9. APPENDICES

9.01 Appendix A : Data Source Documentation

Name	Date	Source
Political boundaries	2021	NH GRANIT/VCGI
Roads	2021	NH DOT/VCGI
Deeryards	2021	NH GRANIT
Surface water (National Hydrography Plus Dataset)	2018	US Geological Survey
Watershed boundaries (National Hydrography Plus Dataset)	2018	US Geological Survey
Wetlands (National Wetlands Inventory)	2021	US Fish and Wildlife Service
Soils	2021	NRCS SSURGO Database
Rare species and communities	2022	NH Natural Heritage Bureau
Topography and Slopes, LiDAR	2021	NH GRANIT
Vernal Pools	2021	Sunapee Conservation Commission
Prominent Peaks	2021	Sunapee Conservation Commission
Ecoregion	2013	Commission for Environmental Cooperation
Active Farms	2022	Sunapee Conservation Commission
Conserved Land	2022	Town of Sunapee
Current Use Land	2022	Town of Sunapee
Tax Map Parcels	2022	Town of Sunapee
Zoning Districts	2022	Town of Sunapee
Wildlife Habitat Type and Tier (Wildlife Action Plan)	2020	NH Fish and Wildlife Service
National Land Cover Dataset	2001,2011, 2019	Multi-Resolution Land Characteristics (MRLC) consortium
Climate Change Resilience Dataset	2016	The Nature Conservancy
Aquifers	2007	US Geological Survey
Public Water Supplies	2022	NH DES
Wellhead Protection Areas	2022	NH DES
Flood Hazard Areas	2021	Federal Emergency Management Agency
Shoreland Protection area	2020	NH DES
Habitat Blocks	2021	Linking Lands Alliance
Wendell Marsh Wells and Sanitary zone	2015	Town of Sunapee

Data distributed by NH GRANIT, the state's GIS Clearinghouse, are periodically updated, as new data sources become available and conditions on the ground change.

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Current Use Category Definitions:

1. Farmland means any cleared land devoted to or capable of agricultural or horticultural use as determined and classified by criteria developed by the NH Commissioner of Agriculture, Markets, and Food and adopted by the Current Use Board.

2. Forest land means any land growing trees as determined and classified by criteria developed by the state forester and adopted by the board. For the purposes of this paragraph, the board shall recognize the cost of responsible land stewardship in the determination of assessment ranges.
3. Forest land with documented stewardship has a lower assessment, to reflect the cost of active stewardship of the land; documentation of a Certified Tree Farm, a Forest Stewardship plan from a licensed forester, or a summary of a Forest Stewardship plan developed privately are sufficient to enroll a parcel in current use as forest land with documented stewardship.
4. Unproductive Land means land, including wetlands, which by its nature is incapable of producing agricultural or forest products due to poor soil or site characteristics, or the location of which renders in inaccessible or impractical to harvest agricultural or forest products, as determined and classified by criteria developed by the board. The board shall develop only one category for all unproductive land, setting its current use value equal to that of the lowest current use value established by the board for any other category.
5. Wetland means those areas of farm, forest and unproductive land that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support and that under normal circumstances.

National Land Cover Database Class Legend Description

Class\ Value	Classification Description
Water	
11	**Open Water**- areas of open water, generally with less than 25% cover of vegetation or soil.
12	**Perennial Ice/Snow**- areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.
Developed	
21	**Developed, Open Space**- areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
22	**Developed, Low Intensity**- areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.
23	**Developed, Medium Intensity** -areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.
24	**Developed High Intensity**-highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.
Barren	
31	**Barren Land (Rock/Sand/Clay)** - areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

Forest	
	41**Deciduous Forest**- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
	42**Evergreen Forest**- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.
	43**Mixed Forest**- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.
Shrubland	
	51**Dwarf Scrub**- Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.
	52**Shrub/Scrub**- areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Herbaceous	
	71**Grassland/Herbaceous**- areas dominated by gramanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
	72**Sedge/Herbaceous**- Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.
	73**Lichens**- Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation.
	74**Moss**- Alaska only areas dominated by mosses, generally greater than 80% of total vegetation.
Planted/Cultivated	
	81**Pasture/Hay**-areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
	82**Cultivated Crops** -areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
Wetlands	
	90**Woody Wetlands**- areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
	95**Emergent Herbaceous Wetlands**- Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

9.02 Appendix B : Ecoregions

This Appendix contains Ecoregion maps for:

1. Level III and IV for New England
2. Level III for the Continental United States
3. Level I and II for North America

Level III and IV Ecoregions of New England

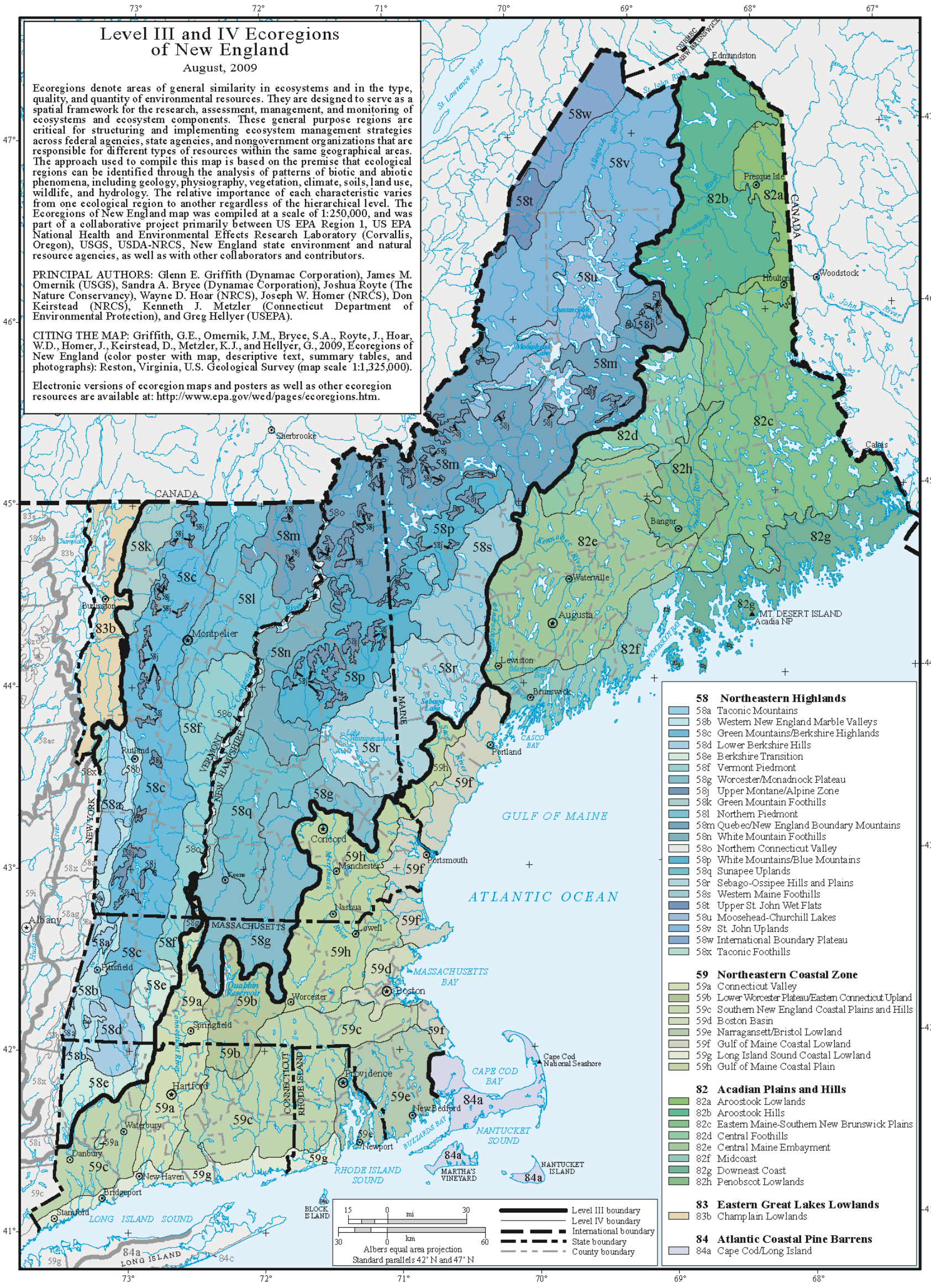
August, 2009

Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. These general purpose regions are critical for structuring and implementing ecosystem management strategies across federal agencies, state agencies, and nongovernment organizations that are responsible for different types of resources within the same geographical areas. The approach used to compile this map is based on the premise that ecological regions can be identified through the analysis of patterns of biotic and abiotic phenomena, including geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The relative importance of each characteristic varies from one ecological region to another regardless of the hierarchical level. The Ecoregions of New England map was compiled at a scale of 1:250,000, and was part of a collaborative project primarily between US EPA Region 1, US EPA National Health and Environmental Effects Research Laboratory (Corvallis, Oregon), USGS, USDA-NRCS, New England state environment and natural resource agencies, as well as with other collaborators and contributors.

PRINCIPAL AUTHORS: Glenn E. Griffith (Dynamac Corporation), James M. Omernik (USGS), Sandra A. Bryce (Dynamac Corporation), Joshua Royte (The Nature Conservancy), Wayne D. Hoar (NRCS), Joseph W. Homer (NRCS), Don Keirstead (NRCS), Kenneth J. Metzler (Connecticut Department of Environmental Protection), and Greg Hellyer (USEPA).

CITING THE MAP: Griffith, G.E., Omernik, J.M., Bryce, S.A., Royte, J., Hoar, W.D., Homer, J., Keirstead, D., Metzler, K.J., and Hellyer, G., 2009, Ecoregions of New England (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,325,000).

Electronic versions of ecoregion maps and posters as well as other ecoregion resources are available at: http://www.epa.gov/wed/pages/ecoregions.htm.



58 Northeastern Highlands

- 58a Taconic Mountains
- 58b Western New England Marble Valleys
- 58c Green Mountains/Berkshire Highlands
- 58d Lower Berkshire Hills
- 58e Berkshire Transition
- 58f Vermont Piedmont
- 58g Worcester/Monadnock Plateau
- 58j Upper Montane/Alpine Zone
- 58k Green Mountain Foothills
- 58l Northern Piedmont
- 58m Quebec/New England Boundary Mountains
- 58n White Mountain Foothills
- 58o Northern Connecticut Valley
- 58p White Mountains/Blue Mountains
- 58q Sunapee Uplands
- 58r Sebago-Ossipee Hills and Plains
- 58s Western Maine Foothills
- 58t Upper St. John Wet Flats
- 58u Moosehead-Churchill Lakes
- 58v St. John Uplands
- 58w International Boundary Plateau
- 58x Taconic Foothills

59 Northeastern Coastal Zone

- 59a Connecticut Valley
- 59b Lower Worcester Plateau/Eastern Connecticut Upland
- 59c Southern New England Coastal Plains and Hills
- 59d Boston Basin
- 59e Narragansett/Bristol Lowland
- 59f Gulf of Maine Coastal Lowland
- 59g Long Island Sound Coastal Lowland
- 59h Gulf of Maine Coastal Plain

82 Acadian Plains and Hills

- 82a Aroostook Lowlands
- 82b Aroostook Hills
- 82c Eastern Maine-Southern New Brunswick Plains
- 82d Central Foothills
- 82e Central Maine Embayment
- 82f Midcoast
- 82g Downeast Coast
- 82h Penobscot Lowlands

83 Eastern Great Lakes Lowlands

- 83b Champlain Lowlands

84 Atlantic Coastal Pine Barrens

- 84a Cape Cod/Long Island

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Level III Ecoregions of the Continental United States

(Revised April 2013)

National Health and Environmental Effects Research Laboratory

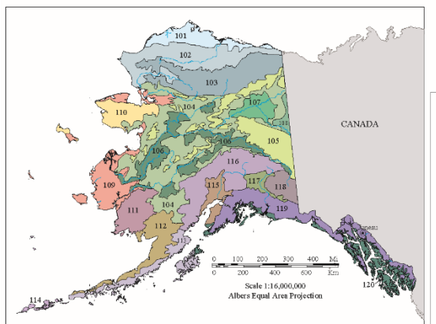
U.S. Environmental Protection Agency

1. Coast Range
2. Puget Lowland
3. Willamette Valley
4. Cascades
5. Sierra Nevada
6. Central California Foothills and Coastal Mountains
7. Central California Valley
8. Southern California Mountains
9. Eastern Cascades Slopes and Foothills
10. Columbia Plateau
11. Blue Mountains
12. Snake River Plain
13. Central Basin and Range
14. Mojave Basin and Range
15. Northern Rockies
16. Idaho Batholith
17. Middle Rockies
18. Wyoming Basin
19. Wasatch and Uinta Mountains
20. Colorado Plateaus
21. Southern Rockies
22. Arizona/New Mexico Plateau
23. Arizona/New Mexico Mountains
24. Chihuahuan Deserts
25. High Plains
26. Southwestern Tablelands
27. Central Great Plains
28. Flint Hills
29. Cross Timbers
30. Edwards Plateau
31. Southern Texas Plains
32. Texas Blackland Prairies
33. East Central Texas Plains
34. Western Gulf Coastal Plain
35. South Central Plains
36. Ouachita Mountains
37. Arkansas Valley
38. Boston Mountains
39. Ozark Highlands
40. Central Irregular Plains
41. Canadian Rockies
42. Northwestern Glaciated Plains
43. Northwestern Great Plains
44. Nebraska Sand Hills
45. Piedmont
46. Northern Glaciated Plains
47. Western Corn Belt Plains
48. Lake Agassiz Plain
49. Northern Minnesota Wetlands
50. Northern Lakes and Forests
51. North Central Hardwood Forests
52. Driftless Area
53. Southeastern Wisconsin Till Plains
54. Central Corn Belt Plains
55. Eastern Corn Belt Plains
56. Southern Michigan/Northern Indiana Drift Plains
57. Huron/Erie Lake Plains
58. Northeastern Highlands
59. Northeastern Coastal Zone
60. Northern Allegheny Plateau
61. Erie Drift Plain
62. North Central Appalachians
63. Middle Atlantic Coastal Plain
64. Northern Piedmont
65. Southeastern Plains
66. Blue Ridge
67. Ridge and Valley
68. Southwestern Appalachians
69. Central Appalachians
70. Western Allegheny Plateau
71. Interior Plateau
72. Interior River Valleys and Hills
73. Mississippi Alluvial Plain
74. Mississippi Valley Loess Plains
75. Southern Coastal Plain
76. Southern Florida Coastal Plain
77. North Cascades
78. Klamath Mountains/California High North Coast Range
79. Madrean Archipelago
80. Northern Basin and Range
81. Sonoran Basin and Range
82. Acadian Plains and Hills
83. Eastern Great Lakes Lowlands
84. Atlantic Coastal Pine Barrens
85. Southern California/Northern Baja Coast

0 100 200 300 400 Mi
0 200 400 600 Km

Scale 1:7,500,000

Albers Equal Area Projection



101. Arctic Coastal Plain
102. Arctic Foothills
103. Brooks Range
104. Interior Forested Lowlands and Uplands
105. Interior Highlands
106. Interior Bottomlands
107. Yukon Flats
108. Ogilvie Mountains
109. Subarctic Coastal Plains
110. Seward Peninsula
111. Alkdun and Kilbuck Mountains
112. Bristol Bay-Nushagak Lowlands
113. Alaska Peninsula Mountains
114. Aleutian Islands (Western portion not shown)
115. Cook Inlet
116. Alaska Range
117. Copper Plateau
118. Wrangell Mountains
119. Pacific Coastal Mountains
120. Coastal Western Hemlock-Sitka Spruce Forests

Ecoregions are areas where ecosystems (and the type, quality, and quantity of environmental resources) are generally similar. This ecoregion framework is derived from Omernik (1987) and from mapping done in collaboration with U.S. EPA regional offices, other Federal agencies, state resource management agencies, and neighboring North American countries (Omernik and Griffith 2014). Designed to serve as a spatial framework for the research, assessment, and monitoring of ecosystems and ecosystem components, ecoregions denote areas of similarity in the mosaic of biotic, abiotic, terrestrial, and aquatic ecosystem components, with humans considered as part of the biota. These ecoregions have been used to develop regional biological criteria and water quality standards, set management goals for nonpoint source pollution, assess land cover trends, report on ecosystem carbon sequestration, and frame wildlife conservation research, among other applications.

Ecological regions can be identified by analyzing the patterns and composition of biotic and abiotic phenomena that affect or reflect differences in ecosystem quality and integrity (Omernik 1987, 1995). These phenomena include geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The relative importance of each characteristic varies from one ecological region to another regardless of the hierarchical level. A Roman numeral classification scheme has been adopted for different levels of ecological regions. Level I is the coarsest level, dividing North America into 15 ecological regions; at Level II the continent is subdivided into 50 classes (CEC 1997, 2006). Level III, shown here, has 105 ecoregions in the continental U.S. For the conterminous United States, the ecoregions have been further subdivided to 967 Level IV ecoregions. Details about the ecoregions or their applications are explained in reports and publications from the state and regional projects (e.g., Bryce et al., 1998, 2003; Chapman et al., 2001, 2006; Gallant et al., 1989; 1995; Griffith et al., 2004, 2009, 2014; McGrath et al., 2002; Omernik, 2004; Omernik et al., 2000; Thorson et al., 2003; Wilken et al., 2011; and Woods et al., 1996, 2002, 2004). For additional information, contact James M. Omernik, USGS, c/o U.S. EPA, 200 SW 35th Street, Corvallis, OR 97333, phone (541) 754-4458, email omernik.james@epa.gov; or Glenn Griffith, USGS, c/o US EPA, 200 SW 35th Street, Corvallis, OR 97333, phone (541) 754-4465, email ggriffith@usgs.gov.

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ECOLOGICAL REGIONS OF NORTH AMERICA

The names and identification numbers for North American Level I, II, and III ecological regions are given in CEC 1997, 2006.

CITING THIS MAP: U.S. Environmental Protection Agency, 2013, Level III ecoregions of the continental United States: Corvallis, Oregon, U.S. EPA – National Health and Environmental Effects Research Laboratory, map scale 1:7,500,000, https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states.

Ecological regions are areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. They are effective for national and regional state of the environment reports, environmental resource inventories and assessments, setting regional resource management goals, determining carrying capacity, as well as developing biological criteria and water quality standards. The development of a clear understanding of regional and large continental ecosystems is critical for evaluating ecological risk, sustainability, and health.

The maps shown here represent a second attempt to holistically classify and map ecological regions across the North American continent (Commission for Environmental Cooperation Working Group, 1997). The mapping from 1997 and 2006 was built upon earlier efforts that had begun individually in all three countries (e.g., Wiken 1986; Omernik 1987). These approaches recognized the need to consider a full range of physical and biotic characteristics to explain ecosystem regions (Omernik 2004). Equally, they recognized that the relative importance of each characteristic varies from one ecological region to another regardless of the hierarchical level. In describing conceptualization in Canada, Wiken (1986) stated:

> *Ecological land classification is a process of delineating and classifying ecologically distinctive areas of the Earth's surface. Each area can be viewed as a discrete system which has resulted from the mesh and interplay of the geologic, landform, soil, vegetative, climatic, wildlife, water and human factors which may be present. The dominance of any one or a number of these factors varies with the given ecological land unit. This holistic approach to land classification can be applied incrementally on a scale related basis from very site-specific ecosystems to very broad ecosystems.*

Determining ecological regions at a continental level is a challenging task. It is difficult, in part, because North America is ecologically diverse and because a nation's territorial boundaries can be a hindrance to seeing and appreciating the perspectives across the landmass of three countries. Developing and refining a framework of North American ecological regions has been the product of research and consultation between federal, state, provincial and territorial agencies. Those agencies were often government departments, but the initiative also involved nongovernmental groups, universities and institutes. The Commission for Environmental Cooperation (CEC) was instrumental in bringing these groups together. The CEC was established in 1994 by Canada, Mexico and the United States to address environmental concerns common to the three countries. The CEC derives its formal mandate from the North American Agreement on Environmental Cooperation (NAAEC). The environmental side accord to the North American Free Trade Agreement (NAFTA).

These maps represent the working group's best consensus on the distribution and characteristics of major ecosystems on all three levels throughout the three North American countries. The methodology encompassed these points in mapping ecological regions:

- Ecological classification incorporates all major components of ecosystems: air, water, land, and biota, including humans.
- It is holistic ("the whole is greater than the sum of its parts")
- The number and relative importance of factors that are helpful in the delineation process vary from one area to another, regardless of the level of generalization.
- Ecological classification is based on hierarchy—ecosystems are nested within ecosystems as mapped, although in reality, they may not always nest.
- Such classification integrates knowledge: it is not an overlay process.
- It recognizes that ecosystems are interactive—characteristics of one ecosystem blend with those of another.
- Map lines depicting ecological classification boundaries generally coincide with the location of zones of transition.

A Roman numeral hierarchical scheme has been adopted for different levels of ecological regions. Level I is the coarsest level, dividing North America into 15 broad ecological regions. These highlight major ecological areas and provide the broad backdrop to the ecological mosaic of the continent, putting it in context at global or intercontinental scales. The 50 Level II ecological regions that have been delineated are intended to provide a more detailed description of the large ecological areas nested within the level I regions. Level II ecological regions are useful for national and subcontinental overviews of ecological patterns. At level III, the continent currently contains 182 ecological regions. The level III ecological region map depicts revisions and subdivisions of earlier level I, II, and III ecological regions (CEC 1997, McMahon et al., 2001, Omernik 1987, USEPA 2006, Wiken 1986, Wiken et al., 1996). These smaller divisions enhance regional environmental monitoring, assessment and reporting, as well as decision-making. Because level III regions are smaller, they allow locally defining characteristics to be identified, and more specifically oriented management strategies to be formulated.

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9.03 Appendix C : Habitat Types & Associated Species

This Appendix contains the habitat summary brochures for the following:

1. Hemlock-Hardwood-Pine Forest
2. Northern Hardwood-Conifer Forests
3. Grasslands
4. Shorelines
5. Headwater Streams
6. Marsh and Shrub Wetlands
7. Natural Community: Montane - subalpine circumneutral cliff
8. Natural Community: Northern hardwood - conifer forest system

Headwater Streams

Habitat Stewardship Series

NEW HAMPSHIRE WILDLIFE ACTION PLAN

Recognizing

headwater streams

Headwater streams are small streams and wetlands at the highest end of a watershed. Some are so small that they don't show up on maps. If a river network is the circulatory system of the landscape, headwater streams are the small capillaries that fan into the larger veins and arteries.

Headwater streams can start as small forested wetlands, beaver impoundments, or cascading mountain streams, varying according to the topography and geology of the surrounding landscape. Topography and geology influence the speed of water flow, the river bottom material, the plants growing around the streams, whether the stream sometimes or always contains water, and which wildlife species live in or use the stream.

Mountain streams

Mountain streams tend to have large rocks, steep grades, and flash floods. Stream salamanders, brook trout, and certain aquatic invertebrates are well adapted to these dynamic habitats.

Mountain stream

Valley stream

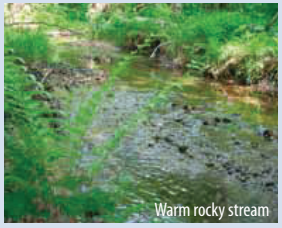
Valley streams

These streams flow through broad, flat valleys. They tend to be slow-moving and surrounded by wetland plants and shrubs. Beaver activity creates a patchwork of wetlands around the streams, including shrub swamps, wet meadows, and ponds. Wildlife are drawn to these areas including ducks, geese, turtles, amphibians, and fish.

Spring-fed brooks

These small streams flow through glacially deposited sand and gravel and originate from natural springs. Their year-round supply of cool water provides a stable environment for brook trout, particularly during hot weather.

Spring-fed brook



Warm rocky stream

Warm rocky streams

The riffles and pools of these rocky brooks are reminiscent of mountain or brook-fed streams, but they are too warm to support cold-water fish. They often flow between beaver ponds in hilly terrain, serving as corridors and hunting grounds for mink, northern water snake, and other wildlife.

Why are headwater streams important?

Many headwater streams are scoured by ice in winter, flood in the spring and fall, and are dry in the summer. Wide variations in water flow and temperature make life difficult in headwater streams. A unique group of plants, amphibians, and insects are adapted to survive in these difficult conditions. These small streams also have a large impact on the health and integrity – both for water quality and wildlife – of major rivers downstream.


Stonefly larvae

Headwater streams are places where forest and stream habitats converge, leading to high densities of insects around the streams. Stoneflies, mayflies, and dragonflies, whose larvae live underwater, are found alongside upland insects such as moths, beetles, and grasshoppers. This concentration of food attracts predators from the surrounding forest including northern long-eared bat, red-shouldered hawk, raccoon and ribbon snake.

Small streams also help remove excess nutrients, such as nitrogen, from a watershed, helping ensure cleaner water downstream. Wood in the small, upriver streams traps leaves and other nitrogen sources, preventing them from accumulating in the lower reaches of the river.

Eastern brook trout may live year-round in tiny streams, feeding on both upland and aquatic insects. They may also travel over 20 miles from larger rivers to headwater streams during the fall spawning season or, if the streams have enough water, to find a cool refuge during the summer months.

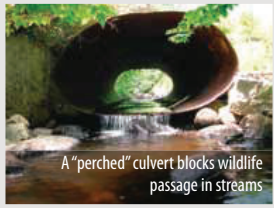
Refuge streams

Many species take advantage of the relative safety of headwater streams for reproduction. Green frogs and spring and two-lined salamanders lay their eggs in intermittent, fishless streams. Common white suckers and rainbow smelt, two fish species, migrate every year into small streams to spawn. Headwater streams also can act as travel corridors for wildlife such as mink, otter, beaver, forest birds, and forest-dwelling bats.

The isolation and harsh conditions of headwater streams can also provide native fish with a refuge from introduced species. Natives such as banded sunfish, redfin pickerel, and redbelly dace can thrive in headwater streams, but are over-run by introduced fish in the more stable and often degraded habitats of larger rivers and lakes.

Overlooked streams

Despite their ecological value, headwater streams are often overlooked by conservation efforts and are not covered by New Hampshire's Comprehensive Shoreland Protection Act. Their small size makes them vulnerable to human impacts, particularly those caused by human development. Use of groundwater by residential or commercial wells can cause streams to dry up. Roads, driveways, and poorly designed or placed culverts fragment streams, causing sedimentation, and isolate wildlife populations. Runoff from paved surfaces can introduce pollutants, increase flooding, and cause spikes in stream temperature. These and other threats are compounded by the tendency to dismiss small streams because they don't command the same recreational and aesthetic appeal of larger lakes and rivers, and because they are often considered too small to provide important habitat.


A "perched" culvert blocks wildlife passage in streams

Stewardship Guidelines for headwater streams

- **Conserving land from development around headwater streams** will allow for the natural processes that prevent flooding, maintain water quality, quantity, and temperature, recycle nutrients, and provide food and habitat at the source and downstream. Maintaining intact, undeveloped headwaters may also buffer the predicted higher temperatures and increased flooding and rainfall associated with climate change.
- **Incorporating headwater stream protection into town and regional planning** through conservation easements and zoning ordinances will have lasting benefits by conserving species, protecting water quality and preventing flood damage.
  - When possible, **keep development, permanent roads, and driveways at least 300 feet away from streams.** Suggested development buffers vary, but a minimum of 300 feet is commonly recommended for protecting wildlife habitat along stream corridors. The benefits of riparian buffers increase with their width.
  - **Maintain pervious (permeable) surfaces** on as much of the landscape as possible. Natural ground is the best filter for storm water, but pervious pavement (as opposed to typical pavement) can reduce stream contamination from storm water in developed areas. Watersheds with as little as 4% of their land area in buildings and pavement have degraded headwater stream habitat.


Roadside salt and sand draining into stream

- **Avoid the use of fertilizers or pesticides near any stream or wetland habitat.** Many pesticides are toxic to aquatic organisms. Excess nutrients from fertilizers pollute water by reducing oxygen levels, killing fish and other species.
- **Avoid culverts, drains or ditches that discharge storm water directly into streams.** Instead, apply designs that filter storm water into the ground, including porous pavement, gravel wetlands, or tree box filters. The UNH Stormwater Center is an excellent resource for the latest research in stormwater management.
- **Properly sized and installed stream crossings are critical for restoring or maintaining the function of streams of all sizes.** Before installing any stream crossing associated with development, consult the New Hampshire Stream Crossing Guidelines available from the UNH Stream & Wetland Restoration Institute and follow all NH wetland laws. For crossings associated with timber harvesting, see best management practice references below.
- **Timber harvesting around headwater and small streams should maintain enough shade and large trees** to maintain stream temperatures, filter run-off, and allow for woody material (dead and dying trees, leaves, branches) to naturally fall into streams. For headwater streams, buffers that maintain about 60% of the canopy in a zone as wide as the height of a mature tree (100 feet) are likely to maintain cold water temperatures and woody material in the stream. In larger streams, riparian buffers of 300 feet or more provide more effective wildlife travel corridors and habitat.
- When doing forest management work near headwater streams, minimize impacts by:
  - **Maintaining dead standing trees, overhanging vegetation, and downed branches and trees** to provide moist cover and shade for wildlife and insects;
  - **Maintaining downed logs** in streams to enhance trout pool habitat;
  - **Consulting the publications** *Good Forestry in the Granite State, 2nd edition* and *Best Management Practices for Forestry: Protecting NH's Water Quality*, both available from UNH Cooperative Extension.
- **Consult a licensed New Hampshire forester before conducting a timber harvest on your property.** Understand and follow all laws pertaining to tree harvesting near wetlands and waterbodies. Follow established best management practices, and harvest timber near headwater streams only when the soils are either frozen (winter) or very dry (summer).

Species Focus
of conservation concern

Eastern brook trout
Brook trout depend on clean, cold water and are well-adapted to living in small streams where they compete for feeding territories in small pools. During much of the year, brook trout eat insects such as beetles and spiders that fall into the stream from overhanging vegetation. In hot weather, brook trout may travel miles upriver to headwater streams seeking cooler water and to find spawning habitat in the fall. New Hampshire remains a stronghold for brook trout in the Eastern U.S., but even here, populations are declining.


Eastern brook trout

Stream salamanders
Stream salamanders are the top predators in streams with no fish. These streams are often seasonal, drying up for part of the year, or they may be protected from upstream fish movement by a barrier such as a waterfall. Spring salamanders, two-lined salamanders, dusky salamanders, and eastern spotted newts are examples of salamanders that may be found in New Hampshire's headwater streams. Stream salamanders are considered indicators of good water quality and healthy stream habitat, but they are sensitive to upland habitat destruction beyond the stream corridor.


Dusky salamander

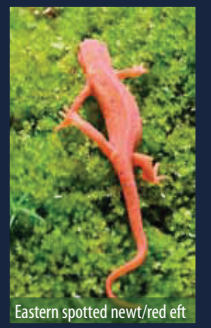
Riffle snaketails
Riffle snaketails are dragonflies that live in streams and small rivers with gravel or sandy bottoms and lots of riffles. Riffle snaketails are very sensitive to damming, and although they are not rare, they are at risk from disturbance. Larvae burrow in the gravel and sand, feeding on aquatic invertebrates that share their sheltered space.


Riffle snaketail

Wildlife found in headwater streams
The species listed here are some of the wildlife that use headwater streams. Be on the lookout for these species and follow stewardship guidelines to help maintain or enhance headwater stream habitats. Species of conservation concern—those wildlife species identified in the Wildlife Action Plan as having the greatest need of conservation—appear in **bold** typeface.

- **American eel**
- **Banded sunfish**
- **Blanding's turtle****
- **Bridle shiner***
- Caddisflies
- Craneflies
- Cusk
- Dusky salamander
- **Eastern brook trout**
- Eastern spotted newt
- Ebony jewelwing
- Fishing spider
- **Little brown bat**
- Louisiana waterthrush
- Mayflies
- Mink
- Northern long-eared bat
- Northern water snake
- Raccoon
- **Redfin pickerel**
- Riffle snaketail
- Spring salamander
- Stoneflies
- **Swamp darter**
- Two-lined salamander
- White sucker

*state-threatened species
**state-endangered species


Eastern spotted newt/red eft

Where to get help
If you have information about a wildlife species of conservation concern, contact NH Fish & Game's Wildlife Division at 603-271-2461. Contact the UNH Cooperative Extension Wildlife Specialist at 603-862-3594 for technical assistance for landowners or your community.

Publications and assistance on forestry and wildlife topics are available through the UNH Extension Educators in Forest Resources in each county. Contact information for each UNH Cooperative Extension office is provided below. Additional publications, contact information, resources, and web versions of all brochures in the Habitat Stewardship Series are available on the UNH Cooperative Extension website at: **nhwoods.org.**

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Carroll County	603-447-3834	Hillsborough County	603-641-6060	Strafford County	603-749-4445
Cheshire County	603-352-4550	Merrimack County	603-225-5505	Sullivan County	603-863-9200
Coös County	603-788-4961				

Authorship
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About the Habitat Stewardship Series
Much of the land in New Hampshire is privately owned. These individuals are the primary stewards of our wildlife and forests, and also our clean water, scenic views, fresh air, natural and cultural heritage, and recreational resources. The Habitat Stewardship Series has been created to help landowners and land managers recognize the habitats critical for wildlife species at risk, and to illustrate the role private landowners can play in sustaining those species through conservation, management, and sound land stewardship.

Photo Credits
Cover photo: Malin Ely Clyde – UNH Cooperative Extension. Other photos: Matt Carpenter – NH Fish and Game; Pam Hunt – NH Audubon; Ben Kimball – NH Natural Heritage Bureau; King County Washington insect archive; Michael Marchand – NH Fish and Game.

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University of New Hampshire Cooperative Extension
Sustainable Forestry Initiative

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Hemlock-Hardwood-Pine Forest

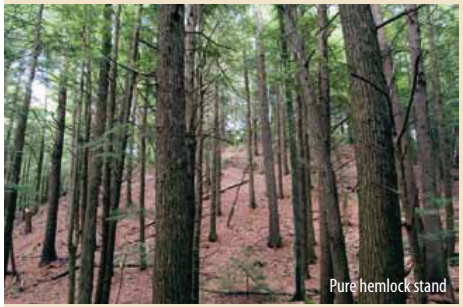
Habitat Stewardship Series

NEW HAMPSHIRE WILDLIFE ACTION PLAN

Recognizing

hemlock-hardwood-pine forest

Hemlock-hardwood-pine forest is the most wide-spread habitat in New Hampshire. Considered the transitional forest habitat between lower elevations of Appalachian oak-pine habitat (<400'), and higher elevations of northern hardwood habitat (>1,500'), hemlock-hardwood-pine forests cover almost 50% of New Hampshire, most of it south of the White Mountains.



Pure hemlock stand

White pine and eastern hemlock are most often the dominant trees, but these forests are highly variable and contain a mix of trees common in other forest types. In typical hemlock-hardwood-pine forests, you'll also find beech and patches of sugar maple and white ash (on rich sites) and red oak (on drier sites). Under the canopy, look for small trees or shrubs such as witch hazel, maple-leaved viburnum, black birch, black cherry, and ironwood, with starflower and Canada mayflower on the forest floor.

Woodland seep

Most white pine stands that have grown up from abandoned pastures are examples of this type of forest habitat. On fertile soils, white pine will be replaced over time by hemlock or hardwoods through a process known as forest succession. Although genuine old-growth forests are rare in New Hampshire, look for forests with old-growth features such as patches of large (>18" diameter) hemlock or beech in the canopy, layers of young trees and shrubs growing in the understory, many standing dead trees ("snags"), and abundant decaying wood on the ground. Large-sized cavity trees, pockets of wetlands, patches of acorn-rich oaks, seeps, and "supra canopy" pine trees (extra-tall pines that rise above the rest of the forest) make some areas of hemlock-hardwood-pine forest especially rich for wildlife.

Where are hemlock-hardwood-pine forests?

Much of Belknap, Merrimack, Hillsborough, Cheshire and Carroll Counties are covered with hemlock-hardwood-pine forests, with excellent examples located at Five Finger Point in Tamworth, Sheldrick Forest Preserve in Wilton, and at University of New Hampshire's College Woods in Durham. Hemlock-hardwood-pine forests are shown in the shaded areas of the map at left.

Why are hemlock-hardwood-pine forests important?

Hemlock-hardwood-pine forests are the habitat that surround and support many smaller and unique habitat types in southern New Hampshire. Most wildlife that require vernal pools, marsh habitat, headwater streams, floodplains, shrublands, grasslands, or peat bogs will also use the surrounding forest to meet their needs for food, cover, or breeding. Hemlock-hardwood-pine forests are common, but shouldn't be taken for granted given the important supporting role they play in the ecosystem.

Acorns and beech nuts in these forests (produced by mature oak and beech trees) are important food for many species including black bear, deer, ruffed grouse, chipmunk, squirrels and blue jay. In turn, raptors such as northern goshawk and Cooper's hawk feed on small mammals and find nesting and perching sites in white pines in the tree canopy. Large areas of hemlock-hardwood-pine provide habitat for forest birds such as scarlet tanager, hermit thrush, Blackburnian warbler and black-throated green warbler.

Habitat loss from development

The biggest threat to hemlock-hardwood-pine habitats in New Hampshire is the loss of these forests to residential and commercial development. New Hampshire has led New England with the fastest population growth for decades, and it continues to lead the region in loss of forestland. Development permanently eliminates habitat, affecting both forest-dwelling wildlife and animals that use forests as corridors between other habitats such as wetlands. Building and construction of paved roads separates wildlife populations, inhibits migration, increases predation and promotes wildlife-vehicle collisions on roads.

Hemlock woolly adelgid

The hemlock woolly adelgid is an insect introduced from Asia that targets both young and mature hemlock trees, killing them over time. A cottony substance on the underside of needles signals an infestation. Infested trees occur in many towns in southern New Hampshire. Preventative or control measures (e.g., insecticides) are ineffective for more than a few trees at time. If hemlock woolly adelgid results in fewer hemlocks in the forest, critical winter cover will be less available for wildlife such as deer, grouse, fisher, and porcupine, and will also negatively affect migrant breeding birds such as black-throated green warbler.

Uniformity

Many stands of hemlock-hardwood-pine forest in New Hampshire are the same age, roughly 80-100 years old. They grew back after extensive timber harvesting and abandonment of farms throughout the last century. Many wildlife species of conservation concern found in these forests are attracted to patches of old or young trees within the larger forest area. Today's forests don't support the same high diversity of wildlife species as older forests that contain a diversity of live and dead trees of different ages and sizes. Complicating matters, the public may prefer to view extensive, unbroken mature forest. As a result, managers are less likely to make large openings (e.g. clearcuts) that will re-grow into the young forests required by many wildlife species.

Stewardship Guidelines

for hemlock-hardwood-pine forests

- **Conserving large blocks (>1000 acres) of hemlock-hardwood-pine forest from development** will provide habitat for wide-ranging wildlife such as black bear, bobcat, northern goshawk, Cooper's hawk and bald eagle.
- **Check hemlock trees regularly for the presence of hemlock woolly adelgid.** Prevention and elimination of new outbreaks and elimination of new infestations is the most effective protection. The University of New Hampshire Cooperative Extension and the N.H. Division of Forests & Lands can help with identification and control options.
- For both land conservation and land stewardship efforts, focus on hemlock-hardwood-pine habitat characterized by **unique features** such as:
  - Areas with **large trees (>18" diameter)** which are important for roosting bats, goshawk nests, and as future snags (standing dead trees) and den trees for bears, bats, birds, and other wildlife.
  - **Rocky cliffs** which provide sunning areas for bobcat.
  - **Forested areas near wetlands**, streams, ponds, or seeps which provide moist habitat for wood turtle, blue-spotted salamander, ribbon snake, and many songbirds.
  - **Areas of young, regrowing forest,** which provide critical habitat for many wildlife species of conservation concern such as American woodcock, Canada warbler, and bobcat. Patches of alder, aspen, birch, and pin cherry are particularly valuable for wildlife.
  - **Areas of mature forest** with old-growth characteristics, such as:
    - many snags and cavity trees,
    - a diversity of tree sizes including both young and old trees growing at all levels of the forest,
    - fallen, decaying trees on the forest floor,
    - gaps in the canopy where trees have fallen or been cut.

Young, regrowing forest

- **Using forest management practices, work to regenerate a mix of tree age classes and tree species.** A full range of age classes, well-distributed across the landscape, is important to support the great diversity of wildlife dependent on hemlock-hardwood-pine habitats. For more information about how forestry can enhance habitat, consult the publication *Good Forestry in the Granite State, 2nd edition*.
- **Provide a continuous supply of young, regenerating forest habitat in patches at least 2 acres in size** to enhance cover for wildlife, berry-producing shrubs, hardwood stump sprouts, and other key features of "early successional" habitats (refer to Shrublands brochure in this series). The larger the forest opening or clearcut, the greater benefit it has for breeding birds, including those breeding in surrounding forests. To maximize the benefit of new forest openings to wildlife, create new patches, at least 5 acres in size, near utility corridors, shrub wetlands, or brushy old fields.
- **Always consult a licensed New Hampshire forester before conducting a timber harvest on your property.** Understand and follow all laws pertaining to the harvesting of trees near wetlands and waterbodies. Follow established Best Management Practices, and harvest timber near wetlands only when the soils are either frozen (winter) or very dry (summer).

Species Focus
of conservation concern

Purple Finch
Purple finches nest in forests with thick hemlock, pine, or other conifers. In winter, they can be found feeding in other habitats such as orchards, shrublands, hardwood forests, or at birdfeeders, often roosting in nearby evergreens. Purple finch populations have declined in New Hampshire over the past forty years for unknown reasons. Purple finch is the state bird of New Hampshire.


Purple finch

Wood turtle
Wood turtles are found throughout New Hampshire, but are more common in the south. They are usually found within 1000 feet of deep, slow-moving rivers and streams, but use surrounding agricultural fields, shrublands, and forestland during the summer. Females lay eggs in sandy soils such as riverbanks, gravel pits or railroad beds. Human development of their habitat, collisions with cars on roads, illegal collection for the pet trade, and injury from mowing equipment threaten the survival of wood turtles.


Wood turtle

American woodcock
Woodcock require patches of dense, young shrubs and trees —alder thickets are ideal. These habitat patches, embedded within a larger forest of hemlock-hardwood-pine, provide cover from flying predators (e.g., hawks), allowing these well-camouflaged birds to hunt for earthworms, their primary food. In early spring, males seeking mates perform a dramatic, circular flight, taking off from grassy openings during dawn and dusk. Listen for the distinctive "peent" call. Woodcock populations have declined in New Hampshire along with the amount of shrubland, young forest, and grassy openings available as habitat.


American woodcock

Blackburnian warbler
The brilliant black and orange Blackburnian warbler is a conspicuous species in mature conifer forest patches, particularly hemlock, spruce and fir. They feed high in the canopy, hunting for beetles, caterpillars, ants and other crawling insects. Populations of Blackburnian warblers are stable in New Hampshire.


Blackburnian warbler

Wildlife that depend on hemlock-hardwood-pine forests

The species listed here are some of the wildlife that use hemlock-hardwood-pine forests. Be on the lookout for these species and follow stewardship guidelines to help maintain or enhance hemlock-hardwood-pine habitats. Species of conservation concern—those wildlife species identified in the Wildlife Action Plan as having the greatest need of conservation—appear in **bold** typeface.

- American toad
- **American woodcock**
- Barred owl
- Black bear
- Black-throated green warbler
- Blackburnian warbler
- **Blanding's turtle****
- **Blue-spotted salamander**
- **Bobcat**
- Broad-winged hawk
- **Canada warbler**
- **Cerulean warbler**
- **Cooper's hawk**
- **Eastern pipistrelle**
- **Eastern red bat**
- **Eastern small-footed bat**
- **Eastern towhee**
- Flying squirrel
- Fisher
- **Jefferson's salamander**
- Moose
- **Northern goshawk**
- **Northern long-eared bat**
- Pine elfin butterfly
- Porcupine
- **Purple finch**
- Red-breasted nuthatch
- **Red-shouldered hawk**
- Red squirrel
- **Ribbon snake**
- **Ruffed grouse**
- **Silver-haired bat**
- Six-spotted tiger beetle
- **Smooth green snake**
- **Spotted turtle***
- **Timber rattlesnake****
- **Veery**
- **Whip-poor-will**
- Wood nymph butterfly
- White-tailed deer
- Wild turkey
- **Wood thrush**
- **Wood turtle**

*state-threatened
**state-endangered

Where to get help

If you have information about a wildlife species of conservation concern, contact NH Fish & Game's Wildlife Division at 603-271-2461. Contact the UNH Cooperative Extension Wildlife Specialist at 603-862-3594 for technical assistance for landowners or your community.

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2/11

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SUSTAINABLE FORESTRY INITIATIVE

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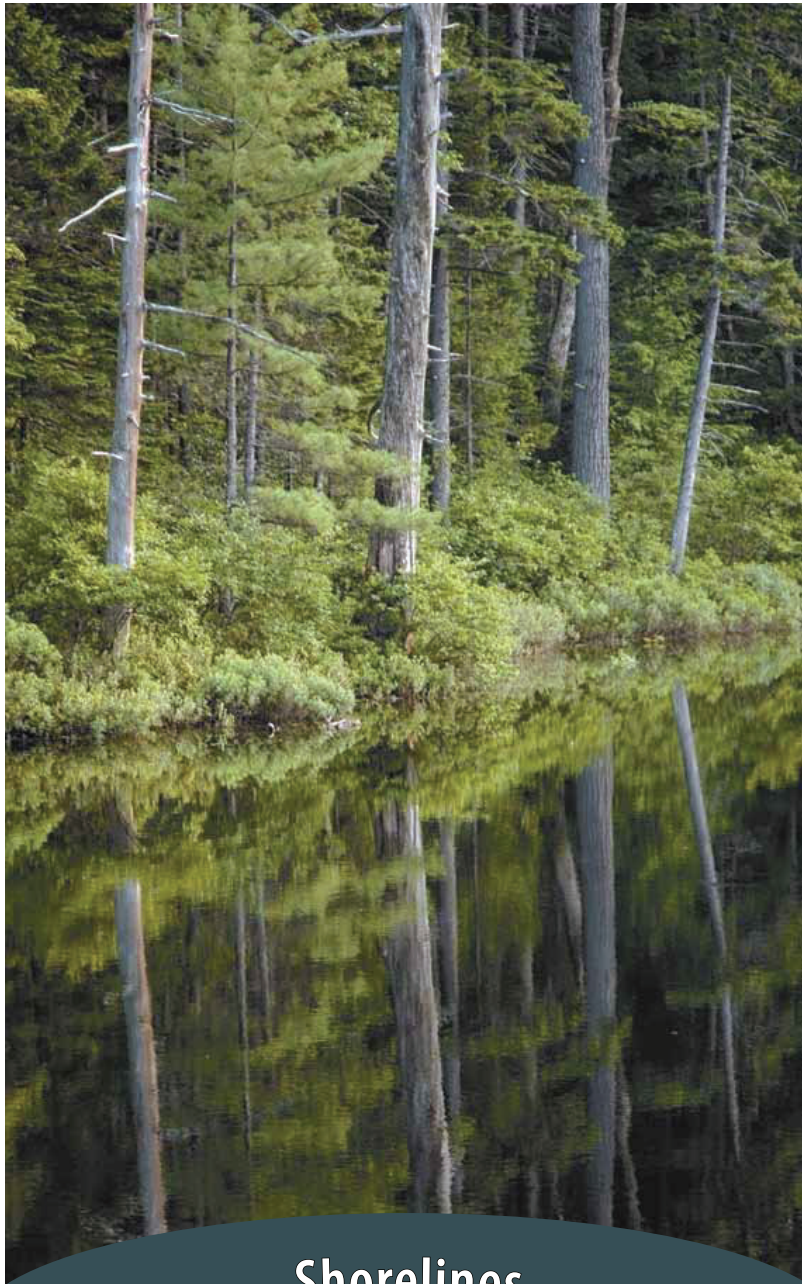


Shorelines

Habitat Stewardship Series

NEW HAMPSHIRE WILDLIFE ACTION PLAN

Recognizing

shoreline habitat

The shorelines of lakes, ponds, and rivers are valuable real estate in New Hampshire, but their importance as wildlife habitat is also significant. The qualities that make shorelines attractive to wildlife may be very different from what makes them attractive for boating and swimming.

Shorelines with extensive, mature forests along the shore are critical yet rare habitats in New Hampshire. High quality shorelines are usually found in places undisturbed by buildings, roads, docks, lawns, or heavy recreational activity. At the water's edge, native aquatic vegetation (plants growing in or under the water), submerged rocks and boulders, and dead trees that have fallen in the water are all features of high quality shoreline habitat. These habitat features become less common as housing density increases around lakes, ponds or rivers.

Underwater vegetation is particularly valuable as cover for wildlife, especially in larger lakes and ponds where wave action or deep water limits the amount of shoreline where plants can grow. Look for plants whose foliage appears to float at the surface or under the water, such as pond lilies, pondweeds, coontail, bladderwort, and native milfoils.

The best shoreline habitat has large areas of diverse underwater vegetation such as coontail and bladderwort mixed with aquatic plants such as pickerelweed and yellow pond lily that grow in scattered stands. When these features are found near deep water, shoreline wetlands, and upland forests, the shoreline habitat becomes a productive hunting ground for great blue and green heron, otter, mink, and larger fish such as eastern chain pickerel and yellow perch.

Yellow pond lily

Why are shorelines important?

The quality of shoreline habitat may be the single biggest influence on the abundance and variety of wildlife that live in or around a water body. Lakes, ponds and rivers with plentiful natural vegetation and undeveloped shorelines surrounded by large blocks of forest will support the greatest number of wildlife species. By comparison, water bodies dominated by docks, stabilized banks, lawns, beaches, houses, and heavy boat traffic support far fewer wildlife species.

Water quality protection

Pollution from widespread sources like roads, houses, and cars (as opposed to factories and other "point sources") is the number one threat to water quality in lakes and ponds in New Hampshire. Native shrubs and trees growing along shorelines help protect the water from soil erosion, runoff, pesticides, chemicals, and excess nutrients. These pollutants kill fish, promote the growth of aquatic weeds, and muddy the water, all of which diminish the value of the lake, pond or river for homeowners, boaters, anglers, swimmers, and wildlife alike. Once a lake, pond, or river has been degraded, it can be difficult to restore its quality.

Natural vegetation

Land along shorelines is critical wildlife habitat. Loons need undisturbed shoreline for nesting at the water's edge. Warbling vireos and song sparrows nest in the branches of shoreline trees and shrubs, and common mergansers use hollows in dead trees. Even trees and shrubs in front of a home can provide valuable cover for passing animals and minimize disturbance to ducks and loons swimming by. Forested shorelines allow forest animals such as moose or raccoons to use the water and food available at the shore.

Dead trees in the water provide habitat for young and adult sunfish, and underwater branches serve as attachment sites for pickerel frog and green frog eggs. Partially submerged tree trunks make excellent sunning spots for painted turtles. Important as it is for wildlife, downed wood from fallen trees is a rare habitat element on developed shorelines, as it's usually removed as an impediment to boating and swimming. Some bare shorelines, such as those along large, fast-moving rivers that are regularly scoured by water and ice, can still be important habitat for wildlife such as dragonfly larvae, bluegills and freshwater mussels.

Rich breeding grounds


Painted turtles bask on logs in the water

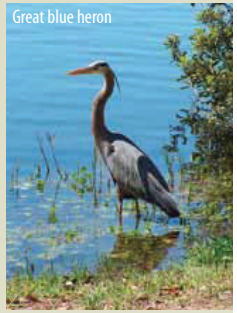
Coves and shallow areas with aquatic vegetation are used as nursery and spawning habitat for many fish, including the state-threatened bridle shiner. A lack of vegetation will ultimately affect fish diversity in a lake or pond. Young fish, insects, and amphibians living in shoreline habitats attract hawks, herons, ducks, mink, raccoons, and northern water snakes which all forage along shorelines. Predatory fish, including bass, pickerel, pike, and creek chubsuckers all forage in aquatic vegetation. Sunfish spawn in circular depressions in shallow water and crayfish are abundant in rocky shallows. Lake shores and shallow ponds are also the home of musk turtles, painted turtles, and snapping turtles. Aquatic plants provide cover for aquatic invertebrates such as snails and dragonfly larvae, which are in turn fed upon by fish and other predators. Filter-feeding freshwater mussels burrow in the fine silt trapped by aquatic plants.

Threats by invasive plants

Invasive plants such as variable milfoil and fanwort threaten the diversity of plants and wildlife in New Hampshire. Invasive plants take over native vegetation and offer less-valuable habitat and food sources for many species of wildlife. When large mats of invasive plants die, they deplete the water of oxygen, which also threatens wildlife.

Stewardship Guidelines for shorelines

- **Conserving land from additional development around shorelines** is critical for maintaining healthy lake and river ecosystems, as these are some of our most degraded habitats. Land conservation of these high-value properties requires strong and stable public and non-profit funding, community partnerships, and financial investment by landowners and voters.
- Landowners around lakes, ponds and rivers should understand and **follow all laws** pertaining to the development, alteration, or cutting of vegetation along shorelines, including the Comprehensive Shoreland Protection Act (see www.des.nh.gov).
- Existing New Hampshire shoreline laws don't explicitly protect wildlife habitat. **Responsibility for protecting and restoring wildlife habitat rests instead with individual shorefront property owners.** If every shoreline owner maintained a portion of their shoreline for wildlife habitat, it would have huge benefits for fish, wildlife, water quality and the aesthetics of our lakes, ponds and rivers. Two publications by UNH Cooperative Extension can help shoreline landowners find the right balance for their property: *Landscaping at the Water's Edge*, and *Integrated Landscaping: Following Nature's Lead*. Other recommendations include:
  - Leave forest undisturbed within at least 100 feet of the shoreline,
  - Retain views by cutting tree branches at view level, leaving the forest floor as undisturbed as possible,
  - Loons, eagles, and other large wildlife will benefit from 300 feet of undisturbed forest along shorelines,
  - On land, leave standing dead and downed trees for nesting and perching wildlife,
  - In the water, leave fallen trees, aquatic plants, and large boulders to provide habitat for aquatic wildlife.


Great blue heron

- **Winter draw-downs** happen on many lakes and ponds to allow for work on docks or to prevent flooding. These water fluctuations can negatively affect wildlife. Freezing temperatures destroy the roots of aquatic plants. Sudden draw-downs may destroy the eggs of fish and adult amphibians. Owners should work with other landowners and lake associations towards management policies that benefit the ecology of the lake or pond.
- The eroding force of **boat wakes** can destroy sensitive shoreline habitat. Plants rooted in fine sandy bottoms are especially vulnerable to waves. Especially on large rivers, boat wakes can disrupt and kill dragonflies as they emerge from their larval stage underwater. Boaters should be aware of their effect on shoreline habitat and reduce their speed near coves or shallow water.
- **Installing a dock requires a permit** and should be done with minimal disturbance of aquatic vegetation. Consider partnering with neighbors on jointly-owned docks to help reduce the number of man-made structures along the shore.

Boats can help habitat by reducing their wake

- **Avoid the use of fertilizers, lime, pesticides and herbicides near any water body**, and follow all laws, including the Comprehensive Shoreland Protection Act, related to the use of these substances. Many pesticides and herbicides are toxic to aquatic organisms. Excess fertilizer also threatens wildlife and water quality through a process called "**eutrophication**." Excess nutrients from fertilizers increase algae growth which clouds the water. The algae then die and decompose, causing a drop in oxygen in the water, which in turn can lead to large-scale fish die-offs.
- **Help stop the spread of invasive aquatic plants.** Always inspect your boat, motor, trailer, and recreational equipment for tag-along plants before launching and after exiting a lake, pond or river. Remove all tag-along plants and dispose of them away from the waterbody.
- **Man-made ponds are a poor substitute for natural ponds and lakes.** However, landowners can improve the habitat and water quality of man-made ponds by following stewardship recommendations for natural shorelines.

Species Focus
of conservation concern

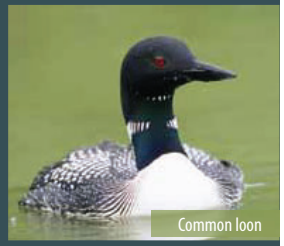
Bridle shiner
Once common throughout the Atlantic seaboard, the bridle shiner is now absent from much of its former range. A state-threatened fish in New Hampshire, the bridle shiner depends on submerged aquatic vegetation for cover and spawning. They may be found along the shorelines of large lakes, the backwaters of large rivers, or in small headwater streams with healthy aquatic vegetation. In New Hampshire, the bridle shiner appears to have disappeared from some lakes due to habitat loss from shoreline development, but in other lakes the reasons are not as clear. Declining water quality from fertilizers, non-native fish introductions, and water level fluctuations at dams may play a role in the bridle shiner's decline.


Bridle shiner

Bald Eagle
Bald eagles live beside the waters of lakes and larger rivers, year-round. They depend on large trees along the shore for both nesting and winter roosting. Eagles nest early, as their chicks require a long period to grow and learn to hunt. They eat live fish in the summer, and in the winter they scavenge dead animals or prey on ducks or fish in open waters like the Connecticut, Merrimack and Androscoggin rivers. Viewers should stay at least 300 feet away from nests and winter roosts, and landowners should leave large trees standing along shorelines, even if dead, as these are ideal nest and perch sites.


Bald eagle

Common Loon
Common loons are a threatened species in New Hampshire. They use lakes and ponds over 50 acres for breeding. Although restored to much of their former range though intense conservation efforts, they are still very vulnerable to human disturbance. Loons nest at the edge of the shore on a mound built a few inches off the ground. Loons on the nest are extremely sensitive to disturbance and will abandon their nest, eggs or chicks when boaters, including paddlers, come too close. Abandoned eggs and chicks are then vulnerable to predators. Shoreline development should stay 600 feet away from loon nests.


Common loon

Eastern pond mussel
Freshwater mussels are among the most threatened animals in North America. While a number of mussel species are common along the shorelines of New Hampshire waters, eastern pond mussels, a species of conservation concern, are found in only a handful of ponds in southeastern New Hampshire. Most freshwater mussels are good indicators of ecosystem health because as filter feeders, they are sensitive to pollution, habitat alteration, and changes in fish populations. Dams and impassable culverts that limit fish passage restrict the spread of freshwater mussels.


Eastern pond mussel

Wildlife found along shorelines
The wildlife species listed here are closely associated with shoreline habitats, but many other species will use shorelines at some time during the year. Be on the lookout for these and other species that use shorelines, and follow stewardship guidelines to help maintain or enhance these habitats. Species of conservation concern—those wildlife species identified in the Wildlife Action Plan as having the greatest need of conservation—appear in **bold** typeface.

- **American eel**
- **Bald eagle***
- Bank swallow
- **Banded sunfish**
- Belted kingfisher
- **Bridle shiner***
- Bullfrog
- **Common loon***
- Common merganser
- Crayfish
- Dragonflies and damselflies
- Eastern chain pickerel
- Eastern kingbird
- **Eastern pond mussel**
- Eastern spotted newt
- Great blue heron
- Mink
- Moose
- Musk turtle
- **Northern harrier****
- Northern water snake
- **Osprey**
- Otter
- Painted turtle
- Raccoon
- **Redfin pickerel**
- Ring-billed gull
- Spotted sandpiper
- Snapping turtle
- Warbling vireo
- White sucker
- Wood turtle
- Yellow perch

*state-threatened species
**state-endangered species

Where to get help
If you have information about a wildlife species of conservation concern, contact NH Fish & Game's Wildlife Division at 603-271-2461. Contact the UNH Cooperative Extension Wildlife Specialist at 603-862-3594 for technical assistance for landowners or your community.

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About the Habitat Stewardship Series
Much of the land in New Hampshire is privately owned. These individuals are the primary stewards of our wildlife and forests, and also our clean water, scenic views, fresh air, natural and cultural heritage, and recreational resources. The Habitat Stewardship Series has been created to help landowners and land managers recognize the habitats critical for wildlife species at risk, and to illustrate the role private landowners can play in sustaining those species through conservation, management, and sound land stewardship.

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University of New Hampshire Cooperative Extension
Sustainable Forestry Initiative

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Northern Hardwood-Conifer Forests

Habitat Stewardship Series

NEW HAMPSHIRE WILDLIFE ACTION PLAN

Recognizing

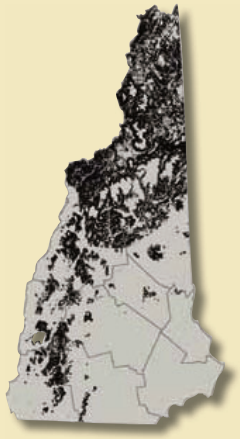
northern hardwood-conifer forests

Thousands of acres of northern hardwood-conifer forests grow on well-drained, fertile slopes of hillsides in New Hampshire, typically between 1,500 and 2,500 feet in elevation. Here, sugar maple, American beech, and yellow birch are the dominant tree species, mixed with red maple, white ash, and patches of hemlock at lower elevations, and red spruce and balsam fir at higher elevations.

Striped maple, witch hazel and hobblebush shrubs are typical in the understory of northern hardwood-conifer forests, with wild sarsaparilla, starflower, and blue-bead lily on the forest floor. Our vast expanses of northern hardwood-conifer forests in northern and western New Hampshire are famous for both spring wildflower displays and brilliant fall foliage.

The best examples of northern hardwood-conifer forests have patches of large trees in the canopy, young trees in the understory, many standing dead trees (snags), and abundant dead and decaying trees on the ground. Large cavity trees, pockets of wetlands, seeps and interspersed patches of conifers make some areas of northern hardwood-conifer forest especially rich for wildlife.

Starflower



Where are northern hardwood-conifer forests in New Hampshire?

Northern hardwood-conifer forests cover about 20% of the state, with Grafton and Coos counties containing 80% of that habitat. A band of northern hardwood-conifer forest is also found in the southwestern highlands in Sullivan, Cheshire and parts of Hillsborough Counties. Public lands with extensive examples of northern hardwood-conifer forests include many parts of the White Mountain National Forest, Mountain Pond in Chatham, Cardigan Mountain in Orange, and Fitch Mountain in Stratford. Northern hardwood-conifer forests are shown in the shaded areas of the map at left.

Why are northern hardwood-conifer forests important?

Many of New Hampshire's northern hardwood-conifer forests remain unfragmented by development and roads, making them an important ecological refuge for plants and animals. These forests provide habitat for hundreds of species of wildlife, including forty-two mammals and seventy-three birds.

Keeping common wildlife common


Pileated woodpecker

Northern hardwood-conifer forests help keep our common wildlife common, providing space for everything from the smallest insects to the widest-ranging mammals and birds. Today, sightings of black bears, scarlet tanagers, pileated woodpeckers, and fisher are commonplace. If they are to remain common, these and other species require a forested backdrop within our rapidly-developing landscape.

Uniformity

Many stands of northern hardwood-conifer forest in New Hampshire are the same age, roughly 80-100 years old. They grew back after extensive timber harvesting and abandonment of farms throughout the last century. Many wildlife species of conservation concern found in northern hardwood-conifer forests are attracted to patches of old or young trees within the larger forest area. Today's forests don't support the same high diversity of wildlife species as older forests that contain a diversity of live and dead trees of different ages and sizes. Complicating matters, the public may prefer to view extensive, unbroken mature forest. As a result, managers are less likely to make large openings (e.g. clearcuts) which will re-grow into the young forests required by many wildlife species.

Refuge for forest birds

New England forests are home to the highest concentration of breeding songbirds in the United States. Migrating birds such as eastern wood-pewee, black-throated blue warbler, wood thrush and many others carefully time their arrival to coincide with the swarms of insects (such as black flies and mosquitoes!) that are an important food source for young birds. Maintaining rich and healthy breeding areas for these birds is especially important given extensive habitat loss in the birds' southern wintering sites in South America, Mexico, and the Caribbean.

Habitat loss to development

Residential and second-home development in northern hardwood-conifer forests has increased in the last quarter century. The problem is cumulative, as each new development fragments the forest into smaller and smaller blocks, eliminating habitat, separating wildlife populations, inhibiting migration, increasing predation and promoting wildlife collisions on roads.

High-grading

High-grading is a non-sustainable logging practice where the best trees are cut and poor quality trees are left to grow. Some northern hardwood-conifer forests have been repeatedly high-graded, and are now dominated by low-quality, low-value trees and are less dense, less mature, and less diverse. High-grading affects wildlife by removing the larger diameter trees, which reduces the development of large nut-producing trees, large diameter cavity trees, and lessens woody material on the forest floor.

Stewardship Guidelines

for northern hardwood-conifer forests

- **Conserving large blocks (>1000 acres) of northern hardwood-conifer forest from development** will provide habitat for wide-ranging wildlife such as black bear, bobcat, Canada lynx and northern goshawk.
- For both land conservation and land stewardship efforts, focus on northern hardwood-conifer habitat characterized by unique features such as:
  - **Large trees** (>18" diameter) which are important for roosting bats, goshawk nests, and as future snags (standing dead trees) and den trees for bears, bats, birds, and other species.
  - **Rocky cliffs** which provide sunning areas for bobcat.
  - **Forested areas near wetlands, streams, ponds, or seeps** which provide moist habitat for wood turtle, blue-spotted salamander, ribbon snake, and many songbirds.
  - **Areas of young, regrowing** forest, which provide critical habitat for many wildlife species of conservation concern such as American woodcock, Canada warbler, and bobcat. Patches at least five (5) acres in size will benefit the most wildlife.
  - Areas of **mature forest with characteristics of old-growth**, such as:
    - many snags and cavity trees;
    - a diversity of tree sizes including both young and old trees growing at all levels of the forest;
    - fallen, decaying trees on the forest floor;
    - gaps in the canopy where trees have fallen or been cut.
  - **Pockets of spruce, fir, pine or hemlock trees** (conifers), used as winter shelter by northern goshawk, great horned owl, red squirrel, porcupine, and white-tailed deer.


Downed woody material

- **Using forest management, work to regenerate a mix of tree age classes and tree species.** A full range of age classes, well-distributed across the landscape, is important to support the great diversity of wildlife dependent on northern hardwood-conifer habitats. For more information about how forestry can enhance habitat, consult the publication *Good Forestry in the Granite State, 2nd edition*.
- **Provide a supply of patches, over time, of young, regenerating forest habitat** (>2 acres) to enhance cover for wildlife, berry-producing shrubs, hardwood stump sprouts, and other key features of "early successional" habitats (refer to Shrublands brochure in this series). The larger the forest opening or clearcut, the greater benefit it has for breeding birds, including those breeding in surrounding forests. To maximize the benefit of new forest openings to wildlife, create new patches, at least 5 acres in size, near utility corridors, shrub wetlands, or brushy old fields.
- Northern hardwood-conifer forests are critical for many migratory forest birds such as black-throated blue warbler, eastern wood-pewee, and wood thrush. Populations of many forest birds are declining, but most are still common in New Hampshire. An initiative by Vermont Audubon (www.vt.audubon.org) details **bird-friendly management practices** such as softening edges between habitats and limiting management activities during the breeding season (April-August).
- Wildlife don't recognize property boundaries. **Discuss land stewardship plans with neighboring landowners**, and consider cooperating to create on-going, coordinated habitat management projects.
- **Always consult a licensed New Hampshire forester before conducting a timber harvest on your property.** Understand and follow all laws pertaining to the harvesting of trees near wetlands and waterbodies. Follow established best management practices, and harvest timber near wetlands only when the soils are either frozen (winter) or very dry (summer).

Species Focus
of conservation concern

Wood thrush
This large thrush is smaller than a robin, has a spotted breast and brown back, and makes a beautiful, flute-like call that sounds like "ee-oh-layyy." Wood thrushes nest in mature, deciduous forests with a thick understory, moist soil, and heavy leaf litter on the forest floor. Populations of these birds are declining, partly due to the destruction of forests in their wintering grounds in Mexico. Providing large forest blocks, unfragmented by development, may help sustain this species.


Wood thrush

Bobcat
Bobcats use sunny, south-facing cliffs and rocky outcrops to sun themselves during the winter. Since the 1960s, bobcat populations have declined in New Hampshire, likely because our forests have matured. There is much less dense, young forest to provide habitat for bobcat prey, including snowshoe hare and other small mammals. Managing forests for different age classes (both young and old trees) will increase prey and benefit bobcats.


Bobcat

Northern goshawk
This steel-colored hawk is a forceful predator in northern hardwood-conifer forests. Goshawks build nests – and aggressively defend them – in mature forests with large trees and an open understory. They hunt over a large area for rabbits, mice, squirrels, songbirds, and ruffed grouse. These prey animals are most abundant in patches of young forest, so forest openings are also important to goshawk survival. Goshawk habitats are threatened by human development which can disturb nest sites and make prey less available.


Northern goshawk

Eastern red bat
These bats migrate to New Hampshire for the summer from their wintering grounds in the southern United States. They spend the day roosting in the foliage of large, mature trees, often near streams or other water bodies. There are relatively few records of red bats in New Hampshire, but their secretive roosting behavior makes them difficult to locate in the forest. Like other migratory bats, eastern red bats can be killed by wind turbines, a concern given the increasing interest in wind power. Fortunately, eastern red bats do not appear to be susceptible to white-nose syndrome, a lethal disease that affects cave-hibernating bats.


Eastern red bat

Wildlife found in northern hardwood-conifer forests

The wildlife species listed here use northern hardwood-conifer forests. Be on the lookout for these species and follow stewardship guidelines to help maintain or enhance northern hardwood habitats. Species of conservation concern--those wildlife species identified in the Wildlife Action Plan as having the greatest need of conservation--appear in **bold** typeface.

- **American woodcock**
- Black bear
- Black-throated blue warbler
- **Blue-spotted salamander**
- **Bobcat**
- **Canada lynx*****
- **Canada warbler**
- **Cooper's hawk**
- **Eastern pipistrelle**
- **Eastern red bat**
- Eastern wood-pewee
- Flying squirrel
- Gray fox
- **Hoary bat**
- **Mink frog**
- Moose
- **Northern goshawk**
- **Northern long-eared bat**
- Ovenbird
- Pileated woodpecker
- **Purple finch**
- Red-eyed vireo
- **Ribbon snake**
- **Ruffed grouse**
- **Silver-haired bat**
- **Smooth green snake**
- Turkey
- **Veery**
- White-breasted nuthatch
- White-tailed deer
- **Wood thrush**
- **Wood turtle**

*** state-endangered, federally-threatened species

Where to get help

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UNIVERSITY of NEW HAMPSHIRE Cooperative Extension

SUSTAINABLE FORESTRY INITIATIVE

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Grasslands

Habitat Stewardship Series

NEW HAMPSHIRE WILDLIFE ACTION PLAN

Species Focus
of conservation concern

Eastern meadowlark
These songbirds require fields larger than 15 acres, with tall grasses and a mix of wildflowers typical of fields that have gone un-mowed for up to five years. Meadowlarks will also breed in lush hayfields, but the fields must be of a sufficient size.


Eastern meadowlark

Bobolink
Bobolink, although not listed as a species of conservation concern, is the most common grassland-nesting bird found in New Hampshire fields. Ideal bobolink habitat is a lush hayfield larger than five acres, that is mowed once a year in September. Removing the hay from the field is also beneficial, as the birds prefer fields without thick thatch layers. A one- or two-acre border area might be mowed only every two or three years to provide a diverse mix of wildflowers such as milkweed, aster, goldenrod, and thistle. These plants attract a wide variety of insects that provide a rich food source for bobolinks and other birds.


Bobolink

Smooth green snake
Smooth green snakes live and feed in open habitats such as pastures, old fields, and wet meadows throughout New Hampshire. Edges of these habitats provide the rotting logs and mammal burrows in which smooth green snakes lay eggs in summer and hibernate in winter. They feed on insects, slugs, caterpillars and earthworms. Populations of smooth green snakes are in decline due to habitat loss. Frequent mowing and low mower blades can kill snakes. Insecticide spraying in agricultural fields (especially for slugs) may also impact smooth green snakes by reducing the amount of prey available.


Green snake

Managing Small Fields for Wildlife

Many landowners own fields smaller than five acres. These fields are still important for other wildlife species, and as foraging areas for grassland birds nesting in nearby larger fields or migrating songbirds passing through. Landowners can manage their fields to improve the overall plant and wildlife diversity by:

- Mowing fields only once every two or three years to increase wildflower and insect diversity.
- Mowing as late in the fall as possible (September-October) to allow late-blooming wildflowers to form and provide nectar sources for migrating butterflies.
- Maintaining some areas of bare ground (poor soils or heavily-grazed areas) for such species as killdeer and horned larks.
- Establishing a rotational mowing or grazing program in which different parts of a field are mowed/grazed at different times. This creates a patchwork of different grass heights that provides cover and feeding opportunities to the greatest number of wildlife. Contact your county UNH Cooperative Extension Agricultural Educator for more information on establishing a rotational mowing or grazing program on your land.

Recognizing
grassland habitats

Grasslands are an increasingly rare sight in New Hampshire. More than 70 species of wildlife use these open areas of fields and wildflowers to meet their needs for food, cover, or breeding. Learn to recognize the habitat values of grasslands and discover what you can do to maintain and conserve these special habitats.

- The most common grassland habitats in New Hampshire are agricultural fields such as hayfields, pastures and fallow fields. Here, vegetation consists of a mixture of grass species, or a combination of grasses, sedges and wildflowers.

- Airports, capped landfills, military installations, and wet meadows may also function as grassland wildlife habitat if they support similar vegetation. Croplands are also used by many grassland wildlife species, and are also important as potential grasslands, since they may be easily converted to grow grass if crop farming practices are abandoned.
- Vegetation growing in grassland habitats may be tall (over four feet), short (less than 6 inches), or a combination. Vegetation height plays an important role in determining which wildlife species will use the habitat. A common trait of all grassland habitats is that they contain few (if any) trees or shrubs.
- Today, most plants growing in grasslands are non-native grasses, introduced by humans for agricultural uses. These include timothy, Kentucky bluegrass, orchard grass and perennial ryegrass. Two native grasses, big bluestem and little bluestem, as well as native wildflowers such as goldenrod and aster, are also common in our grasslands today.

Where are New Hampshire's grasslands?

Development and natural forest succession have combined to reduce grassland habitats in New Hampshire to the point that grasslands currently cover only about four percent of our landscape. However, large grassland habitats (those greater than 25 acres in size) still exist in every county in New Hampshire, with the highest concentrations in Grafton County (with 20 percent of our remaining grasslands), Merrimack County (13 percent), and Coos County (12 percent). Some level of conservation restriction protects about eight percent of New Hampshire's large grassland habitats.

Historical
changes in grassland habitats

Historically, Native Americans and beavers were the primary forces responsible for creating and maintaining grassland habitats in New England. Native Americans created grasslands when they burned the land for agriculture and to improve forage for game species such as white-tailed deer. At the same time, ponds above abandoned beaver dams grew into grassy meadows after the water drained and the nutrient-rich soil was exposed to sunlight.

In more recent history, fire suppression and limits to where beavers are allowed to build dams has meant that grasslands are restricted mainly to agricultural areas. The peak of agricultural clearing in the state occurred in the mid-1800s. Since then, New England has been losing grassland habitats, which have grown back into forest. With their well-drained soils, tree-less fields, and ample road frontage, agricultural lands also offer attractive sites for development.

Today most grasslands in New Hampshire require maintenance by humans. If left alone, these habitats will grow back into shrubs and small trees, reverting eventually to forest.

Declines in grassland-nesting birds

Bird species that depend on grasslands have declined, along with their habitats, faster than any other group of birds in New England. Most grassland-nesting birds are "area sensitive," which means they won't nest in fields smaller than a certain size. The following list is a simplified guide to the required minimum field size and the preferred vegetation height in fields used by grassland-nesting birds:

Birds of smaller grasslands (<25 acres)		
Bobolink	5+ acres	dense grass taller than 3 feet
Eastern meadowlark	15+ acres	dense grass and wildflowers taller than 3 feet
Savannah sparrow	20+ acres	prefers sites with both short and tall vegetation
Birds of larger grasslands (>25 acres)		
Grasshopper sparrow*	30+ acres	prefers sites with short, sparse grass; uncommon
Northern harrier**	30+ acres	forages in short grass fields, nests in wet meadows
Upland sandpiper**	150 acres	prefers sites with short, spare grass; very rare

*state-threatened species **state-endangered species

Agricultural practices and bird nesting

Without the work of farmers and other landowners, most grasslands would quickly revert to forest. However, the timing of mowing can affect a field's ability to provide habitat for grassland-nesting birds and other wildlife. Farmers growing high-quality forage for livestock usually mow their fields two or three times during the summer. At least one of these mowings typically occurs between May and mid-July, a time that corresponds with the nesting season for most grassland-nesting birds. Mowing during this period can destroy nests and eggs, kill fledglings, or cause adult birds to abandon their nests.

Stewardship Guidelines for grasslands

- Grasslands of any size provide valuable habitat for wildlife in New Hampshire. If you own fields, maintain them by mowing in the fall at least once every three years to discourage trees and shrubs. It is much more difficult and expensive to create a new field than to maintain an existing field by mowing.
- Focus land conservation on large grasslands (greater than 25 acres in size), which benefit the greatest number of wildlife species and are increasingly rare in the state.
- In fields where intensive agricultural production is not an issue, mow fields after August 1st, the end of grassland-breeding bird season. Mowing even later (August-October) is ideal, since this allows late-flowering wildflowers such as aster and goldenrod to provide nectar for migrating butterflies. Areas where later mowing may be possible include airfields, capped landfills, fallow fields, edge habitats, marginal farmland, weedy areas, and fields producing bedding straw.
- In agricultural fields, modifications to mowing techniques can help reduce impacts on grassland-breeding birds during the breeding season (May through mid-July):
  - Raise mowing bar to six inches or more in areas with grassland bird concentrations.
  - Grassland birds roost in the fields at night, so avoid mowing after dark.
  - Use flushing bars on haying equipment (for more information, contact the Wildlife Division of the New Hampshire Fish and Game Department at 271-2461).
  - Delay mowing in wetter areas or in grasslands along rivers.


Tractor with flushing bar

- Farmers are faced with many pressures during the growing season—variable weather, equipment demands, planting schedules—making it difficult for them to incorporate a refined mowing technique and schedule to accommodate grassland-nesting birds. However, interested farmers have a number of federal and state cost-share programs available to help pay for practices that benefit wildlife. Contact your county UNH Cooperative Extension office or the Natural Resources Conservation Service (NRCS) for more information about these cost-share programs.
- Where possible, remove all shrubs and trees growing in the middle of fields, as these decrease the useable acreage as perceived by grassland-nesting birds.
- Burning fields, particularly in areas with poor soil, can improve soil nutrients and mimic historical disturbances to grassland habitats. Burning will also help spread native grasses (see below) if they already exist in a field. Some New Hampshire landowners have established partnerships with their local fire departments to burn fields on an annual basis as training for firefighters.


A controlled burn

- Warm-season grasses, many of which are native to the U.S., may be a viable alternative to (non-native) cool-season grasses as an agricultural hay crop. Warm-season grasses are more difficult to establish, but they offer some benefits to landowners willing to take on the challenge. They require less fertilizer, lime, and herbicides, and are more drought-tolerant. For wildlife, they offer better nesting cover (growing as in bunches, with space between for movement and nests), a more dependable food source, and better winter cover, since they don't mat down during heavy snows. The NRCS and UNH Cooperative Extension can provide advice and possible cost-share funds to plant warm-season grasses.

Wildlife found in grasslands

Grasslands of all sizes will be used by over 150 different wildlife species throughout the year. Below are some examples of species that depend on grassland habitats. Be on the lookout for these species, and follow the stewardship guidelines provided to help maintain or enhance grassland habitats in your area. Species of conservation concern—those wildlife species identified in the Wildlife Action Plan as having the greatest need of conservation--appear in **bold** typeface.

- **American bittern**
- American kestrel
- **Black racer**
- **Blanding's turtle**
- Bobolink
- **Eastern hognose snake**
- **Eastern meadowlark**
- **Grasshopper sparrow***
- **Horned lark**
- **Northern harrier****
- **Northern leopard frog**
- **Purple martin****
- Savannah sparrow
- Small rodents (important as prey species)
- **Smooth green snake**
- Turkey
- **Upland sandpiper****
- **Vesper sparrow**
- **Whip-poor-will**
- White-tailed deer
- **Wood turtle**

❖ The threatened and endangered status of many wildlife species is under review. For the current list, visit NH Fish and Game's website at wildlife.state.nh.us

* state-threatened species
** state-endangered species

Where to get help

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Authorship

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University of New Hampshire Cooperative Extension

Sustainable Forestry Initiative

Marsh and Shrub Wetlands

Habitat Stewardship Series

NEW HAMPSHIRE WILDLIFE ACTION PLAN

Species Focus
of conservation concern

Least bittern

Least bitterns are rare in New Hampshire, with sightings concentrated in the southern part of the state. These shy birds use marshes dominated by cattails and scattered shrubs, where they feed on fish, amphibians, snakes and insects. Purple loosestrife, an invasive plant that can dominate cattail marshes and is difficult to eliminate, threatens their marsh habitats. Pollution and sedimentation caused by nearby development can also degrade marsh habitats. Least bitterns appear to tolerate urbanized areas as long as their wetlands remain relatively undisturbed.

Least bittern

Blanding's turtle

Blanding's turtles require large blocks of connected wetland and upland habitats with little development. They spend most of their time in marsh and shrub wetlands, but during breeding or nesting, they will travel up to 1/2 mile and may come into contact with vehicles, pets and upland habitats degraded by development. Individuals can live to be more than 70 years old, but they don't begin to reproduce until they are 15-20 years old. Females lay only a few eggs in late May to early July. This low fertility means that a few adult deaths can have a catastrophic effect on the regional population of Blanding's turtles. Roads have the deadliest impact, as Blanding's turtles are easily killed by vehicles as they try to cross roads in search of nesting sites or mates.

Blanding's turtle

Osprey

Ospreys are fish-eating birds who forage and breed along our large rivers, estuaries and lakes. These large birds also require marsh habitat, where beaver flooding creates standing dead trees (snags) for nesting, and shallow waters for easier access to fish. They will build nests in heron rookeries within beaver flowages; biologists have also had success building artificial nesting platforms on utility poles that cross wetlands, attracting nesting osprey to previously unoccupied areas. Where osprey nests are present, reduce or eliminate all recreational activity within 330 feet of nest sites to prevent disrupting the osprey's breeding.

Osprey

Spotted turtles

Spotted turtles have many of the same habitat requirements and life-cycle characteristics as Blanding's turtles, and both species are found in similar shallow-water habitats in southern New Hampshire. The spotted turtle is declining throughout its range and faces similar threats from habitat loss and road crossings as Blanding's turtles.

Spotted turtle

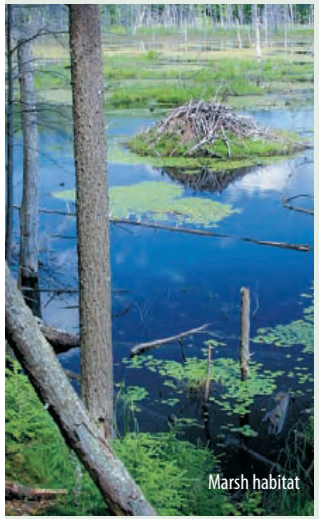
Recognizing

marsh and shrub wetlands

Marsh and shrub wetlands encompass a variety of wetland types, each with different vegetation, but with one thing in common: the soils in them are wet most of the year. The cycle of a beaver flowage, from ponded water (marsh) to abandoned/drained area (wet meadow), and re-growth (shrub wetland), can contain all types of marsh and shrub wetlands over time.These wetlands fit into three groups, identified by their vegetation:

Wet meadow habitat

- **Wet meadows** are filled with sedges and grasses. Wet meadows may not be flooded all year, but they are wet for long periods during spring and summer. They provide a rich habitat for such critical species as ribbon snake, spotted turtle and northern harrier.



Marsh habitat

- **Marshes** contain plants that grow out of water, but whose roots are wet, such as cattails, pickerelweed, and water lilies. Blanding's turtles, American black duck and red-winged blackbirds rely on marsh habitat for their feeding and lifecycles.
- **Shrub wetlands** are thickets of shrubs and young trees growing out of wet soils, and they often flood in the spring. Spotted turtles, Canada warblers, New England cottontail, and American woodcock all use shrub wetlands for food, cover, or breeding habitat.

Shrub wetland habitat

Why are marsh and shrub wetlands important?

Marsh and shrub wetlands are rich habitats that provide a number of critical ecosystem functions such as flood control, pollutant filtration, erosion control, and wildlife habitat. Marshes are important for fish and amphibian breeding and for waterfowl, and they connect people to habitat through hunting, fishing, tourism, and recreation. Shrub wetlands may seem inhospitable to people, but their dense thickets provide reliable cover from predators for many wildlife species.

Where are marsh and shrub wetlands?

High-quality marsh and shrub wetlands are found in all parts of the state, with higher concentrations in Rockingham and Belknap Counties. Lake Umbagog, Great Bay, and the Connecticut River Valley have been identified as particularly important areas for waterfowl habitat, due to their extensive high-quality marsh and shrub wetlands. High-quality wetlands are typically defined as being:

- at least 1000 feet from houses, roads or recreational trails
- surrounded by intact vegetation
- in remote areas where beaver dams don't affect humans

Threats from development

Historically, New Hampshire has lost fewer wetlands to development than many other states. However, we also have little direct protection for these important parts of our ecosystem. As southern New Hampshire faces increasing development pressure, wetlands and their surrounding uplands are at risk. Construction setbacks aren't always required around wetlands in New Hampshire (except septic systems) and marsh and shrub wetlands are routinely filled and damaged by driveway and road crossings. Loss of upland habitat, pollution, salt runoff from roads, and destruction of beaver dams (because of their proximity to backyards) all have a detrimental effect on our marsh and shrub wetland communities.

Threats from invasive plants

Invasive plants such as purple loosestrife, common reed (*Phragmites*), and Japanese knotweed threaten the diversity of plants in marshes, and several woody plants such as glossy buckthorn are a problem in shrub wetlands. Invasive plants take over native vegetation and offer less-valuable habitat and food sources for many species of wildlife.

Purple loosestrife

Stewardship Guidelines

for marsh and shrub wetlands

- Focus land conservation around beaver flowages across the landscape, not just around present-day beaver impoundments. Doing so allows the natural abandonment and establishment of new dams. Conserving only the present-day impoundments while allowing development and road-building near abandoned dams forever precludes the natural succession of those abandoned beaver ponds– from newly flooded sites, to stagnant ponds, to open meadows, and back to reforested landscapes.
- Maintain beaver dams and flowages and use beaver dam water control devices to maintain a consistent water level (important for protecting property or roads).
- Locate new roads and development where they are unlikely to be flooded by potential beaver dam sites.
- For land conservation efforts to successfully protect wetlands wildlife, uplands surrounding wetlands need to be protected as well. A 300 foot buffer of upland, un-impacted by development (no paved roads, buildings, etc.) protects water resources and habitat for many species. However, to truly isolate the wetland from negative development impacts, this buffer may have to extend 1000 feet or more from the wetland edge.
- Regenerate and promote growth of aspen and other hardwoods in small patches or strips along slow streams and rivers to enhance the food supply for beavers. Mallards and black ducks will benefit, as they nest on open ground around waterbodies.
- New Hampshire Fish and Game tracks sightings of rare reptiles and amphibians. Report any sightings to the NH Reptile and Amphibian Reporting Program online at wildlife.state.nh.us.
- Maintain habitat structures such as dead standing trees and overhanging vegetation in the water to provide cover for wildlife; keep downed logs as basking sites for turtles.
- Leave and protect standing dead trees as habitat for heron and osprey nesting, as roosting sites for bats, and as cavity nesting sites for a variety of other birds and mammals.
- Focus wetland restoration efforts on restoring flooding to marshes. Bogs and forested wetlands (such as red-maple swamps) aren't easily re-created after damage to their vegetation or after changes in their flooding patterns.
- Don't use heavy machinery within wetland soils to avoid negative impacts on animals or disruption of the wetland's flooding pattern.
- Where feasible, maintain open, sunny areas with little vegetation (or sandy areas) adjacent to or near marshes for turtle nesting.
- Maintain brush and other woody debris in and around wetlands to provide cover for small mammals, amphibians, and reptiles.
- Limit recreational access (either completely or with as few access points as possible), as even low levels of human disturbance can disrupt marsh wildlife. Where access is allowed, avoid trampling existing aquatic vegetation. ATVs shouldn't be allowed in or around wetlands.
- Where human-built dams are present, avoid drawing down water levels in fall and winter, as this exposes dispersing and hibernating amphibians and reptiles to colder temperatures.

A beaver dam

Wildlife found in marsh and shrub wetlands

Many wildlife species use marsh and shrub wetlands for some aspect of their life cycle, whether for breeding, feeding, cover or nesting. Below are some examples of species that depend on marsh and shrub wetland habitats. Be on the lookout for these species and other wildlife associated with marsh and shrub wetlands. Follow stewardship guidelines to help maintain or enhance marsh and shrub wetlands. Species of conservation concern--those wildlife species identified in the Wildlife Action Plan as having the greatest need of conservation--appear in **bold** typeface.

- **American black duck**
- **American bittern**
- **American woodcock**
- **Blanding's turtle**
- **Common moorhen**
- **Eastern red bat**
- **Great blue heron**
- Green darner dragonfly
- **Least bittern**
- Mink
- Muskrat
- **New England cottontail**
- **Northern harrier****
- **Northern leopard frog**
- **Osprey***
- **Pied-billed grebe****
- Red-winged blackbird
- **Ringed boghaunter dragonfly****
- **Rusty blackbird**
- **Sedge wren****
- **Silver haired bat**
- **Spotted turtle**
- Spring peeper
- Virginia rail

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FISH GAME

UNIVERSITY of NEW HAMPSHIRE COOPERATIVE EXTENSION

SUSTAINABLE FORESTRY INITIATIVE

• Montane - subalpine cliff system

Landscape settings: steep outcrops on mountain side slopes

Soils: dry to wet, acidic to circumneutral, turfy mineral to organic substrates in cracks and on benches

Spatial pattern: steep outcrops (in excess of 65 degrees slope) to over-hanging (<1–100+ acres); irregular

Physiognomy: sparsely vegetated to partially wooded

Distribution: mostly above 2,200 ft. elevation in the White Mountains and northward, and scattered in adjacent subsections to the south

Description: Montane - subalpine cliffs in NH are generally found above 2,200 ft. in elevation and are thus concentrated in the White Mountain region and sparingly at higher elevations elsewhere in the state. The most common natural community in this system is ***montane - subalpine acidic cliff***, which dominates the entire area of many cliffs. ***Montane - subalpine circumneutral cliff*** communities are relatively uncommon within this system, and when they do occur they are often restricted to only certain zones of a cliff, with the remainder of the cliff corresponding to ***montane - subalpine acidic cliff***.

Circumneutral conditions on cliffs can arise from two possible sources: 1) where the matrix bedrock is intermediate, mafic, calc-silicate, or carbonate-bearing; and/or 2) where groundwater passes through fractured bedrock and transports base-cations to the cliff face (particularly under overhangs) (Bailey 2001, Sperduto 2001, Sperduto 2002). These conditions typically occur as restricted zones on otherwise acidic cliffs. Only a few cliffs in New Hampshire have close to uniformly circumneutral conditions across the entire cliff face.

Seeps are relatively common in montane - subalpine cliff systems. Typically they occupy relatively small areas but occasionally cover an acre or more in extent. The plants that occur on cliff seeps are very distinct from those that typify more dry or mesic cliff conditions; the difference is equivalent to that seen when going from a fen to an upland forest. They range from acidic to circumneutral conditions and are indicated by wetland species.

Diagnostic natural communities:

- Montane - subalpine acidic cliff (S4)
- Montane - subalpine circumneutral cliff (S2S3)

Peripheral or occasional natural communities:

- Red spruce - heath - cinquefoil rocky ridge (S3S4) – on less steep, slab portions of cliff system

Associated natural community systems: Cliff systems are often but not always associated with talus systems; massive cliffs with little fracturing tend not to have much talus debris at their bases, whereas those with considerable fracturing do have talus slopes. Montane - subalpine cliffs are also frequently associated with montane rocky ridge and subalpine heath - krummholz/rocky bald systems.

Characteristic species:

Montane - subalpine acidic cliff:

Picea rubens (red spruce)
Abies balsamea (balsam fir)
Sibbaldiopsis tridentata (three-toothed cinquefoil)
Juncus trifidus (highland rush)
Paronychia argyrocoma (silverling)*
Oclemena acuminata (sharp-toothed nodding-aster)
Betula alleghaniensis (yellow birch)

On both montane and temperate acidic cliffs:

Deschampsia flexuosa (wavy hair grass)
Polypodium virginianum (rock polypody)
Cystopteris tenuis (Mackay's fragile fern)
Cystopteris fragilis (fragile fern)

Montane - subalpine circumneutral cliff:

Vascular plants
Campanula rotundifolia (Scotch bellflower)
Dryopteris fragrans (fragrant wood fern)*
Dasiphora floribunda (shrubby-cinquefoil)
Thuja occidentalis (northern white cedar)
Woodsia ilvensis (rusty cliff fern)

Bryophytes
Tortella tortuosa (moss)*
Gymnostomum aeruginosum (moss)*
Distichium capillaceum (moss)*
Myurella siberica (liverwort)*
Amphidium mougeotii (moss)*

On both montane and temperate circumneutral cliffs:

Asplenium trichomanes (maidenhair spleenwort)
Woodsia ilvensis (rusty cliff fern)
Sambucus racemosa (red elderberry)

On seepy portions:

Acid seepage indicators:
Drosera rotundifolia (round-leaved sundew)
Houstonia caerulea (little bluet)
Viola spp. (violets)
Circaea alpina (small enchanter's-nightshade)

Subacid to circumneutral seepage indicators:
Vascular plants
Trichophorum alpinum (alpine clubsedge)
Pinguicula vulgaris (violet butterwort)*
Woodsia glabella (smooth cliff fern)*

Bryophytes
Preissia quadrata (liverwort)*
Mnium thomsonii (moss)*
Cryptomnium hymenophylloides (moss)*
Conocephalum conicum (liverwort)

• Northern hardwood - conifer forest system

Landscape settings: mountains, high hills, and mountain valleys

Soils: loose and firm glacial till, glacio-fluvial soils (e.g., river and kame terraces, outwash), stabilized talus

Spatial pattern: matrix (<10–1,000+ acres); irregular and linear zonation of component communities

Physiognomy: forest

Distribution: 1,400–2,500 ft. elevation in northern NH and along the western highlands; occasionally found down to about 1,000 ft. elevation in cool, mesic settings

Description: New Hampshire's northern hardwood forests are characterized by *Fagus grandifolia* (American beech), *Acer saccharum* (sugar maple), and *Betula alleghaniensis* (yellow birch). These northern hardwood forests are positioned latitudinally and elevationally between the high-elevation spruce - fir forest and hemlock - hardwood - pine forest systems. Northern hardwood forests are generally found between 1,400–2,500 ft. in elevation in northern NH and along the western highlands (Sunapee Uplands subsection), although the tolerance range of individual species varies. Some occurrences can be found down to about 1,000 ft. elevation.

The upslope ecotone to spruce - fir forest is marked by the appearance of *Picea rubens* (red spruce), *Abies balsamea* (balsam fir), the increased importance of yellow birch, and the disappearance of sugar maple and beech; the downslope ecotone to the hemlock - hardwood - pine forest system is marked by the appearance of more *Tsuga canadensis* (hemlock) along with *Quercus rubra* (red oak), *Pinus strobus* (white pine), and occasionally *Ostrya virginiana* (ironwood) and decreased dominance of yellow birch and sugar maple.

The matrix forest community type of this system, ***sugar maple - beech - yellow birch forest***, mixes with patches of several other communities. ***Hemlock - oak - northern hardwood forests*** occur at lower elevations (800–2,000 ft.) and are differentiated from the matrix community by a substantial presence of hemlock. They occur in valley bottoms and lower mountain slopes of the White Mountains, and middle to higher elevations of hills and low mountains of the Sunapee Uplands subsection of western New Hampshire. ***Hemlock - spruce - northern hardwood forests*** are also found at elevations below 2,000 ft. This is a conifer to mixed community type with considerable hemlock and spruce mixing with variable amounts of birches, other northern hardwoods, balsam fir, and sometimes white pine. It occurs primarily on river terraces, stream ravines, and compact till settings in the mountains where it transitions to more pure northern hardwoods on richer soils (e.g., fine tills). ***Semi-rich mesic sugar maple forests*** are a common but relatively small part of the mosaic formed by this system where there is slightly enriched till or fine river terrace sediments. Both ***beech forest*** and ***hemlock forest*** types are occasional in this and the hemlock- hardwood - pine forest systems, but generally form relatively small patches. ***Northern hardwood - spruce - fir forests*** mark the transition to the high-elevation spruce - fir forest system, but in most cases are considered part of the northern hardwood - conifer forest system because the hardwood trees that disappear in ***high-elevation spruce - fir forest*** (due to climate and/or soil conditions) are still present. Some spruce - fir or mixed forests that have been cut or heavily disturbed may currently support a hardwood or mixed forest canopy, and may or may not succeed to greater spruce - fir prominence.

Diagnostic natural communities:

- Northern hardwood - spruce - fir forest (S4)
- Sugar maple - beech - yellow birch forest (S5) – matrix forest type
- Hemlock - spruce - northern hardwood forest (S3S4)
- Hemlock - oak - northern hardwood forest (S4)
- Semi-rich mesic sugar maple forest (S3S4)

Peripheral or occasional natural communities:

- Beech forest (S4)
- Hemlock forest (S4)
- Northern white cedar forest/woodland (S1)

Associated natural community systems: Northern hardwood - conifer forest systems transition upslope to high-elevation spruce - fir forest systems. Downslope they transition to either 1) hemlock - hardwood - pine forest systems, especially in low elevation valleys of White Mountains and further south; or 2) lowland spruce - fir forest/swamp systems in the North Country and some valley bottoms in the White Mountains.

Characteristic species:

Characteristic species of the northern hardwood - conifer forest system:

Trees - hardwoods
Acer saccharum (sugar maple)
Fagus grandifolia (American beech)
Betula alleghaniensis (yellow birch)
Acer rubrum (red maple)
Betula papyrifera (paper birch)
Acer pensylvanicum (striped maple)
Prunus pensylvanica (pin cherry)
Fraxinus americana (white ash)

Trees - conifers
Tsuga canadensis (hemlock)
Abies balsamea (balsam fir)
Picea rubens (red spruce)
Pinus strobus (white pine) – infreq. at low elev.

Understory species absent or less frequent in communities of hemlock - hardwood - pine forest system:

Herbs and fern allies
Clintonia borealis (yellow bluebead-lily)
Huperzia lucidula (shining firmoss)
Dryopteris campyloptera (mountain wood fern)
Oxalis montana (northern wood sorrel)
Oclemena acuminata (sharp-toothed nodding-aster)
Streptopus lanceolatus (lance-leaved twistedstalk)

Shrubs & dwarf shrubs
Acer spicatum (mountain maple)
Viburnum lantanoides (hobblebush)
Chamaepericlymenum canadense (bunchberry)
Coptis trifolia (three-leaved goldthread)
Lonicera canadensis (American honeysuckle)
Polystichum braunii (Braun's holly fern)

Species common to communities of both systems:

Dryopteris intermedia (evergreen wood fern)
Aralia nudicaulis (wild sarsaparilla)
Lysimachia borealis (starflower)
Uvularia sessilifolia (sessile-leaved bellwort)
Epifagus virginiana (beech-drops)
Maianthemum canadense (Canada-mayflower)
Mitchella repens (partridge-berry)
Monotropa uniflora (one-flowered Indian-pipe)

Species infrequent in northern hardwood - conifer system (characteristic of hemlock - hardwood - pine forests):

Betula lenta (cherry birch)
Betula populifolia (gray birch)
Prunus serotina (black cherry)
Quercus rubra (red oak)
Hamamelis virginiana (American witch-hazel)
Gaultheria procumbens (eastern spicy-wintergreen)
Viburnum acerifolium (maple-leaved viburnum)

9.04 Appendix D : Soil Survey Descriptions

This data dictionary provides essential information about the soil attributes contained in the spreadsheet tables located on the NH NRCS web site http://www.nh.nrcs.usda.gov/Soil_Data/Soil_Data or the attribute table accompanying the NRCS soil spatial data distributed through GRANIT (NHSoilMaster.dbf). The description, units of measure and labeling of soil attributes conforms to the standards of the USDA National Cooperative Soil Survey (NCSS) and the National Soil Information System (NASIS). The data contained within the tables are consistent with, and are derived from, the NRCS National Soil Information System. The tables located on the NH NRCS web site reflect the official soil dataset for New Hampshire. They take precedence over any other source of soil information. The attribute information is specific for each survey area and reflects the most current level of understanding of soil properties and their behavioral characteristics. This data may not agree with previously published soil survey reports that represent historical records of our level of knowledge at the time of publication. Likewise, the attribute data that is provided in these tables are subject to change as the soil survey program continues to refine our ability to measure and interpret soil physical and chemical properties. It is the responsibility of the users of this information to adequately document when these attributes were retrieved for a specific purpose and that any land use decision made based on these attributes reflect the NCSS standards at that time. Because this data is subject to change, it is the user's responsibility to update their records as appropriate and not to rely on data previously downloaded from the NH NRCS web site or from the GRANIT web site.

9.04(a) Farmland classification

Farmland classification identifies map units as prime farmland, farmland of statewide importance, farmland of local importance, or unique farmland. It identifies the location and extent of the soils that are best suited to food, feed, fiber, forage, and oilseed crops. NRCS policy and procedures on prime and unique farmlands are published in the "Federal Register," Vol. 43, No. 21, January 31, 1978.

9.04(b) Forest soil group

NH Forest Soil Groups (NHFSGs) consist of map units that are similar in their potential for commercial forest products, their suitability for native tree growth, and their use and management. Considered in grouping the map units are depth to bedrock, texture, saturated hydraulic conductivity, available water capacity, drainage class, and slope. The grouping applies only to soils in the State of New Hampshire.

The NHFSGs have been developed to help land users and managers in New Hampshire evaluate the relative productivity of soils and to better understand patterns of plant succession and how soil and site interactions influence management decisions. The soils are assigned to one of five groups (IA, IB, IC, IIA, and IIB). Several map units in New Hampshire either vary so greatly or have such a limited potential for commercial forest products that they have not been assigned to an NHFSG (NC). Examples of NC map units are very poorly drained soils and soils at high elevations. The kinds of tree species generally growing in climax stands in each of the five NHFSGs vary from county to county. This information is available through local NRCS field offices.

IA—This group consists of very deep, loamy, moderately well drained or well drained soils. Generally, these soils are more fertile than other soils and have the most favorable soil moisture relationships.

IB—The soils in this group are generally sandy or loamy over sandy material and are slightly less fertile than group IA soils. Group IB soils are moderately well drained or well drained. Their soil moisture is adequate for good tree growth, but it may not be quite as abundant as that in group IA soils.

IC—The soils in this group are in areas of outwash sand and gravel. They are moderately well to excessively drained. Their soil moisture is adequate for good softwood growth but is limited for hardwoods.

IIA—This diverse group includes many of the same soils as those in groups IA and IB. The soils are separated into a unique group, however, because they have physical limitations that make forest management more difficult and costly, i.e., steep slopes, bedrock outcrops, erosive textures, surface boulders, and extreme rockiness.

IIB—The soils in this group are poorly drained. The seasonal high water table is generally within 12 inches of the surface. Productivity is generally less than that of soils in the other groups.

NC—The map units in this category either vary so greatly or have such a limited potential for commercial forest products that they have not been assigned to an NHFSG. Commonly, onsite visit would be required to evaluate the situation.

9.04(c) Hydric soils

This rating indicates the percentage of map units that meets the criteria for hydric soils. Map units are composed of one or more map unit components or soil types, each of which is rated as hydric soil or not hydric. Map units that are made up dominantly of hydric soils may have small areas of minor nonhydric components in the higher positions on the landform, and map units that are made up dominantly of nonhydric soils may have small areas of minor hydric components in the lower positions on the landform. Each map unit is rated based on its respective components and the percentage of each component within the map unit.

The thematic map is color coded based on the composition of hydric components. The five color classes are separated as 100 percent hydric components, 66 to 99 percent hydric components, 33 to 65 percent hydric components, 1 to 32 percent hydric components, and less than one percent hydric components.

In Web Soil Survey, the Summary by Map Unit table that is displayed below the map pane contains a column named 'Rating'. In this column the percentage of each map unit that is classified as hydric is displayed.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). Under natural conditions, these

soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

References:

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.

Soil Survey Staff. 2006. Keys to soil taxonomy. 10th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.

9.04(d) Gravel source

Gravel consists of natural aggregates (2 to 75 millimeters in diameter) suitable for commercial use with a minimum of processing. It is used in many kinds of construction. Specifications for each use vary widely. Only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of gravel are gradation of grain sizes (as indicated by the Unified classification of the soil), the thickness of suitable material, and the content of rock fragments. If the bottom layer of the soil contains gravel, the soil is considered a likely source regardless of thickness. The assumption is that the gravel layer below the depth of observation exceeds

the minimum thickness. The ratings are for the whole soil, from the surface to a depth of about 6 feet. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be gravel.

The soils are rated "good," "fair," or "poor" as potential sources of gravel. A rating of "good" or "fair" means that the source material is likely to be in or below the soil. The bottom layer and the thickest layer of the soils are assigned numerical ratings. These ratings indicate the likelihood that the layer is a source of gravel. The number 0.00 indicates that the layer is a poor source. The number 1.00 indicates that the layer is a good source. A number between 0.00 and 1.00 indicates the degree to which the layer is a likely source.

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

9.04(e) Sand source

Sand is a natural aggregate (0.05 millimeter to 2 millimeters in diameter) suitable for commercial use with a minimum of processing. It is used in many kinds of construction. Specifications for each use vary widely. Only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand are gradation of grain sizes (as indicated by the Unified classification of the soil), the thickness of suitable material, and the content of rock fragments. If the bottom layer of the soil contains sand, the soil is considered a likely source regardless of thickness. The assumption is that the sand layer below the depth of observation exceeds the minimum thickness. The ratings are for the whole soil, from the surface to a depth of about 6 feet.

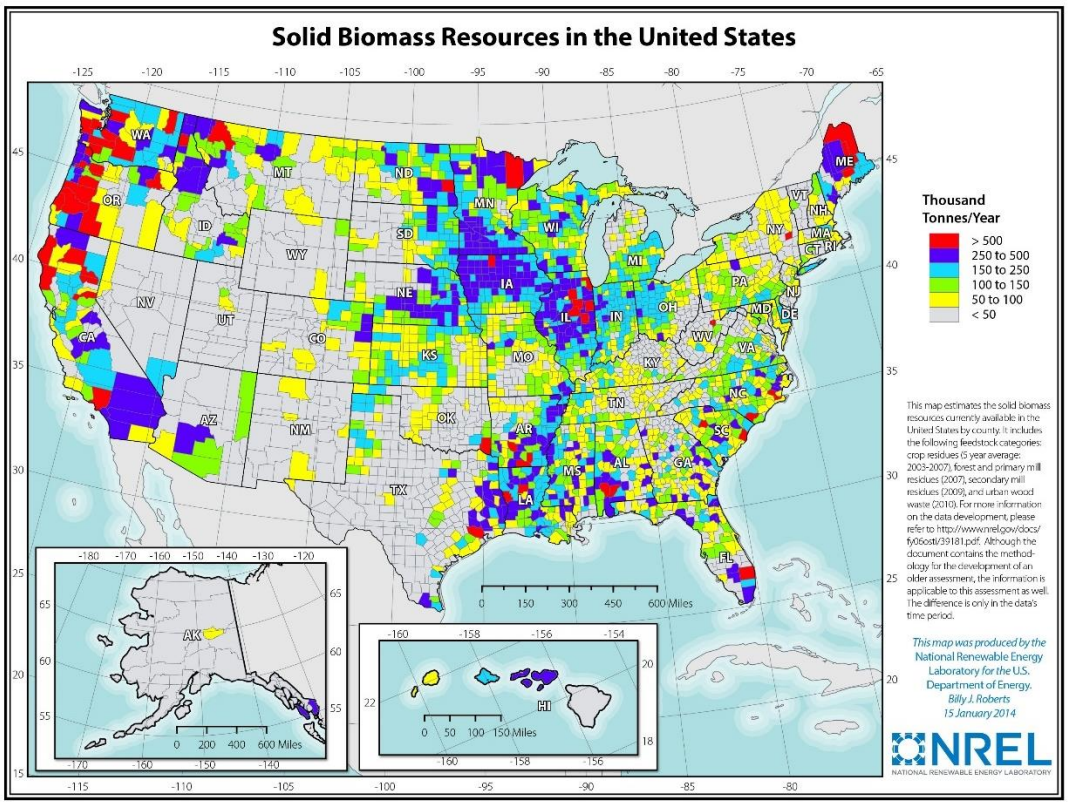
The soils are rated "good," "fair," or "poor" as potential sources of sand. A rating of "good" or "fair" means that sand is likely to be in or below the soil. The bottom layer and the thickest layer of the soil are assigned numerical ratings. These ratings indicate the likelihood that the layer is a source of sand. The number 0.00 indicates that the layer is a "poor source." The number 1.00 indicates that the layer is a "good source." A number between 0.00 and 1.00 indicates the degree to which the layer is a likely source.

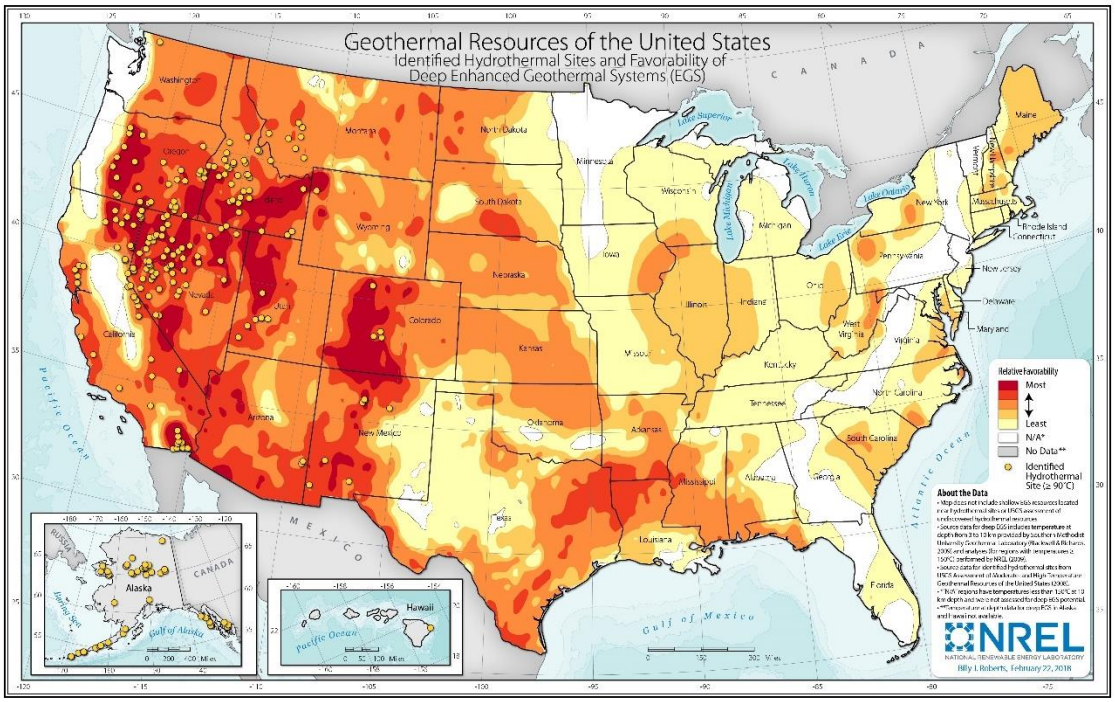
The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent

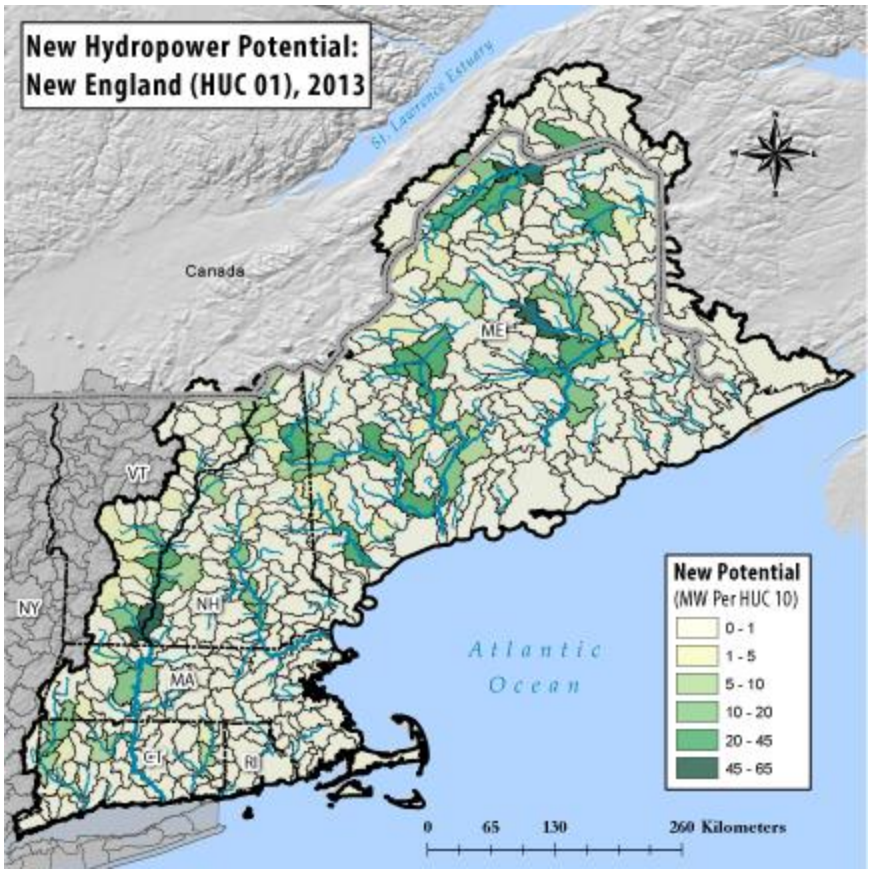
composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

9.05 Appendix E : Renewable Energy

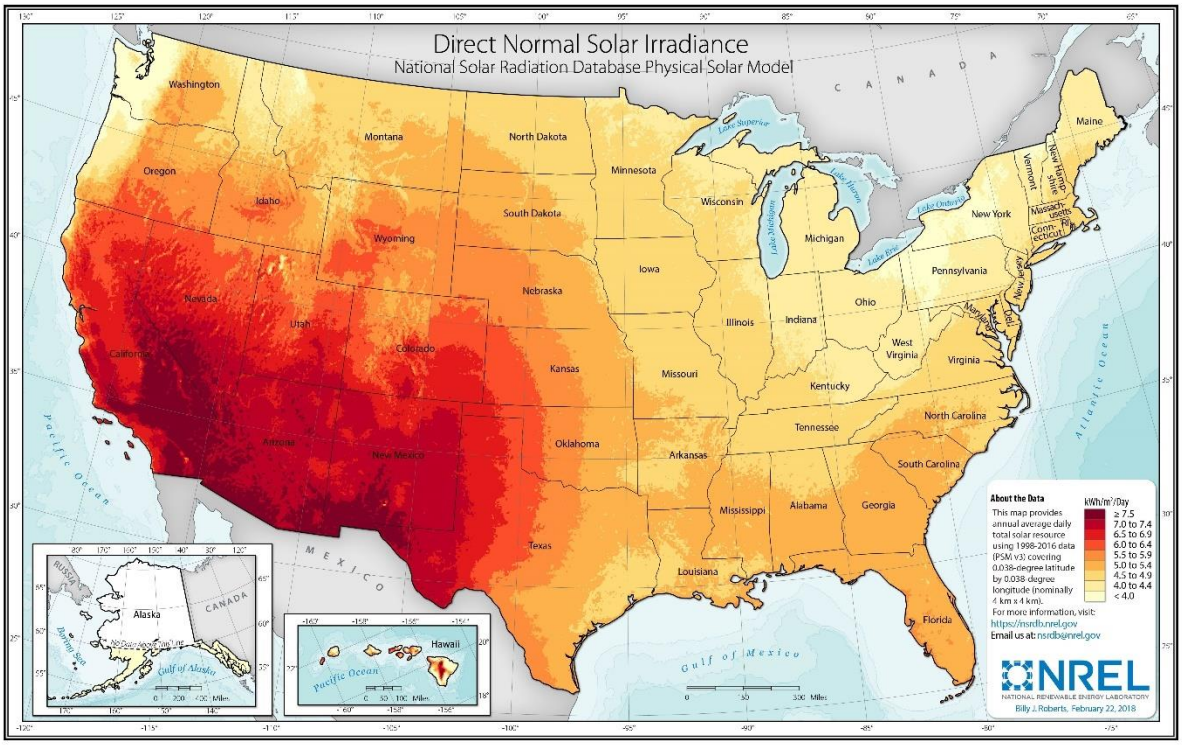


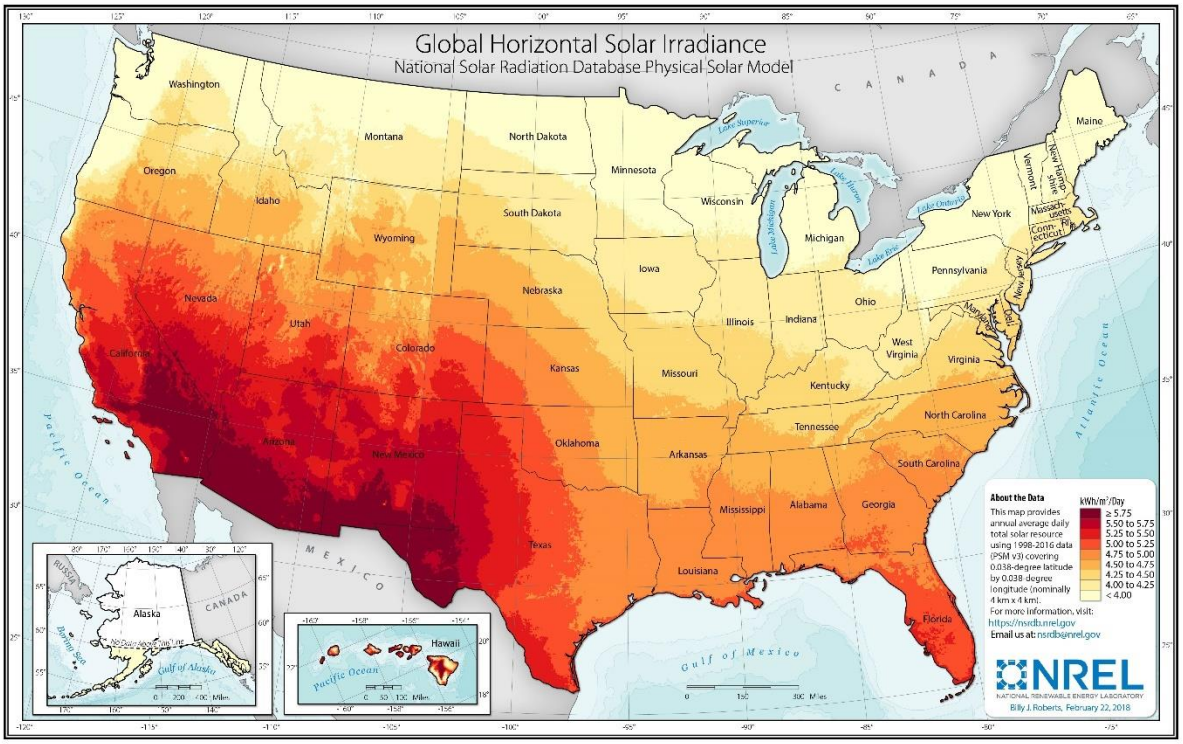




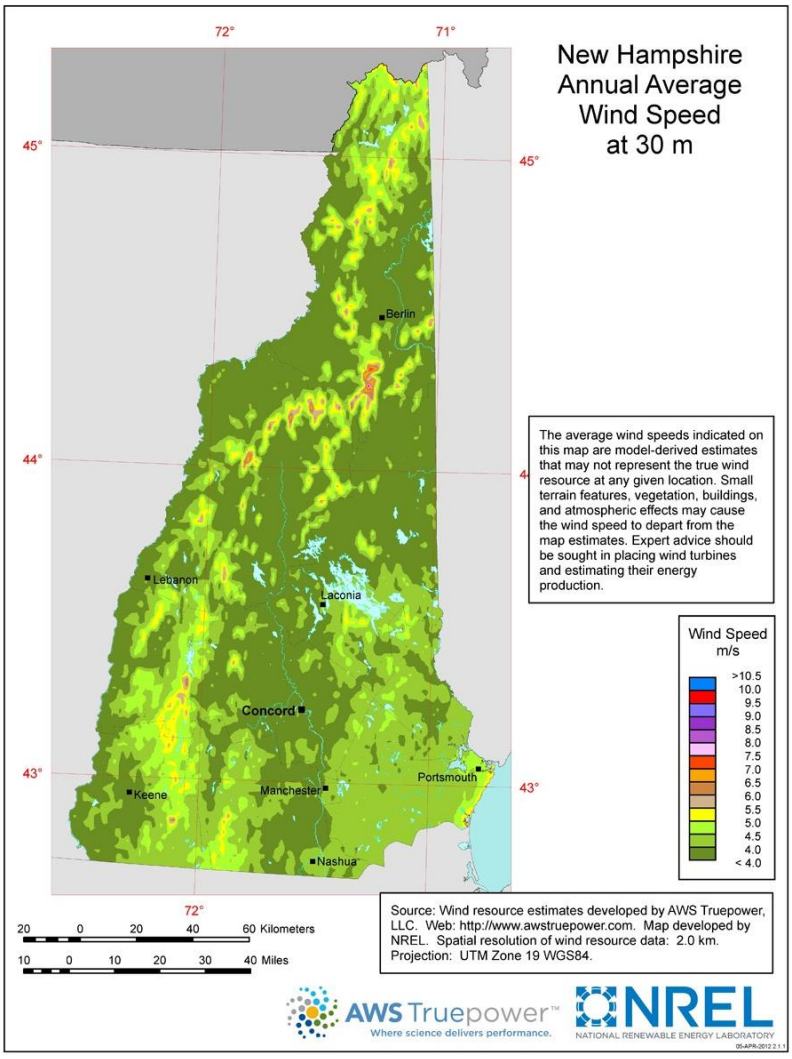
Source: Oak Ridge National Laboratory 2013

Hydropower Potential from New Stream-Reach Development for New England Region Dataset Overview. This dataset provides hydropower potential data (high-energy intensity stream-reaches and new potential areas for hydropower development) and environmental attributes in stream segments that do not currently have hydroelectric facilities in the New England Region 1 HUC. The data is aggregated to HUC10 watersheds.

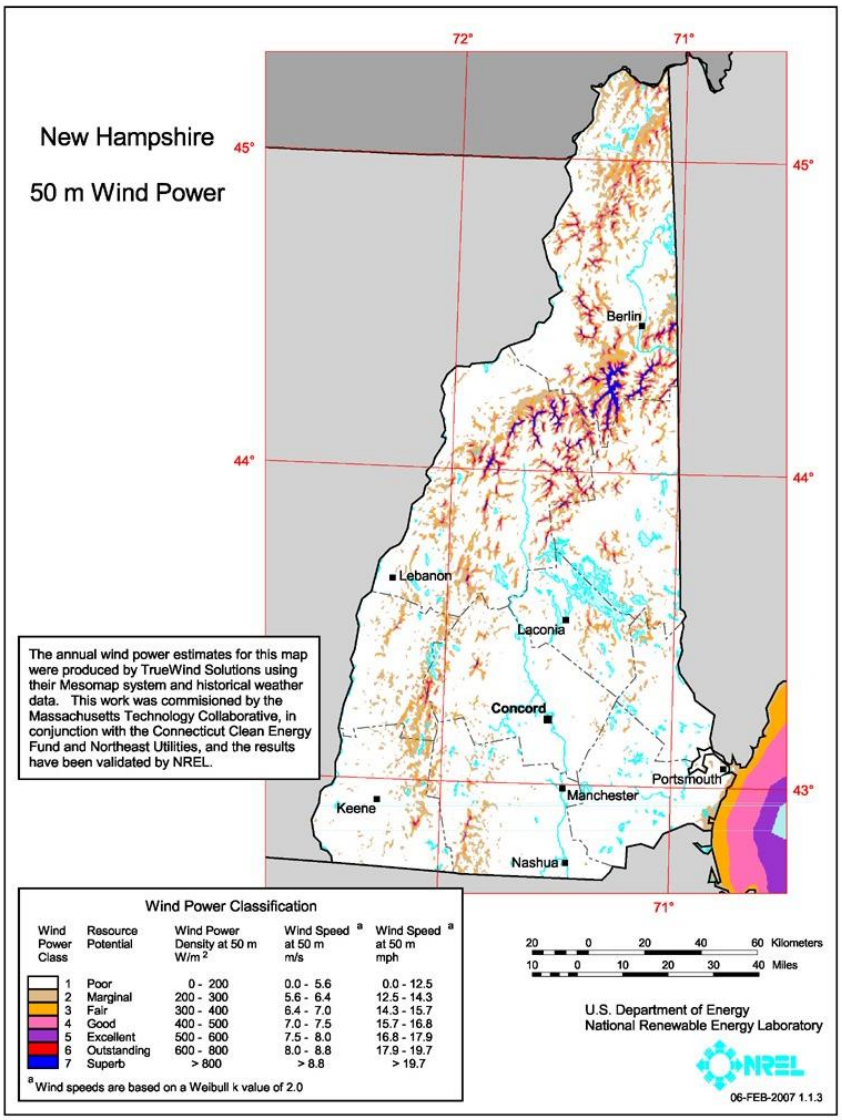

Direct Normal Solar Irradiance
National Solar Radiation Database Physical Solar Model
Washington
Oregon
California
Idaho
Nevada
Montana
Wyoming
Utah
Arizona
Colorado
New Mexico
North Dakota
South Dakota
Nebraska
Kansas
Oklahoma
Texas
Minnesota
Iowa
Missouri
Arkansas
Louisiana
Wisconsin
Illinois
Michigan
Indiana
Ohio
Kentucky
Tennessee
Mississippi
Alabama
Georgia
Florida
South Carolina
North Carolina
Virginia
West Virginia
Pennsylvania
New York
Maine
Vermont
New Hamp-shire
Massach-usetts
Con-necticut
Rhode Island
New Jersey
Delaware
Maryland
CANADA
MEXICO
Pacific Ocean
Atlantic Ocean
Gulf of Mexico
Alaska
Hawaii
About the Data
This map provides annual average daily total solar resource using 1998-2016 data (PSM v3) covering 0.038-degree latitude by 0.038 degree longitude (nominally 4 km x 4 km).
For more information, visit:
https://nsrdb.nrel.gov
Email us at: nsrdb@nrel.gov
kWh/m²/Day
≥ 7.5
7.0 to 7.4
6.5 to 6.9
6.0 to 6.4
5.5 to 5.9
5.0 to 5.4
4.5 to 4.9
4.0 to 4.4
< 4.0
NREL
NATIONAL RENEWABLE ENERGY LABORATORY
Billy J. Roberts, February 22, 2018


Global Horizontal Solar Irradiance
National Solar Radiation Database Physical Solar Model
Washington
Oregon
California
Idaho
Nevada
Montana
Wyoming
Utah
Arizona
Colorado
New Mexico
North Dakota
South Dakota
Nebraska
Kansas
Oklahoma
Texas
Minnesota
Iowa
Missouri
Arkansas
Louisiana
Wisconsin
Illinois
Michigan
Indiana
Ohio
Kentucky
Tennessee
Mississippi
Alabama
Georgia
Florida
South Carolina
North Carolina
Virginia
West Virginia
Pennsylvania
New York
Maine
Vermont
New Hamp-shire
Massach-usetts
Con-necticut
Rhode Island
New Jersey
Delaware
Maryland
CANADA
MEXICO
Pacific Ocean
Atlantic Ocean
Gulf of Mexico
Alaska
Hawaii
About the Data
This map provides annual average daily total solar resource using 1998-2016 data (PSM v3) covering 0.038-degree latitude by 0.038-degree longitude (nominally 4 km x 4 km).
For more information, visit:
https://nsrdb.nrel.gov
Email us at: nsrdb@nrel.gov
kWh/m²/Day
≥ 5.75
5.50 to 5.75
5.25 to 5.50
5.00 to 5.25
4.75 to 5.00
4.50 to 4.75
4.25 to 4.50
4.00 to 4.25
< 4.00
NREL
NATIONAL RENEWABLE ENERGY LABORATORY
Billy J. Roberts, February 22, 2018

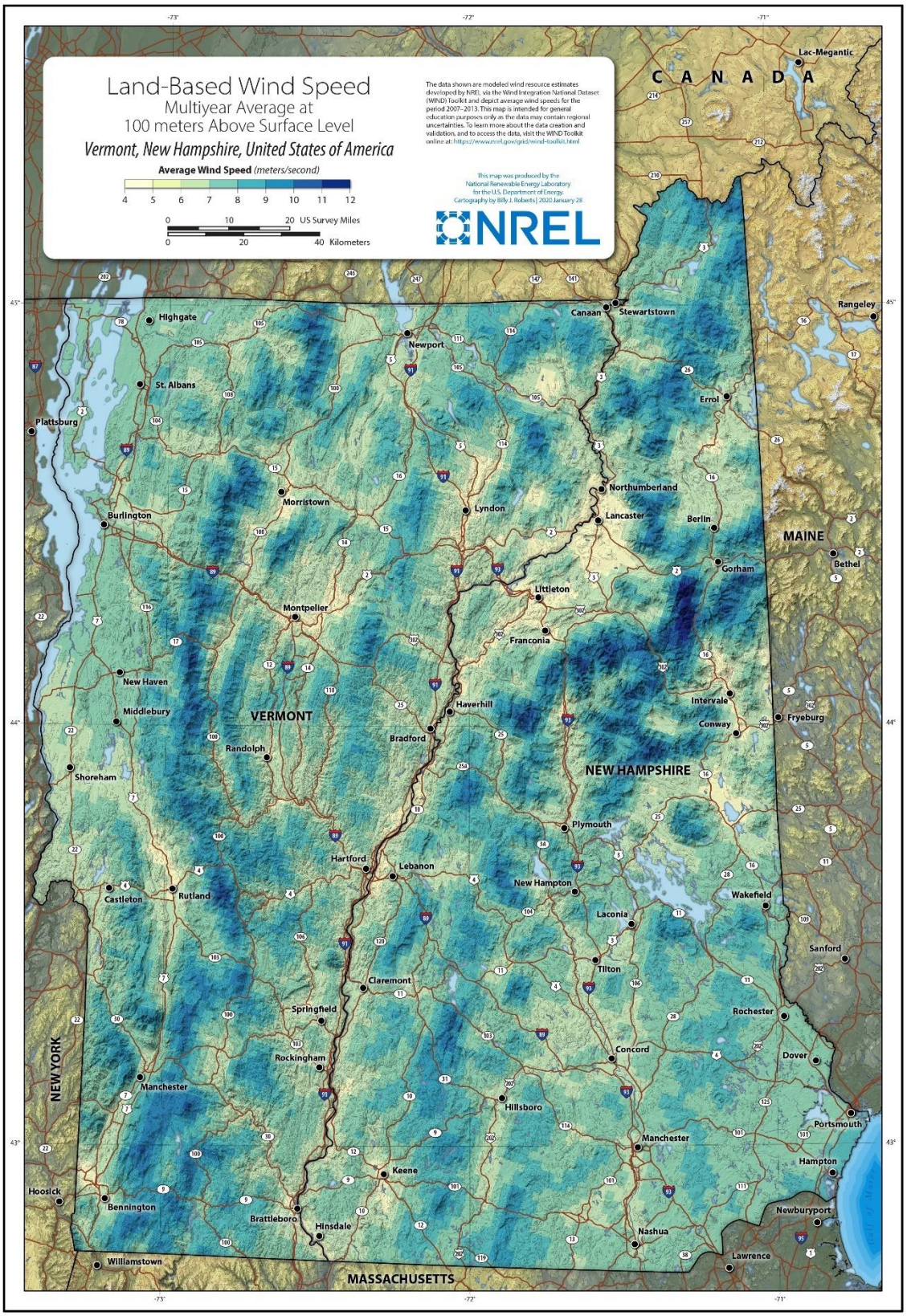
Wind Power Sources: National Renewable Energy Laboratory and AWS Truepower.



This map shows the predicted mean annual wind speeds at a 30-m height, presented at a spatial resolution of 2 kilometers that is interpolated to a finer scale. Areas with good exposure to prevailing winds and annual average wind speeds around 4 meters per second and greater at a 30-m height are generally considered to have a suitable wind resource for small wind projects. Small wind turbines are typically installed between 15 and 40 m high. Given the technological advancements in the wind industry, locations with lower wind speeds that may not have been suitable for wind development in the past may be suitable today or in the future. The average wind speeds indicated on this map are model-derived estimates that may not represent the true wind resource at any given location. Small terrain features, vegetation, buildings, and atmospheric effects may cause the wind speed to depart from the map estimates. Consumers should seek expert advice for siting wind turbines and estimating their energy production.



This resource map shows estimates of wind power density at 50 m above the ground and depicts the resource that could be used for community-scale wind development using wind turbines at 50-60-m hub heights. As a renewable resource, wind was classified according to wind power classes, which were based on wind speed frequency distributions and air density. These classes ranged from Class 1 (the lowest) to Class 7 (the highest). In general, at a 50-m height, wind power Class 4 or higher could have been useful for generating wind power with turbines in the 250-kW to 750-kW rating. Given the advances in technology, resources below Class 4 may now be suitable for the new midsize wind turbines. In recognition of these continuing advancements in wind energy technologies and the ability for the current generation of wind turbines to extract cost competitive wind energy from lower wind speeds the Energy Department has moved away from the wind power classification system and now reports wind speeds only.


Land-Based Wind Speed
Multiyear Average at
100 meters Above Surface Level
Vermont, New Hampshire, United States of America
Average Wind Speed (meters/second)
4 5 6 7 8 9 10 11 12
0 10 20 US Survey Miles
0 20 40 Kilometers
The data shown are modeled wind resource estimates developed by NREL via the Wind Integration National Dataset (WIND) Toolkit and depict average wind speeds for the period 2007–2013. This map is intended for general education purposes only as the data may contain regional uncertainties. To learn more about the data creation and validation, and to access the data, visit the WIND Toolkit online at: https://www.nrel.gov/grid/wind-toolkit.html
This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy.
Cartography by Billy J. Roberts | 2020 January 28
NREL
CANADA
VERMONT
NEW HAMPSHIRE
MAINE
NEW YORK
MASSACHUSETTS
Lac-Megantic
Canaan
Stewartstown
Rangeley
Highgate
Newport
St. Albans
Errol
Plattsburg
Northumberland
Morristown
Lyndon
Lancaster
Berlin
Burlington
Gorham
Bethel
Littleton
Montpelier
Franconia
New Haven
Middlebury
Haverhill
Intervale
Fryeburg
Conway
Bradford
Randolph
Shoreham
Plymouth
Hartford
Lebanon
New Hampton
Wakefield
Castleton
Rutland
Laconia
Sanford
Tilton
Claremont
Springfield
Rochester
Rockingham
Concord
Dover
Manchester
Hillsboro
Portsmouth
Manchester
Hampton
Keene
Hoosick
Bennington
Brattleboro
Hinsdale
Nashua
Newburyport
Williamstown
Lawrence
-73°
-72°
-71°
45°
44°
43°

9.06 Appendix F : Historic & Cultural Resources

9.06(a) Geological

(i) Mine, Quarried, Natural Rock Features

1. Indians Cave: Located on Keyser Hill

Indians' Cave is a natural cave formed by broken granite at the surface of the hill that have shifted to create this natural cave that forms the basis of a local legend from the 1860s or earlier. Legend has a native American man and woman sheltering at the cave after small pox wiped out their tribe, but they were also infected and died together in the cave. The cave first known as Hedgehog Den was renamed by a group of excursionists in 1878 who paid a local stone cutter to carve the name and date into the stone at the cave entrance.

2. Bears' Den: Located in Simpson Reserve

Bear's Den is a natural group of huge glacial erratic boulders that form a cave near Red Water Brook, accessed today by a hiking trail.

3. Pulcifer Rock: off Caldwell Lane

Pulcifer Rock is a glacial erratic, like the nearby Bear's Den rock cluster. It is consistently referenced in all the old deeds for the land within the triangle formed by Hells Corner Road, Rte 103-B (Edgemont Road) and Caldwell Lane.

4. Twin Willow Mica Mine: Located on Mica Mine Hill north of Trow Hill Road

Sunapee's only commercial mica mine was located at a deposit discovered in the early 1880s by John L. George (1839-1919) a local farmer and amateur mineralogist. Mine operations began in 1895 by men from Lempster when large pieces of mica were worth about 1/10 the price of gold. In 1896 mining rights were purchased by the Boston Mica Company that extracted mica from the spring to fall until about 1905.

5. Samuel Bailey Granite Quarry: Located off south side of Rolling Rock Road

Samuel Bailey (1792-1892) was Sunapee's early and best-known quarryman who operated a granite quarry from the 1830s into the 1860s at this location quarrying natural fissured surface rock with hand tools, first establishing Sunapee's long quarry history.

6. Boyce & Bailey Granite Quarry: Located off Burkehaven Hill Road

In 1884 Samuel Bailey (1792-1892) sold the rights to his 2nd major quarry, north of Rolling Rock Road to his grandson Murvin Bailey and neighbor Arland Boyce. This was Sunapee's largest quarry that produced a fine grain granite called Light Sunapee and Dark Sunapee, well suited for monuments and building use. The industry was aided by the arrival of the railroad in 1877. Blocks from this quarry were purportedly used for the Library of Congress building in Washington D.C. This quarry remained active until about 1910.

7. Stocker Granite Quarry: Located off Edgemont Road

This quarry is located on land that was once Samuel Bailey's land, now owned by William Stocker. He and his family quarry, cut, shape and polish granite for a variety of uses since the 1980s to present day.

(i) Burial Grounds & Burial Structures

1. Colby Burial Ground: Located on Stagecoach Road

Established in 1801 as the town's official burial ground on land of Joshua Gage, surrounded by a stone wall. Burials include several Revolutionary War veterans. This cemetery continues to be in use today.

2. Old Eastman Burial Ground: Located on North Road

Established in 1801 as the town's official burial ground on land of Elijah Eastman.

3. Cooper-Young Burial Ground: Located off Stagecoach Road

Established about 1808 on land of Cornelius Young, who was the first burial, and contains several Revolutionary War veteran graves. About _ were buried there, all lived in the local area of this cemetery, with the last in 1925.

4. Lower Village Burial Ground & Granite Tomb: located at Lower Main Street

Established about 1815 on land of Nathanial Perkins, where the North Meeting House was built in 1832. In 1868 the town had a granite holding tomb constructed at this cemetery. 1950 was the last burial here.

5. South Sunapee Cemetery: Located on Harding Hill Road

Established about 1822 on land owned by Thomas Pike, where the South Meeting House was built in 1833. Families from south Sunapee are buried here. This cemetery continues to be used today.

6. George's Mills Village Cemetery: Located on Main Street

Established in 1865 by Elbridge G. Chase (1815-1895) for residents of George's Mills. Graves are unusually laid-out to orient North-South with burials facing Lake Sunapee. This cemetery continues to be in use today.

7. Crowther Chapel & Burial Ground: Located on Stagecoach Road

Built in 1936 by Mary and Samuel Crowther on their property after the death of their young son John. This small stone chapel with a Tiffany window, is a quiet, reflective place in the forest on land once owned by Joshua Gage. The Crowther family graves are nearby. The Chapel is open Sundays in the summer to the public.

(ii) Early Settlement Roads & Stone Culverts / Bridges

1. Mill Road (stone culverts) laid-out 1769, at Webb Home Farm Forest, in use as Angell Brook Rd, Trask Brook Rd, Cross Rd, Brook Rd
2. Thurber Road, laid-out in 1772, in use as Stagecoach Rd, Winn Rd, North Rd to Springfield
3. Whipple Road to Croydon, laid-out in 1773, in use as Ryder Corner Rd
4. North Road, laid-out 1786, in use as Prospect Hill Rd, part of Otter Hill Rd
5. County Road, laid-out 1786, in use as Bradford Rd
6. Goshen Road, laid-out 1789, in use as Nutting Rd
7. Abandoned sections of the Georges Mills Road

(iii) Sugar River Railroad

1. Railroad bed built 1870-71 from Newbury to Newport; discontinued 1955.

2. Granite block trestle 1871, off Paradise Rd
3. Wendell Depot 1872, 52 Depot Rd (see buildings)

(iv) Stone Structures

1. Sugar River Railroad granite trestle

Built in 1870 with granite blocks provided by Augustus Trask and George Paul, probably from Samuel Bailey's granite quarry off Rolling Rock Road for the Sugar River Railroad formed in 1865 to build the section of track and stations between Bradford and Claremont. The line later became part of the concord & Claremont Railroad and then the B&M Railroad. Rail traffic began over the trestle in 1872 and continued to 1955.

(v) Stone Dams

1. Sugar River granite block dam: Located on River Road

Built circa1836 by the Sunapee Company, a consortium of businessmen, it is the oldest surviving dam on the Sugar River in Sunapee. Several mills on both sides of the river were powered by water held by this dam. The damaged top section was rebuilt.

2. Sugar River gristmill, tannery & pulp mill dam: Located by Hames Park, Main Street

First built in 1797 by millwright John Chase Jr for a mill pond to power a grist and sawmill, This dam was also used by a leather tannery and excelsior mill from the 1860s to 1890s. In 1888 the dam was refurbished for use by the new wood pulp mill and in 1925, refurbished again for use by the Lake Sunapee Power Company's new hydroelectric station penstock. Portions of this dam still exist.

3. Sugar River excelsior mill dam: Located north of Town Hall, Edgemont Road

The boulder dam was built in 1888 by Wm. Clinton Stocker of Sunapee for a new excelsior mill after selling is old mill to the wood pulp company. The excelsior mill operated until about 1898. In 1895 the Sunapee Electric Light Company, of Clinton Stocker and his nephew Arthur Stocker, located a turbine at the excelsior mill powered by water in the mill pond at this dam, and installed the first village street and house lighting.

4. Sugar River Smithville dam: Located off Abbott court

Boulder dam built in 1854 by John B. Smith (1818-1884) arguably Sunapee's most important machinist, inventor and industrialist, who founded Smith Machine Company in the lower village on the bank of the Sugar River where he built a wood shop, machine shop, and forge where his patented wooden clothes pin machines were manufactured for sale across the country. His mills burned down in 1871 but he rebuilt and in 1874 had perfected a grinding technique to make a perfect two-piece achromatic lens, then the standard for telescopes. John had become interested in astronomy and was one of very few men in America who had achieved this. John produced about 5 telescopes in Sunapee, quite an achievement. One telescope was 60" long, 4" diameter with a power from 80 to 400 diameters. His telescopes were purchased by the Cambridge Observatory and Grand Prairie College.

5. Sugar River George Sawmill Canal: Located off Lower Main St.

About 1840 Elijah George 2nd and his sons began construction of canal, about 370-ft long, averaging 6-ft deep and totalling about 644,000 cu ft of soil and rock dug and moved by hand on the south side of the Sugar River to flow water to a grist and sawmill that they built located south of the Lower Main Street bridge. The canal remained in use until 1887. It remains as a land form with stone walls and the remains of pulleys and shafts from the mill.

6. Sugar River Trow Sawmill dam: Located off Lower Main St

The second Willis Trow sawmill in the Lower Village, its dam and canal race were built in 1895 at the south side of the Sugar River. After damage to the dam from the Great Hurricane of 1938, a diesel engine provided power to run the mill instead of water power. The canal was filled in, but the portions of the stone dam remain. This sawmill continues to be operated by the 4th generation, Jeffrey Trow in 2022, a 127-year family history on this site. The Trow Sawmill is the last operating wood products mill in Sunapee.

7. Sugar River dam at Wendell Marsh

About 1800, Abiathar Young (1753-1827) built a dam that created Wendell Marsh to operate a sawmill at the south end of today's marsh. Operation of the sawmill continued after his death by his 4 sons until 1832 when the land was sold out of the family. In 1923 the Abiathar Young water flow rights and dam site were sold to Francis Murphy, who represented the newly formed Lake Sunapee Power Company. A new dam was built near the site of the old dam and nearly 1-mile of 6-ft diameter wooden penstock was built to power a 750-HP hydro-electric turbine located near Wendell Depot. This dam and hydro-electric facility operated until 1952. The dam remained in place and in 2014 was rebuilt to modern standards by the NH Fish and Game Department to maintain water levels in Wendell Marsh, a wildlife refuge.

8. Otter Pond dam at Otter Brook

In the late 1780s John Harvey built a mill at Otter Pond, sold to Ichabod Hearsee in 1791, and sold again in 1805 to miller Daniel George. The dam at Otter Pond has been maintained to this day. Daniel George and his descendants operated grist and sawmills on Otter Brook that flows from this dam into the 1890s. The village of Georges Mills was named for Daniel George.

9. Ledge Pond Brook dams

The stone dams on Ledge Pond Brook were built about 1810 by Caleb Mudgett and about 1840, probably by Wells Davis to create two mill ponds on Ledge Pond Brook for the operation of a sawmill on the brook at the north side of Perkins Pond Road. In 1849 the sawmill was owned by James Trow, who built a third dam at Ledge Pond. From James, 5 generations of the Trow family have operated sawmills in Sunapee and continue to do so in 2022. These stone dams exist in 2022 and two are protected in the MacWilliams Lot, conserved by Ausbon Sargent. The sawmill operated from about 1810 to the 1880s.

10. Angell Brook sawmill dam

This stone dam powered a sawmill, built bout 1795, by Joseph Chase on Angell Brook at the north side of Bradford Road. It was one of two sawmills in south Sunapee and the only dam remnants in this part of town to survive today.

(vi) Stone Walls

1. Range & Lot line stone walls (see stone wall mapper)
2. Farm yard & pasture stone walls
3. Granite bank walls at roads: High Street 1890, Central St 1948
4. Granite bank walls at river: Hames Works at High Street 1890, Main St at Rte.11 1909
5. Granite bank walls at lake: Sunapee Harbor 1890

(vii) Cellar holes and barn foundations

1. Wm McBritton house site at Webb Home Farm Forest
2. E. Young-Eleaser Sischo house site at Webb Home Farm Forest
3. Nathaniel Perkins house site c1800 at 279 Youngs Hill Rd

4. Joshua Freeto house site 1829, at Wendell Marsh
5. Francis Pingree c1794, Trow Hill Road
6. Sam Cilley-Josiah Conant farm house c1800, Dodge Pasture Rd
7. Theodore Davis farm house & barns c1828, Dodge Pasture Rd
8. James Eastman farm house c1834 Maurer Rd
9. Robert Emerson farm house c1800, Dodge Pasture Rd
10. David Perrin - Noyes farm house c1810, Dodge Pasture Rd
11. No. 6 Schoolhouse 1817 site of 741 North Rd
12. Joseph Pillsbury farm house c1795 off Main St Geo Mills
13. Jacob Evans-John Bartlett farm house & barn c1780, site of 800 North Rd

(viii) Significant Buildings

Type	Circa year	Description	Location	Type	Circa year	Description	Location
Farm	1780	Benjamin George farm house	101 Bradford Rd	Lighthouse	1892 rebuilt 1960	Loon Island Lighthouse	Lake Sunapee
	1780	Woodward farm house	Bradford Road		1909 rebuilt 19802	Burkehaven Lighthouse	Lake Sunapee
	1780s	Esek Young -John Angell farm house	45 Angell Brook Rd	Church	1859	Methodist Church parsonage	11 Lower Main St
	1789	Whittier Perkins farm house	175 North Road		1871	Methodist Church	9 Lower Main St
	1790	William Gage farm house	324 Stagecoach Rd		1897	Methodist Church	37 Prospect Hill Rd
	1790s	Abiathar Young farm house	183 Youngs Hill Rd		1898	St. James Episcopal Church	378 Lake Avenue
	1791 rebuilt 1881	Stephen Lang farm house	3 Messer Rd	Schoolhouse	1860	No. 5 Schoolhouse	85 Prospect Hill Road
	1790s	Daniel Moses - Merrill farm house & barns	144 Route 11		1867	No. 8 Schoolhouse	86 Lower Main St
	1790 altered 1931	Joshua Gage farm house & barns	258 Stagecoach Rd		1870	No. 7 Schoolhouse	77 Route 11
	1794	Abijah Emerson farm house	526 North Road		1877	No. 2 Schoolhouse	10 Schoolhouse Lane
	1795	Ichabod Heasee farm house	1279 Route 11		1877	No. 3 Schoolhouse	310 North Road
	1796	Esquire Woodward farm house	Keyes Road off Trow Hill Rd		1893	No. 1 Schoolhouse	48 Bradford Rd
	1798	Philbrick Huntoon farm house	77 Burkehaven Hill Rd	Store / Amenity	1815	Dane house general store	21 High St
	1798	Samuel George farm house	223 North Road		1826	Conant - Russell Store	4 Prospect Hill Rd
	1800	Job Clapp farm house	110 Brook Rd		1835	Cutting tavern house	77 Main St
	1800	James Young farm house	34 Stagecoach Rd		1843	Marble General Store	87 Lower Main St
	1800	Enoch Perkins farm house	140 Perkins Pond Rd		1850	Gardner Tavern	100 Lower Main St
	1800	Perkins farm house	140 Perkins Pond Rd		1851	Josiah Turner's general store	3 Alpine Court

Type	Circa year	Description	Location	Type	Circa year	Description	Location
	1800	Francis Smith farm house	511 North Road		1855	Hopkins Wallet Shop house	9 Central St
	1800	Samuel Patch farm house & barn	962 Route 11		1857	Tin Shop	2 Alpine Court
	1800	Hadley Muzzey farm house	1007 Main St Georges Mills		1870	Knowlton Block – IOOF Hall	41 Main St
	1802	Joseph Chase farm house	47 Harding Hill Rd		1872	Wendell Depot	52 Depot Rd
	1804	Thomas Pike farm house	28 Bradford Rd		1889	Hame Works Office	1 High St
	1805	Trask-Paul farm house	9 Youngs Hill Rd		1890	Flanders Livery-Museum	74 Main St
	1805	Enoch Harvey farm house	171 Burkehaven Hill Rd		1890	Harbor Hotel Livery	58 Main St
	1806	James Atwood farm house	218 Nutting Rd		1792	Philip Huntoon Stone House	100 Rolling Rock Rd
	1808	Asahel Dickinson farm house	66 Hells Corner Rd		1800	Jonathan Worster house	7 Alpine Court
	1808	Joshua Bartlett farm house	749 North Rd		1800	Moses Muzzey house	Route 11
	1809	John Currier farm house	26 Caldwell Lane		1800	Stone House	485 Edgemont Rd
	1810	Caleb Whitaker farm house	330 Nutting Rd		1823	Nathan Burpee - Russell house	1 Prospect Hill Rd
	1810	Jonathan Crowell farm house	143 Bradford Rd		1832	John Colby house	24 High St
	1810	Cornelius Young farm house & barn	207 Stagecoach Road		1840	Moses Muzzey house	7 North Rd
	1810	Samuel Gardner farm house	24 Fairway Drive		1844	Jesse Wilson house	110 Lower Main St
	1812	Amos Rowell-Levi Colby farm house	172 Sleeper Rd		1845	Amos George house	116 Lower Main St
	1812	Moses Eastman farm house	247 Prospect Hill Rd		1851	William Stevens house	55 Central St
	1815	Clapp farm house	59 Cross Rd		1854	John B. Smith house	25 Abbott Court
	1815	Abiathar Young Jr farm house	164 Lower Main St		1876	Robert C. Osgood cottage, Star Island, oldest surving lake cottage	
	1820s	Samuel Bailey farm barn	154 Edgemont Rd		1880	Pleasant Home - Conrad Manor	27 Prospect Hill Road
	1821	Ichabod Eastman farm house	12 Ryder Corner Rd	House	1906	Billy B Van estate house and barn	242 & 247 Prospect Hill Rd

Type	Circa year	Description	Location	Type	Circa year	Description	Location
	1822	Abial Cooper farm house	28 Old Granliden Rd	Farm	1830s	Ryder farm house	250 Perkins Pond Rd
	1824	William Trow farm house	16 Trow Hill Road		1832	Hackett farm house	199 Edgemont Rd
	1825	Ira Hurd farm house	270 Nutting Rd		1832	Abial Cooper farm house	79 Rolling Rock Rd
	1825	William Trow farm house	915 Route 11		1832	John Balch farm house	34 High St
	1825	Eliakim Putney farm house & barn	37 Meadow Brook Rd		1832	John Gardner farm house	15 Central St
	1825	Jacob Stickney farm house	60 Wayland Rd off Prospect Hill Rd		1835	Daniel George Jr. farm house	1282 Route 11
	1825	Elbridge Chase farm house & barns	79 Prospect Hill Rd		1840s	Gideon Angell farm barn	524 Stagecoach Road
	1828	Francis Pingree farm house	Woodham Springs Route 11		1840	Gardner farm barn	125 Burkehaven Hill Rd
	1830s	Elijah George farm barn	325 North Rd		1840s	Welcome Angell farm house & barns	171 Route 103
	1830	Oliver Young farm house	66 Stagecoach Rd		1847	Elias Abbott farm house	6 Prospect Hill Rd

9.06(c) Recreation

(i) Hiking & snowmobile trails

1. Ledge Pond Town Forest trails
2. MacWilliams Conservation Land trails
3. Class 6 - Dodge Pasture Rd, laid-out 1810, abandoned in 1930s.
4. Dewey Woods Town Forest 1928, hiking trails 2007 & 2011
5. Garnet Hill Park 1948, hiking trails 2011
6. Wendell Marsh Town Forest trails
7. Harbor River Walk 1997
8. Tilton Park aka Ski Tow Hill, 1938, Sun-Ragged-Kearsarge Greenway Trail
9. Frank Simpson Reserve 2004, Sun-Ragged-Kearsarge Greenway Trails
10. Webb Harrison lot trail 2006
11. Webb Home Farm Forest trails 1972
12. Abandoned railroad bed trail
13. Webb-Dane Lot trail 2006

(ii) Parks

1. Sunapee Harbor Park 1971, Bandstand 1996, Main St.
2. Sunapee Harbor Town Wharf 1944, Main St.
3. Coffin Park 1966, Harbor River Walk 1997, Fitness equipment 2020, Edgemont Rd
4. Tilton Park aka Ski Tow Hill 1938, Playground at Edgemont Rd
5. Hames Park 1998, 42 Main St
6. Osborne Reflecting Pool 1966, at High St bridge
7. Veterans' Park 1948, ball field, 567 Route 11
8. Dewey Beach 1936, Garnet St
9. Dewey Woods Ball Field 1973 & 1990
10. Georges Mills Beach & Town Wharf 1938, Cooper St

(iii) Water Body Access

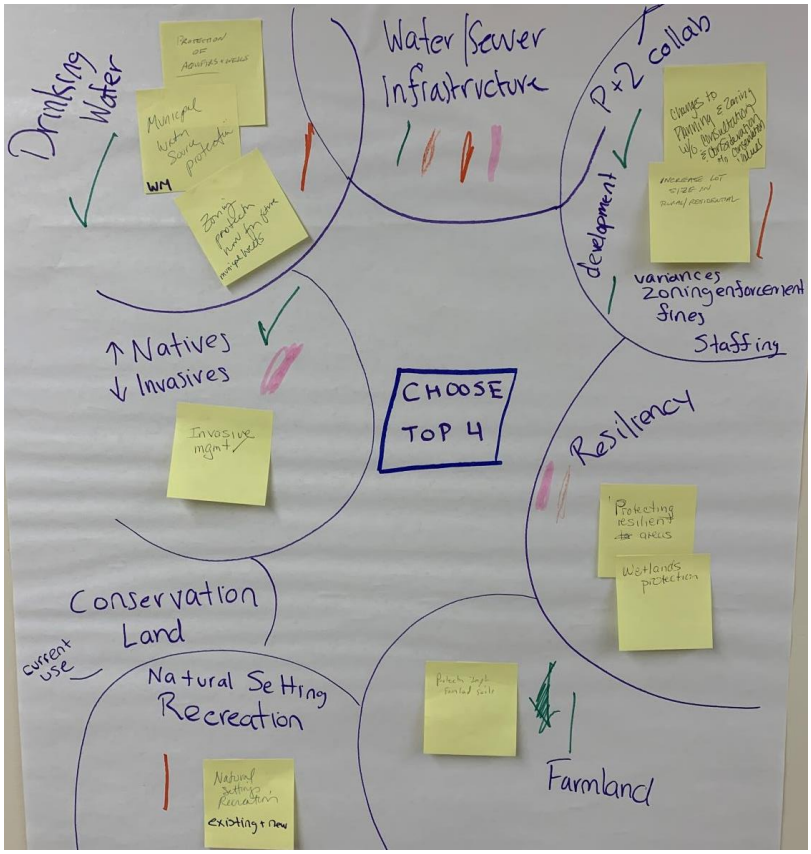
1. Sunapee Harbor town wharf and boat launch 1944, 83 Main St
2. Georges Mill town wharf and boat launch, Cooper St
3. Dewey Beach, 1936 Garnet St
4. Perkins Pond boat launch, Perkins Pond Rd
5. Ledge Pond, off Meadow Brook Rd
6. Sugar River at River Road
7. Sugar River at Coffin Park
8. Sugar River at Wendell Marsh

(iv) Scenic Vistas and Viewpoints

1. View to Corbin Park from Burkehaven Hill Road
2. View to Mt Sunapee from North Rd, Trow Hill Road
3. View of Sugar River from River Road
4. View to Mt Sunapee from Trask Brook Road
5. Views of Lake Sunapee from Harbor & Beaches
6. Note: Lake Sunapee Scenic & Cultural Byway: 103-B / Rte 101 / Rte 11 / Sun Harbor

9.07 Appendix G : Conservation Plan Process

At the regular meeting of the Sunapee Conservation Commission on November 11, 2022, project consultant (Upper Valley Lake Sunapee Regional Planning Commission) facilitated a prioritization exercise. Commission members were asked to provide their priority focus areas, focus topics, and specific actions for the conservation plan. Members were provided with Town maps and results of the co-occurrence analysis to inform their choices. The consultant than facilitated discussion with opportunity for members to describe their choices and for consensus on how similar items were grouped together. Once priorities were understood, members were asked to select those focus areas and focus topics of highest priority. Members who were not in attendance at the meeting shared their highest priorities via email based on those chosen during the meeting. This process resulted in the following:



Focus topics. Each heading indicates a group of priorities and discussion topics, further described under each bullet. The numerical value next to each heading reflects the number of SCC members who voted for this topic as a high priority.

- 5 - Water / sewer infrastructure
  - where expansion might occur
  - advance development where infrastructure available to reduce impact on natural resources
- 5 - Planning and zoning collaboration
  - Advance enforcement through available staffing
  - Reduce variance and increase predictability
  - Consider appropriate enforcement and use of fines
  - Increase lot size in rural residential
  - Ensure changes in planning/zoning include consultation with SCC and consideration of conservation values
- 4 - Protect resiliency zones
  - Protect resilient areas
  - Wetlands protection
- 4 - Protect drinking water sources
  - Municipal water source protection
  - Zoning protection for future wells

    - Protection of aquifers
- 3 - Invasives management
    - Unsure where to start, not much information available outside of the efforts by LSPA
    - Keep scenic vista sight lines clear from invasive species disturbance.
    - Flip side is to advance native plants and species.
- 3 - Preserve farmland and important farmland soils
- 2 - Advance natural settings recreation
    - Support existing and new places

Focus areas. Each heading indicates a group of priority areas, further described under each bullet. The numerical value next to each heading reflects the number of SCC members who voted for this topic as a high priority.

- 5 - South Sunapee south of Rte. 103 (connection to large Mt Sunapee tracts)
    - Concern for use of NH Highway garage at high co-occurrence area along Nutty Rd
    - Discussion of opportunity to connect with Q2C corridor just south
- 5 – Wellhead and drinking water supply protections
    - Wendell Marsh Well head protection area
    - Shoreland along Lake Sunapee protections, particular concern for homes not connected to public systems and septic that may fail, impacting WQ
    - Wellhead protection areas over all
- 5 - Red Water Creek to Mud Pond including Blueberry Mt southeast corner of town
- 4 - Identify preferred area for development and no development
- 4 - Ledge Pond / northwest corner of town (highest rated area on the draft co-occurrence map)
- 1 - Lower Sugar River

Specific actions. Each item listed below was identified as a specific action the SCC could take as part of the Conservation Plan. These items were not prioritized.

- Continue protecting large and small high value conservation lands
- Protecting large undeveloped land tracts
- Identify prime wetlands
- Zoning protection now for future municipal wells
- Enforcing existing regulations
- Integrating NRI into planning board decision making
- Protecting wildlife corridors
- No variances
- What can be done to further protect NW Sunapee?

Interviews. To inform the Conservation Plan, project consultant performed a series of interviews with the following individuals.

- Town Water and Sewer Department, Aaron Cartier.
- Town Recreation Department, Steve Bourque.
- Town Highway Department, Scott Hazelton.
- Town Planning and Zoning Department, Scott Hazelton and Michael Marquise.
- Lake Sunapee Protective Association, Geoff Lizotte.

9.08 Appendix H : Additional Resources

This Appendix contains the following information:

1. Private Well water testing & exceedance rates in Sunapee (2006-2020)
2. Quabbin to Cardigan Partnership, 2018 Regional Plan
3. Lake Sunapee Scenic and Cultural Byway brochure
4. Lake Sunapee Ice-Out dates according to the Sunapee Historical Society

New Hampshire

Health and Human Services Data Portal

NH DIVISION OF Public Health Services
Department of Health and Human Services

Private Well Water Quality: Town Summary

Sunapee: Private well water testing & exceedance rates by town (2006-2020) with associated county and state exceedance rates

Town	Contaminant	Health limit	Units	Number of wells tested by town	Percent of wells exceeding health limit by town	Percent of wells exceeding health limit by county	Percent of wells exceeding health limit in NH
Sunapee	Arsenic	5.0	µg/L	170	10.0	6.2	25.2
	Chloride	250.0	mg/L	188	2.7	1.1	2.9
	Copper (flushed)	1.3	mg/L	170	0.6	1.1	0.9
	Copper (stagnant)	1.3	mg/L	162	10.5	10.3	12.6
	Fluoride	4.0	mg/L	183	0.0	0.4	0.7
	Iron	0.3	mg/L	169	17.8	19.6	18.7
	Lead (flushed)	15.0	µg/L	172	0.6	1.4	1.8
	Lead (stagnant)	15.0	µg/L	163	19.0	14.9	14.0
	Manganese	0.3	mg/L	169	8.9	6.6	5.8
	Nitrate	10.0	mg/L	187	0.5	0.1	0.5
	Nitrite	1.0	mg/L	187	0.0	0.0	0.0
	Radon	2,000.0	pCi/L	92	77.2	59.4	50.1
	Sodium	20.0	mg/L	169	19.5	20.7	33.9
	Uranium	30.0	µg/L	178	15.7	7.0	4.2

- These data cannot predict whether individual wells are above or below a drinking water health limit for a given contaminant. Testing your well water is the only way to know what is in your water. These data are to inform well users of water quality trends found in tested wells in and around the town or county of interest. More information for testing and treating private well water: https://www.des.nh.gov/water/drinking-water/private-wells
- Towns with less than 20 wells tested have been excluded from this analysis as the number of tested wells are too low to support reliable estimates. These suppressed town level data are shaded grey in the map and indicated with an asterisk (*) in the chart. Years of private well testing data include 2006 - 2020.
- Maximum values were compared against health limits based on NH Maximum Contaminant Levels (MCLs), NH Ambient Groundwater Quality Standards (AGQS), USEPA MCLs, NH DES Recommended Action Levels, or Aesthetic Levels.

Q2C Regional Plan

Quabbin to Cardigan Partnership - 2018

The Quabbin-to-Cardigan Partnership Q2C

- Q2C Regional Boundary
- Core Conservation Focus Areas
- Connectivity Corridors
- Conservation & Public Lands
- Lakes & Reservoirs
- Rivers & Streams
- State Boundaries
- Town Boundaries
- Interstate Highways
- US & State Highways
- Local Roads

ABOUT

Launched in 2003, the Quabbin to Cardigan Partnership (Q2C) is a collaborative, landscape-scale effort to conserve the Monadnock Highlands of north-central Massachusetts and western New Hampshire. The two-state region spans one hundred miles from the Quabbin Reservoir northward to Mount Cardigan and the White Mountain National Forest, and is bounded to the east and west by the Merrimack and Connecticut River valleys. Encompassing approximately two million acres, the Quabbin to Cardigan region is one of the largest remaining areas of intact, interconnected, ecologically significant forest in central New England, and is a key headwater of the Merrimack and Connecticut Rivers.

The Quabbin to Cardigan Partnership is a collaborative effort of twenty-seven private organizations and public agencies working on land conservation in the two Q2C states. The Quabbin to Cardigan Partnership does not protect land directly, its member organizations do. Land is conserved strictly on a willing-seller basis through a combination of conservation easements and land acquisitions, managed by private landowners, conservation organizations, and public agencies. The Quabbin to Cardigan partners share a vision of consolidating the permanent protection of the region's most ecologically significant forest blocks, and key connections between them for wildlife movement and human recreation.

With the original plan completed in 2007, the Q2C strategic conservation plan was updated in 2018 using new natural resource data and an improved, science-based methodology. Newly released climate change resilience data from The Nature Conservancy was also incorporated into the updated plan. Quabbin to Cardigan partners also participated in a consensus-building process to update the "shared vision" for the Q2C region. The Q2C plan has identified approximately 750,000 acres of core conservation focus areas that represent the region's most ecologically significant forests. These conservation focus areas represent about 38% of the two million acre region. An additional 290,000 acres, or 15% of the region, has been identified as key connectivity corridors that buffer and link the core areas.

For more information: www.q2cpartnership.org

METHODOLOGY OVERVIEW

First, the Q2C partnership reviewed and affirmed the 2006 conservation planning goal and focus, as follows:

"To consolidate the permanent protection of the region's most ecologically significant forest blocks, and key connections between them for wildlife passage and human recreation."

Several natural resource features were evaluated to identify forest blocks with significant embedded ecological features, as follows:

- **Forest blocks** in three size classes: 250 to 500 acres, 500 to 1,000 acres, and blocks greater than 1,000 acres;
- **Water resources**, including riparian, shoreline, and wetland buffers; wetlands; floodplains; and, high-quality stream watersheds;
- **Wildlife habitat**, including state wildlife action plan habitat condition mapping for both New Hampshire and Massachusetts, as well as uncommon wildlife habitat types; and,
- **Climate change resilience**, using The Nature Conservancy's (TNC) prioritized diversity and connectivity data from 2016.

A GIS Advisory Team comprised of several knowledgeable staff drawn from various partnership organizations and agencies then assigned weighted values to the natural resource data layers, and a co-occurrence map was generated to determine areas within the Q2C region with high aggregate scores. A GIS-based "focal mean analysis" was then produced from the co-occurrence mapping with the goal of smoothing values across the region to aid in focus area identification. The top 40% of focal mean scores was selected as core conservation focus areas.

Connectivity was addressed by using the conservation focus areas as nodes between which connecting corridors were determined by "least cost" GIS processing using TNC landscape permeability data generated as part of the climate change resilience study released in 2018. The top 20% of corridor route scores were selected as having the highest probability of long-term functioning as regional wildlife movement patterns.

See the technical report at the link above for more detailed information.

Mt. Cardigan

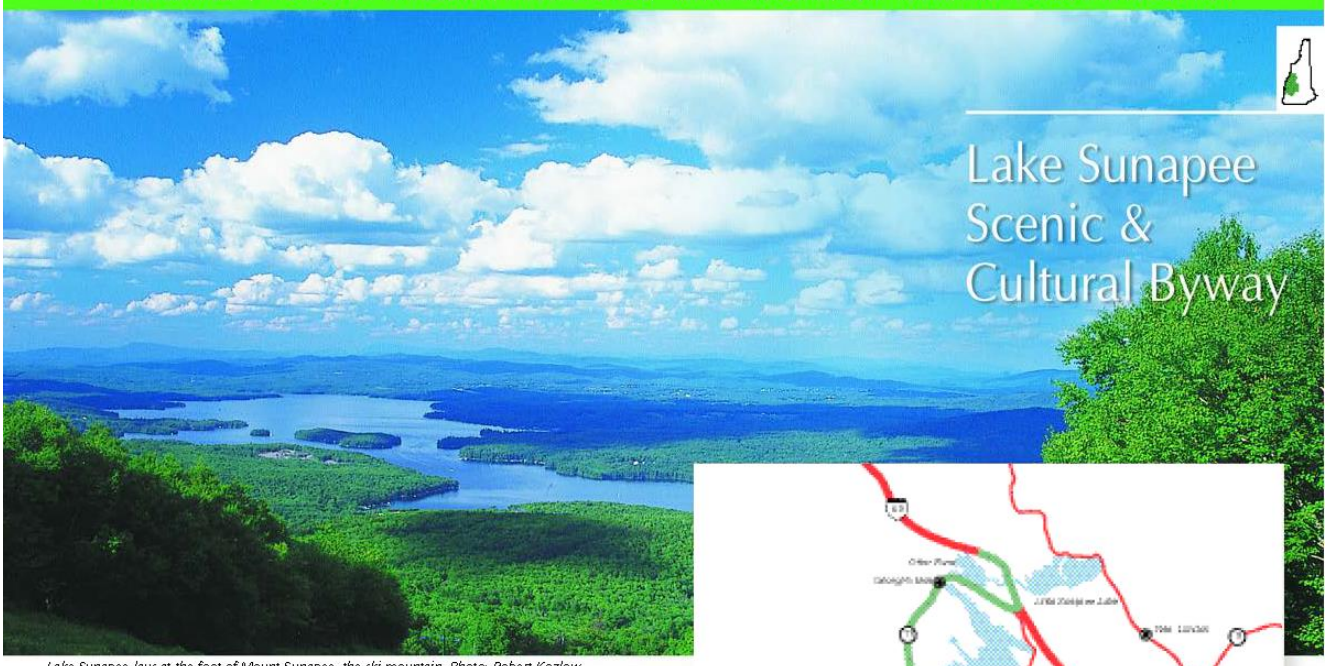
Quabbin Reservoir

0 5 10 20 Miles

Map Prepared by
GreenFire GIS
June 2018

DISTANCE: 25 MILES ♦ HIGHLIGHTS: STATE BEACH, WILDLIFE REFUGE, SCENIC SHORELINE, BOAT TOURS, AND YEAR-ROUND RECREATION

Lake Sunapee Scenic & Cultural Byway



Lake Sunapee lays at the foot of Mount Sunapee, the ski mountain. Photo: Robert Kozlow

This 25 mile route borders Lake Sunapee and is a slower paced and beautiful alternative to Interstate 89. Visitors and residents alike know that Lake Sunapee is a destination in itself. Year-round recreational opportunities abound, including boating, biking, swimming, snowmobiling, downhill and cross-country skiing, ice-boating and maple-sugaring. Local residents take pride in Lake Sunapee for its exceptional water quality and beauty. Protection efforts have enabled Lake Sunapee to consistently be named one of the cleanest lakes in the state.

Early European settlers were drawn to the Sunapee area's rich natural resources as were Native Americans, and tourism has been an important part of life in this area for over 100 years. Before the dawn of the automobile, guided steamboats met the trains at Newbury Harbor to deliver passengers and freight all around the 9-mile long lake. Today, the scene has changed, and where once there were grand hotels and boarding houses, now are year-round homes and summer cottages.

NEWBURY. Newbury has long been a popular summer vacation spot, and the population triples in the summer. Along this route, stop in at the new Bell Cove Caboose, a caboose renovated as a small interpretive center along the byway. Along NH 103 you might also want to stop off at Sunapee State Beach or at Mount Sunapee Resort, a popular ski and winter sports area. From the top of Mount Sunapee you can look westward into Vermont or look north toward the fabled Franconia Range, and on a clear day, view Mount Washington in the Presidential Range.

The Fells Historic Site at the John Hay National Wildlife Refuge is part of 876 protected acres of a forest country estate. This site along Route 103A includes perennial and woodland gardens, hiking trails and abundant wildlife. Escape for a while by stopping to enjoy the full richness of this beautiful area.

SUNAPEE. Sunapee Harbor, along Route 11, is the heart of the Sunapee region and is a great place to stop and take in the area's heritage, culture and natural beauty. Go for a walk on the "greenway" or take one of the guided boat tours offered on Lake Sunapee. Also visit the Sunapee Scenic Byway Information Booth on Route 11 for information about other activities in the area.

SPECIAL CONSIDERATIONS: Newbury's Bell Cove Caboose Information Center and the Sunapee Scenic Byway Information Booth are open seasonally from Memorial Day thru Columbus Day.

CONTACT: The Lake Sunapee Business Association, 800-258-3530. Town of Newbury www.town.newbury.nh.us or www.town.newbury.nh.us/act/bellcove.html

ICE OUT DATES FOR LAKE SUNAPEE

YEAR	DAY	YEAR	DAY	YEAR	DAY	YEAR	DAY	YEAR	DAY
1869	May 10	1902	Apr. 12	1935	Apr. 25	1968	Apr. 14	2001	May 4
1870	May 10	1903	Apr. 5	1936	Apr. 14	1969	Apr. 27	2002	Apr. 12
1871	Apr. 12	1904	May 1	1937	May 2	1970	May 1	2003	Apr. 27
1872	May 3	1905	Apr. 25	1938	Apr. 18	1971	May 6	2004	Apr. 18
1873	May 6	1906	Apr.29	1939	May 7	1972	May 9	2005	Apr. 19
1874	May 9	1907	May 1	1940	May 7	1973	Apr. 19	2006	Apr. 3
1875	May 12	1908	Apr. 26	1941	Apr. 18	1974	Apr. 20	2007	Apr. 24
1876	May 11	1909	Apr. 22	1942	Apr. 19	1975	May 5	2008	Apr. 23
1877	Apr. 25	1910	Apr. 6	1943	May 3	1976	Apr. 16	2009	Apr. 12
1878	Apr. 18	1911	May 2	1944	May 1	1977	Apr. 19	2010	Apr. 4
1879	May 12	1912	Apr. 26	1945	Apr. 1	1978	May 1	2011	Apr. 21
1880	Apr. 20	1913	Apr. 17	1946	Mar 29	1979	Apr. 28	2012	Mar. 22
1881	May 6	1914	May 1	1947	Apr. 27	1980	Apr. 20	2013	Apr. 18
1882	Apr. 29	1915	Apr. 20	1948	Apr. 9	1981	Apr. 9	2014	Apr. 23
1883	May 7	1916	May 1	1949	Apr. 6	1982	Apr. 28	2015	Apr. 25
1884	May 2	1917	May 7	1950	Apr. 26	1983	Apr. 16	2016	Mar. 18
1885	Apr. 30	1918	Apr. 26	1951	Apr. 20	1984	Apr. 21	2017	Apr. 16
1886	Apr. 24	1919	Apr. 14	1952	Apr. 20	1985	Apr. 16	2018	Apr. 29
1887	May 7	1920	Apr. 29	1953	Apr. 5	1986	Apr. 15	2019	Apr. 20
1888	May 14	1921	Mar. 29	1954	Apr. 16	1987	Apr. 13	2020	Apr. 3
1889	Apr. 20	1922	Apr. 6	1955	Apr. 22	1988	Apr. 16	2021	Apr. 9
1890	Apr. 26	1923	Apr. 27	1956	May 9	1989	Apr. 21	2022	Apr. 7
1891	Apr. 24	1924	Apr. 19	1957	Apr. 20	1990	Apr. 16	2023	
1892	Apr. 16	1925	Apr. 26	1958	Apr. 24	1991	Apr. 8	2024	
1893	May 13	1926	May 4	1959	Apr. 26	1992	Apr. 23	2025	
1894	Apr. 19	1927	Apr. 20	1960	Apr. 25	1993	Apr. 22	2026	
1895	Apr. 30	1928	Apr. 30	1961	May 3	1994	Apr. 20	2027	
1896	Apr. 28	1929	Apr. 14	1962	Apr. 26	1995	Apr. 14	2028	
1897	Apr. 29	1930	Apr. 17	1963	Apr. 21	1996	Apr. 21	2029	
1898	Apr. 18	1931	Apr. 16	1964	Apr. 28	1997	Apr. 24	2030	
1899	May 3	1932	Apr. 26	1965	Apr. 30	1998	Apr. 13	2031	
1900	Apr. 30	1933	Apr. 30	1966	Apr. 26	1999	Apr. 13	2032	
1901	Apr. 24	1934	Apr. 24	1967	Apr. 27	2000	Apr. 9	2033	

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