large rivers drain the area. Mesic to dry oak-pine forests with various combinations of oaks and white pine prevail with some hemlock-hardwood-pine forest and areas of northern hardwood forest in northern areas. The **Gulf of Maine Coastal Lowland Ecoregion (221Ak)** is a 10 to 20 miles wide coastal strip extending north from the Boston Basin. The ecoregion has relatively low relief, and elevations are mostly from sea level to 250 feet. Extensive glacial deposits blanket this region, with sand beaches that front large salt marshes. The vegetation mosaic includes oak forests, extensive post-settlement white pine, pitch pine in sandy areas, and saltmarsh.

The **Adirondack-New England Mixed Forest-Coniferous Forest-Alpine Meadow Province (M211)** (close to the EPA Level III Northeastern Highlands (58)) has a modified continental climatic regime with long, cold winters and warm summers. The landscape is mountainous and was previously glaciated. Forest vegetation is a transition between boreal on the north and broadleaf deciduous to the south. This Province has two Sections in Massachusetts that are subdivided into subsections called Ecoregions in this Classification. The **New England Piedmont Section (M211B)** occurs east and west of the Connecticut River Valley along Massachusetts' northern border. It has open, low mountains and monadnocks and northern hardwoods forests. **The Southern Vermont Piedmont Ecoregion (M211Bb)** drains occasionally steep hills in moderate to high-gradient streams to the Deerfield and Connecticut Rivers. Marble and limestone bedrock underlie much of the area, supporting rich vegetation where glacial sediments or

ground water have produced calcium enriched soils. Northern and transitions hardwood forests predominate. The **Worcester – Monadnock Plateau (M211Bd)** (or Hillsboro Inland Hills and Plains Subsection in the USFS maps) includes the most hilly areas of the central upland with a few high monadnocks and mountains. Transition hardwoods with oaks, hemlock, and white pines are common, but northern hardwoods also occur. Forested wetlands are common, and forested and non-forested peatlands are abundant. Surface waters are acidic. The **Green, Taconic, Berkshire Mountains Section (M211C)** occurs on the Berkshire Plateau and to the west except for the lower Housatonic Valley (Western New England Marble Valley Ecoregion (Association) of the Hudson Highlands (221AeW). It includes the eastern edge of the Taconic Mountains, the northern New England Marble Valley, the very southern edge of the Green Mountains, and the Berkshire Plateau. The **Western New England Marble Valley Association of the Taconic Mountain Ecoregion (M21CbE)** includes the river valleys and floodplains of the Hoosic, Green, and northern portions of the Housatonic Rivers, the rolling hills at the edges of the valleys and some lower slopes of the surrounding mountains. Marble bedrock and large areas of calcareous outwash deposits are found in the river valleys produce calcium rich soil and water in the ecoregion that supports species- and nutrient-rich forests and wetlands with many plants and animals found few other places in the state. The predominance of northern hardwoods separates this marble valley from the lower Housatonic valley directly south. The **Taconic Highlands Association of the Taconic Mountains Ecoregion (M211CbW)** includes the mid-and upper slopes of the Taconics and Mt Greylock in this hilly and mountainous region. Streams are generally small and high-gradient. The forests are predominantly northern hardwoods with some transition hardwoods to the south, both with hemlock and white pine. Red spruce and balsam fir mix with northern hardwoods in the upper elevations. The **Berkshire-Vermont Upland Ecoregion (M211Cc)** has low mountains with steep slopes to narrow river valleys. Acidic soils from acidic bedrock and glacial derived materials occur throughout. Spruce mixes with northern hardwood forests in the higher northern areas with transition forests to the south where spruce is lacking even at higher elevations. Two small lobes of the **Southern Green Mountain Ecoregion (M211Cd)** extend into Massachusetts from its northern expanse. These mountainous areas are on acidic bedrock; the two parts of the ecoregion are separated by the Hoosic River (in M211CbW) that is on calcareous bedrock generally covered with acidic glacial till. The eastern predominantly high elevation part of M211Cd has northern hardwoods and hemlock forests with red spruce and balsam fir at the highest elevations. A history of fires in the western part of M211Cd has promoted the establishment of mid elevation oak forests, with northern hardwoods above them.