Natural Community Systems of New Hampshire

Daniel D. Sperduto

New Hampshire Natural Heritage Bureau

New Hampshire Natural Heritage Bureau

DRED – Division of Forests & Lands
PO Box 1856 – 172 Pembroke Road, Concord, NH 03302-1856
(603) 271-2214

The New Hampshire Natural Heritage Bureau is located within the NH Department of Resources and Economic Development's Division of Forests and Lands. Primarily an information resource, the bureau finds, tracks, and facilitates the protection of New Hampshire's rare plants and exemplary natural communities. It is not a regulatory agency; instead, the bureau works with landowners and land managers to help them protect New Hampshire's natural heritage and meet their land-use needs. Its mission, as mandated by the Native Plant Protection Act of 1987 (NH RSA 217-A), is to determine protective measures and requirements for the survival of native plant species in the state, to investigate the condition and rarity of plant species, and to distribute information regarding the condition and protection of these species and their habitats.

The New Hampshire Natural Heritage Bureau is an excellent source of information on plants and natural communities in New Hampshire, including their ecology and distribution in the state. It maintains the state's only comprehensive database of New Hampshire's exemplary natural communities, rare plants, and rare animals, including their known locations. Rare wildlife locations are maintained in cooperation with the Nongame and Endangered Wildlife Program at the New Hampshire Fish and Game Department, which has legal authority over all wildlife in the state. The bureau is also a member of the NatureServe network, which connects nearly 80 Natural Heritage Programs throughout the United States, Canada, and several Latin and South American countries.

On the web: http://www.nhdfl.org/about-forests-and-lands/bureaus/natural-heritage-bureau/

2nd edition, June 2011

(1st edition, December, 2005)

TABLE OF CONTENTS

LIST OF APPENDICES

ACKNOWLEDGEMENTS

Many thanks to Bill Nichols for his partnership in developing *Natural Communities of New Hampshire*, the detailed work that forms the basis of this system classification. Special thanks to Pete Bowman, Ben Kimball, and Bill Nichols for critical editorial and classification contributions in this second edition.

Other staff and former staff of the NH Natural Heritage Bureau contributed to this classification including Stephanie Neid, Chris Gaughan, Sara Cairns, Lionel Chute, Liz Harvey, Melissa Coppola, and Don Kent. The Nature Conservancy played a key role in the original creation of the natural community systems classification.

Thanks also to the staff at NatureServe and heritage programs involved in valuable discussions at workshops and in working groups on ecological system classification. NH Heritage is grateful to NH Fish and Game, U.S. Fish and Wildlife Service, and the Environmental Protection Agency Wetlands Protection - State Development Grant Program for providing funding for the initial classification work and development of this document. Thanks finally to Collis Adams and Ken Kettenring at the Department of Environmental Services for facilitating the EPA funding.

SUMMARY

Particular associations of natural communities repeatedly co-occur in the landscape and are linked by a common set of driving forces, such as landforms, flooding, soils, and nutrient regime. These are referred to as **natural community systems**. Systems are at an appropriate scale for many conservation applications, including ecological integrity assessments, mapping and predictive modeling, correspondence to wildlife and wildlife habitats, and as broad "coarse-filter" targets in conservation planning. They can be used as a tool to track locations and compare entire sites without having to refer to all communities at a site, particularly when these communities may intergrade and be difficult to map. They allow for the application of a more general classification when detailed information is not available or detailed surveys are not feasible. Systems can provide a more practical scale for conservation planning and site comparisons. Finally, systems can sometimes make more suitable mapping units than communities for integrating wildlife occurrence data and habitat needs with plant information, for example in the case of a kettle hole bog system that contains multiple peatland communities. The classification and mapping of exemplary natural community systems can therefore be effective at identifying high priority conservation targets.

Natural community systems may be a more appropriate level of vegetation classification for users that have relatively little experience with plants. When simply using the broad classes of communities and systems, such as floodplain forests, talus slopes, and rocky ridges, one can begin to grasp the diversity of landscape types that strongly influence vegetation. Such landscape categories can be found in the higher levels of this classification's table of contents.

System descriptions explain how natural communities are linked into larger units in the landscape, providing us with an understanding of natural community patterns at a different scale. For instance, there are five natural communities that are often found together on peaks above 4,900 ft. elevation in New Hampshire. Each individual community corresponds to a particular combination of exposure, substrate, wetness, and snow depth, but all five share the predominant influence of an extreme climate and short growing season. Collectively, these individual communities forms a larger "alpine tundra system." In this document, 45 natural community systems (18 upland and 27 wetland) are described for the state of New Hampshire. Diagnostic characteristics of each system include component natural communities, physical structure, ecological conditions, and geographic distribution.

INTRODUCTION

Natural communities are a valuable tool for understanding biological variation in the landscape. When used as conservation targets, natural communities serve as efficient "coarse filters" for protecting a broad array of species, including obscure species that are little-known or not readily identifiable. This coarse-filter approach to conservation has been a key motivation in the development of the current classification of 197 terrestrial, palustrine, and estuarine natural communities (Sperduto and Nichols 2011). In turn, this classification has been used by partners who have protected many ecologically significant sites in New Hampshire.

The development of this classification has also lead to some important observations about the differences in size and diversity among natural communities. Key among these is the observation that most of the landscape is covered by only a few "matrix" forming community types, while the majority of community types occur as small or large patches within the matrix. Further, certain patch communities tend to occur together in the landscape where similar conditions are found, forming a consistent pattern at a coarser scale.

These coarser scale units are called "natural community systems." Each natural community system is a collection of communities that are linked by a common set of underlying or driving physical features and conditions. These include landscape setting, environmental features (e.g., hydrology, soils, and nutrients), and ecological dynamics (e.g., fire and flooding). Natural community systems form cohesive and distinguishable units on the ground and recur in similar settings.

While natural communities are the primary units for understanding ecological patterns on the New Hampshire landscape, they can sometimes be difficult to use for conservation planning. Some community types occur as very small patches (<1 acre), and many types occur in complex mosaics with other communities, making mapping at the community scale difficult or impractical. In contrast, natural community systems have numerous practical applications for conservation practitioners, several of which are discussed below.

- **Practical scale for conservation.** Natural community systems are described at a practical scale for a wide range of conservation applications. Conservation planning and site prioritization at state and regional scales, ecological research and monitoring, and GIS mapping and modeling endeavors are all facilitated by using natural community systems as a complementary tool to natural community and species approaches. Natural community systems allow conservation targets (e.g., wetland sites) that consist of many communities (at times over a dozen types) to be classified as a single system. Systems also allow for comparisons among sites and focus attention on the key ecological features of each site. Finally, natural community systems facilitate ecological classification of sites, through interpretation of limited field data or predictive mapping, when detailed field data are not available or readily collected.
- **Understandable to a broad audience.** Natural community systems improve communication among a wide range of conservation practitioners. There are considerably fewer natural community systems than there are natural community types. In addition, the driving factors that link groups of communities are integrated into the concept and name of each system (e.g., montane talus, kettle hole bog, and high-gradient rocky riverbank systems). As such, a broad range of potential users, from botanists to landowners, have a common language of intuitive ecological units that describes New Hampshire's natural diversity. Natural community systems provide a "big picture" view of the biological landscape of the state and region.

- **Applicable to a broad region.** The New Hampshire natural community systems classification is widely applicable to other portions of the once-glaciated northeast and north-central North America. New Hampshire is at the interface of several major biogeographic regions (i.e., alpine, boreal, temperate, and coastal), and systems described from the state are broadly applicable or closely related to those from the Great Lakes to the Canadian Maritime region.
- **Links to wildlife habitats and plant and wildlife modeling.** Natural community systems have direct utility and applicability to wildlife and rare plant species conservation and management. Although natural communities are effective "coarse-filter" units for capturing many invertebrate species (e.g., insects, soil micro-fauna) and other obscure life forms, birds and mammals often have ranges or territories larger than the scale of individual communities. Thus, in some cases the best match of wildlife habitats are systems, rather than natural communities. The same can be said for relationships to rare plant species: some species occur in a broader range of conditions than are found in one community type and are better represented at the system scale. Systems are also described at a more appropriate scale for predictive range mapping for some rare wildlife and plant species. For example, the habitat description for the rare northern bog lemming (*Synaptomys borealis*) identifies conditions that might occur in 25 or more communities in New Hampshire. However, these habitat descriptors would correspond to only a few natural community systems. To predict the entire potential range of northern bog lemmings in the region, and possibly locate new occurrences, one could overly known populations with the known or probable range of these systems.
- **Compatibility with NatureServe's ecological systems.** NatureServe[1] has developed a classification of ecological systems that is applicable to all of North America. The New Hampshire Natural Heritage Bureau has developed a one-to-one cross-walk between these ecological systems and the natural community systems described in this document, which are more specific and relevant to conditions in New Hampshire. Using NatureServe's classification, The Nature Conservancy has created a map of ecological systems for the northeastern United States. This map has broad utility in modeling, research, and landscape analysis and is being used in the work of NH Fish & Game and others.
- **Evaluating conservation priorities.** Newly developed ecological integrity assessment methods (New Hampshire Natural Heritage Bureau & NatureServe 2011) are applied at the system scale, enabling comparisons and conservation prioritization among sites. Ranking natural community systems has practical value, since evaluating the quality of a site and identifying conservation and protection needs almost always requires thinking beyond the scale of an individual community.

Using the Natural Community System Classification

Users of this manual should note that there are important differences between natural communities and natural community systems. Some basic guidelines and assumptions about the definitions of systems and their application to mapping are described below.

- **The primary criterion for defining natural community systems is a pattern of co-occurring sets of communities in the landscape that are linked by common driving forces.** Two systems are

[1] NatureServe is an international network of natural heritage programs whose mission is to provide the scientific basis for effective conservation action.

indicated instead of one when the ecological conditions and driving forces are substantially different and corresponding sets of natural communities occur independently of one another. For example, riverbank systems are considered distinct from floodplain systems, in part because they can occur independently of one another and in part because there are substantial and well defined hydrological and community composition differences between the two. The types of communities on a floodplain are not perfectly correlated with the types of communities in its adjacent riverbank (the two sets of communities can occur independently of one another), and some riverbanks have no adjacent floodplain. Community composition along river channels and riverbanks is distinct from that on adjacent floodplains because of differences in the frequency and intensity of flooding.

- **Natural community systems can contain a broad array of ecological conditions and vegetation structures.** This is particularly true in settings where gradients are steep and compressed into narrow zones (such as river or pond shores). This diversity of community types can also be found in other systems where a driving ecological factor is more significant than the structure of the individual community types (such as river dynamics for floodplain systems).
- **Individual natural communities have different levels of fidelity to natural community systems.** The natural communities that can be found in a system are listed according to two broad categories: those that are *diagnostic* and those that are *peripheral* or *occasional*. Diagnostic communities are restricted to or characteristic of a particular system. They may or may not occur in a particular example of a system, but the system is the primary one (or one of the few primary ones) in which the community occurs. Peripheral or occasional communities can occur within or adjacent to a system but are not present in most examples; among these, peripheral communities are those that tend to occur in ecotone areas adjacent to other systems.
- **For pragmatic reasons, delineations of natural community systems may contain inclusions of other systems, or natural communities that are more typical of other systems when** 1) the included systems or communities are small or marginal (ecotonal) to the primary system at a site; or 2) when the included system or community is so finely embedded or tessellated within the primary system as to make its delineation impractical. For instance, there is often a narrow zone of a medium level fen or marsh communities along the upland edge or open water borders of an otherwise poor level fen/bog system; or a narrow ring of black spruce peat swamp around large poor level fen/bogs. Whether a system is delineated as a separate system within a larger wetland complex will depend on: 1) its size and degree of embedded-ness (a practical consideration); and 2) its conservation significance (i.e., whether the example is large enough and in good enough condition to be exemplary in and of itself and therefore a conservation target of interest).

Note: Rare species (state endangered or threatened) listed in this document are followed by an asterisk (*).

Table 1. Natural Community Systems of New Hampshire: Terrestrial

Coarse Hydrologic Regime	Dominant Structure	Mineral Enrichment	Landscape	Substrate/ Landform	Elevation	System
Terrestrial (upland)	Open to Woodland	Low	Hills and Mountains	Summit/ridge	>4,900 ft. (-4,200)	**Alpine tundra system**
				Ravine	>4,200 ft.	**Alpine ravine/snowbank system**
				Summit/ridge	3,000 – 4,900'	**Subalpine heath - krummholz/rocky bald system**
				Cliff	>2,200 ft.	**Montane - subalpine cliff system**
				Outcrop/shallow bedrock	2,000 – 3,500 ft.	**Montane rocky ridge system**
				Talus/loose rock	>2,200 ft.	**Montane talus slope system**
				Ridge – cliff – talus	<2,200	**Temperate ridge - cliff - talus system**
			Lowlands/ Valley Bottom	Sand and gravel	<1,000 ft.	**Pitch pine sand plain system**
				Sand dune	<50 ft.	**Coastal sand dune system**
				Rocky shore	<15 ft.	**Maritime rocky shore system**
	Forest	Low to Moderate	Mountains	Loose and firm till	2,500 – 4,500 ft.	**High-elevation spruce - fir forest system**
			Mountains, high hills, and mountain valleys	Loose and firm till, glacio-fluvial	1,400 – 2,500 ft.	**Northern hardwood - conifer forest system**
			Mountain valleys and lowland flats	Firm till, glacio-fluvial	1,000 – 2,500 ft.	**Lowland spruce - fir forest/swamp system**
			High to low hills, mountain valleys, and lowland flats	Loose and firm till, glacio-fluvial	<1,500 ft.	**Hemlock - hardwood - pine forest system**
			Hills, valleys, and lowland flats	Loose and firm till, glacio-fluvial, marine silt/clay	<900 ft.	**Appalachian oak - pine forest system**
		Moderate to high	Concavities and lower slopes of hills and mountains	Mesic loose and firm till, glacio-fluvial	<2,600 ft.	**Rich mesic forest system**
			Hills and lower mountain slopes	Dry-mesic loose till, talus, or loose rock	500 – 2,000 ft.	**Rich temperate rocky woods system**
					<900 ft.	**Rich Appalachian oak rocky woods system**

Coarse Hydrologic Regime	Substrate	Dominant Structure	Mineral Enrichment	Hydrogeomorphic Setting & Water Source	System
Palustrine	Primarily Organic (peat & muck organic layer >16")	Open	Oligotrophic	Depressional, closed or near-closed, topogenous	**Alpine subalpine bog system**
					Kettle hole bog system
					Poor level fen/bog system
			Weakly - mod. minerotrophic	Depressional, open, topogenous/limnogenous	**Medium level fen system**
			Mod. - strongly minerotrophic	Sloping, open, soligenous	**Montane sloping fen system**
					Patterned fen system
					Calcareous sloping fen system
		Wooded	Oligotrophic	Depressional, near-closed, topogenous	**Black spruce peat swamp system**
					Coastal conifer peat swamp system
					Temperate peat swamp system
			Minerotrophic	Depressional, open, soligenous	**Mont./near-boreal minerotrophic peat swamp system**
	Primarily Mineral (organic layer <16")	Wooded	Minerotrophic	Depressional & sloping, open, topogenous/soligenous	**Temperate minerotrophic swamp system**
					Lowland spruce - fir forest/swamp system
				Sloping, open, soligenous	**Forest seep/seepage forest system**
		Open	Minerotrophic	Depressional, open, limnogenous	**Drainage marsh - shrub swamp system**
	Mineral - Sand & gravel	Open	Oligotrophic	Sand plain pond border, limnogenous/groundwater	**Sandy pond shore system**
				Depressional, closed, topogenous & groundwater or perched	**Sand plain basin marsh system**
Riparian	Mineral	Open	Oligotrophic to moderately minerotrophic	River channels and river banks	**Low-gradient silty-sandy riverbank system**
					Moderate-gradient sandy-cobbly riverbank system
					High-gradient rocky riverbank system
		Wooded	Minerotrophic	Floodplains	**Montane/near-boreal floodplain system**
					Major river silver maple floodplain system
					Temperate minor river floodplain system
Estuarine	Peat & Mineral	Open	Minerotrophic	Protected embayments, tidal rivers, intertidal	**Salt marsh system**
				Tidal rivers, intertidal	**Brackish riverbank marsh system**
				Isolated basin separated from ocean by cobble berm	Coastal salt pond marsh system
	Mineral			Exposed embayments, tidal rivers, intertidal	**Sparsely vegetated intertidal system**
				River channel, creek, and bay-bottoms, subtidal	**Subtidal system**

Water Source notes: topogenous = influenced by surface runoff; limnogenous = influenced by lake, pond, & stream water; soligenous = influenced by groundwater seepage.

CLASSIFICATION OF UPLAND NATURAL COMMUNITY SYSTEMS

OPEN TO WOODLAND SYSTEMS ON BEDROCK- OR SAND-CONTROLLED LANDSCAPES

ALPINE AND SUBALPINE HABITATS

Alpine and subalpine vegetation in New Hampshire is restricted to high-elevation peaks and ravines of the White Mountains, a few scattered high-elevation monadnocks in central and southern New Hampshire, and several cold microhabitats at lower elevations. The alpine zone above treeline is characterized by a severe climate. Communities here are dominated by low, mat-forming shrubs, sedges, rushes, grasses, mosses, and lichens. The vegetation is exposed to high winds, low temperatures, heavy cloud cover, fog, and high precipitation. These climatic stressors result in a short growing season. Vegetation here mostly occurs on well drained soils with low nutrient availability and high organic matter content. In New Hampshire, climatic treeline occurs at approximately 4,900 ft. elevation. However, alpine and subalpine systems can be found on ridges and summits at lower elevations due to local compensating factors such as exposure to wind, poor soil development, or recent fire history. Subalpine systems are intermediate between alpine tundra system and high elevation spruce - fir forest system; they are distinguished by open rocky balds and stunted spruce, fir, and birch trees (krummholz). These lower elevation areas are generally smaller and have communities with fewer alpine-restricted species. There are three primary systems for alpine and subalpine vegetation, corresponding to high alpine peaks, lower subalpine ridges and summits, and wet alpine ravines.

• Alpine tundra system

Landscape settings: exposed summits and ridges

Soils: shallow, mostly very acidic, well drained organic and/or coarse mineral material (sand, gravel, stone) over bedrock; patterned frost-action features are evident in places (rock rings, rock stripes, soil boils, and stone terraces resulting from differential movement of coarse and fine mineral material); also open talus and felsenmeer

Spatial pattern: small to large patches (5–1000+ acres), irregular zonation

Physiognomy: dwarf shrub, herbaceous, and sparsely vegetated communities with scattered krummholz (stunted trees < two meters tall)

Distribution: White Mountains

Description: The alpine tundra system is the primary system in the alpine zone, which is restricted to the higher peaks of the White Mountains. This system is dominated by classic ***sedge - rush - heath meadows***, ***felsenmeer barrens***, and other well drained natural communities that occupy most of the summits, ridges, and slopes above treeline (e.g., above 4,900 ft. and down to about 4,200 ft. on exposed ridges of a few higher peaks). It contrasts with alpine ravine/snowbank systems, which occur in the steep, wet, and snow-laden environments of our large, high-elevation ravines. Both of these systems contrast with the subalpine heath - krummholz/rocky bald system found on summits and ridges from 3,000–4,900

ft. Alpine/subalpine bog systems occur as relatively small but distinct peatland patches in some alpine and subalpine areas.

Five diagnostic natural communities comprise a high percentage of the area in this system: ***diapensia shrubland***, ***alpine heath snowbank***, ***Bigelow's sedge meadow***, ***sedge - rush - heath meadow***, and ***felsenmeer barren***. Within this mosaic, smaller patches of several other communities are found. ***Black spruce - balsam fir krummholz*** is common as a narrow band at the transition to spruce - fir forest and also occurs as small island patches above treeline. Small patches of ***alpine herbaceous snowbank/rill*** are also found in the mosaic, but the largest patches of that community occur in alpine ravine/snowbank systems.

There are about 70 species largely restricted to the alpine tundra system. The dominant plants of this system include dwarf alpine shrubs (bilberry, cranberry, and blueberry heaths, other dwarf shrubs) and alpine sedges and rushes. There are relatively few forbs. Nearly all of these plants are perennials. The alpine-restricted species found in the alpine tundra (examples listed below) are absent or present only in much-reduced abundance in the lower subalpine heath - krummholz/rocky bald system. Endemic or near-endemic species of alpine areas of northeastern North America include *Nabalus boottii* (Boott's rattlesnake-root)*, *Potentilla robbinsiana* (Robbin's cinquefoil)*, and *Geum peckii* (White Mountain avens)*.

In New Hampshire, alpine tundra systems are restricted to the Presidential Range (from Mt. Madison to Mt. Pierce), Franconia Ridge, and smaller but nonetheless substantial patches on Mt. Moosilauke, Mt. Guyot, Bondcliff, and South Twin Mtn.

Diagnostic natural communities:

- Diapensia shrubland (S1)
- Alpine heath snowbank (S1S2)
- Bigelow's sedge meadow (S1)
- Sedge - rush - heath meadow (S1)
- Felsenmeer barren (S2)

Peripheral or occasional natural communities:

- Black spruce - balsam fir krummholz (S2S3)
- Labrador tea heath - krummholz (S2)
- Montane landslide barren and thicket (S3S4)
- Alpine herbaceous snowbank/rill (S1)
- Moist alpine herb - heath meadow (S1)

Associated natural community systems: At lower elevations, the alpine tundra system most often transitions directly to high-elevation spruce - fir forest system, and occasionally to subalpine heath - krummholz/rocky bald system. A few occurrences of alpine/subalpine bog system are embedded in the alpine tundra system of the Presidential Range, but it is most commonly associated with subalpine heath - krummholz/rocky bald systems at slightly lower elevations.

Characteristic species:

Species largely restricted to the alpine tundra system:

Herbs

Carex bigelowii (Bigelow's sedge)*

Juncus trifidus (highland rush)

Anthoxanthum monticola (alpine sweet grass)*

Geum peckii (White Mountain avens)* - near endemic

Nabalus boottii (Boott's rattlesnake-root)* - northeastern endemic

Potentilla robbinsiana (Robbin's cinquefoil)* - endemic

Dwarf shrubs

Diapensia lapponica (diapensia)*

Salix uva-ursi (bearberry willow)*

Betula glandulosa (glandular birch)*

Betula minor (dwarf birch)*

Kalmia procumbens (alpine-azalea)*

Rhododendron lapponicum (Lapland rosebay)*

Phyllodoce caerulea (purple mountain-heath)*

• Alpine ravine/snowbank system

Landscape settings: high-elevation ravines, particularly those with distinct cirque headwalls

Soils: dry to wet, mostly acidic, somewhat poorly- to well-drained, shallow organic or organic-rich coarse mineral materials over rock; also bare talus and bedrock (outcrops, slabs, and cliffs); mixed mineral debris in landslide gullies and debris cones

Spatial pattern: small to large patch (50–300+ acres), irregular and vertical-linear zonation

Physiognomy: sparsely vegetated, dwarf shrubland, herbaceous, krummholz, and tall shrub thicket

Distribution: Presidential Range of the White Mountains

Description: Alpine ravine/snowbank systems are recognizable by the convergence of several characteristic natural communities in high alpine ravines. Alpine ravines have the largest occurrences and/or concentration of ***alpine herbaceous snowbank/rill*** and ***alpine ravine shrub thicket*** communities, along with sizable patches of ***black spruce - balsam fir krummholz*** and ***montane landslide barren and thicket*** natural communities. This system is most distinct in the major, high-elevation, cirque-like ravines with large snowpacks on the eastern side of the Presidential Range (Oakes Gulf, Tuckerman Ravine, Huntington Ravine, and Great Gulf). These ravines have a classic bowl-shaped cirque headwall rimmed by cliffs and rock slabs. The cliffs and slabs may be divided by landslide and avalanche gullies, with alpine rill streams running down the gullies. Sometime the ravines are choked with talus. ***Alpine herbaceous snowbank/rill*** communities are found along steep and wet rocky gullies, at the bases of headwalls, and on the wet brows of the ravine above the headwall. ***Alpine heath snowbanks*** occur where deep snow lingers late into the growing season, allowing plants more typical of lower elevations to survive in the alpine zone. ***High-elevation balsam fir forest*** can extend up from the ravine bottom and onto the side-slopes, becoming shorter and scrubbier as it transitions to krummholz, heath - krummholz, or other alpine/subalpine communities. A few ravines have ***subalpine cold-air talus shrublands*** at their base. In these communities, late-melting ice under huge boulders supports stunted *Picea mariana* (black spruce) and alpine plants well below treeline. Alpine ravine systems are less distinct in smaller and lower elevation ravines that have a higher proportion of ***black spruce - balsam fir krummholz*** and scrubby ***high-elevation balsam fir forest*** and smaller patches of the other diagnostic communities.

Species listed below are specific to snowbank, rill, ravine, or cliff habitats and thus are more frequent or abundant in this system than in the more well drained conditions of the alpine tundra system, although some are found in smaller isolated snowbank patches or along rills outside of ravine settings.

Diagnostic natural communities:

- Alpine herbaceous snowbank/rill (S1)
- Alpine ravine shrub thicket (S1S2)
- Black spruce - balsam fir krummholz (S2S3)
- Montane landslide barren and thicket (S3S4)
- Alpine heath snowbank (S1S2)
- Subalpine cold-air talus shrubland (S1)

Peripheral or occasional natural communities:

- Labrador tea heath - krummholz (S2)
- Subalpine sloping fen (S1)
- Moist alpine herb - heath meadow (S1)
- Sedge - rush - heath meadow (S1)

Associated natural community systems: This system transitions to alpine tundra on more well drained slopes and ridges above alpine ravines, and to high-elevation spruce - fir forest systems at lower elevations.

Characteristic species:

Plants abundant and concentrated in alpine ravine/snowbank systems
(snowbank, rill, ravine, and cliff habitats):

Shrubs

Alnus viridis ssp. *crispa* (green alder)
Vaccinium cespitosum (dwarf blueberry)*
Salix argyrocarpa (Labrador willow)*
Salix planifolia (tea-leaved willow)*
Spiraea alba var. *latifolia* (meadowsweet)

Herbs

Solidago macrophylla (large-leaved goldenrod)
Veratrum viride (American false hellebore)
Viola palustris (northern marsh violet)*
Arnica lanceolata (lance-leaved arnica)*
Oxyria digyna (mountain-sorrel)*
Epilobium hornemannii (Hornemann's willow-herb)*
Sibbaldia procumbens (sibbaldia)*
Saxifraga rivularis (alpine-brook saxifrage)*
Saxifraga cernua (nodding saxifrage)*
Saxifraga paniculata ssp. *neogaea* (white mountain saxifrage)*

• Subalpine heath - krummholz/rocky bald system

Landscape settings: exposed summits and ridges

Soils: dry to moist, mostly very acidic, well drained, shallow organic and/or coarse mineral soils (sand, gravel) over bedrock or talus, with frequent rock outcrop exposures

Spatial pattern: small to large patch (<5–200+ acres), irregular zonation

Physiognomy: sparsely vegetated to dwarf shrubland structure with patches of krummholz (stunted trees < two meters tall)

Distribution: White Mountains and high elevations to the south from about 3,000 to 4,900 ft. elevation

Description: This system occurs on summits and ridges from about 3,000 ft. to 4,900 ft. outside the Presidential Range and Franconia Ridge. It is characterized by one or, less frequently, both of the two heath - krummholz communities and sometimes ***subalpine dwarf shrublands*** in more exposed areas. A few peaks have extensive, sparsely-vegetated bedrock exposures classified as ***subalpine rocky balds***.

The two heath - krummholz communities that are diagnostic of this system contain bilberry, cranberry, and blueberry heaths joined by various mixtures of *Ledum groenlandicum* (Labrador tea) and *Kalmia angustifolia* (sheep laurel). Lichens are common and often abundant. Heath - krummholz communities occur as nearly pure dwarf shrublands (<10–15 cm tall) to mixtures of 20–60% krummholz. These communities usually have substantial rock, talus, gravel, or stone exposure (>25%). *Picea rubens* (red spruce) is among the krummholz-forming trees below 3,500 ft., and *Picea mariana* (black spruce) appears above 3,500 ft. *Betula cordifolia* (heart-leaved paper birch) and *Abies balsamea* (balsam fir) are found throughout. ***Sheep laurel - Labrador tea heath - krummholz*** occurs on peaks between 3,000 and 3,500 ft.; above this, sheep laurel, red spruce and other species drop out, marking the transition to ***Labrador tea heath - krummholz***. Typically, either one or the other of these heath - krummholz communities is present, probably due to the restricted elevation range of the subalpine area on any given peak.

More exposed areas of this system on rocky or gravelly substrate correspond to ***subalpine dwarf shrubland*** (above 3,400 ft.) or ***subalpine rocky bald*** (mostly <3,500 ft.) communities. Floristically, the ***subalpine dwarf shrubland*** is intermediate between heath - krummholz and ***sedge - rush - heath*** communities; it lacks the abundance of sheep laurel, Labrador tea, and krummholz patches found in heath - krummholz communities *and* has a lower abundance of *Carex bigelowii* (Bigelow's sedge)* and *Juncus trifidus* (highland rush) than found in the ***sedge - rush - heath*** community of higher elevations. It is essentially a subalpine analogue to ***sedge - rush - heath meadow*** and ***diapensia shrubland*** communities. It occurs in exposed settings with shallow or ephemeral snow cover. Vegetation is typically dwarfed (<20 cm in height) and dominated by *Empetrum* spp. (crowberries), subalpine *Vaccinium* species, and *Sibbaldiopsis tridentata* (three-toothed cinquefoil). Higher elevation alpine tundra and alpine ravine/snowbank species are absent or intermittent in this system (see list under alpine tundra system).

Diagnostic natural communities:

- Subalpine dwarf shrubland (S2)
- Black spruce - balsam fir krummholz (S2S3)

- Labrador tea heath - krummholz (S2)
- Sheep laurel - Labrador tea heath - krummholz (S2)
- Subalpine rocky bald (S2)

Peripheral or occasional natural communities:

- Diapensia shrubland (S1)
- Red spruce - heath - cinquefoil rocky ridge (S3S4)
- Montane heath woodland (S2)

Associated natural community systems: Most examples of this system occur at the tops of higher peaks outside of the Presidential Range and Franconia Ridge, and therefore do not transition to alpine tundra systems. At lower elevations this system often transitions to montane rocky ridge systems or high-elevation spruce - fir forest. In parts of the White Mountains, this system forms mosaics with alpine/subalpine bogs that have collectively been referred to as "heath balds" (Fahey 1976; Doyle 1987). These "heath balds" occur mostly below 4,000 ft. elevation on flat to gently sloping ridgetops of the Mahoosuc, Carter-Moriah, and Baldface Ranges, with a few smaller examples found in several other scattered locations.

Characteristic species:

Species characteristic of both heath – krummholz communities:

Krummholz trees (<2 m height)

Betula cordifolia (heart-leaved paper birch)
Abies balsamea (balsam fir)

Shrubs

Rhododendron groenlandicum (Labrador-tea)
Vaccinium uliginosum (alpine blueberry)
Vaccinium vitis-idaea ssp. *minus* (mountain cranberry)
Vaccinium angustifolium (lowbush blueberry)
Vaccinium myrtilloides (velvet-leaved blueberry)
Empetrum nigrum (black crowberry)
Empetrum atropurpureum (red crowberry)

Lichens

Cladina rangiferina
Cladina alpestris
Cetraria islandica

Species restricted to sheep laurel type:

Picea rubens (red spruce)
Kalmia angustifolia (sheep laurel)
Rhododendron canadense (rhodora)
Ilex mucronata (mountain holly)

Species restricted to Labrador tea type:

Picea mariana (black spruce)

Subalpine dwarf shrubland:

Shrubs

Vaccinium uliginosum (alpine blueberry)

Vaccinium vitis-idaea (mountain cranberry)

Vaccinium angustifolium (lowbush blueberry)

Sibbaldiopsis tridentata (three-toothed cinquefoil)

Empetrum nigrum (black crowberry)

Empetrum atropurpureum (red crowberry)

Rhododendron groenlandicum (Labrador-tea)

Diapensia lapponica (diapensia)* (>3500 ft.)

Herbs

Occasional species:

Carex bigelowii (Bigelow's sedge)*

Juncus trifidus (highland rush)

Solidago leiocarpa (Cutler's goldenrod)*

Lichens

Cladina rangiferina

Cetraria islandica

Subalpine rocky bald:

Shrubs

Rhododendron canadense (rhodora)

Ilex mucronata (mountain holly)

Kalmia angustifolia (sheep laurel)

Vaccinium uliginosum (alpine blueberry)

Vaccinium vitis-idaea (mountain cranberry)

Vaccinium angustifolium (lowbush blueberry)

Sibbaldiopsis tridentata (three-toothed cinquefoil)

Empetrum nigrum (black crowberry)

Empetrum atropurpureum (red crowberry)

Rhododendron groenlandicum (Labrador-tea)

Herbs

Minuartia groenlandica (mountain sandplant)

Juncus trifidus (highland rush)

Lichens

Cladina rangiferina

Cetraria islandica

• 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)

• Montane rocky ridge system

Landscape settings: outcrops and shallow-to-bedrock areas on ridges, summits, and steep side slopes

Soils: shallow, very acidic, organic and turfy mineral materials over bedrock

Spatial pattern: irregular and elliptically linear (along ridges) with frequent outcrops (<5 – 100+ acres); irregular zonation

Physiognomy: woodland and sparse woodlands with trees, short shrubs, and some herbs; sparsely vegetated outcrop openings are embedded at a finer scale

Distribution: mid-elevations (1,400 ft.–) 2,000–3,500 ft. (–3,900 ft.) in western and northern NH, most abundant in the White Mountains

Description: Montane rocky ridges occur on outcrops and shallow-to-bedrock ridges and summits at mid-elevations in New Hampshire. Most are dominated by some combination of *Picea rubens* (red spruce) and/or *Pinus resinosa* (red pine). Outcrops include cliff slabs, which are steep bedrock exposures of less than 65 degree slope. The majority of locations of this system occur between 2,000 and 3,500 ft. in elevation, but can range from 1,400 and 3,900 ft. if local conditions are suitable. These rocky ridges, summits, and slabs have a woodland to sparse woodland canopy structure (ranging from completely open patches to thin forest cover >60%), much open bedrock exposure, and one or more of the primary diagnostic communities that overlap in their elevation ranges. ***Red pine rocky ridges*** occur between 1,400–2,700 ft., ***red spruce - heath - cinquefoil rocky ridges*** from 1,700–3,000 ft., and ***montane heath woodlands*** above 2,500 ft. Many ridge, slab, and outcrop areas are characterized by some combination of these diagnostic communities depending on the elevation range or other ecological influences present at the site. Although many specific locations on the ground correspond definitively to one of these communities, ambiguous transition areas are also common, where the primary species mix in various combinations. ***Jack pine rocky ridge*** communities occur at a few sites in the White Mountains up to about 3,900 ft. elevation.

Small cliffs are found in some examples of this system. In contrast with montane rocky ridge systems, temperate ridge - cliff - talus systems occur at lower elevations away from the White Mtns (mostly <2,000 ft.) and are characterized by the presence of *Quercus rubra* (red oak) and, below 1,000 ft., Appalachian oaks and hickories. The temperate ridge - cliff - talus system also differs in the inclusion of a mixture of rocky ridge, cliff and talus communities.

Diagnostic natural communities:

- Red spruce - heath - cinquefoil rocky ridge (S3S4)
- Red pine rocky ridge (S2)
- Jack pine rocky ridge (S1)
- Montane heath woodland (S2)

Peripheral or occasional natural communities:

- Montane - subalpine acidic cliff (S4)

Associated natural community systems: Downslope, this system sometimes transitions to montane - subalpine cliff, montane talus slope, temperate ridge - cliff - talus, or rich temperate rocky woods systems. Upslope (when it exists), this system transitions to subalpine heath - krummholz/rocky bald, northern hardwood - conifer, or high-elevation spruce - fir - (northern hardwood) forest systems.

Characteristic species:

Trees

Picea rubens (red spruce)

Pinus resinosa (red pine)

Pinus banksiana (jack pine)

Abies balsamea (balsam fir)

Betula cordifolia (heart-leaved paper birch)

Sorbus americana (American mountain-ash)

Sorbus decora (showy mountain-ash)

Shrubs

Vaccinium myrtilloides (velvet-leaf blueberry)

Rhododendron canadense (rhodora)

Amelanchier bartramiana (mountain shadbush)

Sibbaldiopsis tridentata (three-toothed cinquefoil)

Herbs

Solidago simplex ssp. *randii* var. *monticola* (montane Rand's goldenrod)

Paronychia argyrocoma (silverling)*

Piptatherum canadense (Canada mountain-rice grass)*

Polygonum douglasii (Douglas' knotweed)*

Species common to both montane and temperate rocky ridges:

Vaccinium angustifolium (lowbush blueberry)

Deschampsia flexuosa (wavy hair grass)

Betula papyrifera (paper birch)

Maianthemum canadense (Canada-mayflower)

Kalmia angustifolia (sheep laurel)

Pteridium aquilinum ssp. *latiusculum* (bracken fern)

Gaultheria procumbens (eastern spicy-wintergreen)

• Montane talus slope system

Landscape settings: most common below cliffs on steep, mid- to lower-slope positions (concave or neutral slope); occasionally found in deep talus gorges or without a cliff

Soils: variable soils including no soil development on open talus; coarse to fine mineral colluvium accumulation among talus boulders or in gullies, often mixed with organic matter; with or without shallow organic layer development

Spatial pattern: small to large patches (<1 to hundreds of acres); variably shaped but often linear-elliptical along base of cliff

Physiognomy: woodlands, sparse woodlands, and open talus with trees, herbs, shrubs, bryophytes, and/or lichens

Distribution: mid to high elevations in the White Mtns (mostly above 2,200 ft., occasionally as low as 1,500 ft.)

Description: Montane talus slopes are found at mid to high elevations in the White Mountains and are characterized by spruce, fir, and various other northern species. This system tends to have an open woodland character, with frequent canopy gaps and lichen-dominated talus barren openings. Soil development is variable on these slopes, and moisture conditions range from dry to mesic. Larger examples have giant talus blocks at their base with late-melting ice that produces a cold, moist microclimate supporting alpine plants well below treeline. Most occurrences of this system are found above 2,200 ft. elevation, but occasionally found down to about 1,500 ft. This system includes a few lower elevation "talus gorges" such as Ice Gulch and Devil's Hopyard. Talus areas that are completely forested with no openings or woodland structure are likely to be better classified as rocky examples of ***sugar maple - beech - yellow birch forest***, ***high-elevation spruce - fir forest***, or ***northern hardwood - spruce - fir forest*** natural communities.

The most frequent community (***birch - mountain maple wooded talus***) in this system has a sparse canopy of birches (*Betula* spp.) and has a patchy understory of shrubs and herbs. ***Spruce - moss wooded talus*** forms on colder sites, such as north-facing slopes and gorges, and includes an overstory of conifers over dense carpets of bryophytes. ***Subalpine cold-air talus shrublands*** correspond to talus areas with large, ice-cooled boulders where the microclimate supports black and red spruce, heaths and evergreen shrubs, and lichen and mosses characteristic of alpine and montane habitats. Mosses and lichens are abundant but not well documented to the species level. Herbaceous species are notably sparse or absent. Little is specifically documented about the biota in ***montane lichen talus barrens***, but crustose, umbillicate, and foliose lichens are prominent.

Diagnostic natural communities:

- Birch - mountain maple wooded talus (S3)
- Spruce - moss wooded talus (S2S3)
- Subalpine cold-air talus shrubland (S1)

- Montane lichen talus barren (S3)
- Montane landslide barren and thicket (S3S4)

Associated natural community systems: Montane talus slopes are often, but not always, found below montane - subalpine cliff systems, and surrounded by either northern hardwood or high-elevation spruce - fir forest systems.

Characteristic species:

Birch - mountain maple wooded talus:

Trees and tall shrubs
Betula papyrifera (paper birch)
Betula cordifolia (heart-leaved paper birch)
Betula alleghaniensis (yellow birch)
Sorbus americana (American mountain-ash)
Sorbus decora (showy mountain-ash)
Acer spicatum (mountain maple)

Herbs, short shrubs, and vines
Polypodium virginianum (rock polypody)
Vaccinium angustifolium (lowbush blueberry)
Vaccinium myrtilloides (velvet-leaf blueberry)
Ribes glandulosum (skunk currant)
Deschampsia flexuosa (wavy hair grass)
Solidago simplex ssp. *randii* var. *monticola* (montane Rand's goldenrod)
Juncus trifidus (highland rush)
Parthenocissus quinquefolia (Virginia-creeper)
Fallopia cilinodis (fringed bindweed)

Spruce - moss wooded talus:

Trees:
Picea rubens (red spruce)
Abies balsamea (balsam fir)

Shrubs and herbs
Rhododendron groenlandicum (Labrador-tea)
Gaultheria hispidula (creeping spicy-wintergreen)
Vaccinium myrtilloides (velvet-leaf blueberry)
Oxalis montana (northern wood sorrel)
Clintonia borealis (yellow bluebead-lily)

Non-vascular
Mosses and liverworts abundant

Subalpine cold-air talus shrubland:

Dwarf shrubs
Rhododendron groenlandicum (Labrador-tea)
Kalmia angustifolia (sheep laurel)
Empetrum nigrum (black crowberry)
Empetrum atropurpureum (red crowberry)
Vaccinium vitis-idaea (mountain cranberry)
Vaccinium uliginosum (alpine blueberry)
Vaccinium myrtilloides (velvet-leaf blueberry)
Vaccinium angustifolium (lowbush blueberry)
Rhododendron canadense (rhodora)
Gaultheria hispidula (creeping spicy-wintergreen)

Non-vascular
Mosses and liverworts abundant Crustose, umbillicate, and foliose lichens abundant

• Temperate ridge - cliff - talus system

Landscape settings: steep slopes and ridges with exposed bedrock—outcrops, cliffs, and talus

Soils: variable soils; little to no soil development on open talus, cliffs, and rock outcrops; variable organic development or coarse to fine mineral soil colluvium among talus boulders or in gullies; mostly shallow, draughty, acidic soils on ridges and slopes

Spatial pattern: elliptical to irregularly linear along steep slope contours (1–50+ acres)

Physiognomy: mosaic of sparsely vegetated barrens on talus, cliffs and outcrops, and woodlands and sparse woodlands on talus and dry slopes

Distribution: Mostly below 2,200 ft. elevation, primarily in southern and central New Hampshire

Description: This system is found on steep slopes and adjacent rocky ridges at elevations below 2200 ft., primarily in southern and central New Hampshire. It typically expresses itself as a complex mosaic of rocky woodlands, rock outcrops, cliffs, and talus slopes with an abundance of oaks, pitch or white pines, and other temperate species. Rocky ridge communities typically occupy ridgetops and upper slopes and have a woodland or sparse woodland structure with extensive bedrock exposure. These bedrock outcrops include slabs with less than 65 degree slopes. Slabs with slopes greater than 65 degrees are classified as ***temperate acidic cliffs***. Where erosion of cliffs and slabs produces accumulations of large boulders, talus communities are formed. These include ***temperate lichen talus barrens***, which are lichen-dominated boulder fields with little vascular plant cover, and wooded talus communities such as ***red oak - black birch wooded talus***, which generally have an open woodland structure. Wooded talus communities have variable and patchy understories of tall shrubs, herbs, vines, and *Polypodium virginianum* (rock polypody) on boulders depending on local soil development. Large talus slopes with big boulders can produce a cold micro-climate created by late melting ice which supports species with more northern affinities, such as red spruce or mountain ash.

At elevations below 1,000 ft., species of Appalachian distribution are common, such as *Quercus alba* (white oak), *Quercus velutina* (black oak), *Quercus montana* (chestnut oak), *Pinus rigida* (pitch pine), and *Carya* spp. (hickories). *Quercus rubra* (red oak) and *Pinus strobus* (white pine) are also common in these areas. Sites with Appalachian communities such as ***Appalachian oak - pine rocky ridge*** and ***chestnut oak forest/woodland*** are generally restricted to the southern tier of the state. Above 1,000 ft. elevation, Appalachian species disappear and *Quercus rubra* (red oak) is often the dominant tree in rocky woods and on forested talus communities. Dry-site species dominate the understory, including an abundance of blueberries, huckleberries, grasses and sedges, and lichens.

At higher elevations in the mountains, this system is replaced by the montane rocky ridge system, montane talus slope system, and/or montane - subalpine cliff system. Large montane ridges, cliffs and talus slopes in the mountains are classified as independent systems because they are considerably larger and support more diverse complexes of communities than their temperate counterparts. These systems are differentiated from the temperate system by the presence of

communities dominated by *Picea rubens* (red spruce) and/or *Pinus resinosa* (red pine), and the absence of *Quercus rubra* (red oak).

Diagnostic natural communities:

- Appalachian oak - pine rocky ridge (S3)
- Chestnut oak forest/woodland (S1S2)
- Red oak - pine rocky ridge (S3S4)
- Pitch pine rocky ridge (S1)
- Circumneutral rocky ridge (S1)
- Red oak - black birch wooded talus (S3S4)
- Appalachian wooded talus (S1S2)
- Temperate lichen talus barren (S2S3)
- Temperate acidic cliff (S4)
- Temperate circumneutral cliff (S2)

Peripheral or occasional natural communities:

- Dry red oak - white pine forest (S3S4)
- Red oak - ironwood - Pennsylvania sedge woodland (S2)
- Dry Appalachian oak forest (S3)

Associated natural community systems: This system represents the combination of three system types described in the 2005 systems classification – Appalachian oak rocky ridge system, temperate acidic talus system, and temperate cliff system – and red oak - pine rocky ridges, previously included in the montane rocky ridge system. Individual rocky ridge, cliff or talus landscape settings at lower elevations rarely occur at system-level scales that support more than 1 or 2 natural community types. However, system-level complexes of communities are found where ridge, cliff, and talus formations co-occur at single sites (or at least two out of three). In these circumstances, each setting may only contain one or two communities, but collectively form repeating assemblages of 3-6 communities.

In the mountains, the montane rocky ridge system, montane - subalpine cliff system, and montane talus slope system remain separate, as they tend to occur at larger scales and with a greater diversity of communities, meriting their system status. Ridge, cliff, and talus examples that support more mineral-rich conditions over significant areas are classified as separate systems due to the distinctly different assemblage of communities.

Characteristic species:

Trees

Quercus rubra (red oak)
Quercus alba (white oak)
Quercus velutina (black oak)
Quercus montana (chestnut oak)
Quercus ilicifolia (scrub oak)
Carya spp. (hickories)
Pinus strobus (white pine)
Pinus rigida (pitch pine)
Betula lenta (cherry birch)
Ostrya virginiana (ironwood)
Acer spicatum (mountain maple)

Shrubs and vines (lianas)

Vaccinium pallidum (hillside blueberry)
Gaylussacia baccata (black huckleberry)
Juniperus communis var. *depressa* (common juniper)
Comptonia peregrina (sweet-fern)
Arctostaphylos uva-ursi (red bearberry)
Hamamelis virginiana (American witch-hazel)
Rubus spp. (raspberries and blackberries)
Sambucus racemosa (red elderberry)
Fallopia cilinodis (fringed bindweed)
Parthenocissus quinquefolia (Virginia-creeper)

Herbs

Aureolaria pedicularia var. *intercedens* (intervening fern-leaved false foxglove)
Solidago odora (licorice goldenrod)*
Schizachyrium scoparium (little bluestem)
Deschampsia flexuosa (wavy hair grass)
Polypodium virginianum (rock polypody)
Dryopteris marginalis (marginal wood fern)
Maianthemum canadense (Canada-mayflower)
Aralia nudicaulis (wild sarsaparilla)

• Pitch pine sand plain system

Landscape settings: lowland, valley bottom settings with extensive sand and gravel deposits derived from glacio-fluvial meltwaters [outwash plains, ice-contact features (eskers, kames), and ancient river deltas and terraces]

Soils: Excessively well drained sands and gravels with modest duff accumulation due to frequent fire

Spatial pattern: small to large patches (10–1,000 acres)

Physiognomy: woodlands with tall shrub, dwarf shrub, and graminoid dominated openings; successional to forest in the absence of fire

Distribution: central and southern NH

Description: This system occurs primarily on droughty, excessively well drained soils in central and southern New Hampshire and is best developed on the extensive sand plain areas of the Ossipee and lower Merrimack River Valley regions. These areas are characterized by a regime of frequent historic fires and indicated by *Pinus rigida* (pitch pine), *Quercus ilicifolia* (scrub oak), other fire-maintained plant species as well as numerous Lepidoptera that are obligates to these plants. The central natural community of this system, ***pitch pine - scrub oak woodland***, forms a discontinuous canopy with dense shrub layer of scrub oak and low heaths. Several successional and disturbance-related expressions can be present, including scrub oak thickets, pockets of pitch pine forest, grassy openings, and heath barrens. Fire is important for maintaining community structure, dynamics, and composition (floristic and faunal). ***Pitch pine - scrub oak woodlands*** require fire to return at intervals of 50–100 years to maintain community composition. Logging history also influences canopy structure, and in combination with fire history, explains much of the compositional variation seen in this system. Other natural communities are characteristic in the larger mosaic, particularly in portions of the sand plain that have had less frequent fire return intervals (i.e., areas more isolated from the most frequently burned areas) or those that occur on more mesic sandy soils (i.e., those adjacent to rivers or wetlands). These communities include ***mixed pine - red oak woodland***, ***red pine - white pine forest***, and ***pitch pine - Appalachian oak - heath forest***.

Diagnostic natural communities:

- Pitch pine - scrub oak woodland (S1S2)

<u>Primarily found in the Ossipee region</u>

- Mixed pine - red oak woodland (S1S2)
- Red pine - white pine forest (S3)

Primarily found in the Merrimack River Valley (and coastal regions)

- Pitch pine - Appalachian oak - heath forest (S1)

Peripheral or occasional natural communities:

- Dry red oak - white pine forest (S3S4)
- Dry Appalachian oak forest (S3)
- Dry river bluff (S3)
- Pitch pine - heath swamp (S1S2)
- Red maple - pitch pine - cinnamon fern forest (S1S2)

Associated natural community systems: This system is commonly interspersed with open peatland systems where sand plains intersect the water table. Kettle hole bog, poor level fen/bog, and medium level fen systems are most common in these landscapes. In central NH, pitch pine sand plain systems transition to hemlock - hardwood - pine forest system on adjacent sand plain or till settings with no (or a less frequent) fire history. In southern parts of the state it transitions to Appalachian oak - pine forest system on till or sand plain settings with less frequent fire histories.

Characteristic species:

Frequent species of the ***pitch pine - scrub oak woodland***:

Primarily sand plain species:

Pinus rigida (pitch pine)
Quercus ilicifolia (scrub oak)
Ceanothus americanus (New Jersey redroot)
Quercus prinoides (dwarf chestnut oak)
Piptatherum pungens (short-awned mountain-rice grass)
Lespedeza capitata (round-headed bush-clover)
Digitaria cognata (fall crabgrass)
Lechea spp. (pinweeds)
Crocanthemum canadense (Canada frostweed)
Ionactis linariifolia (flax-leaved stiff-aster)
Carex tonsa (shaved sedge)
Hudsonia ericoides (golden heather)*
Liatris novae-angliae (northern blazing star)*
Lupinus perennis (wild lupine)*
Asclepias amplexicaulis (clasping milkweed)*
Cyperus lupulinus var. *macilentus* (Great Plains flatsedge)

Other common to occasional species:

Vaccinium angustifolium (lowbush blueberry)
Vaccinium pallidum (hillside blueberry)
Apocynum androsaemifolium (spreading dogbane)
Carex lucorum (Blue Ridge sedge)
Comandra umbellata (bastard-toadflax)
Oryzopsis asperifolia (white-grained rice grass)
Schizachyrium scoparium (little bluestem)
Pteridium aquilinum ssp. *latiusculum* (bracken fern)
Comptonia peregrina (sweet-fern)
Pinus strobus (white pine)
Betula populifolia (gray birch)
Quercus rubra (red oak)
Quercus velutina (black oak)

Frequent species of the ***mixed pine - red oak woodland***:

Trees

Pinus resinosa (red pine)
Pinus strobus (white pine)
Pinus rigida (pitch pine)
Quercus rubra (red oak)

Shrubs

Vaccinium angustifolium (lowbush blueberry)
Vaccinium pallidum (hillside blueberry)
Comptonia peregrina (sweet-fern)
Quercus ilicifolia (scrub oak) – low abundance
Kalmia angustifolia (sheep laurel)

Herbs

Oryzopsis asperifolia (white-grained rice grass)
Pteridium aquilinum ssp. *latiusculum* (bracken fern)

• Coastal sand dune system

Landscape settings: coastal strands between ocean and estuarine or upland systems

Soils: shifting sands

Spatial pattern: small patch (1–20 acres); typically linear zones parallel to the shoreline with fore-dune and back-dune zones

Physiognomy: grassland, herbaceous, dwarf shrubland, shrubland, shrub thicket, forest/woodland

Distribution: limited to Seabrook

Description: Coastal dune systems occur in areas with shifting sand associated with the immediate coastal environment. Several community types correspond to four broad zones: sandy shore, foredune, interdune, and backdune. The two primary physical processes that produce these different zones and their corresponding communities are (1) the degree of exposure to or protection from on-shore winds and therefore degree of sand stabilization, and (2) soil moisture. The sandy shore is most exposed to winds and the occasional storm surge, and is a relatively flat area in front of the dune. The foredune is the most exposed portion of the dune to onshore winds and salt spray and is typically dominated by *Ammophila breviligulata* (American beach grass)* with few other species. The interdune is usually dominated by beach grass with a broader diversity of species. More protected portions of the dune (backdune) are characterized by forests and woodlands, shrub thickets, and interdunal swales. There are no intact dune systems remaining in New Hampshire. The Dunes in Seabrook is the largest dune remnant; several smaller ones are scattered along the heavily developed coast.

The ***maritime sandy beach*** occupies the sandy shore zone. Vegetation is extremely sparse, and consists of a few succulent plants amidst bare sand. ***Beach grass grasslands*** are typically found on the foredune and other dune areas with actively shifting sand. In NH's only remaining example, most of the foredune has been destroyed by development. This community may also occur as a narrow strand of vegetation along the shore away from intact dune areas. *Ammophila breviligulata* (American beach grass)*, the dominant species, creates extensive colonies by spreading underground stems called rhizomes. *Solidago sempervirens* (seaside goldenrod) and *Hudsonia tomentosa* (hairy hudsonia) can also be abundant. The low-growing shrub hairy hudsonia is the dominant species of the ***hudsonia maritime shrubland***, which dominates portions of the interdune. ***Bayberry - beach plum maritime shrublands*** are short to moderate height shrub thickets found in the backdune area and in small, protected hollows in the interdune. Sandy soils are a bit more stable than those found in the foredune and exposed areas of the interdune. ***Coastal interdunal marsh/swale*** is a fresh water wetland community found in sandy depressions between sand dunes. Dominants vary from swale to swale but include *Vaccinium macrocarpon* (large cranberry) and *Juncus balticus* ssp. *littoralis* (Baltic rush). ***Coastal shoreline strand/swale*** is a sparsely vegetated upper intertidal community that can be found on backdune sandy depressions and channels bordering salt marshes. This community is flooded less than daily and is often characterized by plant stems and other detritus washed in on the higher tides and covering much of the substrate surface. These upper intertidal

areas form either large patches or narrow strands along protected low-energy shorelines and are important habitat for various arthropods, shore birds, and other animals and are sparsely vegetated by halophytic herbs.

Diagnostic natural communities:

- Maritime sandy beach (S1)
- Beach grass grassland (S1)
- Hudsonia maritime shrubland (S1)
- Bayberry - beach plum maritime shrubland (S1)
- Maritime wooded dune (S1)
- Coastal interdunal marsh/swale (S1)

Peripheral or occasional natural communities:

- Coastal shoreline strand/swale (S2)

Associated natural community systems: Coastal sand dunes are typically sandwiched between salt marsh systems and open, wave-racked beaches on the immediate ocean shoreline.

Characteristic species:

Beach grass grassland:

Ammophila breviligulata (American beach grass)*
Solidago sempervirens (seaside goldenrod)
Hudsonia tomentosa (hairy hudsonia)*
Danthonia spicata (poverty oatgrass)
Schizachyrium scoparium (little bluestem)
Lathyrus japonicus var. *maritimus* (beach vetchling)
Lechea maritima (beach pinweed)
Polygonum articulatum (coastal jointed knotweed)
Cyperus lupulinus var. *macilentus* (Great Plains flatsedge)
Aristida tuberculosa (seaside threeawn)*
Cyperus grayi (Gray's umbrella sedge)*

Bayberry - beach plum maritime shrubland:

Shrubs
Morella caroliniensis (small bayberry)
Prunus maritima (beach plum)
Toxicodendron radicans (poison-ivy)
Rosa virginiana (Virginia rose)

Bayberry - beach plum (cont.):

Herbs
Oenothera perennis (little evening-primrose)
Achillea millefolium ssp. *lanulosa* (common yarrow)
Fallopia scandens (climbing bindweed)
Artemisia campestris ssp. *caudata* (field wormwood)*

Coastal interdunal marsh/swale:

Shrubs

Vaccinium macrocarpon (large cranberry)

Aronia floribunda (purple chokeberry)

Ilex verticillata (common winterberry)

Toxicodendron radicans (poison-ivy)

Herbs

Juncus balticus ssp. *littoralis* (Baltic rush)

Triadenum virginicum (Virginia marsh-St. John's-wort)

• Maritime rocky shore system

Landscape settings: offshore islands

Soils: Well to somewhat excessively well drained, thin soils over bedrock and in cracks in outcrop

Spatial pattern: small patch (<5–100+ acres); zonation parallel to shoreline

Physiognomy: shrub thickets, and sparsely vegetated rocky barrens and intertidal areas

Distribution: Isles of Shoals

Description: This system occurs in small, exposed, remnant rocky stretches along the mainland and on the Isles of Shoals in the Atlantic Ocean off the New Hampshire coast. An intact example only occurs on the Shoals, several small islands set six miles offshore where they are more exposed to and battered by the maritime environment (e.g., salt spray, guano, wave action, tides, and exposure to sun and wind) than most nearby mainland rocky shorelines. The most protected areas on larger islands and mainland shorelines are more wooded and support a mosaic of ***maritime shrub thicket*** and ***coastal rocky headland*** communities. The latter community has a woodland structure (25–60% tree cover) dominated by *Juniperus virginiana* (eastern red cedar) and *Myrica pensylvanica* (northern bayberry).

Depending on degree of exposure, the ***maritime shrub thicket*** consists of short (mostly less than 1 m) to tall (mostly 1–2.5 m) shrub thickets occurring landward of the most exposed rocky shorelines. These thickets are dominated by shrubs and stunted trees with a lower abundance of understory herbs. The interior of smaller islands or portions of larger islands with seabird nesting colonies support ***maritime meadows***. This community is invariably linked to seabird nesting colonies, as guano deposition from gulls and cormorants plays a significant role in maintaining species composition and structure.

Maritime rocky barren**s** lie between ***maritime meadows*** or ***maritime shrub thickets*** at higher elevations and ***intertidal rocky shores*** at lower elevations. These exposed rocky barrens have a sparse cover of herbs and even fewer shrubs that creep down from the shrub thicket above into protected crevices. Little soil and wind-driven salt spray limit plant growth on the exposed bedrock. Small depressions within this community hold ***brackish water pools*** characterized by salt tolerant herbs.

Intertidal rocky shores are found from the supra-littoral (splash) zone down to the shore expose at low tide. They are exposed to wave action, tides, and when the tides are drawn down, sun and wind. These environmental factors have a strong influence on species composition and zonation. Vascular plant species are absent. Non-vascular species include blue-green algae and lichens in the supra-littoral and high littoral zones and several species of macroalgae in the middle and lower intertidal zones.

Diagnostic natural communities:

- Intertidal rocky shore (S1)
- Maritime rocky barren (S1)
- Brackish water pool (S1)
- Maritime cobble beach (S1)
- Maritime meadow (S1)
- Maritime shrub thicket (S1)

Peripheral or occasional natural communities:

- Coastal salt pond meadow marsh (S1)
- Coastal salt pond emergent marsh (S1)
- Coastal salt pond flat (S1)
- Coastal shoreline strand/swale (S2)
- Short graminoid - forb meadow marsh/mudflat (S4)
- Highbush blueberry - winterberry shrub thicket (S4)
- Coastal rocky headland (S1)

Associated natural community systems: This system occurs on the Isles of Shoals and in small, exposed, partially-intact stretches along the mainland shore.

Characteristic species:

Maritime shrub thicket:

Short and tall shrub thickets:

Abundant shrubs

Morella caroliniensis (small bayberry)

Aronia floribunda (purple chokeberry)

Aronia melanocarpa (black chokeberry)

Toxicodendron radicans (poison-ivy)

Rosa virginiana (Virginia rose)

Amelanchier spicata (dwarf shadbush)

Other occasional species

Achillea millefolium ssp. *lanulosa* (common yarrow)

Festuca rubra ssp. *pruinosa* (frosty red fescue)

Symphyotrichum novi-belgii (New York American-aster)

Sedum sp. (stonecrops)

Sibbaldiopsis tridentata (three-toothed cinquefoil)

Agrostis capillaris (Rhode Island bentgrass)

Fallopia scandens (climbing bindweed)

Prunus maritima (beach plum)

Tall shrub thickets (additional species):

Shrubs

Amelanchier canadensis (eastern shadbush)

Parthenocissus quinquefolia (Virginia-creeper)

Rosa rugosa (beach rose)

Rubus allegheniensis (common blackberry)

Rubus idaeus ssp. *strigosus* (strigose red raspberry)

Prunus serotina (black cherry)

Acer rubrum (red maple)

Ilex verticillata (common winterberry) – dom. in low wet swales

Herbs

Agrostis capillaris (Rhode Island bentgrass)

Anthoxanthum odoratum (large sweet grass)

Elymus repens (creeping wild-rye)

Poa pratensis (Kentucky blue grass)

Poa compressa (flat-stemmed blue grass)

Fragaria virginiana ssp. *virginiana* (common strawberry)

Maianthemum stellatum (star-like false Solomon's-seal).

Maritime rocky barren:

Herbs

Solidago sempervirens (seaside goldenrod)

Juncus gerardii (saltmarsh rush)

Festuca rubra (red fescue)

Symphyotrichum subulatum (annual saltmarsh American-aster)

Achillea millefolium ssp. *lanulosa* (common yarrow)

Toxicodendron radicans (poison-ivy)

Dwarf shrubs

Morella caroliniensis (small bayberry)

Small embedded fresh to brackish water depressions:

Lemna minor (common duckweed)

Persicaria hydropiper (water-pepper smartweed)

Persicaria punctata (dotted smartweed)

Scutellaria galericulata (hooded skullcap)

Iris versicolor (blue iris)

Lycopus uniflorus (northern water-horehound)

Typha latifolia (broad-leaved cat-tail)

Schoenoplectus pungens (three-square bulrush)

Bolboschoenus robustus (sea-coast tuber-bulrush)

Eleocharis uniglumis (one-glumed spikesedge)*

Argentina egedii ssp. *groenlandica* (coastal silverweed)

Lythrum hyssopifolia (hyssop-leaved loosestrife)

Juncus gerardii (saltmarsh rush)

PRIMARILY FOREST AND WOODLAND SYSTEMS ON TILL, FLUVIAL, TALUS, OR ROCKY SUBSTRATES

MATRIX FORESTS (ON TILL, SAND PLAIN, AND OTHER FLUVIAL MATERIALS WITH AN INFREQUENT FIRE HISTORY)

The forests in this section dominate most of New Hampshire's landscape. Most of the forests of New Hampshire are characteristic of the nutrient-poor end of the spectrum, primarily due to the prominence of granitic bedrock and glacial till that is low in mineral nutrient content. The more common forest systems described here are characterized by a broad range of moisture regimes and substrates including dry to mesic conditions, glacial till, fluvial river terraces, sand plains that are not burned frequently, and even stabilized talus areas that are not enriched or open canopied. Enriched hardwood forests are distinct among NH forests and are described as separate systems. The other upland systems (described above) occupy unusual settings embedded as small or large patches within the more common forest mosaic: alpine summits, rocky balds, cliffs and talus, fire-burned sand plains, and those found on New Hampshire's short but distinct coastline.

The five major forest systems described for New Hampshire relate closely to continental and regional-scale vegetation patterns. At the continental scale, broad climatic regions define areas with similar vegetation. The boreal forest and eastern temperate forest regions are the two North American climate regions that relate most closely to New Hampshire's forests. The boreal forest region is a subarctic conifer forest that dominates the polar regions of North America, Europe, and Asia. The eastern temperate forest region covers much of eastern North America south of the boreal forest. These regions can be divided into smaller units based on the distribution patterns shared by many species that are centered in different parts of the region.

New Hampshire sits at the cross-roads between these two climate regions. In New Hampshire, forests dominated by boreal species occur from the White Mountains northward. Characteristic boreal species include balsam fir, black spruce, paper birch, larch and quaking aspen. Numerous species in New Hampshire are restricted to the southeastern portion of the boreal forest, or occupy the transition zone between boreal forests and eastern deciduous forests, including red spruce, red pine, and northern white cedar. The middle and lower elevation forests (below 2,400 ft.) of central and southern New Hampshire are characterized by the presence of eastern temperate forest species. Hemlock, yellow birch, white pine, sugar maple, American beech, red maple, and black cherry occur throughout the state. Southern New Hampshire marks the transition to the so-called central hardwood or Appalachian oak region, where forests are dominated by oaks, hickories, and pines with less beech and hemlock than in central New Hampshire.

We describe five matrix forest systems in New Hampshire. The forests of northern New Hampshire and higher elevations of central and western parts of the state are divided into three systems: lowland spruce - fir forest/swamp, high-elevation spruce - fir, and northern hardwood - conifer forest systems. The forests of central and southern New Hampshire and low elevations in major mountain valleys to the north correspond to two matrix forest systems: an oak - pine forest system centered to the south and a hemlock - hardwood - pine forest system. The latter type is a transitional forest that marks a "tension zone" between oak - pine forests to the south and lower elevations and northern hardwood forests to the north or at higher elevations. This approach is consistent with well-established forest-region patterns described by others (i.e., Westveld 1956; Cogbill 2002), but is more specific in terms of the groups of natural communities that comprise the systems that characterize these major regions.

• Lowland spruce - fir forest/swamp system

Landscape settings: valley bottoms, lowland flats, and lake basins

Soils: mostly on moderately well to poorly drained glacio-fluvial and firm till mineral soils (sand to silt loams, sometimes gravelly), less frequently on loose till; may contain inclusions of well and very poorly drained soils; generally weakly minerotrophic, acidic

Spatial pattern: large patch to extensive (5–500+ acres); linear to broad-linear or irregular; further south, occurs in more isolated small patches; internal zonation of communities typically relates to soil drainage

Physiognomy: forest to woodland

Distribution: well developed and most common north of the White Mountains from 1,000–2,500 ft.; less frequent in the White Mountains; infrequent in the higher valley bottoms south of the mountains

Description: This system is a mosaic of ***lowland spruce - fir forest*** and ***red spruce swamp*** communities that occur on mineral soils. In northern New Hampshire, these communities intergrade in complex ways on the ground with various expressions ranging mostly from well or moderately well drained upland forests to poorly or very poorly drained swamps. Somewhat poorly drained soils are intermediate and very common. The average condition for red spruce swamps is acidic and poorly drained, with shallow, well decomposed organic soils (10–40 cm) over sandy to silty mineral soil. These systems often grade at the very poorly drained end of the spectrum to black spruce peat swamps. In the White Mountains and in other moderate elevation mineral swamp settings where the gradient is not as gradual, ***red spruce swamp*** can be the primary community with an abrupt transition to a narrow spruce - fir forest border or direct transition to hardwood forest or high-elevation spruce-fir systems. Thus, it is more minerotrophic than black spruce peat swamps, but less so than northern white cedar or montane/near-boreal hardwood-conifer minerotrophic swamps.

Lowland spruce - fir forests have a well-developed conifer canopy, a sparse tall shrub understory, sparse to moderate cover of ferns and dwarf shrubs, and moderate to high cover of bryophytes.

Diagnostic natural communities:

- Lowland spruce - fir forest (S3)
- Red spruce swamp (S3)
- Montane black spruce - red spruce forest (S1)

Associated natural community systems: Black spruce peat swamp systems occur on adjacent very poorly drained peat soils. In more minerotrophic settings this system can be adjacent and transition into northern white cedar or montane/near-boreal hardwood-conifer minerotrophic swamps. Upslope, lowland spruce - fir forest/swamps typically transition to northern hardwood - conifer systems. The transition to red spruce swamp is marked by well-developed hummock - hollow topography with wet hollows and higher cover of cinnamon fern and bryophytes.

Characteristic species:

Lowland spruce - fir forest:

Trees and tall shrubs

Picea rubens (red spruce) – dom.

Abies balsamea (balsam fir) – dom.

Betula papyrifera (paper birch) – com.

Betula alleghaniensis (yellow birch) – com.

Betula cordifolia (heart-leaved paper birch) – occ.

Picea glauca (white spruce) – occ.

Picea mariana (black spruce) – occ.

Sorbus decora (showy mountain-ash)

Sorbus americana (American mountain-ash)

Ilex mucronata (mountain holly)

Dwarf shrubs

Chamaepericlymenum canadense (bunchberry)

Linnaea borealis ssp. *americana* (American twinflower)

Amelanchier bartramiana (mountain shadbush)

Coptis trifolia (three-leaved goldthread)

Vaccinium myrtilloides (velvet-leaf blueberry)

Gaultheria hispidula (creeping spicy-wintergreen)

Herbs

Dryopteris campyloptera (mountain wood fern)

Dryopteris intermedia (evergreen wood fern)

Neottia cordata (heart-leaved twayblade)* – moist or seepy areas

Neottia convallarioides (broad-leaved twayblade)* – moist or seepy areas

Bryophytes

Bazzania trilobata (liverwort)

Dicranum scoparium (moss)

Hypnum curvifolium (moss)

Pleurozium schreberi (moss)

Ptilium crista-castrensis (moss)

Brotherella recurvans (moss)

Bazzania denudate (liverwort)

Scapania nemoria (liverwort)

Drepanocladus uncinatus (moss)

Pohlia nutans (moss)

Sphagnum russowii (peat moss)

Sphagnum girgenshonii (peat moss)

Occasional species absent or uncommon in the high elevation spruce - fir:

Aralia nudicaulis (wild sarsaparilla)

Acer pensylvanicum (striped maple)

Trillium erectum (red wakerobin)

Tiarella cordifolia (foam-flower)

Picea glauca (white spruce)

Osmundastrum cinnamomeum (cinnamon fern)

• High-elevation spruce - fir forest system

Landscape settings: mountain side-slopes

Soils: mostly loose and firm cryic tills; also on stabilized talus

Spatial pattern: large patch to matrix (<10–1,000+ acres); irregular shapes along mountain tops and ridges

Physiognomy: forest

Distribution: generally from 2,500–4,500 ft.; lower on side slopes with poor, rocky soils

Description: This system corresponds to the *Picea rubens* (red spruce) and *Abies balsamea* (balsam fir) dominated forests of higher elevation mountains in New Hampshire between 2,500 and 4,500 ft. (locally higher and lower). There are two dominant communities in this system: ***high-elevation spruce - fir forest*** that occurs mostly between 2,500–3,500 ft., and ***high-elevation balsam fir forest*** that occurs from about 3,500–4,500 ft. This system occurs locally lower on ridges and other rocky or infertile sites, and locally higher on relatively protected sites (e.g., ravines up to ca. 5,200 ft.).

High-elevation balsam fir forest occurs below the krummholz zone and is dominated by balsam fir with little or no red spruce and less *Betula cordifolia* (heart-leaved paper birch) than at lower elevations. This community can form patches of wind-induced mortality known as "fir-waves." Fir waves are linear patches of blow-down or standing dead trees oriented perpendicular to the prevailing wind, and arranged in a progression of waves of different ages of resulting regeneration adjacent to one another. A common theory suggests that the trees primarily die from the death of needles and roots due to chronic wind stress.

The ***high-elevation spruce - fir forest*** occurs at lower elevations and typically contains red spruce, balsam fir, and *Betula cordifolia* (heartleaf birch). The specific composition of these forests is much influenced by the disturbance history and to a lesser extent by soils and elevations within the zone.

The transition from the high-elevation spruce - fir forest system to northern hardwood - conifer forest systems is often marked by the ***northern hardwood - spruce - fir forest*** community. This community is characterized by spruce, fir, and northern hardwoods (yellow birch, beech, sugar maple). It forms a narrow to broad zone between the two systems, and it is arguable whether this community is more indicative of one or the other. Depending on disturbance and cutting history, some examples of current hardwood or mixed forests will eventually succeed to conifer dominance (e.g., ***high-elevation spruce - fir forest***). However, examples of ***northern hardwood - spruce - fir forests*** that are likely to stay more mixed over the long term are probably most closely aligned with ***sugar maple - beech - yellow birch forests*** because the northern hardwoods have not been excluded by the climatic and poorer soil conditions closely associated with their disappearance at higher elevations in the ***high-elevation spruce - fir forest***.

Soils in this system are generally very nutrient-poor, acidic Inceptisols or Spodosols with a deep, slowly decomposing humus layer and the variable presence of a grey, leached E (elluviated) horizon. Drainage varies from well to moderately-well drained (somewhat poorly to poorly drained soils are more typical of lowland spruce - fir forest and spruce - fir swamps). Litter of conifers has low nutrient quality and contributes to organic matter accumulation. Cloud-intercept contributes a significant amount of moisture to this system, particularly in the balsam fir zone. Colder temperatures and deep, late-melting snowpacks

at high elevations also contribute to higher moisture levels, lower soil temperatures, a shortened growing season, and accumulation of humus compared to lower elevation northern hardwood forests.

Diagnostic natural communities:

- High-elevation spruce - fir forest (S4)
- High-elevation balsam fir forest (S3S4)

Peripheral or occasional natural communities:

- Northern hardwood - spruce - fir forest (S4)
- Montane landslide barren and thicket (S3S4)

Associated natural community systems: This system transitions to alpine tundra, alpine ravine/snowbank, subalpine heath - krummholz/rocky bald, or montane rocky ridge systems at higher elevations, and northern hardwood - conifer forest systems at lower elevations.

Characteristic species:

Trees and tall shrubs

Abundant species

Picea rubens (red spruce)

Abies balsamea (balsam fir)

Betula papyrifera (paper birch)

Betula alleghaniensis (yellow birch)

Betula cordifolia (heart-leaved paper birch)

Occasional species:

Picea mariana (black spruce) – higher elevs.

Sorbus decora (showy mountain-ash)

Sorbus americana (American mountain-ash)

Ilex mucronata (mountain holly)

Dwarf shrubs

Chamaepericlymenum canadense (bunchberry)

Linnaea borealis ssp. *americana* (American twinflower)

Amelanchier bartramiana (mountain shadbush)

Coptis trifolia (three-leaved goldthread)

Vaccinium myrtilloides (velvet-leaf blueberry)

Gaultheria hispidula (creeping spicy-wintergreen)

Herbs

Dryopteris campyloptera (mountain wood fern)

Dryopteris intermedia (evergreen wood fern)

Huperzia lucidula (shining firmoss)

Oxalis montana (northern wood sorrel)

Clintonia borealis (yellow bluebead-lily)

Neottia cordata (heart-leaved twayblade)* – moist or seepy areas

Neottia convallarioides (broad-leaved twayblade)* – moist or seepy areas

Bryophytes

Bazzania trilobata (liverwort)
Dicranum scoparium (moss)
Hypnum curvifolium (moss)
Pleurozium schreberi (moss)
Ptilium crista-castrensis (moss)
Brotherella recurvans (moss)
Bazzania denudate (liverwort)
Scapania nemoria (liverwort)
Drepanocladus uncinatus (moss)
Pohlia nutans (moss)
Sphagnum russowii (peat moss)
Sphagnum girgenshonii (peat moss)

• 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)

• Hemlock - hardwood - pine forest system

Landscape settings: high to low hills, mountain valleys, lowland flats

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

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

Physiognomy: forest

Distribution: below 1,500 ft. elevation in central and southern NH, extending into low elevations of White Mountains.

Description: This is a transitional forest region or "tension zone" in New Hampshire that is positioned latitudinally and elevationally between northern hardwood - conifer forests to the north and higher elevations (mostly >1,400 ft.) and oak - pine (Appalachian or central hardwood) forests to the south and lower elevations (mostly <900 ft.). This transitional forest lacks most boreal species and central hardwood species that characterize these other forests, but has many Alleghanian species such as *Pinus strobus* (white pine) and *Tsuga canadensis* (hemlock). Many of the other species of this system are common throughout eastern United States. Hemlock - hardwood - pine forests are found throughout the state from the White Mountains south below about 1,500 ft. Dry-mesic to mesic glacial till soils are most abundant, but this system also occupies river terraces, sand plains, and stabilized talus areas covered by a forest canopy. It includes dry, sandy soils with red oak and white pine that have not been burned on a historically frequent enough interval to support pitch pine sand plains system. These areas are likely to be successional to hemlock and/or beech over the long term without the return of fire.

The main matrix forest community that defines this system is ***hemlock - beech - oak - pine forest***. Hemlock and beech are the primary late-successional trees in this community, with maximum ages of about 500 and 300 years, respectively. *Quercus rubra* (red oak) and *Pinus strobus* (white pine) are also typically abundant, in contrast to their absence or low abundance in northern hardwood - conifer forest systems. Most of the old-field white pine stands in central NH are successional examples of this system. *Acer saccharum* (sugar maple) and *Betula alleghaniensis* (yellow birch) are occasional but of less importance than in northern hardwood - conifer forests. They are most frequent in mesic areas such as concavities and along drainages where *Fraxinus americana* (white ash) is frequent, or locally abundant in patches of ***semi-rich sugar maple forests***. *Picea rubens* (red spruce) and *Abies balsamea* (balsam fir) are generally sparse or absent, but are occasional on the lower slopes of some mountains south of the White Mountains (i.e., Ossipee Mountains, Mt. Monadnock). Central hardwood/Appalachian species are essentially absent, including hickories (*Carya* spp.), oaks (*Quercus* spp.) other than red oak, dogwoods, and southern herbs (see oak - pine forest description). These more southern species do appear occasionally as the more definitive oak - pine forests to the south are approached.

Variation in soils or landscape position within this system explains much of the variation in community composition. ***Hemlock forests*** often occur in ravines or extremely rocky sites; ***beech forests*** occur on coarse washed till soils; ***semi-rich mesic sugar maple forests*** occur in colluvial landscape positions or associated with bedrock or till with greater base-cation contributions to the soil; ***hemlock - oak - northern hardwood forest*** occurs in more mesic settings or at higher elevations near the transition to northern

hardwood - conifer forests; ***dry red oak - white pine forests*** occur on sandy or rocky soils that may perpetuate oak and pine dominance locally with repeated disturbance.

Diagnostic natural communities:

- Hemlock - beech - oak - pine forest (S5) – matrix forest type
- Hemlock forest (S4)
- Beech forest (S4)
- Hemlock - white pine forest (S4)
- Dry red oak - white pine forest (S3S4)
- Semi-rich mesic sugar maple forest (S3S4)

Peripheral or occasional natural communities:

- Hemlock - oak - northern hardwood forest (S4)

Associated natural community systems: Hemlock - hardwood - pine forest systems transition upslope and northward to northern hardwood - conifer forest systems. To the south and sometimes lower elevations or onto rocky, dry or frequent-fire landscapes this system transitions to oak - pine forest, Appalachian oak rocky ridge, or pitch pine sand plain systems.

Plants that tend to be more prominent in hemlock - hardwood - pine forests than in northern hardwood - conifer forests include *Hamamelis virginiana* (American witch-hazel), *Betula lenta* (cherry birch), *Prunus serotina* (black cherry), *Ostrya virginiana* (ironwood), *Viburnum acerifolium* (maple-leaved viburnum), *Gaultheria procumbens* (eastern spicy-wintergreen), and *Gaylussacia baccata* (black huckleberry).

Characteristic species:

Characteristic tree species of the hemlock - hardwood - pine forest system:

Tsuga canadensis (hemlock)
Fagus grandifolia (American beech)
Quercus rubra (red oak)
Pinus strobus (white pine)
Acer rubrum (red maple)
Betula papyrifera (paper birch)
Fraxinus americana (white ash)
Betula lenta (cherry birch)
Betula populifolia (gray birch)
Prunus serotina (black cherry)

<u>Shrubs</u> mostly absent from northern hardwood - conifer forests:

Hamamelis virginiana (American witch-hazel)
Viburnum acerifolium (maple-leaved viburnum)
Gaultheria procumbens (eastern spicy-wintergreen)

Herbs 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)

Understory species mostly absent in hemlock - hardwood - pine forests:

Herbs

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)

• Appalachian oak - pine forest system

Landscape settings: hills, valleys, and lowland flats

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

Spatial pattern: large patch to matrix (<10–100+ acres); irregular and linear zonation of component communities

Physiognomy: forest

Distribution: below 900 ft. elevation in southern NH; disjunct into south-central NH on steep, south-facing hills

Description: Appalachian oak - pine forest systems are found mostly below 900 ft. elevation in southern New Hampshire, south of and at lower elevations than the hemlock - hardwood - pine forest system. The southern-most portions of the state are associated with the warmer and drier climatic conditions and apparently more fire-influenced landscapes that prevail south of New Hampshire in lower New England. Much of the area of these forests corresponds to nutrient-poor, dry to mesic, sandy glacial tills, and some large areas of sand plain or shallow-to-bedrock tills, particularly in the seacoast and lower Merrimack and Connecticut River valleys. Sand plains in these areas that have a frequent fire history correspond to pitch pine sand plain; those with a less-frequent fire regime (i.e., more than 50–100 years) are classified as oak - pine forest or sometimes hemlock - hardwood - pine forest systems depending on the composition of trees. More isolated patches of oak - pine forest systems are found to the north in central NH, associated with dry rocky ridges or sand plains with a historic fire regime.

This forest system is marked by the appearance of oaks other than red oak, hickories, and numerous other southern plant species that are found in the Appalachian states and reach their northern limit in or near southern New Hampshire. It is also coincident with the decreased abundance and frequency of *Tsuga canadensis* (hemlock) and *Fagus grandifolia* (American beech) that are more prominent in hemlock - hardwood - pine forests, although both are still commonly present particularly in dry-mesic or mesic sites. *Acer saccharum* (sugar maple) and *Betula alleghaniensis* (yellow birch) are found in low abundance and are restricted to more mesic sites such as along drainages or patches of ***mesic Appalachian oak - hickory forest*** found on lower slopes or silt soils. Southern species characteristic of Appalachian oak - pine forests (see below) are diagnostic of the system even in relatively low abundance (i.e., 1–5% cover for trees) as long as they are relatively consistent and well distributed in the forested area (e.g., not single individuals across many acres).

The natural communities of this system are restricted to the southeastern part of the state and low elevations of the lower Connecticut and Merrimack River watersheds. The dominant forest types are ***mesic Appalachian oak - hickory forests*** on dry-mesic to mesic soils, and ***dry Appalachian oak forest*** on dry soil. Overall, dry-mesic conditions are probably the most common in the landscape, which generally corresponds to the dry-mesic variant of ***mesic Appalachian oak - hickory forest***. This community is essentially the southern counterpart to ***hemlock - beech - oak - pine forests*** that dominate central NH. In some areas of southwest New Hampshire, ***oak - mountain laurel forest*** can be abundant. On soils that are weakly enriched, ***semi-rich oak - sugar maple forest*** can be present. On shallow rocky till sites, ***pitch***

pine - Appalachian oak - heath forest and ***chestnut oak forest/woodland*** can intersperse with the dominant ***dry Appalachian oak - hickory forest***.

Diagnostic natural communities:

- Dry Appalachian oak forest (S3)
- Mesic Appalachian oak - hickory forest (S2S3)
- Oak - mountain laurel forest (S3)
- Semi-rich oak - sugar maple forest (S2S3)

Peripheral or occasional natural communities:

- Pitch pine - Appalachian oak - heath forest (S1)
- Chestnut oak forest/woodland (S1S2)
- Dry river bluff (S3)

Associated natural community systems: At more northern locations or towards more mesic or higher elevation locations, this forest system is transitional to hemlock - hardwood - pine forest system. It transitions to pitch pine sand plain systems in more fire-prone settings, and to Appalachian oak rocky ridge systems in shallow-to-bedrock landscapes.

Characteristic species:

Southern species diagnostic of Appalachian oak - pine forests (many species of hemlock - hardwood - pine forests may also be present):

Quercus alba (white oak)
Quercus velutina (black oak)
Quercus coccinea (scarlet oak)
Quercus alba (white oak)
Quercus montana (chestnut oak)
Carya spp. (hickories)

Pinus rigida (pitch pine)
Sassafras albidum (sassafras)
Kalmia latifolia (mountain laurel)
Desmodium spp. (tick-trefoils)
Benthamidia florida (flowering dogwood)
Swida rugosa (round-leaved dogwood)
Solidago odora (licorice goldenrod)*
Aureolaria spp. (false foxgloves)
Baptisia tinctoria (yellow wild indigo)

RICH HARDWOOD FORESTS (ON TILL, ROCKY, OR TERRACE SUBSTRATES)

Forests referred to as rich woods, rich mesic forests, or enriched hardwood forests are a distinct and consistent feature among hardwood forests throughout eastern North America. The terms "rich" and "enriched" are often used in a loosely defined manner, but typically in reference to presumed mineral or plant-nutrient levels of a site being greater than that of the dominant forests of the region. The high mineral or nutrient levels are indicated by a suite of species mostly restricted to those conditions. The degree of enrichment in forests is a function of several interacting ecological factors including: mineral composition of bedrock and till; rock weatherability; topographic position (including colluviation); hydrologic flow through soil and fractured bedrock that transports minerals; moisture status; other soil characteristics such as base saturation, texture, and organic matter content; and biological activity (litter quality, soil and rock mychorrizae). Generally, rich hardwood forest soils appear to have higher base-saturation, calcium, and nitrogen availability levels than other forest types.

• Rich mesic forest system

Landscape settings: concave to neutral hillside slope positions, particularly in regions of calcium-rich bedrock and in topographic positions influenced by colluviation (e.g., slope-bases, below cliffs, and in coves and drainages)

Soils: variable: mesic to wet-mesic; well to moderately well drained; deep to shallow; loams, silt loams, and fine sandy loams with variable gravel and stone content; often with a well-mixed "mull" A horizon

Spatial pattern: variable (<1–20+ acres), although often elliptical or broad-linear when controlled by topographic features (i.e., slope-bases, coves, and drainages)

Physiognomy: forest

Distribution: throughout the state; more common in regions dominated by calcium-rich bedrock

Description: Rich mesic forest systems are relatively small but distinct forest areas that, despite some minor herbaceous variation, exhibit a remarkably consistent composition from northern to southern New Hampshire. This is in contrast to the matrix forest types surrounding the rich mesic forests, which range from northern hardwood (-conifer) forests in northern New Hampshire, to hemlock - hardwood - pine or Appalachian oak - pine forest systems further south. In all cases, this forest system is marked by the dominance of sugar maple and a host of rich-site indicator species largely restricted to enriched hardwood forests. *Fagus grandifolia* (American beech) and *Betula alleghaniensis* (yellow birch) are more abundant in semi-rich areas and less frequent in rich mesic forests. While rocky areas can be present, this system contrasts with rich temperate rocky woods and rich Appalachian oak rocky woods systems by the absence of extensive talus or loose rocky slopes with herbs and species preferential to dry-mesic rocky sites. They are most common and largest in areas with relatively calcium-rich bedrock and in association with slope-bases and coves, and on river terrace escarpments along the Connecticut and Merrimack Rivers. This system more often than not has a mix of ***rich mesic forest*** and ***semi-rich mesic sugar maple forest*** communities.

Rich mesic forests are indicated by a large number of rich and semi-rich site indicators, many of which are "vernal herbs" that flower and fruit early in the season before tree canopies have fully emerged. There are numerous other herbs that occur in rich mesic forests not listed below, including those found in more nutrient-poor matrix forests of the region.

Diagnostic natural communities:

- Rich mesic forest (S3)
- Semi-rich mesic sugar maple forest (S3S4)

Peripheral or occasional natural communities:

- Semi-rich oak - sugar maple forest (S2S3)

Associated natural community systems: Rich mesic forest systems are found as small to large patches in northern hardwood - conifer forest, hemlock - hardwood - pine forest, and less frequently Appalachian oak - pine forest systems.

Characteristic species:

Semi-rich mesic sugar maple forest:

Trees and shrubs

Acer saccharum (sugar maple)
Fraxinus americana (white ash)
Tilia americana (basswood)
Ostrya virginiana (ironwood)
Swida alternifolia (alternate-leaved dogwood)
Sambucus racemosa (red elderberry)

Herbs

Arisaema triphyllum (Jack-in-the-pulpit)
Viola rotundifolia (round-leaved violet)
Actaea spp. (baneberries)
Tiarella cordifolia (foam-flower)
Solidago flexicaulis (zig-zag goldenrod)
Botrychium virginianum (rattlesnake-fern)
Deparia acrostichoides (silvery false spleenwort)
Milium effusum ssp. *cisatlanticum* (millet grass)
Osmorhiza claytonii (bland sweet-cicely)
Panax quinquefolius (American ginseng)*
Polystichum acrostichoides (Christmas fern)

Rich mesic forest:

Above species plus at least several of the following species:

Adiantum pedatum (northern maidenhair fern)

Caulophyllum thalictroides (blue cohosh)

Dryopteris goldiana (Goldie's wood fern)

Dicentra canadensis (squirrel-corn)

Dicentra cucullaria (Dutchman's-breeches)

Asarum canadense (Canada wild ginger)

Carex platyphylla (broad-leaved sedge)

Carex plantaginea (plantain-leaved sedge)

Ageratina altissima (white snakeroot)

Sanguinaria canadensis (blood-root)

Cypripedium parviflorum var. *pubescens* (large yellow lady's-slipper)*

Viola canadensis (Canada white violet)

Viola pubescens (yellow forest violet

Aralia racemosa (American spikenard)

Pyrola asarifolia (pink shinleaf)*

Osmorhiza berteroi (mountain sweet-cicely)*

Carex aestivalis (summer sedge)*

Galearis spectabilis (showy orchid)*

• Rich temperate rocky woods system

Landscape settings: talus or other rocky slopes in neutral to concave hillside slope positions, and occasionally upper-slope positions, particularly in regions of calcium-rich bedrock

Soils: overall dry-mesic with embedded dry and mesic micro-sites, well to somewhat excessively well drained; moderate to shallow depth fine sandy loams with considerable gravel and stone content with frequent outcrops, talus boulders, and/or unconsolidated stones; sometimes with a well-mixed "mull" A horizon

Spatial pattern: variable (<1–50+ acres), although often elliptical or broad-linear when controlled by topographic position (i.e., cliff-bases and hillside slopes)

Physiognomy: woodland to forest, with patches of unvegetated or sparsely-vegetated lichen talus barrens

Distribution: low to mid elevations in central and southern New Hampshire (500–1,200 ft., occasionally to 2,000 ft.)

Description: This system is found on enriched talus and other rocky slopes in central New Hampshire from about 500 to 1,200 ft. elevation, and occasionally up to about 2,000 ft. in the low elevation valleys in the White Mountain region (Saco, Connecticut, and Androscoggin River valleys). Montane talus slopes lack rich-site indicators, and on average occur at higher elevations and in the mountains well above the lowest elevation valley bottoms. Rich temperate rocky woods differs from rich Appalachian oak rocky woods by the absence of southern oaks and southern species restricted to extreme southern New Hampshire at low elevations (<500 ft.); both are drier and rockier than rich mesic forests (overall dry-mesic). The primary diagnostic community is ***rich red oak rocky woods***, but the larger talus slope often has patches of ***temperate lichen talus barren***, and occasionally patches of ***rich mesic*** or ***semi-rich mesic sugar maple forest*** communities in mesic, colluvial areas at the base of the talus slopes. On forested sites with a talus substrate, ***red oak - black birch wooded talus*** is common.

Tree canopy dominants usually include *Acer saccharum* (sugar maple) and *Quercus rubra* (red oak), with lesser amounts of *Ostrya virginiana* (ironwood) and other hardwoods (softwoods are sparse or absent). Understory shrub and herb species that prefer enriched conditions differentiate this community from acidic till or talus systems. More open or unstable talus areas correspond to ***temperate lichen talus barrens*** where lichens are the dominant life-form. ***Rich mesic forest*** patches can occur at the colluvial bases of some talus slopes, and are marked by the disappearance of red oak, ironwood, beech, and rich site vines or herbs more preferential to rich rocky talus such as *Geranium robertianum* (mountain crane's-bill), *Piptatherum racemosum* (black-seeded mountain-rice grass), *Clematis virginiana* (virgin's bower), and *Toxicodendron radicans* (poison-ivy). Thus, small patches of rich mesic forest are characteristic of this system and do not necessarily indicate a larger rich mesic forest system.

Diagnostic natural communities:

- Rich red oak rocky woods (S2S3)
- Red oak - black birch wooded talus (S3S4)
- Temperate lichen talus barren (S2S3)
- Rich mesic forest (S3)
- Semi-rich mesic sugar maple forest (S4)

Peripheral or occasional natural communities:

- Birch - mountain maple wooded talus (S3)
- Montane lichen talus barren (S3)

Associated natural community systems: This system often transitions to montane rocky ridge and montane - subalpine cliff systems upslope and northern hardwood - conifer forest or hemlock - hardwood - pine forest systems downslope.

Characteristic species:

Trees

Acer saccharum (sugar maple) – dom.
Quercus rubra (red oak) – dom.
Tilia americana (basswood)
Fraxinus americana (white ash)
Ostrya virginiana (ironwood)
Betula lenta (cherry birch)
Acer rubrum (red maple)
Betula alleghaniensis (yellow birch)
Betula papyrifera (paper birch)
Juglans cinerea (white walnut)

Shrubs and vines (often rich-site indicators)

Swida rugosa (round-leaved dogwood)
Clematis virginiana (virgin's bower)
Toxicodendron radicans (poison-ivy)
Corylus cornuta (beaked hazelnut)
Rubus odoratus (flowering raspberry)

Herbs (rich-site indicators)

Micranthes virginiensis (early small-flowered-saxifrage)
Geranium robertianum (mountain crane's-bill)
Aralia racemosa (American spikenard)
Piptatherum racemosum (black-seeded mountain-rice grass)
Milium effusum ssp. *cisatlanticum* (millet grass)
Asarum canadense (Canada wild ginger)
Carex rosea (rosy sedge)/*Carex radiata* (eastern star sedge)
Carex platyphylla (broad-leaved sedge)
Carex sprengelii (long-beaked sedge)

Potential rare species:

Geranium carolinianum (Carolina crane's-bill)*
Cardamine concatenata (cut-leaved toothwort)*
Adlumia fungosa (Allegheny-vine)*
Panax quinquefolius (American ginseng)*
Carex aestivalis (summer sedge)*

• Rich Appalachian oak rocky woods system

Landscape settings: talus or other rocky slopes in neutral to concave hillside slope positions, and occasionally upper-slope positions, particularly in regions of calcium-rich bedrock

Soils: overall dry-mesic with embedded dry and mesic micro-sites, well to somewhat excessively well drained; moderate to shallow depth fine sandy loams with considerable gravel and stone content with frequent outcrops, talus boulders, and/or unconsolidated stones; sometimes with a well-mixed "mull" A horizon

Spatial pattern: small to large patches (1–200+ acres); variably shaped, although often elliptical or broad-linear when controlled by topographic position (i.e., cliff-bases and hillside slopes)

Physiognomy: woodland to forest, rarely with patches of unvegetated or sparsely-vegetated lichen talus barrens

Distribution: low elevations in southern New Hampshire, mostly below 500 ft., ranging to ca. 1,000 ft.

Description: This system is the southern equivalent of rich temperate rocky woods system. It occurs mostly below 500 ft. and of more southerly distribution (e.g., within 30 miles of the coast or Massachusetts border) on rocky to shallow till hillsides. It is indicated by a host of southern plants that do not occur further north or at higher elevations. There are two primary natural communities, ***rich Appalachian oak rocky woods*** and ***red oak - ironwood - Pennsylvania sedge woodland***. ***Temperate lichen talus barrens*** are small and rare in this system, as are patches of ***rich mesic forest***. This system typically transitions to more nutrient poor, rocky conditions on ridgetops, which are classified as Appalachian oak rocky ridge systems. However, it occasionally occupies the ridgetop settings as well, where the ***red oak - ironwood - Pennsylvania sedge woodland*** community dominates. On forested sites where talus is the dominant substrate, the rare ***Appalachian wooded talus*** may occur. The hillsides on which this system occurs include talus, other unconsolidated, loose rocky slopes, and relatively shallow till soils with occasional outcrops.

Many of the diagnostic plants listed for rich temperate rocky woods occur in this system. Indicators of the primary community (***rich Appalachian oak rocky woods***) in this more southern system include hickories, flowering dogwood, oaks other than red oak, and a wide variety of herbs and shrubs that reach their northeastern limit in southern NH. Areas dominated by *Carex pensylvanica* (Pennsylvania sedge) lawns indicate the ***red oak - ironwood - Pennsylvania sedge woodland*** community, which tends to occur somewhat higher on hill side-slopes and even onto adjacent ridgelines compared to the ***rich Appalachian oak rocky woods*** community. These two communities are frequently found together in this system.

Diagnostic natural communities:

- Rich Appalachian oak rocky woods (S1)
- Red oak - ironwood - Pennsylvania sedge woodland (S2)
- Appalachian wooded talus (S1S2)
- Rich mesic forest (S3)
- Semi-rich oak - sugar maple forest (S2S3)

Peripheral or occasional natural communities:

- Appalachian oak - pine rocky ridge (S3)
- Chestnut oak forest/woodland (S1S2)
- Temperate lichen talus barren (S2S3)

Associated natural community systems: This system typically transitions to oak - pine forest systems or sometimes hemlock - hardwood - pine forest systems. More xeric conditions along adjacent ridgetops often mark the transition to Appalachian oak rocky ridge systems that lack the rich-site indicators of rich Appalachian oak rocky woods systems.

Characteristic species:

Rich Appalachian oak rocky woods (plants listed for rich temperate rocky woods system are also found in this system):

Southern species generally not found in north-temperate type:

Trees and shrubs

Quercus alba (white oak)
Carya ovata (shagbark hickory)
Carya cordiformis (bitternut hickory)
Carya glabra (pignut hickory)
Quercus montana (chestnut oak)
Quercus velutina (black oak) – ridgetops
Quercus coccinea (scarlet oak) – ridgetops
Benthamidia florida (flowering dogwood)
Viburnum rafinesquianum (downy arrowwood)*

Herbs

Asplenium platyneuron (ebony spleenwort)
Ranunculus fascicularis (early crowfoot)*
Symphyotrichum patens (late purple American-aster)*
Boechera canadensis (sicklepod rockcress)*
Boechera laevigata (smooth rockcress)*
Boechera missouriensis (green rockcress)*
Aureolaria virginica (downy false foxglove)*
Carex retroflexa (reflexed sedge)*
Lespedeza virginica (slender bush-clover)*
Pycnanthemum incanum (hoary mountain-mint)*
Paronychia canadensis (smooth forked whitlow-wort)*
Thalictrum thalictroides (anemone meadow-rue)*
Asclepias quadrifolia (four-leaved milkweed)*
Woodsia obtusa (blunt-lobed cliff fern)*
Muhlenbergia sobolifera (rock muhly)*
Viola pedata (bird-foot violet)*

CLASSIFICATION OF WETLAND NATURAL COMMUNITY SYSTEMS

PALUSTRINE (NON-TIDAL, NON-RIPARIAN)

PEATLANDS

Open peatland communities can be grouped into five categories based on vegetation structure: (1) open moss lawns and flarks; (2) dwarf- and medium-shrub bogs and poor fens; (3) sedge and shrub/graminoid fens; (4) tall shrub thicket/sparse woodlands; and (5) marshy peatland margin communities. Most peatland examples have several to many natural communities from some or all of these structural categories. The factors that appear to most strongly control which communities occur together in a repeating way within peatlands are a) the source and minerotrophic status of water; and b) the broad climate regime. The sources of water and its characteristics are discussed below.

The terms "bog" and "fen" have been used in many different ways. From a long-term peatland-development perspective, the term "bog" is usually applied only to ombrogenous peatlands that are strictly rain-fed. In this sense, New Hampshire has no known true bogs, but does contain a wide variety of "fens," or peatlands whose development is controlled in part by topogenous (upland runoff), limnogenous (stream or lake), or soligenous (groundwater) sources of water. Floristically, however, New Hampshire does contain peatland vegetation that is largely isolated from the influence of upland runoff, stream or lake water, or seepage, and is similar to vegetation that occurs in ombrogenous settings. We apply the term "bog" to plant communities that have pHs below 4.0 and only have species restricted to oligotrophic conditions. Other peatlands are considered fens. The 4.0 cutoff was shown by Wells (1996) to be a significant and convenient cutoff in Atlantic Canada peatlands. In these peatlands, pHs of 4.0 corresponded well to specific levels of calcium, iron, nitrogen, and magnesium that marked the transition from ombrotrophic conditions of bogs to the more minerotrophic conditions of fens. Data from New Hampshire (Sperduto et al. 2000a) are consistent with this cut-off as evidenced by the absence of species indicative of minerotrophic conditions at pHs below 4.0 in most plots.

It is also important to recognize that the vegetation of bogs and fens change at different rates depending on conditions. Some are quite stable over long periods, changing slowly over long timeframes as peat accumulates, while others undergo rapid change and succession over much shorter timeframes in response to natural or human disturbances. For example, peatlands in lake basins or those associated with streams (e.g., medium level fen systems) may be periodically flooded by beavers. Flooding can result in significant vegetation change, particularly if the peat mat is grounded instead of floating (Mitchell and Niering 1993). Emergent marsh and aquatic vegetation can become established where ericaceous shrubs once grew. However, over the long term water levels could change or peat build-up could resume as the basin continues to accumulate organic matter. Even some kettle hole bogs, which are commonly thought to have relatively stable water levels, have been shown to exhibit broad fluctuations and corresponding changes in vegetation (Miller 1996). Thus, in contrast to the common impression that all peatlands are stable, slowly changing systems, some of the variation we see among them is due to natural or human disturbances over the short term.

Open peatland system descriptions below are based on minor refinements of analyses described in Sperduto et al. (2000a), Sperduto et al. (2000b) and descriptions in Neid (2002), Sperduto and Nichols (2004), and Sperduto and Nichols (2011).

• Alpine/subalpine bog system

Landscape settings: concavities on ridges and on moderate to steep slopes over bedrock in subalpine and alpine zones

Soils: poorly to moderately decomposed peat soils over bedrock, generally less than 75 cm deep; oligotrophic; pHs less than 4.0; topogenous to soligenous water sources

Spatial pattern: small patch (<1–5 ac); circular to irregular shape; concentric zonation or uniform

Physiognomy: dwarf shrub and moss/liverwort lawns

Distribution: restricted to the White Mountains

Description: This system includes sloping and level peatlands that occur in the subalpine and alpine zone from 2,900–4,900 ft. elevation in the White Mountains. They are small (less than an acre to around five acres) and occur in concavities on ridges, and on moderate to steep slopes over bedrock where some combination of limited drainage, the damp subalpine climate, late melting snowpacks, and self-maintaining *Sphagnum* (peat moss) mats contribute to peat accumulation. Sloping peatlands are largely restricted to northern climates, and in New Hampshire they are restricted to the White Mountains and the northern part of the state. Here the cold wet climate and low evapotranspiration rate combine to allow peat to accumulate on sloping ground. ***Alpine/subalpine bogs*** are dominated primarily by lowland bog plants found in poor level fen/bog systems, but are distinguished from them by the presence of alpine and subalpine species.

Alpine/subalpine bog systems contain one or more of three peatland community types (see below). Many examples of this system contain both ***alpine/subalpine bogs*** (very poorly drained concavities and occasionally on slopes) and ***wooded subalpine bog/heath snowbanks*** (sloping to level ground, less wet, more black spruce and balsam fir, but still with thick, peaty organic soils). The former type has several wet-site bog species that are absent in ***wooded subalpine bog/heath snowbanks***. The ***wooded subalpine bog/heath snowbanks*** occur as a border zone around wetter bogs or in association with late melting snowbank areas, and have more black spruce and balsam fir. ***Subalpine sloping fens*** are boggy peat mats on the brow of some high elevation cliffs that are subject to sloughing off the cliff-edge, and contain the rare *Calamagrostis pickeringii* (Pickering's reed grass).

Diagnostic natural communities:

- Alpine/subalpine bog (S1)
- Wooded subalpine bog/heath snowbank (S1S2)
- Subalpine sloping fen (S1)

Associated natural community systems: In parts of the White Mountains, alpine/subalpine bog systems form a mosaic with subalpine heath - krummholz/rocky bald systems that have collectively been referred to as "heath balds" (Fahey 1976; Doyle 1987). These "heath balds" occur mostly below 4,000 ft.

elevation on flat to gently sloping ridgetops of the Mahoosuc, Carter-Moriah, and Baldface Ranges. Smaller examples are found in several other scattered locations. Otherwise alpine/subalpine bog systems are found either within the higher elevation alpine tundra mosaic in the Presidential Range, or embedded as patches within high-elevation spruce - fir forest systems.

Characteristic species:

Species characteristic of alpine/subalpine bog systems but absent or rare in poor level fen/bogs of lowlands:

Alpine/subalpine bog:

Trees – absent or sparse

Dwarf shrubs
Alpine/subalpine indicators:
Vaccinium uliginosum (alpine blueberry)
Empetrum nigrum (black crowberry)
Rubus chamaemorus (baked-apple-berry)*
Vaccinium vitis-idaea (mountain cranberry)
Other dwarf shrubs
Vaccinium oxycoccos (small cranberry)
Kalmia polifolia (bog laurel)
Rhododendron groenlandicum (Labrador-tea)
Chamaedaphne calyculata (leatherleaf) - >10%
Kalmia angustifolia (sheep laurel) - <10%

Herbs
Eriophorum vaginatum ssp. *spissum* (tussock cottonsedge)
Trichophorum cespitosum (tufted clubsedge)

Bryophytes and lichens
Peat mosses – constant & abundant
Sphagnum fuscum (peat moss)
Sphagnum capillifolium (peat moss)
Cetraria islandica (lichen)
Cladina rangiferina (lichen)

Wooded subalpine bog/heath snowbank:

Trees – prominent
Picea mariana (black spruce)
Abies balsamea (balsam fir)

Dwarf shrubs
Alpine/subalpine indicators:
Vaccinium uliginosum (alpine blueberry)
Empetrum nigrum (black crowberry)
Rubus chamaemorus (baked-apple-berry)* – rare but diagnostic
Vaccinium vitis-idaea (mountain cranberry)
Other dwarf shrubs:
Rhododendron groenlandicum (Labrador-tea)
Chamaedaphne calyculata (leatherleaf) - <10%
Kalmia angustifolia (sheep laurel)

Bryophytes and lichens
Peat mosses – less frequent & abundant
Cetraria islandica (lichen)
Cladina rangiferina (lichen)

• Kettle hole bog system

Landscape settings: closed-basin, kettle hole depressions in glacial outwash or ice-contact deposits

Soils: deep, poorly decomposed peat; oligotrophic; pHs $\leq$4.0; topogenous

Spatial pattern: small patch (1–20 acre); circular to irregular shape; more or less concentric zonation

Physiognomy: sparse woodland, tall shrub, dwarf shrub, moss carpets/lawns

Distribution: broadly distributed in New Hampshire, but concentrated in the central and southern portions of the state where kettle holes are more abundant

Description: Kettle hole bogs are found where big chunks of glacial ice were stranded and partially buried in glacial outwash or other coarse ice-contact deposits. The ice chunks subsequently melted, leaving ponds in holes in the ground, with no hydrologic inlets or outlets. Over millennia, peat has progressively filled in the kettle holes from the edges inward toward the pond center; most still have a central bog pond with a floating mat border, while some have covered the kettle surface entirely with peat and filled in the pond. These are oligotrophic peatlands, due to very limited terrestrial runoff influence from their small watersheds and coarse, porous soils, and to the dominance of precipitation as the primary water source (pHs are generally 4.0 or lower). There is often a moat separating the peat mat from the surrounding upland, which is largely a result of increased decomposition due to elevated nutrient levels from upland runoff as well as periodic, seasonal drawdown of the water table. The vegetation is dominated by species indicative of oligotrophic conditions including scattered, stunted *Picea mariana* (black spruce), numerous dwarf heath shrubs [(*Chamaedaphne calyculata* (leatherleaf), *Vaccinium oxycoccos* (small cranberry), *Kalmia angustifolia* (sheep laurel), *Kalmia polifolia* (bog laurel)], lawns (wet, floating lawns dominated by low, turfy mats of the leafy liverwort *Cladopodiella fluitans*, which turns black and looks like mud from a distance), *Utricularia* spp. (bladderworts), and *Rhynchospora alba* (white beaksedge). A typical community sequence from the upland border towards the center of the kettle hole is ***marshy moat*** (when present), tall shrub fen or ***black spruce swamp***, followed by a dense ***leatherleaf - black spruce bog*** zone, then a floating, reddish-colored open moss carpet (*Sphagnum rubellum*) with extremely dwarfed shrubs, and patches of *Sphagnum* pools with *Sphagnum cuspidatum* and the liverwort *Cladopodiella fluitans*. With the exception of the zone immediately along the upland border, pHs are usually 4.0 or lower throughout the bog.

Diagnostic natural communities:

- *Sphagnum rubellum* - small cranberry moss carpet (S3)
- Liverwort - horned bladderwort fen (S3)
- Leatherleaf - black spruce bog (S3)
- Highbush blueberry - mountain holly wooded fen (S3S4)
- Marshy moat (S4)

Peripheral or occasional natural communities:

- Large cranberry - short sedge moss lawn (S3) (*Sphagnum cuspidatum* variant)

- Leatherleaf - sheep laurel shrub bog (S1S3)
- Water willow - *Sphagnum* fen (S3)

Associated natural community systems: Kettle hole bog systems often occur in isolation of other wetland systems. They can also be surrounded by peat swamp systems (temperate, coastal conifer, or black spruce types) or occur adjacent to poor level fen/bog systems and, less frequently, medium level fen systems.

Characteristic species:

Indicators of oligotrophic conditions found in kettle hole and poor level fen/bog systems:

Dwarf to short shrubs

Chamaedaphne calyculata (leatherleaf) - <20" high (max 36")

Kalmia angustifolia (sheep laurel)

Kalmia polifolia (bog laurel)

Andromeda polifolia var. *glaucophylla* (bog rosemary)

Rhododendron groenlandicum (Labrador-tea)

Vaccinium oxycoccos (small cranberry)

Gaylussacia baccata (black huckleberry)

Gaylussacia bigeloviana (dwarf huckleberry)*

Herbs and carnivorous plants

Drosera rotundifolia (round-leaved sundew)

Drosera intermedia (spatulate-leaved sundew)

Sarracenia purpurea (purple pitcherplant)

Eriophorum virginicum (tawny cottonsedge)

Eriophorum vaginatum ssp. *spissum* (tussock cottonsedge)

Carex billingsii (Billings' sedge)

Trees and tall shrubs (sparse and dwarfed)

Vaccinium corymbosum (highbush blueberry)

Picea mariana (black spruce)

pHs generally 4.1 or lower

Lawns with mats of black liverwort

Indicators of weakly to moderately minertrophic conditions **mostly absent** (or limited to peatland margins) in kettle hole and poor level fen/bogs:

Herbs

Carex lasiocarpa ssp. *americana* (wire sedge)

Carex utriculata (swollen-beaked sedge)

Carex stricta (tussock sedge)

Carex lacustris (lake sedge)

Carex canescens (hoary sedge)

Lysimachia terrestris (swamp yellow-loosestrife)

Dulichium arundinaceum (three-way sedge)

Triadenum virginicum (Virginia marsh-St. John's-wort)

Osmundastrum cinnamomeum (cinnamon fern)

Shrubs and trees

Myrica gale (sweet gale)

Spiraea alba var. *latifolia* (meadowsweet)

Spiraea tomentosa (rosy meadowsweet)

Chamaedaphne calyculata (leatherleaf) – >20" and usually closer to 36" high

Vaccinium macrocarpon (large cranberry)

Alnus incana ssp. *rugosa* (speckled alder)

Ilex verticillata (common winterberry)

Acer rubrum (red maple)

pHs generally in low 4s to low 5s

• Poor level fen/bog system

Landscape settings: closed or stagnant, open headwater basins with limited drainage, often in depressions in glacial outwash or ice-contact deposits or broad lake basins away from the influence of lake water

Soils: deep, poorly decomposed peat oligotrophic, pHs generally ≤4.1; topogenous (limited limnogenous and soligenous influence)

Spatial pattern: small to large patch (5–100+ acres), occasionally extensive; circular to irregular shaped; more or less concentric zonation, less often irregular zonation; often with outlet stream, but without inlet streams

Physiognomy: sparse woodland, tall shrub, dwarf shrub, moss carpets/lawns

Distribution: broadly distributed; largest examples in central and northern New Hampshire

Description: Poor level fen/bogs are open, extremely acidic peatlands with only a limited amount of minerotrophic influence from the surrounding uplands, and very little or no groundwater or lake and stream influence. Oligotrophic to weakly minerotrophic conditions prevail, with pHs ranging from the high 3s to low 4s. They occur in a variety of landscape settings, ranging from nearly closed-basins to broad drainageways with sluggish, meandering streams, and adjacent to lakes but away from the influence of the lake-water. They are most frequent in areas of glacial outwash or ice-contact deposits. Peat is generally quite deep and poorly decomposed in the upper layers, with well-developed hummock - hollow topography.

Most of the peatland area is dominated by species indicative of oligotrophic to, at most, weakly minerotrophic conditions including scattered, stunted *Picea mariana* (black spruce), and extensive areas of mostly dwarfed heath shrubs (<0.5 m; *Chamaedaphne calyculata* (leatherleaf), *Vaccinium oxycoccos* (small cranberry), *Kalmia angustifolia* (sheep laurel), *Kalmia polifolia* (bog laurel)). A typical community sequence from the upland border towards the center of the peatland is a tall shrub fen or ***black spruce swamp*** border, followed by a dense ***leatherleaf - black spruce bog*** zone, then a reddish open moss carpet (*Sphagnum rubellum*) with extremely dwarfed shrubs, and occasionally patches of *Sphagnum* pools or lawns with *Sphagnum cuspidatum* or other aquatic peat mosses. There is sometimes a wet moat separating the peat mat from the surrounding upland. This develops from a combination of elevated nutrient levels in upland runoff and the periodic seasonal draw-down of the water table that increases the decomposition of the peat mat at the peatland margin. If a moat is not present, the outer zone is usually dominated by a peat swamp or a tall shrub fen (most commonly ***highbush blueberry - mountain holly wooded fen***). With the exception of the zone immediately along the upland border, pHs are usually in the low 4s or lower throughout the peatland. Floristic differences are evident in northern or higher elevation examples compared to coastal or southern examples, but the overall vegetation patterns are similar.

Diagnostic natural communities:

- *Sphagnum rubellum* - small cranberry moss carpet (S3)
- Leatherleaf - black spruce bog (S3)

- Leatherleaf - sheep laurel shrub bog (S2S3)
- Highbush blueberry - mountain holly wooded fen (S3S4)
- Montane level fen/bog (S2)

Peripheral or occasional natural communities:

- Large cranberry - short sedge moss lawn (S3)
- Mountain holly - black spruce wooded fen (S3)
- Water willow - *Sphagnum* fen (S3)
- Marshy moat (S4)

Associated natural community systems: This system can co-occur in large peatland basins with medium level fen and peat swamp systems (e.g., black spruce, coastal conifer, or temperate peat swamps). It is common for poor level fen/bogs to have small marginal areas adjacent to water bodies or uplands that have more minerotrophic communities typical of medium fens. When these areas are limited in extent or constitute a small proportion of the peatland, they are considered inclusions within the poor level fen/bog; when they are more extensive or constitute a substantial proportion of the peatland, the peatland may best be treated as having both poor and medium level fens systems within the same wetland. Conversely, medium level fens can have areas with more limited minerotrophic influence with poor fen communities. These are treated in the same way.

Characteristic species:

<u>Dwarf to short shrubs</u>

Chamaedaphne calyculata (leatherleaf) - <20" high (max 36")

Kalmia angustifolia (sheep laurel)

Kalmia polifolia (bog laurel)

Andromeda polifolia var. *glaucophylla* (bog rosemary)

Rhododendron groenlandicum (Labrador-tea)

Vaccinium oxycoccos (small cranberry)

Gaylussacia baccata (black huckleberry)

Gaylussacia bigeloviana (dwarf huckleberry)*

<u>Herbs and carnivorous plants</u>

Drosera rotundifolia (round-leaved sundew)

Drosera intermedia (spatulate-leaved sundew)

Sarracenia purpurea (purple pitcherplant)

Eriophorum virginicum (tawny cottonsedge)

Eriophorum vaginatum ssp. *spissum* (tussock cottonsedge)

Carex billingsii (Billings' sedge)

<u>Trees and tall shrubs</u> (sparse and dwarfed)

Vaccinium corymbosum (highbush blueberry)

Picea mariana (black spruce)

pHs generally 4.1 or lower

Refer also kettle hole bog system for list of minerotrophic indicators absent from poor level fen/bog systems.

• Medium level fen system

Landscape settings: sluggish stream, pond or lake borders, open headwater basins, drained depressions in glacial outwash or ice-contact deposits

Soils: deep, poorly- to moderately well-decomposed peat; weakly to moderately minerotrophic; pHs generally in low 4s to mid 5s; topogenous and limnogenous (limited soligenous influence)

Spatial pattern: small to large patch (5–100+ acres); irregularly circular or linear; irregular or banded zonation parallel to stream or pond border; streams often pass through peatland (has inlet and outlet)

Physiognomy: sparse woodland, tall shrub, medium-height shrub, moss carpets/lawns

Distribution: broadly distributed in New Hampshire

Description: Medium level fens are open, acidic peatlands with more minerotrophic influence than poor level fen/bogs due to the effects of upland runoff, exposure to lake and stream water, or limited groundwater seepage. Weakly to moderately minerotrophic conditions prevail, with pHs ranging from the low 4s to mid 5s. They occur in a variety of landscape settings, but mostly along stream and lake borders where the nutrient levels and seasonal fluctuations of water levels are greater than in poor level fens, but less than in emergent marshes (thus allowing peat to accumulate over the long term). They are most frequent around relatively stagnant ponds and lakes and drained depressions in glacial outwash or ice-contact deposits. Peat is moderate to deep and moderately well decomposed in the upper layers, with a well-developed hummock - hollow topography in many of its constituent communities. In New Hampshire, they are more common than kettle hole bog and poor level fen/bog systems.

These systems are a mosaic of open, sedge-dominated fens, dwarf to medium-height shrublands, and open moss lawns, carpets, and pools. Tall shrub fens are also common. In shrubby areas, vigorous patches of *Myrica gale* (sweet gale), *Spiraea alba* var. *latifolia* (meadowsweet), and sometimes *Chamaedaphne calyculata* (leatherleaf) are prominent and usually more than 20" (50 cm) in height (leatherleaf tends to be shorter in poor level fen/bogs). *Ilex verticillata* (common winterberry), *Toxicodendron vernix* (poison-sumac), *Acer rubrum* (red maple), and *Larix laricina* (American larch) indicate weakly to moderately minerotrophic conditions in areas that have tall shrubs and trees (these species are sparse or absent in poor fens). Robust, tall sedges, like *Carex lasiocarpa* (wire sedge), *Carex utriculata* (swollen-beaked sedge), and *Carex stricta* (tussock sedge), are also common, and may dominate large areas individually or in mixtures with other species. Moat areas along the upland margin and lawns, carpets, and pools near water bodies often support aquatic peat mosses and herbs such as *Sphagnum torreyanum*, *S. cuspidatum*, *S. pulchrum*, *Carex canescens* (hoary sedge), *Vaccinium macrocarpon* (large cranberry), *Rhynchospora alba* (white beaksedge), and *Dulichium arundinaceum* (three-way sedge).

A typical natural community sequence from the upland border towards the center of the basin, channel, or water-margin is as follows: a moat; a tall shrub fen zone; a dense medium-height shrub zone with sweet gale; sedge fen; and open moss carpet areas closest to the water's edge. Moss carpets or lawns are typically not present or well developed in fens along streams, but are more common in lake border or floating mat settings.

Diagnostic natural communities:

Moss lawns and sedge/medium-shrub fens

- Sweet gale - meadowsweet - tussock sedge fen (S4)
- Wire sedge - sweet gale fen (S3)
- Large cranberry - short sedge moss lawn (S3)
- Bog rosemary - sedge fen (S3)

Tall shrub fens

- Highbush blueberry - sweet gale - meadowsweet shrub thicket (S4)
- Winterberry - cinnamon fern wooded fen (S4)
- Sweet pepperbush wooded fen (S2)
- Alder wooded fen (S3S4)

Peripheral or occasional natural communities:

- Floating marshy peat mat (S3S4)
- Marshy moat (S4)
- Water willow - *Sphagnum* fen (S3)
- Alder - lake sedge intermediate fen (S2S3)
- Montane level fen/bog (S2)
- Sedge meadow marsh (S4)

Associated natural community systems: In large peatland basins, this system can co-occur with poor level fen/bog systems. It is typical for medium level fen peatlands to have small portions dominated by oligotrophic conditions and communities. When these areas are limited in extent or constitute a small proportion of the wetland, they are considered inclusions within the medium level fen system; when they are more extensive or constitute a substantial proportion of the wetland, the peatland may best be treated as having both poor and medium level fens systems within the same site. Conversely, poor level fen/bogs can have areas with more minerotrophic influence with medium level fen communities.

Characteristic species:

Indicators of weakly to moderately minertrophic conditions found in medium level fens (mostly absent or limited to marginal areas of kettle hole and poor level fen/bogs):

Herbs

Carex lasiocarpa (wire sedge)

Carex utriculata (swollen-beaked sedge)

Carex stricta (tussock sedge)

Carex lacustris (lake sedge)

Carex canescens (hoary sedge)

Lysimachia terrestris (swamp yellow-loosestrife)

Dulichium arundinaceum (three-way sedge)

Triadenum virginicum (Virginia marsh-St. John's-wort)

Osmundastrum cinnamomeum (cinnamon fern)

Shrubs and trees

Myrica gale (sweet gale)

Spiraea alba var. *latifolia* (meadowsweet)

Spiraea tomentosa (rosy meadowsweet)

Chamaedaphne calyculata (leatherleaf) - >20" and usually closer to 36" high

Vaccinium macrocarpon (large cranberry)

Ilex verticillata (common winterberry)

Alnus incana ssp. *rugosa* (speckled alder)

Acer rubrum (red maple)

Larix laricina (American larch)

Toxicodendron vernix (poison-sumac)

pHs generally in low 4s to low 5s

Many species of kettle hole and poor level fen/bog systems may also be found in medium level fens (see list in kettle hole bog system)

• Montane sloping fen system

Landscape settings: moderate- to high-elevation (above 2,400 ft.) valley bottoms and adjacent gently sloped mountain side-slopes; occur on definite soligenous slopes, shallow level depressions, and small drainage-ways associated with old beaver dams

Soils: shallow, well-decomposed peat; often on glacial lake bed or other silty-gravelly mineral deposits; weakly to moderately minerotrophic; pHs average 5.3 (4.2 to 6.3); soligenous and topogenous

Spatial pattern: small to large patch (<5–50+ acres); oval to irregular or linear shapes, irregular zonation

Physiognomy: graminoid - moss lawns, graminoid - shrub, tall shrub, sparse woodland and woodland

Distribution: found above 2,400 ft. in the White Mountains

Description: This peatland system is weakly to moderately minerotrophic and forms nearly level to demonstrably sloping soligenous peat mats in the White Mountains at moderate to high elevations (above 2,400 ft.). This system consists of ***montane sloping fens*** occurring in a mosaic with ***montane alder - heath shrub thickets*** and ***montane heath woodlands***. Peats are well decomposed, and hummock - hollow topography is moderately well to poorly developed. Soil pHs range from 4.2 to 6.2 (average 5.3). Surfaces are nearly level to sloping (up to 10–20 degrees). Portions of some montane sloping fen systems are associated with headwater drainage areas formerly impounded by beavers that were abandoned decades ago and have subsequently filled in with organics.

The key diagnostic natural community of this system, ***montane sloping fen***, is dominated by graminoids or graminoids and shrubs, and is the only known fen in the state or region that is characterized by a grass. *Calamagrostis pickeringii* (Pickering's reed grass) on average contributes about 5% cover, and *Carex wiegandii* (Wiegand's sedge) is frequent (both are state and regionally rare). Numerous other northern poor and medium fen plants are present (listed below).

Diagnostic natural communities:

- Montane sloping fen (S1)
- Montane alder - heath shrub thicket (S1)

Peripheral or occasional natural communities:

- Montane heath woodland (S2)

Associated natural community systems: These systems are often set in a matrix of spruce - fir forest/swamp systems in high-elevation valley bottoms, which sometimes include montane black spruce - red spruce forests.

Characteristic species:

Montane sloping fen:

Herbs

Calamagrostis pickeringii (Pickering's reed grass)
Carex wiegandii (Wiegand's sedge)*
Carex echinata (star sedge)
Carex pauciflora (few-flowered sedge)
Carex oligosperma (few-seeded sedge)
Solidago uliginosa (bog goldenrod)
Veratrum viride (American false hellebore)
Platanthera clavellata (little club-spur bog-orchid)
Drosera rotundifolia (round-leaved sundew)
Eriophorum virginicum (tawny cottonsedge)

Shrubs

Chamaedaphne calyculata (leatherleaf)
Kalmia polifolia (bog laurel)
Rhododendron groenlandicum (Labrador-tea)
Rhododendron canadense (rhodora)
Ilex mucronata (mountain holly)

Lowland peatland plants are absent, including:
Vaccinium corymbosum (highbush blueberry)
Gaylussacia baccata (black huckleberry)
Ilex verticillata (common winterberry)
Woodwardia virginica (Virginia chain fern)

• Patterned fen system

Hydrogeomorphic categories: palustrine, depressional, gently sloping, peatland,

Landscape settings: extensive flats (peatland and lowland spruce - fir forest/swamps)

Soils: moderately well to well decomposed peat; weakly minerotrophic (acidic examples) to strongly minerotrophic (circumneutral to alkaline examples); pHs 4–5 (acidic examples); 6.3–8.0 (circumneutral to alkaline examples); soligenous with some topogenous influence

Spatial pattern: small to large patch (15–50+ ac); oblong to broad ovals; repeating parallel zonation of strings (hummock ridges) and flarks (hollows)

Physiognomy: dwarf shrub with stunted conifers, graminoid - moss carpets

Distribution: found only in extreme northern New Hampshire

Description: Slow groundwater movement through broad gently sloped peatlands forms a series of linear hummock ridges, called strings, separated by parallel hollows known as flarks. Strings and flarks are arranged perpendicularly to the flow of water through the peatland and can form a regular to intricate pattern of parallel ridges and hollows. Acidic patterned fens occur where groundwater seepage is nutrient-poor. Patterned peatlands reach their southern extent in New Hampshire where patterning is less well developed than further north; they are more extensive and well-developed in boreal and subpolar areas where precipitation greatly exceeds evaporation.

The strings and flarks in these patterned peatlands have dramatically different vegetation. The strings in acidic examples are similar to poor level fen/bog vegetation and primarily composed of dwarf shrub vegetation, dominated by *Chamaedaphne calyculata* (leatherleaf), other dwarf shrubs, and scattered, stunted *Picea mariana* (black spruce) and *Larix laricina* (American larch). Herbs are sparse on these hummock ridges. Hollows are filled with open pools, ***liverwort - horned bladderwort fens***, or *Sphagnum* moss carpets with sparse dwarf shrubs and sundews. *Carex exilis* (meagre sedge)* is a diagnostic herb of flarks in New Hampshire patterned fens.

The strings in our one circumneutral example are primarily dominated by stunted (and heavily browsed) *Thuja occidentalis* (northern white cedar), averaging 1 m tall amidst dwarf shrubs, with a taller scattered canopy of northern white cedar, black spruce, eastern larch, and *Acer rubrum* (red maple). Herbs are scattered in low abundance. All of this is over a diverse carpet of peat mosses and "brown" mosses (mostly in Amblystegeacae family). The ***circumneutral - calcareous flarks*** range from a few meters to more than 10 m wide and have a thick mat of brown algae interspersed with low plant cover of herbs and mosses.

While the distinct vegetative differences between acidic and circumneutral examples could support splitting this system into two types, we consider them together as one type for purely pragmatic conservation reasons: there are so few examples, all have high conservation value, and none are likely to be overlooked in conservation efforts.

Diagnostic natural communities:

Flarks

- *Sphagnum rubellum* - small cranberry moss carpet (S3)
- Liverwort - horned bladderwort fen (S3)
- Large cranberry - short sedge moss lawn (S3) (*S. cuspidatum* variant)
- Circumneutral - calcareous flark (S1) (circumneutral examples)

Strings

- Leatherleaf - black spruce bog (S3)
- Northern white cedar circumneutral string (S1)

Associated systems: Patterned fens are surrounded by black spruce peat swamp and lowland spruce - fir forest/swamp systems (acidic examples) and northern white cedar minerotrophic swamp system (circumneutral example).

Characteristic species:

Strings:

Acidic strings:
Picea mariana (black spruce)
Larix laricina (American larch)
Chamaedaphne calyculata (leatherleaf)
Kalmia angustifolia (sheep laurel)
Rhododendron groenlandicum (Labrador-tea)

Northern white cedar circumneutral string
Thuja occidentalis (northern white cedar) – dom.
Picea mariana (black spruce)
Larix laricina (American larch)
Chamaedaphne calyculata (leatherleaf)
Kalmia angustifolia (sheep laurel)
Rhododendron groenlandicum (Labrador-tea)
Muhlenbergia glomerata (spike muhly)
Trichophorum alpinum (alpine clubsedge)
Salix pedicellaris (bog willow)

Flarks:

Acidic flarks:
Cladopodiella fluitans (liverwort)
Utricularia cornuta (horned bladderwort)
Vaccinium oxycoccos (small cranberry)
Drosera rotundifolia (round-leaved sundew)
Drosera intermedia (spatulate-leaved sundew)
Carex exilis (meagre sedge)*
Sphagnum rubellum (peat moss)
Sphagnum cuspidatum (peat moss)

Circumneutral - calcareous flark:
Sphagnum contortum (peat moss)*
Carex exilis (meager sedge)*
Menyanthes trifoliata (buck-bean)
Trichophorum alpinum (alpine clubsedge)
Utricularia minor (lesser bladderwort)
Sarracenia purpurea (purple pitcherplant)
Rhynchospora alba (white beaksedge)
Drosera intermedia (spatulate-leaved sundew)
Carex livida (livid sedge)*
Juncus stygius ssp. *americanus* (moor rush)*
Carex tenuiflora (sparse-flowered sedge)*

• Calcareous sloping fen system

Landscape settings: headwater positions, openings in northern white cedar swamps, steep terraces of rivers or streams, side slopes; also in small basins or catchments, stream margins, and old pastures

Soils: well decomposed shallow to moderately deep peat; strongly minerotrophic; pH ranges from 6.7 to 8.2 (average 7.2); soligenous

Spatial pattern: small patch (mostly <5 acres); irregular zonation or uniform

Physiognomy: graminoid - moss carpets, sedge - medium height sparse shrubland

Distribution: north and northwest of the White Mountains and northern Connecticut River valley

Description: ***Calcareous sedge - moss fens*** are dominated by a distinct assemblage of low sedges and other graminoids over a carpet of "brown" mosses and several uncommon to rare peat mosses. Scattered willow and dogwood shrubs are often present. These peatlands are among the most botanically diverse in New Hampshire and contain many calciphilic plant species in addition to more common wetland species. There are often numerous orchids and other uncommon herbs interspersed among the graminoids and shrubs; these orchids and herbs are absent in oligotrophic to moderately minerotrophic peatland systems (such as medium and poor level fen/bogs and kettle hole bogs). Many of these species are rare, and restricted to these systems.

These systems are restricted to areas that have considerable year-round seepage through base-rich or carbonate-bearing bedrock types. Minerotrophic seepage is the primary water source in these systems and there are often rivulets or small open pools. These systems are small in size and occur in a variety of settings in New Hampshire including both groundwater influenced and "disturbed" areas, such as old pastures. Common settings for this system include headwater positions, open gaps in calcareous seepage swamps (e.g., northern white cedar swamps), step terraces of rivers or streams, and side slopes of hills. They also occur in small basins, kettles, or catchments with seepage influence and along margins of streams flowing through marshes or swamps in areas with calcareous bedrock. Certain expressions of these systems often occur where disturbance maintains vegetation in an early successional state, such as beaver meadows and grazed pastures or hay fields.

Soils typically are comprised of shallow to moderate depths of well-decomposed peat. Peat depth varies with landscape setting; deeper peat accumulation occurs in basins and gentle slopes relative to steeper slopes or periodically disturbed areas such as terraces along major rivers or old pastures. While some examples are nearly level, most have gentle to prominent slopes.

Diagnostic natural communities:

- Calcareous sedge - moss fen (S2)

Associated natural community systems: This system is most often associated with northern white cedar minerotrophic swamp systems, and occasionally drainage marsh - shrub swamp or spruce - fir forest/swamp systems.

Characteristic species:

Calcareous sedge - moss fen:

Trees and shrubs

Swida sericea (red-osier dogwood)

Dasiphora floribunda (shrubby-cinquefoil)

Thuja occidentalis (northern white cedar)

Herbs

Carex interior (inland sedge)

Carex flava (yellow-green sedge)

Carex hystericina (porcupine sedge)

Carex aurea (golden-fruited sedge)*

Carex castanea (chestnut sedge)*

Trichophorum cespitosum (tufted clubsedge)

Packera schweinitziana (New England groundsel)

Lobelia kalmii (brook lobelia)*

Parnassia glauca (fen grass-of-Parnassus)*

Petasites frigidus var. *palmatus* (northern sweet-coltsfoot)*

Cypripedium reginae (showy lady's-slipper)*

Bryophytes

Aulocomnium palustre (moss)

Philonotus fontana (moss)

Sphagnum warnstorfii (peat moss)

Tomenthypnum nitens (moss)

Bryum pseudotriquetrum (moss)

Campyllium stellatum (moss)

Pellia epiphylla (liverwort)

• Black spruce peat swamp system

Landscape settings: closed or stagnant, open headwater basins with limited drainage, often in depressions in glacial outwash or ice-contact deposits or broad lake basins away from the influence of lake water

Soils: deep, moderately decomposed peat; oligotrophic to weakly minerotrophic; pHs generally in 3s to mid 4s, occasionally higher; topogenous

Spatial pattern: small to large patch (5–100+ acres), occasionally extensive; circular to irregular shape, often as exterior zone around open peatlands or sometimes in mosaics with more open peatlands

Physiognomy: forest to woodland and tall shrub

Distribution: broadly distributed in central and northern New Hampshire, much less common in lowland southern New Hampshire

Description: This system corresponds to acidic, nutrient-poor wooded peatlands dominated by boreal conifers and heath shrubs, particularly *Picea mariana* (black spruce) and to a lesser extent *Larix laricina* (eastern larch) and other conifers. The main community is ***black spruce swamp***, which has a transcontinental boreal distribution with extensions south into northern and central New Hampshire. This community often surrounds open peatlands or can dominate peatland basins that have no open communities. This system occurs on moderately deep to very deep peats. Black spruce dominated areas sometimes transition to ***acidic northern white cedar swamps*** on peat or ***red spruce swamps*** on mineral soil, or ***northern white cedar - balsam fir swamps*** on minerotrophic peats. These are acidic peatlands, typically with pHs in the high 3s to mid-4s. Patches of tall shrub peatland thickets (fens with <25% tree cover) are common as part of the swamp mosaic. Where these tall shrub fens become extensive, they should be considered part of an adjacent open peatland system.

Diagnostic natural communities:

- Black spruce swamp (S3)
- Highbush blueberry - mountain holly wooded fen (S3S4)
- Mountain holly - black spruce wooded fen (S3)

Peripheral or occasional natural communities:

- Red spruce swamp (S3)
- Larch - mixed conifer swamp (S3)
- Acidic northern white cedar swamp (S1)
- Northern white cedar - balsam fir swamp (S2)
- Alder wooded fen (S3S4)

Associated natural community systems: This system is often found in association with poor level fen/bogs, kettle hole bogs, and lowland spruce - fir forest/swamp systems. When this system surrounds an open bog or fen system, the two communities that typically mark the transition to open peatland system are ***leatherleaf - black spruce bog*** and ***highbush blueberry - mountain holly wooded fen***. The frequency and size of this system generally diminishes to the south in New Hampshire where temperate or coastal conifer peat systems are more common, and where ***black spruce swamps*** usually form narrow borders around bogs.

Characteristic species:

Black spruce swamp:

Trees and shrubs
Picea mariana (black spruce) – dominant
Occasional:
Larix laricina (American larch)
Picea rubens (red spruce)
Abies balsamea (balsam fir)
Ilex mucronata (mountain holly)
Viburnum nudum (withe-rod)
Lyonia ligustrina (maleberry)

Dwarf shrubs
Rhododendron groenlandicum (Labrador-tea)
Kalmia angustifolia (sheep laurel)
Rhododendron canadense (rhodora)
Vaccinium myrtilloides (velvet-leaf blueberry)
Gaultheria hispidula (creeping spicy-wintergreen)
Chamaepericlymenum canadense (bunchberry)
Coptis trifolia (three-leaved goldthread)

Herbs
Carex trisperma (three-seeded sedge)
Osmundastrum cinnamomeum (cinnamon fern)

Bryophytes
Sphagnum spp. (peat mosses)

• Coastal conifer peat swamp system

Landscape settings: stagnant, closed or open headwater basins with limited drainage; often in depressions in glacial outwash or ice-contact deposits or broad lake basins away from the influence of lake water

Soils: deep, moderately well decomposed peat; oligotrophic to weakly minerotrophic; pHs generally less than 5, occasionally higher; topogenous

Spatial pattern: small to large patch (<5–30+ acres); circular to irregular shape; uniform or forming exterior zone around open peatlands, sometimes in mosaics with more open peatlands

Physiognomy: forest to woodland with tall shrub patches

Distribution: found in coastal New Hampshire with disjunct occurrences in the highlands of southwest New Hampshire, the Merrimack Valley and the Lakes Region

Description: This system corresponds to acidic, oligotrophic peatlands in central and southern New Hampshire dominated by *Chamaecyparis thyoides* (Atlantic white cedar), and occasionally *Pinus rigida* (pitch pine). The system is characterized by one or more of the five Atlantic white cedar natural communities. Atlantic white cedar dominates some or all of a peatland basin, mixing in some areas with ***red maple - Sphagnum basin swamps*** and tall shrub fen communities. It is found in association with and in isolation of open peatland systems. This system occurs on moderately to very deep peat with pHs less than 5, although pH and trophic levels can be higher around the system margins where there is a shift in natural community type. Some inland examples of this system are very acidic (pHs as low as 3.4); seasonally flooded portions of these systems that transition to emergent marshes have higher pHs (4.4 to 6.5). Coastal plain and southern species are more common in this wetland system than in more inland, northern, or higher elevation temperate peat swamps. These include *Clethra alnifolia* (sweet pepperbush), *Rhododendron maximum* (giant rhododendron)*, and *Sphagnum flavicomans* (peat moss). Patches of tall shrub peatland thickets (fens with <25% tree cover) are common as part of the swamp mosaic. Where these tall shrub fens become extensive, they should be considered part of an adjacent open peatland system.

Diagnostic natural communities:

- Atlantic white cedar - yellow birch - pepperbush swamp (S2)
- Atlantic white cedar - leatherleaf swamp (S1)
- Atlantic white cedar - giant rhododendron swamp (S1)
- Inland Atlantic white cedar swamp (S1)
- Seasonally flooded Atlantic white cedar swamp (S2)
- Pitch pine - heath swamp (S1S2)
- Sweet pepperbush wooded fen (S2)
- Highbush blueberry - mountain holly wooded fen (S3S4)
- Red maple - *Sphagnum* basin swamp (S4)

Peripheral or occasional natural communities:

- Black spruce swamp (S3)
- Black gum - red maple basin swamp (S3)
- Highbush blueberry - winterberry shrub thicket (S4)

Associated natural community systems: This system is often found in association with poor level fen/bogs, kettle hole bogs, and in stagnant headwater basins in isolation of other peatlands or open wetlands. Structurally, it is similar to the temperate peat swamp system (which is largely hardwood dominated, more common, and ranges further northward, inland, and to higher elevations).

Characteristic species:

Trees

Abundant

Chamaecyparis thyoides (Atlantic white cedar)

Acer rubrum (red maple)

Frequent:

Betula alleghaniensis (yellow birch)

Tsuga canadensis (hemlock)

Picea rubens (red spruce)

Herbs

Osmundastrum cinnamomeum (cinnamon fern)

Coptis trifolia (three-leaved goldthread)

Mitchella repens (partridge-berry)

Osmunda regalis var. *spectabilis* (royal fern)

Carex trisperma (three-seeded sedge)

Parathelypteris simulata (Massachusetts fern)

Shrubs

Ilex verticillata (common winterberry)

Vaccinium corymbosum (highbush blueberry)

Ilex mucronata (mountain holly)

Clethra alnifolia (sweet pepperbush)

Rhododendron maximum (giant rhododendron)*

Kalmia latifolia (mountain laurel)

Kalmia angustifolia (sheep laurel)

• Temperate peat swamp system

Landscape settings: closed or stagnant, open headwater basins with limited drainage, often in depressions in glacial outwash or ice-contact deposits or lake or pond basins away from the influence of lake water

Soils: deep, moderately well decomposed peat; oligotrophic to weakly minerotrophic; pHs generally less than 5; topogenous

Spatial pattern: small to large patch (<5–50+ acres), circular to irregular shape; uniform or forming exterior zone around open peatlands, sometimes in mosaics with more open peatlands

Physiognomy: forest to woodland with tall shrub patches

Distribution: found in central and southern New Hampshire

Description: This system corresponds to acidic, oligotrophic peatlands in central and southern New Hampshire dominated by *Acer rubrum* (red maple) with variable amounts of conifers and other hardwoods. *Picea rubens* (red spruce) is a common but minor associate, but otherwise northern conifers are absent or sparse, particularly in southern New Hampshire. The tall shrub layer is well developed and dominated by *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (common winterberry). An abundance of peat mosses (*Sphagnum* spp.), *Osmundastrum cinnamomeum* (cinnamon fern), and other herbs are characteristic. It is characterized by oligotrophic to weakly minerotrophic conditions, and therefore lacks minerotrophic indicators (although sometimes found around the margins) indicative of temperate minerotrophic swamps, such as *Onoclea sensibilis* (sensitive fern), *Toxicodendron radicans* (poison-ivy), *Lindera benzoin* (northern spicebush), and *Fraxinus nigra* (black ash). The core community is ***red maple - Sphagnum basin swamp***, which is usually a peatland (>40 cm organic matter) but sometimes occurs on mineral soils with a histic epipedon (shallow organic layer less than 40 cm) where there may be more seasonal water fluctuations than in deep peat settings. Mineral histic examples may occupy the entire swamp basin, or more commonly just the swamp areas marginal to uplands where organic accumulation is less. The system is sometimes found in association with open peatland systems, but may also occur by itself. Measured pHs are generally less than 5.3 (as low as 3.7), although pH and trophic levels can be higher around the system margins where there is often a shift in natural community type. More southern or low elevation examples are more likely to contain species restricted to coastal or southern parts of the state. Patches of tall shrub fens (<25% tree cover) are common as part of the swamp mosaic; where these tall shrub fens become extensive, they may be considered part of an adjacent open peatland system. The transition to upland forests in this swamp system is often marked by a border of ***hemlock - cinnamon fern forest*** or ***red maple - red oak - cinnamon fern forest***.

Diagnostic natural communities:

- Red maple - *Sphagnum* basin swamp (S4)
- Black gum - red maple basin swamp (S3)
- Swamp white oak basin swamp (S1)
- Highbush blueberry - winterberry shrub thicket (S4)

- Highbush blueberry - mountain holly wooded fen (S3S4)
- Winterberry - cinnamon fern wooded fen (S4)

Peripheral or occasional natural communities:

- Hemlock - cinnamon fern forest (S4)
- Red maple - red oak - cinnamon fern forest (S3S4)
- Red maple - pitch pine - cinnamon fern forest (S1S2)
- Red maple - sensitive fern swamp (S3S4)
- Seasonally flooded red maple swamp (S4S5)
- Red spruce swamp (S3)

Associated natural community systems: This swamp system may be found around some poor level fen/bog and kettle hole bog systems, and in association with coastal conifer peat or temperate minerotrophic swamp systems, particularly in larger swamp systems that encompass a broad range of wetland conditions. This system transitions to red spruce swamps at moderate elevations.

Characteristic species:

Trees and shrubs

Abundant species:

Acer rubrum (red maple)

Vaccinium corymbosum (highbush blueberry)

Ilex verticillata (common winterberry)

Occasional to locally abundant species (broad distribution):

Picea rubens (red spruce)

Tsuga canadensis (hemlock)

Betula alleghaniensis (yellow birch)

Ilex mucronata (mountain holly)

Kalmia angustifolia (sheep laurel)

Occasional to locally abundant species (restricted to coastal or southern NH; absent from montane/near-boreal swamps):

Nyssa sylvatica (black gum)

Quercus bicolor (swamp white oak)

Clethra alnifolia (sweet pepperbush)

Ilex laevigata (smooth winterberry)

Rhododendron viscosum (clammy azalea)

Rhododendron maximum (giant rhododendron)

Kalmia latifolia (mountain laurel)

Herbs and bryophytes

Abundant:

Osmundastrum cinnamomeum (cinnamon fern)

Sphagnum spp. (peat mosses)

Occasional to locally abundant (broad distribution):

Carex trisperma (three-seeded sedge)

Thelypteris palustris var. *pubescens* (marsh fern)

Lycopus uniflorus (northern water-horehound)

Carex folliculata (northern long sedge)

Carex canescens ssp. *canescens* (hoary sedge)

Occasional to locally abundant (coastal or southern distribution):

Parathelypteris simulata (Massachusetts fern)

Woodwardia virginica (Virginia chain fern)

Woodwardia areolata (netted chain fern)

Sphagnum torreyanum (peat moss)

• Montane/near-boreal minerotrophic peat swamp system

Landscape settings: headwater basins and broad drainageways, extensive flats, pond and lake basins, and adjacent gentle slopes

Soils: deep to moderately deep, well-decomposed peat, grading to mineral soils in sloped swamp margins; moderately to strongly minerotrophic, pHs range from 4.9–7.5; topogenous and soligenous

Spatial pattern: small to large patches (<5–100+ acres), sometimes extensive; circular-oval or irregular shape; uniform or sometimes with sedgy or shrubby openings or surrounding open peatlands

Physiognomy: forest to woodland with tall shrub or herbaceous openings

Distribution: occurs north and northwest of the White Mountains; disjunct in Conway area

Description: This system is primarily found in the North Country on deep, minerotrophic organic soils with *Thuja occidentalis* (northern white cedar). At least two swamp types are typically present: ***northern white cedar - balsam fir swamps*** tend to occur on organic soils (muck and peat >16 in.); and ***northern hardwood - black ash - conifer swamps*** are often found toward the swamp margins on level to sloping mineral soil (shallow organic layer 0–16 in.). In contrast to more acidic black spruce peat swamps, this swamp system is strongly influenced by minerotrophic groundwater seepage. On sites with a moderate degree of mineral enrichment, the ***larch - mixed conifer swamp*** may be present. Overall, the swamps are conifer-dominated or mixed hardwood - conifer dominated. Abundant to frequent northern conifers and hardwoods includes northern white cedar, *Abies balsamea* (balsam fir), *Larix laricina* (American larch), and *Picea* spp. (spruces); *Fraxinus nigra* (black ash), *Betula alleghaniensis* (yellow birch), and *Acer rubrum* (red maple). Northern white cedar swamps have a northeastern-boreal distribution in North America (Great Lakes to Canadian Maritimes), and extend into northern New Hampshire, mostly north of the White Mountains. In New Hampshire, black ash is most abundant in this system. These are diverse swamp systems that harbor many vascular plants (>200 species) and bryophytes (>65 species), particularly those preferring circumneutral conditions. The peat or muck in the ***northern white cedar - balsam fir swamps*** are usually over a meter in depth, well decomposed, and with an average pH of 6.1 (range of 4.9–7.5); soils in ***northern hardwood - black ash - conifer swamps*** consist of circumneutral to subacid (pH of 5.3–6.3), shallow, well decomposed muck over silty material. The sloping mineral soil margins can also transition to ***northern white cedar seepage forest***. There are a few cedar swamps south of the White Mountains, which contain the ***northern white cedar - hemlock swamp*** community. ***Alder wooded fens*** are often part of this system, and can mark the transition to open peatland systems or alder alluvial shrublands along large streams. ***Calcareous sedge - moss fens*** occur in a few swamps, in openings where calcareous groundwater discharge is prominent.

Diagnostic natural communities:

- Northern white cedar - balsam fir swamp (S2)
- Northern white cedar seepage forest (S2)
- Northern hardwood - black ash - conifer swamp (S3)

- Larch - mixed conifer swamp (S3)

Peripheral or occasional natural communities:

- Alder wooded fen (S3S4)
- Alder seepage thicket (S3)
- Calcareous sedge - moss fen (S2)
- Acidic northern white cedar swamp (S1)
- Northern white cedar - hemlock swamp (S2)
- Northern hardwood seepage forest (S3)

Associated natural community systems: Medium level and rich sloping fens are often associated with this swamp system, and in large wetland basins may co-occur with montane/near-boreal hardwood - conifer minerotrophic swamp systems.

Characteristic species:

Northern white cedar - balsam fir swamp:

Trees

Abundant:

Thuja occidentalis (northern white cedar)

Abies balsamea (balsam fir)

Occasional species:

Fraxinus nigra (black ash)

Betula alleghaniensis (yellow birch)

Acer rubrum (red maple)

Picea spp. (spruces)

Dwarf shrubs and herbs

Carex trisperma (three-seeded sedge)

Osmundastrum cinnamomeum (cinnamon fern)

Coptis trifolia (three-leaved goldthread)

Rubus pubescens (dwarf raspberry)

Oxalis montana (northern wood sorrel)

Rubus dalibarda (dewdrop)

Carex leptalea (bristly-stalk sedge)

Dryopteris cristata (crested wood fern)

Tiarella cordifolia (foam-flower)

Bryophytes

Hylocomium splendens (moss)

Amblystegium riparium (moss)

Rhytidiadelphus triquetrus (moss)

Rhytidiadelphus subpinnatus (moss)

Thuidium delicatulum (moss)

Bazzania trilobata (liverwort)

Rhizomnium punctatum (moss)

Sphagnum girgensohnii (peat moss)

Sphagnum subtile (peat moss)

Sphagnum russowii (peat moss)

Characteristic species largely absent from other cedar swamp communities:

Mitella nuda (naked bishop's-cap)

Carex pedunculata (long-stalked sedge)

Orthilia secunda (one-sided-shinleaf)

Platanthera obtusata (blunt-leaved bog-orchid)

Rhamnus alnifolia (alder-leaved buckthorn)

Some potential rare species (***northern white cedar - balsam fir swamp***):

Petasites frigidus var. *palmatus* (northern sweet-coltsfoot)*

Carex castanea (chestnut sedge)*

Cypripedium reginae (showy lady's-slipper)*

Cypripedium parviflorum var. *pubescens* (large yellow lady's-slipper)*

Cypripedium parviflorum var. *makasin* (greater yellow lady's-slipper)*

Liparis loeselii (Loesel's wide-lipped orchid)*

Northern hardwood - black ash - conifer swamps:

Trees

Abundant species:

Fraxinus nigra (black ash)

Betula alleghaniensis (yellow birch)

Abies balsamea (balsam fir)

Picea rubens (red spruce)

Frequent species:

Thuja occidentalis (northern white cedar)

Acer rubrum (red maple)

Picea glauca (white spruce)

Populus balsamifera (balsam poplar)

Fraxinus americana (white ash)

Northern hardwood - black ash - conifer swamps (cont):

Shrubs

Alnus incana ssp. *rugosa* (speckled alder)

Ilex verticillata (common winterberry)

Viburnum nudum (withe-rod)

Toxicodendron radicans (poison-ivy)

Lonicera canadensis (American honeysuckle)

Herbs

Geum rivale (water avens)

Onoclea sensibilis (sensitive fern)

Impatiens capensis (spotted touch-me-not)

Tiarella cordifolia (foam-flower)

Hydrocotyle americana (American marsh-pennywort)

Packera schweinitziana (New England groundsel)

Chrysosplenium americanum (golden-saxifrage)

Carex gynandra (nodding sedge)

Galium kamtschaticum (boreal bedstraw)

Bryophytes

Abundant (particularly the "Brown Mosses" and other non-Sphagnum mosses) but poorly documented

PRIMARILY MINERAL SOIL WETLANDS

These are non-riparian systems found in depressional or sloped settings or along drainages of small streams (i.e., first and second order). They lack forested floodplains or well developed, periodically exposed river or stream channel and bank communities that develop on larger streams and rivers (generally third order and higher).

MINEROTROPHIC MINERAL SWAMPS (WEAKLY TO STRONGLY MINEROTROPHIC)

• Temperate minerotrophic swamp system

Landscape settings: depressional headwater basins and drainage ways; sloping mineral soils around open wetlands; pond and lake basins

Soils: mostly flat to moderately sloping mineral soils or shallow, well-decomposed peat or muck; moderately to strongly minerotrophic; pHs in the 5s and 6s; topogenous to soligenous, non-riparian

Spatial pattern: small to large patches (<5–50+ acres); circular-oval or irregular shaped; uniform, sometimes with shrubby openings or surrounding open wetlands

Physiognomy: forest to woodland with tall shrub openings

Distribution: widespread south of the White Mountains

Description: This is a relatively common red maple swamp system found in central and southern New Hampshire with well decomposed shallow peat or mineral soils, including classic seepage swamps and other more common minerotrophic swamp types. This system ranges from examples with shallow organic layers over silty or sandy mineral soils and apparent seepage influence to sometimes relatively shallow, well decomposed peat. Measured pHs are typically in the 5s and 6s. It is dominated by *Acer rubrum* (red maple), with lesser quantities of other hardwoods (*Fraxinus nigra* (black ash), *Betula alleghaniensis* (yellow birch)) and occasional conifers, particularly *Tsuga canadensis* (hemlock). Many of the species found in temperate peat swamps can also be found in this system, including southern and coastal species, but species indicative of moderately to strongly minerotrophic conditions are diagnostic (listed below). Northern conifers, shrubs, and herbs of montane/near-boreal swamps are absent or sparse. The shrub layer is typically well developed, as are the herb and bryophyte layers, which are also quite diverse. *Sphagnum* mosses are usually in relatively low abundance compared to temperate peat swamp systems, but can be abundant in particularly seepy locations. These swamps support a substantial non-*Sphagnum* bryophyte layer. Strongly sloping examples on seepy silty soils often can have a great deal of black ash, *Carex lacustris* (lake sedge), or *Symplocarpus foetidus* (skunk-cabbage). Shrubby openings are common in these swamps. The ***red maple - sensitive fern swamp*** community is the most common swamp type in this system. This system is often bordered by ***hemlock - cinnamon fern*** or ***red maple - red oak - cinnamon fern forests*** that are intermediate between swamp and upland forest. Examples that transition to emergent marshes may contain ***seasonally flooded red maple swamp*** and those that transition to peatlands may contain ***red maple - Sphagnum basin swamp***.

Diagnostic natural communities:

- Red maple - sensitive fern swamp (S3S4)
- Red maple - black ash swamp (S3)
- Red maple - lake sedge swamp (S3)
- Highbush blueberry - winterberry shrub thicket (S4)

Peripheral or occasional natural communities:

- Hemlock - cinnamon fern forest (S4)
- Red maple - red oak - cinnamon fern forest (S3S4)
- Red maple - elm - lady fern silt forest (S1S2)
- Red maple - *Sphagnum* basin swamp (S4)
- Seasonally flooded red maple swamp (S4S5)
- Alder seepage thicket (S3)

Associated natural community systems: In larger swamp basins this system can transition into temperate peat swamp systems. It also can transition into emergent marsh - shrub swamps.

Characteristic species:

Trees and shrubs

Abundant species:

Acer rubrum (red maple)

Ilex verticillata (common winterberry)

Occasional to locally abundant species:

Tsuga canadensis (hemlock)

Betula alleghaniensis (yellow birch)

Vaccinium corymbosum (highbush blueberry)

Infrequent to locally abundant indicators of at least weakly minerotrophic conditions:

Fraxinus nigra (black ash)

Fraxinus americana (white ash)

Lindera benzoin (northern spicebush)

Ulmus americana (American elm)

Alnus incana ssp. *rugosa* (speckled alder),

Viburnum dentatum var. *lucidum* (smooth arrowwood)

Spiraea alba var. *latifolia* (meadowsweet)

Toxicodendron radicans (poison-ivy)

Toxicodendron vernix (poison-sumac)

Sambucus nigra ssp. *canadensis* (common elderberry)

Weakly minerotrophic indicators (cont.):

Lindera benzoin (northern spicebush)

Viburnum lentago (nannyberry)

Swida sericea (red-osier dogwood)

Swida amomum var. *schuetzeana* (northwestern silky dogwood)

Rubus pubescens (dwarf raspberry)

Herbs and bryophytes

Abundant or locally abundant indicators of at least weakly minerotrophic conditions:

Onoclea sensibilis (sensitive fern)

Carex lacustris (lake sedge)

Carex stricta (tussock sedge)

Infrequent to locally abundant indicators of at least weakly minerotrophic conditions:

Impatiens capensis (spotted touch-me-not)

Caltha palustris (marsh-marigold)

Viola spp. (violets)

Geum rivale (water avens)

Symplocarpus foetidus (skunk-cabbage)

Hydrocotyle americana (American marsh-pennywort)

Sphagnum squarrosum (peat moss)

Mnium spp. (mosses)

• Forest seep/seepage forest system

Landscape settings: groundwater discharge points and zones in upland forests; bases of steep slopes; slopes where slowly-pervious soil layers force groundwater to the surface

Soils: usually silty or loamy, sometimes sandy, with a shallow muck layer; poorly to very poorly drained non-riparian; moderately to strongly minerotrophic, subacid to circumneutral (mid 5s to >7); soligenous and topogenous

Spatial pattern: small patches, points, or narrow-linear zones perpendicular (e.g., slope-bases) or parallel to flow direction such as seepage runs (0.1–10+ acres); uniform zonation or sometimes with multiple, parallel seepage runs

Physiognomy: forest or woodland tree canopy, usually sparse to moderate shrub layer, and very dense herb and bryoid layer

Distribution: broad distribution in the state, but more common and larger examples found in northern New Hampshire

Description: This is a broadly defined, spatially small wetland system that corresponds to forest seeps, seepage runs along headwater streamlets, and to their somewhat larger counterparts of northern New Hampshire, seepage forests. These tend to be small, isolated, sloping seepage wetlands up to about 5 acres in size, with most examples being much smaller (<0.25 ac). While small, they are distinct from their surrounding upland forests. Soils are saturated to seasonally saturated, poorly to very poorly drained and have a shallow muck layer over silty or loamy (occasionally sandy) materials. pHs range from the mid 5s to over 7. They have some floristic similarities to other minerotrophic swamp systems, but they have a more limited set of vascular plants in any given example, and are more variable from one seep to another. They are well demarcated, however, by a set of seepage and other minerotrophic plants that, as a group, primarily occur in seeps. Seepage forest examples are found primarily in northern New Hampshire; examples further south tend to be small patch forest seeps. *Fraxinus nigra* (black ash) dominated swamps (black ash variant of ***northern hardwood - black ash - conifer swamp***) occur on shallow but distinctly sloping silty soils at slope-bases and around swamp margins.

Diagnostic natural communities:

- Acidic *Sphagnum* forest seep (S3S4)
- Subacid forest seep (S3S4)
- Circumneutral hardwood forest seep (S3)
- Northern hardwood seepage forest (S3)
- Northern hardwood - black ash - conifer swamp (S3)

Peripheral or occasional natural communities:

- Alder seepage thicket (S3)

Associated natural community systems: This system is most often embedded within upland forests, although they occasionally occur at the border of various other wetland types.

Characteristic species:

Seepage indicators:

Tiarella cordifolia (foam-flower)
Carex scabrata (eastern rough sedge)
Glyceria melicaria (northeastern manna-grass)
Circaea alpina (small enchanter's-nightshade)
Symphyotrichum puniceum (purple-stemmed American-aster)
Chrysosplenium americanum (golden-saxifrage)
Platanthera dilatata (white northern bog-orchid)
Galium kamtschaticum (boreal bedstraw)
Geum rivale (water avens)
Mitella diphylla (two-leaved bishop's-cap)
Neottia cordata (heart-leaved twayblade)*
Neottia convallarioides (broad-leaved twayblade)*
Sphagnum squarrosum and other bryophytes
Cardamine pensylvanica (Pennsylvania bitter-cress)
Chelone glabra (white turtlehead)
Hydrocotyle americana (American marsh-pennywort)
Veratrum viride (American false hellebore)
Carex leptalea (bristly-stalk sedge)
Carex disperma (soft-leaved sedge)
Equisetum sylvaticum (wood horsetail)
Cypripedium parviflorum var. *pubescens* (large yellow lady's-slipper)*
Cystopteris bulbifera (bulbil fragile fern)

OPEN-BASIN AND STREAMSIDE WETLANDS

This system occurs on fine mineral to organic substrates (sand, muck, or shallow muck over sand or silt) along stream drainageways or open basins (i.e., those that have an outlet). Communities are seasonally to semi-permanently flooded, with aquatic beds being permanently flooded or only intermittently exposed. Emergent marshes and aquatic bed communities found along rivers and major streams are similar to those in streamside and open-basin settings but co-occur with riverbank and river channel communities typically absent along smaller streams (see low gradient silty - sandy riverbank system).

• Drainage marsh - shrub swamp system

Landscape settings: along streams and small rivers in drainageways and in open headwater depressions

Soils: well decomposed muck and mineral soils, very poorly to poorly drained; moderately to strongly minerotrophic; pHs mostly in 5s and 6s; limnogenous

Spatial pattern: large patch (<1–200+ acres); extensive broad-linear shape with inlets and outlets; irregular or linear zonation (parallel to stream corridors and pond and lake margins)

Physiognomy: aquatic beds, herbaceous emergent, medium and tall shrublands and shrub thickets, forested and woodland swamp

Distribution: widespread throughout New Hampshire

Description: This system occurs on well-decomposed muck and mineral soils along small, low-gradient, seasonally flooded streams (mostly first- and second-order) and in open basins with outlet streams. Soils consist of sandy and silty mineral materials and/or well decomposed muck (often shallow organics over mineral soil). Most examples exhibit a broad flood regime gradient from permanently flooded or intermittently exposed to seasonally flooded conditions. Corresponding natural communities include ***aquatic beds***, ***emergent marshes***, ***meadow marshes***, ***alluvial shrub thickets***, and seasonally flooded swamps. Periodic beaver activity sets successional states back towards deeper water communities (pond, ***aquatic beds***, or ***emergent marsh***), while beaver dam abandonment and subsequent pond drainage shifts the successional track back towards meadow marsh and more wooded states. Some abandoned beaver meadows consist of ***sedge meadow marshes*** characterized by minerotrophic peat mosses and marsh herbs on well decomposed muck and often with standing snags indicative of raised water levels. These peaty marshes likely succeed to shrub or swamp states with continued drainage. Medium fen communities are occasionally associated with this system, particularly along sluggish drainages or in inlets away from the influence of streams. ***Emergent marsh*** and ***aquatic bed*** communities in this system also occur along lower energy sections of rivers and major streams (see also low gradient silty-sandy riverbank system), ponds, and lakes. There is considerable variation among examples of this system in terms of diversity of communities, flood regimes, and successional states present, but there is relatively little geographic variation across the state. Community composition is influenced to some extent by stream and soil characteristics (i.e., mineral vs. organic soils) and geography, although many of the natural communities in this system have wide geographic ranges. Most of the variation among examples relates to diversity of flood regime conditions and effects of beaver activity on community composition.

Diagnostic natural communities:

Emergent marshes and aquatic beds

- Tall graminoid meadow marsh (S4)
- Short graminoid - forb meadow marsh/mudflat (S4)
- Sedge meadow marsh (S4)
- Herbaceous seepage marsh (S3)
- Lake sedge seepage marsh (S3)
- Emergent marsh (S5)
- Cattail marsh (S4)
- Bayonet rush emergent marsh (S2)
- Aquatic bed (S4S5)

Shrublands, shrub thickets, and wooded swamps

- Mixed tall graminoid - scrub-shrub marsh (S4S5)
- Highbush blueberry - winterberry shrub thicket (S4)
- Buttonbush shrubland (S4)
- Alder alluvial shrubland (S3)
- Alder - dogwood - arrowwood alluvial thicket (S4)
- Meadowsweet alluvial thicket (S3S4)
- Mixed alluvial shrubland (S4)
- Seasonally flooded red maple swamp (S4S5)

Associated natural community systems: Drainage marsh - shrub swamp systems are found in association with some medium level fen systems and sometimes transition to oligotrophic peat swamp or minerotrophic swamp systems.

Characteristic species:

Common (shallow) ***emergent marsh*** species:

Calamagrostis canadensis (bluejoint)
Carex stricta (tussock sedge)
Glyceria canadensis (rattlesnake manna grass)
Leersia spp. (cut grasses)
Scirpus cyperinus (woolly bulrush)
Carex utriculata (swollen-beaked sedge)

Common (medium-depth and deep) ***emergent marsh*** species:

Pontederia cordata (pickerelweed)
Peltandra virginica (green arrow-arum)
Sagittaria latifolia (common arrowhead)
Sparganium americanum (American bur-reed)
Eleocharis palustris (common spikesedge)
Typha latifolia (broad-leaved cat-tail)
Juncus militaris (bayonet rush)

Aquatic bed species:

Potamogeton spp. (pondweeds)
Brasenia schreberi (water-shield)
Nuphar variegata (bullhead pond-lily)
Nymphaea odorata (white water-lily)
Utricularia vulgaris ssp. *macrorhiza* (greater bladderwort)
Lemna minor (common duckweed)
Vallisneria americana (tape-grass)
Myriophyllum spp. (water-milfoils)
Bidens beckii (Beck's water-marigold)*
Persicaria hydropiperoides (false water-pepper smartweed)

Common species of shrub communities:

Ilex verticillata (common winterberry)
Vaccinium corymbosum (highbush blueberry)
Alnus incana ssp. *rugosa* (speckled alder)
Viburnum nudum (withe-rod)
Salix spp. (willows)
Myrica gale (sweet gale)
Spiraea alba var. *latifolia* (meadowsweet)
Cephalanthus occidentalis (common buttonbush)

Seepage marsh species:

Alnus incana ssp. *rugosa* (speckled alder)
Carex lacustris (lake sedge)
Impatiens capensis (spotted touch-me-not)
Onoclea sensibilis (sensitive fern)
Eutrochium maculatum (spotted Joe-Pye weed)
Symplocarpus foetidus (skunk-cabbage)
Symphyotrichum puniceum (purple-stemmed American-aster)
Toxicodendron vernix (poison-sumac)
Hydrocotyle americana (American marsh-pennywort)
Carex stipata (awl-fruited sedge)
Equisetum sylvaticum (wood horsetail)
Osmunda regalis var. *spectabilis* (royal fern)

SAND PLAIN POND SHORE AND BASIN MARSHES

These systems occur in sand plain settings along lake and pond shores and in closed basins with no inlets or outlets. They are distinguished from typical limnogenous wetlands (e.g., emergent marshes) by their unusual geomorphic settings, floristic composition, and broadly fluctuating water levels. Vertical water fluctuations influenced by precipitation, evapotranspiration, groundwater fluctuations, and limited topographic runoff inputs dominate the hydrology in closed-basin marshes. Pond shores are also characterized by wide, seasonal water level fluctuations, but differ from basin marshes by pronounced wave action and ice scour. These systems harbor many plants restricted to or concentrated in the Atlantic coastal plain region, and contain a high proportion of the state's coastal plain flora. In more southern states, these wetlands are commonly referred to as coastal plain pond shores.

• Sandy pond shore system

Landscape settings: borders of ponds and lakes with sandy bottoms or sandy littoral zones

Soils: sand and gravel, sometimes peaty sands; poorly to very poorly drained; seasonally and semi-permanently, intermittently exposed, and permanently flooded; oligotrophic; limnogenous

Spatial pattern: extensive narrow-linear shape (2–50 m wide by 10–1,000+ m in length); narrow zonation parallel to shoreline

Physiognomy: tall-medium shrub, tall herbaceous, short herbaceous, floating and submersed aquatic

Distribution: mostly east-central and southern New Hampshire, occasional further north

Description: Sandy pond shores occur primarily in central and southern New Hampshire in association with sand plain regions and occasionally along lakes in till settings where there is a local accumulation of sand along the shore. These sandy to gravelly shores and peaty sand shores are a stressful environment for plants to grow due to the infertile mineral soil, widely fluctuating water levels, and regular wave action and ice scouring. Narrow vegetation zones are strung parallel to the shoreline and relate to elevation above the lake and degree of wave and ice disturbance (ranging from shrub border to ***aquatic beds***). While these wetlands do contain many common wetland species, a high proportion of the plants present are stress-tolerators or ruderals, and many have coastal plain affinities and are restricted to pond shores or basin marshes in New Hampshire. The primary diagnostic natural community types of this system are the ***bulblet umbrella-sedge open sandy pond shore*** and ***water lobelia aquatic sandy pond shore***. Examples with peaty sand development occur on only a few lakes (including Ossipee Lake) and are characterized by the ***twig-rush sandy pond shore*** community with a high diversity of rare coastal plain species. A few examples on Ossipee Lake have the rare ***hudsonia inland beach strand*** community, characterized by sand plain species on a dry beach ridge. Sand and gravel shores of lakes in ponds in the White Mountains and North Country have some floristic and geomorphic similarities, but lack coastal plain and southern species. Further sampling and evaluation of these examples is needed to determine if they warrant consideration as separate systems.

Diagnostic natural communities:

- Sweet gale - alder shrub thicket (S3)
- Hudsonia inland beach strand (S1)
- Twig-rush sandy turf pond shore (S1)
- Bulblet umbrella-sedge open sandy pond shore (S2)
- Water lobelia aquatic sandy pond shore (S2)
- Bayonet rush emergent marsh (S2)
- Montane sandy pond shore (S1)

Associated natural community systems: Sandy pond shores are always associated with ponds, lakes and adjacent, upland forest. It is sometimes associated with poor to medium level fen and emergent marsh - shrub swamp systems that typically occur behind a sandy berm or on lower-energy sections of shoreline.

Characteristic species:

Pond shore wetland communities:

Rhexia virginica (Virginia meadow-beauty)
Cladium mariscoides (twig-rush)
Viola lanceolata (lance-leaved violet)
Euthamia caroliniana (coastal plain grass-leaved-goldenrod)*
Cyperus dentatus (bulblet umbrella sedge)
Juncus pelocarpus (brown-fruited rush)
Gratiola aurea (golden hedge-hyssop)
Agalinis paupercula var. *borealis* (boreal small-flowered agalinis)
Eriocaulon aquaticum (seven-angled pipewort)
Lobelia dortmanna (water lobelia)
Sagittaria graminea (grass-leaved arrowhead)
Sagittaria latifolia (common arrowhead)
Juncus militaris (bayonet rush)

Hudsonia inland beach strand:

Hudsonia tomentosa (hairy hudsonia)*
Hudsonia ericoides (golden-heather)*
Prunus pumila var. *depressa* (eastern dwarf cherry)
Quercus ilicifolia (scrub oak)
Pinus rigida (pitch pine)
Schizachyrium scoparium (little bluestem)
Vaccinium macrocarpon (large cranberry)

• Sand plain basin marsh system

Landscape settings: shallow depressions in outwash, ice-contact deposits and other glacio-fluvial soils; semi-perched or groundwater-connected

Soils: sand or gravelly sand with shallow muck or sandy muck surface horizons; poorly to very poorly drained; seasonally and semi-permanently flooded to intermittently exposed; oligotrophic; topogenous and groundwater influence (vertical fluctuations dominant)

Spatial pattern: small patch (<1–15 acres); individual basins with oval, circular and irregular shapes; occur as single basins or as clumps of separate basins in close proximity with no or only intermittent surface water connection; concentric zonation

Physiognomy: tall-medium shrub, tall herbaceous, short herbaceous, floating and submersed aquatic

Distribution: mostly east-central and southern New Hampshire, occasional further north

Description: These marshes occur in closed basins (having no inlets or outlets) in sand plain settings (outwash and other ice-contact deposits). In contrast to peatlands in closed basins, these wetlands have widely fluctuating seasonal and annual water levels, and no or relatively little organic matter accumulation in at least a portion of the basin. As with sandy pond shores, these wetlands have infertile mineral soils and support a combination of common wetland marsh plants and uncommon stress-tolerators and ruderals (including numerous coastal plain species) that are rare or infrequent in other habitats in the state. They occur primarily in central and southern New Hampshire although a few examples that lack coastal plain species can be found in the White Mountain region. Concentric vegetation zonation is typical and wave and ice action is absent. Many of the species listed for sandy pond shore system occur in sand plain basin marshes, plus others. Examples with the ***meadow beauty sand plain marsh*** community contain numerous rare and coastal plain species that are associated with a well-developed sandy drawdown zone.

Diagnostic natural communities:

- Highbush blueberry - winterberry shrub thicket (S4)
- Meadowsweet - robust graminoid sand plain marsh (S3S4)
- Meadow beauty sand plain marsh (S1)
- Three-way sedge - manna-grass mudflat marsh (S2S3)
- Spike-rush - floating-leaved aquatic mudflat marsh (S1)
- Sharp-flowered manna-grass shallow peat marsh (S1)
- Montane sandy basin marsh (S1)

Peripheral or occasional natural communities:

- Red maple - Sphagnum basin swamp (S4)
- Swamp white oak basin swamp (S1)
- Pitch pine - heath swamp (S1S2)
- Buttonbush shrubland (S4)

Associated natural community systems: These systems are typically set in upland forest mosaics and thus isolated from other wetlands. Occasionally they are adjacent to temperate or coastal conifer peat swamp systems with shallow organic horizons (see peripheral or occasional natural communities above).

Characteristic species:

Rhexia virginica (Virginia meadow beauty)
Cladium mariscoides (twig-rush)
Viola lanceolata (lance-leaved violet)
Euthamia caroliniana (coastal plain grass-leaved-goldenrod)*
Cyperus dentatus (bulblet umbrella sedge)
Juncus pelocarpus (brown-fruited rush)
Gratiola aurea (golden hedge-hyssop)
Agalinis paupercula var. *borealis* (boreal small-flowered agalinis)
Eriocaulon aquaticum (seven-angled pipewort)
Sagittaria latifolia (common arrowhead)
Eleocharis tenuis (slender spikesedge)
Dichanthelium acuminatum ssp. *spretum* (spurned hairy rosette-panicgrass)
Xyris difformis (bog yellow-eyed-grass)

RIPARIAN (NON-TIDAL)

The following systems correspond to riparian zones at the terrestrial - aquatic interface: some of the constituent communities are jurisdictional wetlands and some are not, but all are dramatically influenced by periodic river flooding. They occur primarily along third and higher order streams and rivers and include stream and river floodplains, river channels, and river banks.

These riparian systems on mineral soils are broken into two broad groups: 1) river channels and riverbank systems that occur below the bankful stage of a river (the river level at which the river spills onto its floodplain); and 2) floodplains, which are flooded by the river when the river spills over its banks. Bankful stage on rivers worldwide occurs on average on a 2–3 year return interval. Alluvial shrub thickets on smaller rivers and large streams can occur on annually flooded floodplains that occur elevationally below a higher floodplain forest (when present) or upland forest.

RIVER CHANNELS (AND ASSOCIATED RIVERBANKS AND OPEN FLOODPLAINS)

River channels are areas between riverbanks. Riverbanks are the elevated ground bordering and containing a river. Low riverbanks are immediately adjacent to river channels and are typically inundated for substantial portions of the year. Substrates are variable in these settings with composition dependent on the slope gradient of the river and position relative to the main channel. High-energy environments are indicated by sand, gravel, cobble, boulder, or bedrock substrate where fast currents scour and transport finer particles downstream. These settings tend to have a sparse or low percent cover of plants. Low to moderate-energy environments are indicated by sand or silt substrate and may range from sparse to moderate plant cover.

Although energy level is an important variable that affects community composition within river systems, river gradient appears to be a more stable predictor of the overall community assemblage than energy per se; energy level varies with gradient, elevation, and river stage (high or low, rising or falling), whereas river gradient better represents the long term average condition. High gradient rivers often transport fine sediments at high or low stage, whereas low gradient rivers may only transport fine sediments at a particular stage level. The following three river channel/riverbank systems occur largely in moderate- to high-energy environments along rivers and large streams in the state. Most occur on mineral or rock substrate with relatively little organic matter accumulation. Lower gradient rivers can also have emergent marshes on muck substrate, aquatic beds, and other communities associated with lower energy settings.

• Low-gradient silty-sandy riverbank system

Landscape settings: river channels and riverbanks (below the bankful flood-stage level) along low gradient sections of rivers and large streams (with or without well-developed adjacent floodplain)

Soils: primarily alluvial sands, loams, and silt loams; moderately minerotrophic

Spatial pattern: extensive narrow-linear patches (several meters wide and miles long); linear zones parallel to river or patchy zonation corresponding to intermittent bar deposits

Physiognomy: tall shrub, medium-height shrub, herbaceous emergent, sparsely vegetated, aquatic

Distribution: broadly distributed throughout the state

Description: This system corresponds to sandy or silty river channels and riverbanks along low gradient, low to moderate energy, meandering sections of large streams and minor rivers. Sandy or silty channel bars are occasional, but gravel and cobble bars are relatively rare or absent in this depositional environment. ***Aquatic bed*** and ***emergent marsh*** communities are common, whereas these are typically absent or not well developed in higher energy settings of moderate- and high-gradient sections of river. These communities are typically indicated by a higher density of vegetation and emergent marsh forbs, including species absent from high-energy environments. Typically, this system has a high diversity of species.

Shrubbier portions of this system are characterized by alder, dogwoods, and Viburnums, and sometimes a diverse assemblage of other shrubs. Adjacent floodplains typically have red or silver maple floodplain forest communities, but examples of this system may lack well-developed wooded floodplain forests. Instead they may have extensive alluvial alder floodplains along large streams that are flooded at least annually, or they may transition rapidly to upland.

Diagnostic natural communities:

<u>River channels and low riverbanks</u>

- Cobble - sand river channel (S3S4)
- Mesic herbaceous river channel (S4)
- Twisted sedge low riverbank (S3S4)

<u>Riverbanks</u>

- Herbaceous riverbank/floodplain (S4)
- Bluejoint - goldenrod - virgin's bower riverbank/floodplain (S3S4)
- Alder alluvial shrubland (S3)
- Alder - dogwood - arrowwood alluvial thicket (S4)
- Meadowsweet alluvial thicket (S3S4)

<u>Emergent marshes and aquatic beds</u>

- Short graminoid - forb meadow marsh/mudflat (S4)
- Emergent marsh (S5)

- Bayonet rush emergent marsh (S2)
- Cattail marsh (S4)
- Aquatic bed (S5)

Peripheral or occasional natural communities:

- Dry river bluff (S3)

Associated natural community systems: This system is most often associated with temperate minor river and major river silver maple floodplain systems, and rarely montane/near boreal floodplains that occur on large streams.

Characteristic species:

Herbaceous river channel and riverbank communities:

Poa spp. (blue grasses)
Agrostis spp. (bentgrasses)
Calamagrostis canadensis (bluejoint)
Panicum spp. (panicgrasses)
Carex torta (twisted sedge)
Apocynum cannabinum (hemp dogbane)
Symphyotrichum spp. (American-asters)
Solidago spp. (goldenrods)
Persicaria spp. (smartweeds)
Eutrochium spp. (Joe-Pye-weeds)
Hieracium spp. (hawkweeds)
Equisetum arvense (field horsetail)
Glyceria and *Puccinellia* spp. (manna grasses)
Leersia spp. (cut grasses)
Juncus spp. (rushes)
Eleocharis spp. (spikesedges)
Carex lupulina (hop sedge)
Carex crinita (fringed sedge)
Schoenoplectus torreyi (Torrey's bulrush)
Schoenoplectus smithii var. *setosus* (Smith's bulrush)
Scirpus cyperinus (woolly bulrush)
Bulbostylis capillaris (tufted hair-sedge)
Cicuta spp. (water-hemlocks)
Sium suave (water-parsnip)
Impatiens capensis (spotted touch-me-not)
Thelypteris palustris var. *pubescens* (marsh fern)
Onoclea sensibilis (sensitive fern)
Osmundastrum cinnamomeum (cinnamon fern)
Triadenum virginicum (Virginia marsh-St. John's-wort)
Bidens spp. (beggar-ticks)
Lycopus uniflorus (northern water-horehound)
Iris versicolor (blue iris)
Lysimachia terrestris (swamp yellow-loosestrife)

Shrub and vines of riverbank and river channel communities:

Alnus incana ssp. *rugosa* (speckled alder)
Alnus serrulata (smooth alder)
Swida spp. (dogwoods)
Viburnum spp. (viburnums)
Clematis virginiana (virgin's-bower)
Spiraea alba var. *latifolia* (meadowsweet)

• Moderate-gradient sandy-cobbly riverbank system

Landscape settings: river channels and riverbanks (below the bankful transition to floodplain) along moderate-gradient sections of rivers and large streams

Soils: primarily alluvial sand, gravel, and cobble; oligotrophic to moderately minerotrophic

Spatial pattern: large patch, extensive narrow-linear (typically 5+ m wide and up to miles long); linear zones parallel to riverbanks or patchy zonation corresponding to intermittent bar deposits

Physiognomy: sparse woodland, tall shrub, medium-height shrub, herbaceous, sparsely vegetated, aquatic

Distribution: broadly distributed throughout the state

Description: This system is associated with moderate gradient, moderate to high-energy sections of major and minor rivers with frequent sand, gravel, and cobble bar deposits and coarse-textured riverbanks. Ice and flood scour are important annual disturbances, producing sparse to moderate cover of herbs and shrubs on coarse substrates. Thus the natural communities in this system on average are sparsely vegetated. Rapids or riffle sections are common among the depositional bars. Floodplain forests (primarily silver maple, sugar maple, and balsam fir types) are often adjacent to this riverbank system. This system lacks extensive deposits of boulders and rock that are characteristic of high-gradient rocky riverbanks. It has a higher abundance of coarse deposits (gravel to cobble) compared to low-gradient silty-sandy riverbanks. This system includes extensive alder thickets on large northern streams or small rivers that are flooded at least annually but lack floodplain forests.

This system lacks well-developed emergent marsh vegetation found in low-gradient riverbank systems.

Diagnostic natural communities:

River channels and low riverbanks

- Boulder - cobble river channel (S3)
- Cobble - sand river channel (S3S4)
- Mesic herbaceous river channel (S4)
- Riverweed river rapid (S2S3)
- Willow low riverbank (S3)
- Twisted sedge low riverbank (S3S4)
- Dwarf cherry river channel (S2)
- Hudsonia - silverling river channel (S1)

Medium to high riverbanks and open floodplains

- Herbaceous riverbank/floodplain (S4)
- Bluejoint - goldenrod - virgin's bower riverbank/floodplain (S3S4)
- Alder alluvial shrubland (S3)
- Mixed alluvial shrubland (S4)
- Acidic riverbank outcrop (S3)
- Circumneutral riverbank outcrop (S1)
- Acidic riverside seep (S1)
- Calcareous riverside seep (S1)

Associated natural community systems: This system is associated with all three floodplain systems or may occur without a well-developed forested floodplain along upper reaches of large mountain streams with annually flooded shrub floodplains. Montane/near-boreal floodplain systems are almost always associated with this riverbank system (but not vice versa).

Characteristic species:

Species diagnostic of this system (generally not found on low-gradient silty-sandy riverbanks):

Prunus susquehanae (Appalachian dwarf cherry)

Prunus pumila var. *depressa* (eastern dwarf cherry) *Schizachyrium scoparium* (little bluestem)

Andropogon gerardii (big bluestem)

Vaccinium cespitosum (dwarf blueberry)*

Calamagrostis pickeringii (Pickering's reed grass)

Solidago simplex ssp. *randii* var. *monticola* (montane Rand's goldenrod)

Hudsonia tomentosa (hairy hudsonia)

Paronychia argyrocoma (silverling)*

• High-gradient rocky riverbank system

Landscape settings: river channels and riverbanks along high-gradient sections of rivers and large streams; below the bankful flood-stage of river marked by transition to floodplain (when floodplain is present)

Soils: primarily bedrock, boulders, stones, and some cobble with interstitial sand and gravel; oligotrophic to moderately minerotrophic

Spatial pattern: large patch, extensive narrow-linear (typically 5+ m wide and up to miles long); linear zones parallel to riverbanks or patchy zonation corresponding to intermittent cobble bar deposits

Physiognomy: sparse woodland, tall to medium-height shrub, herbaceous, sparsely vegetated

Distribution: most common in the White Mountains and north, and scattered along upper reaches and intermittent steep-gradient sections of minor and major rivers throughout much of the state

Description: River channels and banks in steep gradients are degradational environments in which fine sediments are transported downstream at high or low river stages, leaving boulders and bedrock as the dominant channel substrate. Ice and flood scour are pronounced. Meanders and bars comprised of finer sediments are sparse. High-gradient rocky riverbanks are extensive along the upper reaches of rivers leading out of the mountains, and scattered on high-gradient sections of other rivers elsewhere in the state. Sparsely vegetated boulders and some cobble are characteristic channel and riverbank material, often with sand in the interstices. Exposures of sediments finer than cobble are intermittent or rare. Alder alluvial thickets and other herbaceous to wooded communities occur on slightly higher riverbanks. Outcrops are present in some examples; riverside seeps are rare. Rare or uncommon northern and subalpine plants are found in this system along northern rivers (not found in low energy settings or southern New Hampshire).

Diagnostic natural communities:

River channels

- Boulder - cobble river channel (S3)
- Cobble - sand river channel (S3S4)
- Riverweed river rapid (S2S3)

Riverbanks

- Herbaceous riverbank/floodplain (S4)
- Alder alluvial shrubland (S3)
- Acidic riverbank outcrop (S3)
- Circumneutral riverbank outcrop (S1)
- Acidic riverside seep (S1)
- Calcareous riverside seep (S1)

Associated natural community systems: This system typically borders upland forests on till or high river terraces and does not occur along river sections with well-developed floodplains. Occasionally it is adjacent to the upper reaches of montane/near-boreal floodplain systems.

Characteristic species:

Trees and shrubs

Alnus incana ssp. *rugosa* (speckled alder)

Salix spp. (willows)

Seedlings and saplings of tree species

Herbs

Osmunda claytoniana (interrupted fern)

Deschampsia anadyrensis (glaucous hair grass)

Deschampsia flexuosa (wavy hair grass)

Calamagrostis canadensis (bluejoint)

Danthonia spicata (poverty oatgrass)

Panicum spp. (panicgrasses)

Doellingeria umbellata (tall white-aster)

Solidago bicolor (white goldenrod)

Other composites:

Eutrochium maculatum (spotted Joe-Pye weed)

Houstonia caerulea (little bluet)

Carex torta (twisted sedge)

Fragaria virginiana (common strawberry)

Rare or uncommon northern and subalpine plants:

Vaccinium cespitosum (dwarf blueberry)*

Calamagrostis pickeringii (Pickering's reed grass)

Calamagrostis stricta ssp. *inexpansa* (northern neglected reed grass)*

Hieracium robinsonii (Robinson's hawkweed)*

Agrostis mertensii (northern bentgrass)

Riverside seeps:

Triantha glutinosa (sticky false asphodel)*

Drosera rotundifolia (round-leaved sundew)

Carex garberi (elk sedge)*

FLOODPLAIN FORESTS (AND ASSOCIATED RIVERBANKS AND OPEN FLOODPLAINS)

River floodplains occur at the interface between the aquatic and terrestrial environments in river valley bottomlands adjacent to river channels. They are dynamic environments affected by periodic, temporary flooding. As water levels rise over riverbanks, sediment transported from upstream is deposited where water slows and spreads out across the floodplain terraces (Wistendahl 1958; Jorgenson 1978). Coarse sediments fall out along edges of main channels forming natural sandy levees, while finer, silty sediments settle on flat, higher terraces behind the levees. Mixing and churning flood waters can create a mosaic of different soil conditions and microtopographic variability within the floodplain (Bornette and Amoros 1996; Hupp 1986; Hupp and Osterkamp 1985; Barnes 1978). Soil drainage ranges from well drained coarse sands on levees, to poorly drained silts and mucks in floodplain sloughs and oxbows, vernal pools, and microtopographic depressions.

The combination of floodplain forest and open floodplain communities (e.g., oxbows, meadows, and thickets) largely depends on river watershed size, gradient, and channel morphometry, which in turn affect the timing, frequency, intensity, and duration of flooding. By definition, river floodplains occur above bankful stage. Return intervals for low floodplains in New Hampshire are approximately every one to three years. Medium and high floodplains have longer return intervals. Most non- or only partially-wooded floodplain communities occur on low floodplains. Depressional sloughs, oxbows, vernal pools, and other micro-topographic depressions within the floodplain tend to pond flood waters and are inundated for longer periods than low floodplains. High terraces are inactive floodplains that are essentially isolated from flood dynamics, with flood intervals that exceed 100 years, and are not considered part of floodplain systems described here. The lack of periodic flooding allows for soils to develop to a greater extent (soil horizon development) and vegetation generally consists of upland species not restricted to floodplains.

• Montane/near-boreal floodplain system

Landscape settings: floodplains (above bankful) along moderate-gradient sections of rivers and large streams

Soils: sandy alluvium (loamy sand, sandy loam, silt loams, and occasionally sand over gravel or cobble); moderately minerotrophic

Spatial pattern: large patch, extensive broad-linear (<1–50+ acres); meandering linear and semi-circular zones parallel to riverbanks or corresponding to floodplain terracing and oxbow, slough, or over-flow channel formations

Physiognomy: forest, woodland, sparse woodland, tall to medium-height shrub, herbaceous, and aquatic

Distribution: primarily found on flashy northern rivers in the White Mountains or north country, and occasional in north-central New Hampshire

Description: This floodplain system is associated with montane and northern rivers in New Hampshire that often have flashy flood regimes and relatively high-gradients compared to other river systems. Flashy flood regimes are those affected by high intensity, short-duration floods from mountain runoff events. The most diagnostic natural communities are sugar maple and balsam fir floodplain forests, and occasionally red maple floodplain forest. When silver maple floodplain forests are present they typically form a narrow border and are not the dominant forest type. Moderate gradient sandy-cobbly riverbanks are typically adjacent to these floodplains, although some examples occur on higher- or lower-gradient sections of river. Some smaller, northern river floodplains contain balsam fir floodplain/silt plains and alder thickets that lack sugar maple floodplain forest communities.

Examples along larger rivers with ***sugar maple - ironwood - short husk floodplain forest*** contain mixes of *Acer saccharum* (sugar maple), *Ostrya virginiana* (ironwood), and other common upland trees. Shrubs are generally not dominant, except at forest edges. Compared to average northern hardwood forests, the herb layer is often more lush – commonly with a high total coverage, and a species composition indicative of semi-rich conditions. ***Sugar maple - silver maple - white ash floodplain forest*** can occur on lower adjacent floodplains, marked by the appearance of *Acer saccharinum* (silver maple) and more mesic site plants. ***Balsam fir floodplain/silt plain***s have a somewhat less floristically rich flora that lacks ironwood and contains more softwoods, and common wet-site herbs of northern NH.

Diagnostic natural communities:

Floodplain forests

- Balsam fir floodplain/silt plain (S2)
- Sugar maple - silver maple - white ash floodplain forest (S1S2)
- Sugar maple - ironwood - short husk floodplain forest (S1)

Herbaceous and shrubby floodplains

- Alder alluvial shrubland (S3)
- Mixed alluvial shrubland (S4)
- Herbaceous riverbank/floodplain (S4)
- Bluejoint - goldenrod - virgin's bower riverbank/floodplain (S3S4)

Peripheral or occasional natural communities:

- Silver maple - false nettle - sensitive fern floodplain forest (S2)

Associated natural community systems: Moderate gradient sandy-cobbly riverbanks are typically adjacent to these floodplains, although some examples occur on higher- or lower-gradient sections of river.

Characteristic species:

Sugar maple - ironwood - short husk floodplain forest:

Trees

Acer saccharum (sugar maple)
Ostrya virginiana (ironwood)
Quercus rubra (red oak)
Fraxinus americana (white ash)
Prunus serotina (black cherry)
Pinus strobus (white pine)

Herbs

Solidago caesia (axillary goldenrod)
Uvularia sessilifolia (sessile-leaved bellwort)
Toxicodendron radicans (poison-ivy)
Aralia nudicaulis (wild sarsaparilla)
Carex pedunculata (long-stalked sedge)
Brachyelytrum aristosum (northern short husk grass)

Balsam fir floodplain/silt plain:

Trees and shrubs

Abies balsamea (balsam fir)
Acer rubrum (red maple)
Pinus strobus (white pine)
Alnus incana ssp. *rugosa* (speckled alder)

Herbs

Calamagrostis canadensis (bluejoint)
Carex stricta (tussock sedge)
Spiraea alba var. *latifolia* (meadowsweet)
Coptis trifolia (three-leaved goldthread)
Chamaepericlymenum canadense (bunchberry)
Oclemena acuminata (sharp-toothed nodding-aster)

• Major river silver maple floodplain system

Landscape settings: floodplains (above bankful) along moderate-gradient and low-gradient sections of major rivers

Soils: sandy to silty alluvium (loamy sand, sandy loam, silt loams); moderately to strongly minerotrophic

Spatial pattern: large patch, extensive broad-linear (<1–50+ acres); meandering linear and semi-circular zones parallel to riverbanks or corresponding to floodplain terracing and oxbow, slough, or over-flow channel formations

Physiognomy: forest, woodland, sparse woodland, tall to medium-height shrub, herbaceous, and aquatic

Distribution: found primarily along the main-stems of the Connecticut and Merrimack Rivers, and occasionally on lower reaches of major tributaries

Description: Floodplains corresponding to this system occur along major rivers in New Hampshire (e.g., the Connecticut and Merrimack) and are indicated by the dominance of one or both types of silver maple floodplain forest, and sometimes oxbow marshes and various meadow and thicket communities. Flooding on these rivers is affected by snowmelt from the White Mountains that peaks a bit later in the spring than melting snowpacks along more minor tributaries, and by the much larger water volume found on these main-stem rivers. Forest canopies are dominated by mature *Acer saccharinum* (silver maple), which forms a tall, arching, cathedral-like ceiling above the level floodplain adjacent to the river channel. Whereas shrubs are poorly represented, vines tend to be abundant, especially in canopy gaps and along forest edge transitions to other communities. The ***silver maple - wood nettle - ostrich fern floodplain forest*** type is most common along the Connecticut River, while the ***silver maple - false nettle - sensitive fern*** type is most common on the Merrimack, Ashuelot, Contoocook, and Suncook Rivers. This type exhibits different dominant herbs and generally more grasses and sedges. On more minor rivers silver maple floodplain forest communities are reduced to a narrow band or relatively small portion of the floodplain system compared to other forest types or disappear altogether. Red maple and other floodplain forest types predominate when silver maple disappears.

Floodplain forests of this system often form a mosaic with more open floodplain communities. Shrub thickets and herbaceous meadows may occur on low floodplains and adjacent riverbanks. ***Aquatic beds***, ***emergent marshes*** and shrub thickets in oxbows may also occur and are typically flooded annually. ***Riverwash plain and dunes*** occur on a few sandy pointbar floodplains of the Merrimack River and are kept open by some combination of infrequent scouring by major floods and subsequent shifting windblown sands. Flood regimes have been altered considerably by dam control of major flood events, lengthening the return interval of medium and high floodplains along some sections of river. Invasive plants are problematic in many examples of this system, particularly *Celastrus orbiculatus* (Asian bittersweet) and *Berberis thunbergii* (Japanese barberry).

Diagnostic natural communities:

- Silver maple - wood nettle - ostrich fern floodplain forest (S2)
- Silver maple - false nettle - sensitive fern floodplain forest (S2)

- Alder alluvial shrubland (S3)
- Alder - dogwood - arrowwood alluvial thicket (S4)
- Herbaceous riverbank/floodplain (S4)
- Bluejoint - goldenrod - virgin's bower riverbank/floodplain (S3S4)
- Emergent marsh (S5) – in oxbows
- Aquatic bed (S4S5)

Peripheral or occasional natural communities:

- Sugar maple - silver maple - white ash floodplain forest (S1S2)
- Red maple floodplain forest (S2S3)
- Buttonbush shrubland (S4) – in oxbows
- Riverwash plain and dunes (S1)

Associated natural community systems: Most often this system is adjacent to the low-gradient silty-sandy riverbank system and sometimes the moderate-gradient sandy-cobbly riverbank. It often transitions to river terraces dominated by upland forest types, and in some locales to rich sugar maple - oak - hickory terrace forest.

Characteristic species:

Silver maple - wood nettle - ostrich fern floodplain forest:

Trees

Abundant species:
Acer saccharinum (silver maple)
Occasional to locally abundant:
Fraxinus americana (white ash)
Ulmus americana (American elm)
Populus deltoides (eastern cottonwood)
Celtis occidentalis (common hackberry)
Juglans cinerea (white walnut)

Herbs and vines

Dominant to abundant species:
Matteuccia struthiopteris ssp. *pensylvanica* (ostrich fern)
Laportea canadensis (Canada wood-nettle)
Occasional, never dominant:
Onoclea sensibilis (sensitive fern)
Athyrium angustum (narrow lady fern)
Cinna arundinacea (sweet wood-reed)
Boehmeria cylindrica (small-spiked false nettle)

Occasional species (cont.):
Impatiens capensis (spotted touch-me-not)
Thalictrum pubescens (tall meadow-rue)
Arisaema triphyllum (Jack-in-the-pulpit)
Vitis riparia (river grape)
Rare species:
Arisaema dracontium (green dragon)*

Silver maple - false nettle - sensitive fern floodplain forest:

Trees

Abundant species:

Acer saccharinum (silver maple)

Occasional to locally abundant:

Ulmus americana (American elm)

Herbs and vines

Dominant species:

Onoclea sensibilis (sensitive fern)

Boehmeria cylindrica (small-spiked false nettle)

Silver maple - false nettle - sensitive fern floodplain forest (cont.):

Occasional to locally abundant species:

Toxicodendron radicans (poison-ivy)

Cinna latifolia (slender wood-reed)

Cinna arundinacea (sweet wood-reed)

Carex crinita (fringed sedge)

Carex intumescens (greater bladder sedge)

Athyrium angustum (narrow lady fern)

Impatiens capensis (spotted touch-me-not)

Thalictrum pubescens (tall meadow-rue)

Arisaema triphyllum (Jack-in-the-pulpit)

Matteuccia struthiopteris ssp. *pensylvanica* (ostrich fern)

• Temperate minor river floodplain system

Landscape settings: floodplains (above bankful) along moderate-gradient and low-gradient sections of minor rivers and large streams

Soils: sandy to silty alluvium (loamy sand, sandy loam, silt loams); moderately to strongly minerotrophic

Spatial pattern: large patch, extensive broad-linear (<1–50+ acres); meandering linear and semi-circular zones parallel to riverbanks or corresponding to floodplain terracing and oxbow, slough, or over-flow channel formations

Physiognomy: forest, woodland, sparse woodland, tall to medium-height shrub, herbaceous, and aquatic

Distribution: found along major streams and minor rivers throughout central and southern NH

Description: This system corresponds to hardwood-dominated floodplains in central and southern New Hampshire along large streams and minor rivers, including the tributaries of the Merrimack and Connecticut Rivers and smaller rivers in the Piscataqua and Ossipee River watersheds. It is indicated by the dominance of ***red maple floodplain forest*** and occasionally other types (e.g., sycamore, swamp white oak, and balsam fir), often in a mosaic with oxbow marshes, vernal pools, and floodplain meadows and thickets. Canopies of these forests are strongly dominated by *Acer rubrum* (red maple), and the understory ranges from open to viny and somewhat shrubbier than silver maple floodplains, with an abundance of ferns. Compared to their major river counterparts, minor river floodplains appear to have reduced flood intensity, duration, and earlier peak floods due to absence or reduced importance of mountain snow-pack meltwater. Silver maple floodplain forests may form narrow borders or small patches, but do not dominate extensive areas as they do along the main-stems of major rivers. This system includes ***swamp white oak floodplain forests*** restricted to silty alluvial and marine sediments in the coastal region. Low, medium, and high floodplain variants are distinguishable in many occurrences, which correspond to slightly different elevations and thus flood return intervals. These are marked by corresponding shifts in abundance of species preferential to wetter or drier conditions. Invasive plants are problematic in many examples of this system, particularly *Celastrus orbiculatus* (Asian bittersweet) and *Berberis thunbergii* (Japanese barberry).

Diagnostic natural communities:

Floodplain forests

- Silver maple - false nettle - sensitive fern floodplain forest (S2)
- Red maple floodplain forest (S2S3)
- Sycamore floodplain forest (S1)
- Swamp white oak floodplain forest (S1)

Herbaceous and shrub floodplain communities

- Alder alluvial shrubland (S3)
- Alder - dogwood - arrowwood alluvial thicket (S4)
- Meadowsweet alluvial thicket (S3S4)

- Herbaceous riverbank/floodplain (S4)
- Bluejoint - goldenrod - virgin's bower riverbank/floodplain (S3S4)
- Emergent marsh (S5) – in oxbows

Peripheral or occasional natural communities:

- Balsam fir floodplain/silt plain (S2)
- Buttonbush shrubland (S4) – in oxbows

Associated natural community systems: This system frequently occurs in association with low-gradient silty-sandy riverbank systems and less commonly with moderate-gradient sandy-cobbly riverbanks.

Characteristic species:

Floodplain forest communities:

Trees

Abundant:

Acer rubrum (red maple)

Occasional to locally abundant:

Prunus serotina (black cherry)

Carya ovata (shagbark hickory)

Quercus rubra (red oak)

Quercus bicolor (swamp white oak)

Fraxinus americana (white ash)

Tilia americana (basswood)

Shrubs

Carpinus caroliniana ssp. *virginiana* (American hornbeam)

Ilex verticillata (common winterberry)

Viburnum spp. (viburnums)

Vaccinium corymbosum (highbush blueberry)

Swida amomum var. *schuetzeana* (northwestern silky dogwood)

Toxicodendron radicans (poison-ivy)

Herbs

Onoclea sensibilis (sensitive fern)

Osmunda regalis var. *spectabilis* (royal fern)

Floodplain forest herbs (cont.):

Athyrium angustum (narrow lady fern)

Boehmeria cylindrica (small-spiked false nettle)

Impatiens capensis (spotted touch-me-not)

Common species of shrub and herbaceous floodplain communities:

Shrubs

Alnus incana ssp. *rugosa* (speckled alder)

Swida sericea (red-osier dogwood)

Salix sericea (silky willow)

Clematis virginiana (virgin's-bower)

Spiraea alba var. *latifolia* (meadowsweet)

Cephalanthus occidentalis (common buttonbush)

Herbs

Calamagrostis canadensis (bluejoint)

Solidago rugosa (wrinkle-leaved goldenrod)

Solidago gigantea (smooth goldenrod)

Onoclea sensibilis (sensitive fern)

Euthamia graminifolia (common grass-leaved-goldenrod)

Doellingeria umbellata (tall white-aster)

Carex vesicaria (lesser bladder sedge)

Carex stricta (tussock sedge)

Carex crinita (fringed sedge)

Carex lupulina (hop sedge)

TIDAL AND SUBTIDAL (ESTUARINE)

Estuarine systems in New Hampshire occur in subtidal and intertidal coastal habitats connected to the ocean but semi-enclosed by land and protected from high-energy wave action. Subtidal habitats are influenced by tides but are continuously submerged. Intertidal habitats are periodically exposed and flooded by tides (including spring tide and splash zone areas). Water within estuarine systems is at least occasionally diluted by fresh water runoff, and is distinguished from fresh water by salinity levels of >0.5 parts per thousand (ppt). Estuarine systems extend seaward to an imaginary line drawn across the mouth of a bay or river or to the seaward limit of wetland vascular plants when they are not included within the imaginary line. Upstream and landward, estuarine systems extend to where ocean-derived salts are less than or equal to 0.5 parts per thousand (ppt) during the period of average annual low fresh water flow (Cowardin et al. 1979).

Surface water salinity fluctuates widely according to seasonal variation in fresh water discharge. Salt marsh soil water salinity roughly corresponds to polyhaline levels (18–30 ppt). In certain areas, evaporation may increase salinity above polyhaline levels. Salinity levels less than 18 ppt but greater than 0.5 ppt (meso- and oligohaline levels) typically support brackish marsh communities. Fresh water marshes occur where salinity levels are 0.5 ppt or less during the period of annual low fresh water flow.

INTERTIDAL WETLANDS

Intertidal systems are intermittently flooded and exposed by tidal fluctuation. They can be broken into three broad groups according to flooding frequency: upper, middle, and lower intertidal. These flood regimes have an important influence in structuring vegetation within each system described below. The *upper intertidal* is the irregularly flooded zone (substrate flooded less than daily) occurring between the upper reaches of the spring tide/splash zone and mean high tide. It includes high salt marsh, brackish marsh, high marsh pannes and pools, high brackish riverbank marsh, and coastal shoreline strand/swale communities. The upper intertidal zone also supports coastal salt pond marshes, which are wetlands lying beyond the upper reach of spring tides but periodically infused with salt water during storm events. *Middle intertidal* refers to the regularly flooded zone (substrate flooded at least once daily) occurring between the mean high tide and mean low tide, which supports low salt marsh, low marsh pannes and pools, low brackish riverbank marsh, intertidal flat, and intertidal rocky shore natural communities. The *lower intertidal* is the irregularly exposed zone (substrate exposed less than daily) occurring between the mean low tide and very low spring tide, which supports the lower reaches of the intertidal flat and intertidal rocky shore natural communities.

• Salt marsh system

Landscape settings: intertidal coastal embayments

Soils: marine peat; organic materials 16 to 50" thick overlying sandy materials (low marsh); organic materials >50" over sand, silt, or bedrock (high marsh); shallow peats (<16") are occasional in areas towards outer limits of salt marsh (seaward and inland); poly-haline (18–30 ppt), strongly minerotrophic

Spatial pattern: large patch, narrow-linear to irregularly linear (<1–100+ acres); narrow to broad linear bands fringing coastal shorelines, with scattered orbicular patches: linear bands of low salt marsh; broad-linear patches of high salt marsh; intermittent strands of brackish marsh along upland border; small orbicular patches of pannes and pools

Physiognomy: primarily herbaceous

Distribution: occurs at Great Bay, in the Blackwater River estuary, and in other coastal embayments

Description: Salt marsh systems include upper and middle intertidal areas corresponding to high and low salt marsh, respectively, with an intermittent brackish marsh border along upland edge. Small salt pools and pannes are common, particularly in the high marsh. Salt marsh soil water salinity roughly corresponds to polyhaline levels (18–30 ppt). In pannes and pools, evaporation may increase salinity above polyhaline levels. The transition between high and low salt marsh occurs approximately at the mean high water mark; from here high salt marsh stretches landward to the upper reaches of spring tides. Brackish marshes occur where fresh water runoff along the upland border reduces salt concentrations to meso-haline levels.

Low salt marshes are dominated by *Spartina alterniflora* (smooth cordgrass) and occur between mean sea level and mean high tide in areas protected from high-energy wave action. Other vascular halophytes occur in low abundance. Macroalgae (seaweed) may also be present. ***High salt marshes*** are strongly dominated by *Spartina patens* (saltmeadow cordgrass), with lesser amounts of other graminoids. ***Brackish marshes*** are often indicated by *Bolboschoenus robustus* (sea-coast tuber-bulrush), *Carex paleacea* (chaffy sedge), and *Typha angustifolia* (narrow-leaved cat-tail), among other species. ***Salt pannes and pools*** (pools are deeper) are low wet areas isolated from tidal creeks that occur in both saline and brackish marshes where they support fine-scale natural communities (less than $1m^2$ to over $100\ m^2$). Salinity levels in pannes found in the high salt marsh are typically in the range of 40–50(–60) ppt. Species composition varies with salinity, hardness of substrate, elevation, soil oxygen, hydroperiod, and other factors.

The abilities of individual plant species to tolerate the challenging combination of stresses in salt marshes dictate which plant species grow where. There are numerous factors that affect plant distribution: hydroperiod (duration and frequency of tidal flooding), soil salinity, soil oxygen, nutrient availability, elevation of substrate, concentration of growth inhibitors, storms, ice-scouring, land use history, and competitive interactions and biological facilitation between and among species.

Between the time of European settlement until recently, salt marshes were routinely drained by farmers to increase the productivity of salt-meadow cordgrass and spike grass for hay, pasture, mulch, and in an effort to reduce salt marsh mosquito (*Aedes sollicitans*) populations. The ecological impacts of ditching

include reduced flood duration and lowered water table and changes in species composition across many groups of organisms in the marsh (insects, mollusks, crustaceans, shorebirds, waterfowl, and plants).

Diagnostic natural communities:

- Marsh elder shrubland (S1)
- High salt marsh (S3)
- Salt pannes and pools (S3)
- Low salt marsh (S3)

Peripheral or occasional natural communities:

- Coastal salt pond meadow marsh (S1)
- Coastal salt pond emergent marsh (S1)
- Coastal salt pond flat (S1)
- Brackish marsh (S2S3)
- Coastal shoreline strand/swale (S2)

Associated natural community systems: Salt marsh systems transition to brackish riverbank marsh upstream and sparsely vegetated intertidal towards the subtidal zone.

Characteristic species:

Low salt marsh:

Abundant species:
Spartina alterniflora (smooth cordgrass)
Occasional to locally abundant:
Salicornia depressa (common glasswort)
Atriplex spp. (oraches)
Eleocharis parvula (little-headed spikesedge)*
Suaeda spp. (sea-blites)
Spergularia marina (saltmarsh sand-spurry)
Ascophyllum nodosum (knotted wrack)
Fucus spp. (rockweeds)

High salt marsh:

Dominant:
Spartina patens (saltmeadow cordgrass)
Occasional species
Spartina alterniflora (smooth cordgrass; short form)
Distichlis spicata (saltgrass)
Juncus gerardii (saltmarsh rush)

Brackish marsh:

Bolboschoenus robustus (sea-coast tuber-bulrush)
Carex paleacea (chaffy sedge)
Typha angustifolia (narrow-leaved cat-tail)

Salt pannes and pools:

Triglochin maritima (saltmarsh arrow-grass)

Spartina alterniflora (smooth cordgrass; short form)

Ruppia maritima (widgeon-grass)

Bolboschoenus maritimus ssp. *paludosus* (saltmarsh tuber-bulrush)

Stuckenia pectinata (Sago false pondweed)*

Zannichellia palustris (horned-pondweed)*

• Brackish riverbank marsh system

Landscape settings: tidal riverbanks and near mouths of low-gradient coastal rivers feeding estuaries

Soils: marine peat and silt and clay; organic materials 16 to 50" thick overlying silty materials; oligo- to meso-haline (0.5–18 ppt); strongly minerotrophic

Spatial pattern: large patch (extensive narrow-linear) along riverbanks (several to 50 m wide by 50–2,000+ m long); linear zonation parallel to riverbank

Physiognomy: herbaceous, sparsely vegetated

Distribution: restricted to tidal sections of primarily Great Bay coastal rivers and large streams below the lowest dams

Description: Brackish tidal riverbanks are flooded by tidal salt water that is diluted by fresh water flowing in from the watershed above. They consist of low and high brackish riverbank communities. ***Brackish marsh***, another type of estuarine marsh occurring in oligo- to meso-haline soil water settings, may occur intermittently along the upper edge of the high brackish riverbank marsh. ***Low brackish riverbank marshes*** typically occur in zones between mean sea level and mean high tide along moderate to steep brackish river- and stream-banks. The hydroperiod (duration and frequency of tidal flooding) in ***low brackish riverbank marshes*** roughly corresponds to that found in the low salt marsh, whereas soil water salinity is more equivalent to brackish marshes (0.5–18 ppt). Fresh water can form a lens on top of the salt water, causing salinity to fluctuate widely with the tides. ***High brackish riverbank marshes*** typically occur as narrow zones along moderate to steep brackish river- and stream-banks flooded less than daily (e.g., between the mean high water mark and the upper reaches of spring tides). The hydroperiod of ***high brackish riverbank marshes*** corresponds to that found in the high salt marsh, whereas soil water salinity is more equivalent to brackish marshes (0.5–18 ppt). Where slopes are gentler, the low and high marshes may cover broader areas.

Much of the high and low marsh soil along stream and river mouths entering the Great Bay complex and the narrow margins around the bay consists of organic materials 16 to 50" thick overlying silty materials. Some stretches of riverbank consist of marine silt or clay, and gravelly or cobbly material is found along upper sections of large streams corresponding to this system.

Numerous rare plants that occur in brackish riverbank marsh systems but not in salt marsh systems are diagnostic (listed below). *Spartina alterniflora* (smooth cordgrass) typically dominates the physically stressful low marsh. As salinity decreases, *Bolboschoenus robustus* (sea-coast tuber-bulrush) and *Typha angustifolia* (narrow-leaved cat-tail) become more prominent and may dominate the low marsh in some examples. A variable mix of graminoids and forbs characterize the high marsh zone.

Diagnostic natural communities:

- High brackish riverbank marsh (S1S2)
- Low brackish riverbank marsh (S1S2)

Peripheral or occasional natural communities:

- Brackish marsh (S2S3)

Associated natural community systems: This system may grade into sparsely-vegetated intertidal and subtidal systems toward the channel, and upland forest (landward) or fresh water stream borders (upstream).

Characteristic species:

Dominant to locally abundant species:

Spartina alterniflora (smooth cordgrass)

Bolboschoenus robustus (sea-coast tuber-bulrush)

Typha angustifolia (narrow-leaved cat-tail)

Other common species:

Symphyotrichum novi-belgii (New York American-aster)

Spartina patens (saltmeadow cordgrass)

Juncus gerardii (saltmarsh rush)

Typha angustifolia (narrow-leaved cat-tail)

Spartina pectinata (prairie cordgrass)

Agrostis stolonifera (creeping bentgrass)

Carex paleacea (chaffy sedge)

Solidago sempervirens (seaside goldenrod)

Schoenoplectus pungens (three-square bulrush)

Characteristic rare plants:

Limosella australis (Atlantic mudwort)*

Lilaeopsis chinensis (eastern grasswort)*

Crassula aquatica (pygmy-weed)*

Samolus valerandi ssp. *parviflorus* (seaside brookweed)*

• Coastal salt pond marsh system

Landscape settings: partially protected, supratidal coastal basins

Soils: Pawcatuck mucky peat over fine to coarse mineral and rocky substrates

Spatial pattern: small patch

Physiognomy: aquatic beds, flats, herbaceous emergent, meadow marsh, and shrub thickets

Distribution: adjacent to high-energy maritime shorelines

Description: This system is only known in the state from a single viable example at Odiorne Point State Park. The system occupies a coastal basin that is separated from the ocean by a ***maritime cobble beach*** and ***maritime shrub thicket***. The basin ranges from temporarily to seasonally flooded on higher ground to semi-permanently flooded in low elevation areas. Ponded water in 2011 was nearly fresh (weakly oligohaline) but salinity in this system type periodically increases from salt water intrusion during storm events when sea water washes over cobble berms. Vegetation is highly variable both temporally and spatially, likely the result of the dynamic nature of the hydrologic and salinity processes governing the system. Much of the ponded area that exists early in the growing season draws down later in the summer, exposing mud flats in low areas. Water levels can also rise rapidly after a storm. For example, areas in the marsh that were merely saturated just prior to the arrival of a tropical storm in 2011 were deeply inundated after the storm's departure. Many of the plant species occurring in the coastal salt pond marsh system can be found in fresh or brackish wetlands, but when growing together indicate brackish conditions. Other plant species that found only in fresh water habitats are restricted here to higher ground along the wetland's upper edge, where plant diversity is highest. Four natural communities occurring in the coastal salt pond marsh system are described below.

The ***coastal salt pond flat*** occurs adjacent to the emergent marsh but in lower lying areas that are seasonally to semi-permanently flooded. Plants develop from rhizomatous perennials creeping into this community from the emergent marsh at higher elevations or emerge from buried or recently deposited seeds as inundated areas are exposed.

The ***coastal salt pond emergent marsh*** occurs between the flat and meadow marsh in saturated to semi-permanently flooded settings with seasonably variable water levels. Water levels in shallower portions of the emergent marsh range from a few to several centimeters for most of the growing season. Later in the growing season, the soil surface may be exposed for the remainder of the summer. In deeper sections of the emergent marsh, 0.5 m or more of water may semi-permanently inundate the ground. These soils are exposed only during drier periods.

The ***coastal salt pond meadow marsh*** is semi-permanently saturated to seasonally flooded and is located on higher ground adjacent to the emergent marsh. Flooding typically occurs during the spring or high-runoff and precipitation events, but in most years, the water table remains at or below the surface for much of the growing season.

In addition to the three preceding rare communities, a narrow and discontinuous band of ***highbush blueberry - winterberry shrub thicket*** occurs along the upper edge of the coastal salt pond meadow marsh.

Diagnostic natural communities:

- Coastal salt pond flat (S1)
- Coastal salt pond emergent marsh (S1)
- Coastal salt pond meadow marsh (S1)

Peripheral or occasional natural communities:

- Highbush blueberry - winterberry shrub thicket (S4)

Associated systems: This system is associated with upland communities landward and the maritime rocky shore system, salt marsh system, sparsely vegetated intertidal system, and subtidal system seaward.

Characteristic species:

Coastal salt pond flat:

Eleocharis parvula (little-headed spikesedge)*

Eleocharis uniglumis (one-glumed spikesedge)*

Eleocharis flavescens var. *olivacea* (yellow spikesedge)

Lemna minor (common duckweed)

Nymphaea odorata (white water-lily)

Coastal salt pond emergent marsh:

Typha angustifolia (narrow-leaved cat-tail)

Schoenoplectus tabernaemontani (soft-stemmed bulrush)

Schoenoplectus pungens (three-square bulrush)

Bolboschoenus robustus (sea-coast tuber-bulrush)

Phragmites australis (common reed)

Coastal salt pond meadow marsh:

Spartina pectinata (prairie cordgrass)

Solidago sempervirens (seaside goldenrod)

Symphyotrichum novi-belgii (New York American-aster)

Agrostis stolonifera (creeping bentgrass)

Lythrum salicaria (purple loosestrife)

Lythrum hyssopifolia (hyssop-leaved loosestrife)

Thelypteris palustris var. *pubescens* (marsh fern)

• Sparsely vegetated intertidal system

Landscape settings: partially protected, intertidal coastal embayments

Soils: fine to coarse mineral and rocky substrates; moderately to strongly minerotrophic

Spatial pattern: large patch, extensive narrow-linear to extensive fringes; 10–1,000+ m long lengths of shoreline; uniform or narrow zonation parallel to shore

Physiognomy: sparsely vegetated

Distribution: restricted to the Great Bay estuarine complex, tidal coastal rivers, and other tidal embayments

Description: This system corresponds to intertidal areas with sparse vascular vegetation that occur between salt marsh, brackish marsh or upland systems landward and subtidal systems seaward. They include partially protected intertidal shores along rivers and other embayments; coastal shoreline strand/swales on coarse to fine mineral sediments; intertidal rocky shores on rocky or cobbly materials; and intertidal mudflats on broad to narrow, nearly flat extents of sand, mud, and silt. Vascular plant cover is sparse to generally no more than 25%.

Coastal shoreline strand/swales are flooded less than daily and are often characterized by plant stems and other detritus washed in on the higher tides and covering much of the substrate surface. These upper intertidal areas form either large patches or narrow strands along protected low-energy shorelines and are important habitat for various arthropods, shore birds, and other animals.

Intertidal rocky shores are on open stretches of estuarine rivers and streams or quiet, partially enclosed shores. They are flooded daily by tides. Macroalgae are often common on bedrock and rubble including *Ascophyllum nodosum* on larger outcrops and *Fucus vesiculosus* on less stable strata. Rocky shores may form large patches or narrow strands below the upper intertidal shoreline and are important habitat for various arthropods, predatory fish, wading birds, mud snails, and other animals. ***Intertidal flats*** are gently sloping, sparsely vegetated areas between salt or brackish marshes landward and subtidal communities seaward (including tidal creek channels). They form in depositional environments protected from high-energy wave action along the coast behind rocky spits, barrier beaches, and sand bars or along bays and rivers.

Diagnostic natural communities:

- Intertidal rocky shore (S3)
- Coastal shoreline strand/swale (S2)
- Intertidal flat (S3)

Associated systems: This system occurs between salt marsh systems, brackish riverbank marsh systems, or upland communities landward, and subtidal systems seaward.

Characteristic species:

Coastal shoreline strand/swales:

Spergularia marina (saltmarsh sand-spurry)
Salicornia depressa (common glasswort)
Suaeda linearis (annual sea-blite)
Limonium carolinianum (Carolina sea-lavender)
Puccinellia maritima (seaside alkali grass)

SUBTIDAL WETLANDS

Subtidal areas are continuously submerged. Vascular plants are typically absent or sparse; seaweeds, eelgrass, and oysters are important diagnostic biota.

• Subtidal system

Landscape settings: lowest (subtidal) portions of coastal embayments

Soils: mineral sediments and mud; strongly minerotrophic, saline to brackish

Spatial pattern: large patch, extensive flats to narrow-linear (up to 100s of acres); broad patches, linear, and irregular zonation

Physiognomy: sparsely vegetated to unvegetated

Distribution: restricted to the Great Bay estuarine complex, tidal coastal rivers, and other tidal embayments

Description: This system corresponds to continuously-submerged subtidal areas. In New Hampshire, subtidal systems include the ***eelgrass bed*** community and other (currently unclassified) aquatic communities on the bottoms of estuarine creeks, channels, and bays. The system performs important ecological functions including supporting oyster, eelgrass, and flounder populations, providing refuge for fish and invertebrates that retreat from exposed eelgrass beds, intertidal flats, and estuarine marshes at low tide, and serving as spawning and nursery areas for numerous species of aquatic animals (Short 1992). Vascular plants are typically absent or sparse in this system. Seaweeds are an important component of channel/bay bottoms and their surrounding environments. A total of 169 seaweed species have been documented as occurring in the Great Bay Estuary (Mathieson and Penniman 1991). ***Eelgrass beds*** dominated by *Zostera marina* (eel-grass) occur in estuarine waters, on mud rich in organic matter, or on sand bottoms. This rooted aquatic vascular plant covers nearly half of the bottom of Great Bay (2,585 acres). ***Eelgrass beds*** trap sediments, dissolved nutrients, and larval organisms flowing through the community and are an important contributor to ecosystem health and productivity. They serve as breeding, nursery, and feeding areas for many species of fish and invertebrates. ***Eelgrass beds*** also provide foraging grounds for waterfowl and wading birds that feed on the eelgrass or the fish and invertebrates the beds harbor. Oyster beds occur in shallow, mixohaline estuarine waters of Great Bay. Oysters (*Crassostrea virginica*) are an important food source for many other animals including starfish, crabs, fishes, and waterfowl.

Diagnostic natural communities:

- Eelgrass bed (S1)

Associated natural community systems: New Hampshire's subtidal systems are bordered landward by sparsely-vegetated intertidal systems and seaward (beyond channel mouths) by marine environments.

LITERATURE CITED

Barnes, W.J. 1978. The distribution of floodplain herbs as influenced by annual flood elevation. Wisconsin Academy of Sciences, *Arts and Letters* 66: 254-266.

Bornette G. and C. Amoros. 1996. Disturbance regimes and vegetation dynamics: Role of floods in riverine wetlands. *Journal of Vegetation Science* 7: 615-622.

Brinson, M.M. 1993. Changes in the Functioning of Wetlands Along Environmental Gradients. *Wetlands,* 13(2): 65-74.

Brinson, M.M. 1993. A Hydrogeomorphic Classification for Wetlands. Technical Report WRP-DE-4. US Army Corps of Engineers, Washington, DC.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service, Washington, DC. FWS/OBS-79/31.

Doyle, K.M., Fahey, T.K. and R.D. Paratley. 1987. Subalpine heathlands of the Mahoosuc Range, Maine. *Bulletin of the Torrey Botanical Club* 114: 429-436.

Fahey, T.J. 1976. The vegetation of a heath bald in Maine. Bulletin of the Torrey Botanical Club 103: 23-29.

Goebel, P.C., B.J. Palik, L.K. Kirkman, M.B. Drew, L. West, and D.C. Pederson. 2001. Forest ecosystems of a Lower Gulf Coastal Plain landscape: multifactor classification and analysis. *Journal of the Torrey Botanical Society* 128(1): 47-75.

Hupp C.R. and W.R. Osterkamp. 1985. Bottomland vegetation distribution along Passage Creek, Virginia, in relation to fluvial landforms. *Ecology* 66: 670-681.

Hupp, C.R. 1986. Upstream variation in bottomland vegetation patterns, northwestern Virginia. *Bulletin of the Torrey Botanical Club* 113: 421-430.

Jorgenson, N. 1978. Sierra Club Naturalists Guide to Southern New England. Sierra Club Books, San Francisco, CA.

Jorgenson, M.T. 2000. Hierarchical organization of ecosystems at multiple spatial scales on the Yukon-Kuskokwim Delta, Alaska, U.S.A. *Arctic, Antarctic, and Alpine Research*, 32(3): 221-239.

Kangas, P.C. 1990. An Energy Theory of Landscape for Classifying Wetlands. Pp. 15-23. *In:* A.E. Lugo, M. Brinson, and S. Brown (ed.) Ecosystems of the World 15: Forested Wetlands. Elsevier Press.

Mathieson, A.C. and C.A. Penniman. 1991. Floristic patterns and numerical classification of New England estuarine and open coastal seaweed populations. *Nova Hedwigia* 52: 453-485.

Miller, S.D. 1996. The vegetation and tree ring history of Spruce Hole Bog. M.S. thesis, University of New Hampshire, Durham, NH.

Mitchell, C.C. and W. Niering. 1993. Vegetation change in a topogenic bog following beaver flooding. *Bulletin of the Torrey Botanical Club* 120: 136.

NatureServe. 2003. A Working Classification of Terrestrial Ecological Systems in the Coterminous United States. International Terrestrial Ecological Systems Classification. NatureServe, Arlington, VA. 61 pp. + appendices.

Neid, Stephanie L. 2002. Guide to Open Peatlands in New Hampshire. Prepared by the NH Natural Heritage Program for the New Hampshire Audubon Society. Concord, NH.

New Hampshire Natural Heritage Bureau & NatureServe. 2011. Level 2.5 Ecological Integrity Assessment Manual – Wetland Systems. NH Natural Heritage Bureau, Department of Resources and Economic Development, Concord, NH.

Noble, I.R. and H. Gitay. 1996. A functional classification for predicting the dynamics of landscapes. *Journal of Vegetation Science*, 7: 329-336.

Rawinski, T.J. 1984. New England Natural Community Classification. Unpublished document. Eastern Heritage Task Force, The Nature Conservancy, Boston, MA.

Semeniuk, C.A. and V. Semeniuk. 1995. A geomorphic approach to global classification for inland wetlands. *Vegetatio*, 118: 103-124.

Short, F.T. 1992. (Ed.) The Ecology of the Great Bay Estuary, New Hampshire and Maine: An Estuarine Profile and Bibliography. National Oceanographic and Atmospheric Administration - Coastal Ocean Program.

Sperduto, D.D. 2004a. Upland Natural Community Systems of New Hampshire. NH Natural Heritage Bureau, Department of Resources and Economic Development, Concord, NH.

Sperduto, D.D. 2004b. Wetland Ecological Systems of New Hampshire. NH Natural Heritage Bureau, Department of Resources and Economic Development, Concord, NH.

Sperduto, D.D., W.F. Nichols, and N. Cleavitt. 2000a. Bogs and Fens of New Hampshire. NH Natural Heritage Inventory, Department of Resources & Economic Development, Concord, NH.

Sperduto, D.D., and W.F. Nichols. 2000b. Exemplary Bogs and Fens of New Hampshire. NH Natural Heritage Inventory, Department of Resources & Economic Development, Concord, NH.

Sperduto, D.D. and W.F. Nichols. 2011. Natural Communities of New Hampshire. 2nd Edition. NH Natural Heritage Bureau, Concord, NH. Pub. UNH Cooperative Extension, Durham, NH.

Sperduto, D.D. and W.F. Nichols. 2004. Natural Communities of New Hampshire. 1st Edition. NH Natural Heritage Bureau, Concord, NH. Pub. UNH Cooperative Extension, Durham, NH.

Vitt, D.H. 1994. An overview of factors that influence the development of Canadian peatlands. *Memoirs of the Entomological Society of Canada*, 169: 7-20.

Wells, D.E. 1996. Classification of peatland vegetation in Atlantic Canada. Journal of Vegetation Science. 7:847-878.

Wistendahl W.A. 1958. The flood plain of the Raritan River, New Jersey. *Ecological Monographs* 28: 129-153.

Zoltai, S.C. and D.H. Vitt. 1995. Canadian wetlands: Environmental gradients and classification. *Vegetatio* 118: 131-137.

Appendix 1. Explanation of Global and Subnational Rank Codes.

These rank codes describe the degree of vulnerability of an element of biodiversity (species, natural community, or natural community system) to extirpation, either throughout its range (global or "G" rank) or within a subnational unit such as a state (subnational or "S" rank). For species, the vulnerability of a sub-species or variety is indicated with a taxon ("T") rank. For example, a G5T1 rank for a sub-species indicates that the sub-species is critically imperiled (T1) while the species is secure (G5).

Code	Examples		Description
1	G1	S1	Critically imperiled because of extreme rarity (e.g., one to five occurrences), very restricted range, very steep recent declines, or other factors making it extremely vulnerable to extirpation.
2	G2	S2	Imperiled due to very few occurrences (e.g., six to 20), restricted range, steep recent declines, or other factors making it very vulnerable to extirpation.
3	G3	S3	Vulnerable due to relatively few occurrences (e.g., 21 to 80), relatively restricted range, recent declines, or other factors making it vulnerable to extirpation.
4	G4	S4	Apparently secure due to having more than a few occurrences (e.g., >80) and/or an extensive range, but possible cause for long-term concern due to local recent declines or other factors.
5	G5	S5	Secure; widespread and abundant.
U	GU	SU	Status uncertain. More information needed.
H	GH	SH	Known only from historical records (e.g., a species not reported as present within the last 20 years or a community or system that has not been reported within 40 years).
X	GX	SX	Believed to be extinct. May be rediscovered, but habitat alteration or other factors indicate rediscovery is unlikely.

Modifiers are used as follows:

Code	Examples		Description
Q	G5Q	GHQ	Questions or problems may exist with the element's taxonomy or classification, so more information is needed.
?	G3?	3?	The rank is uncertain due to insufficient information at the global level, so more inventories are needed. When no rank has been proposed the global rank may be "G?" or "G5T?".

When ranks are somewhat uncertain or the element's status appears to fall between two ranks, the ranks may be combined. For example:

G4G5	The element rank is either 4 or 5, or its rank is near the border between the two.
G5T2T3	For a plant or animal, the species is globally secure (G5), but the sub-species is vulnerable or imperiled (T2T3).
G5?Q	The element seems to be secure globally (G5), but more information is needed to confirm this (?). Further, there are questions or problems with the element's taxonomy or classification (Q).
G3G4Q S1S2	The element is globally vulnerable or apparently secure (G3G4), and there are questions about its taxonomy or classification (Q). In the subnation, the element is imperiled or critically imperiled (S1S2).

Appendix 2. Explanation of state listing codes.

In 1987, the New Hampshire state legislature passed the Native Plant Protection Act (RSA 217-A) and formally recognized that "for human needs and enjoyment, the interests of science, and the economy of the state, native plants throughout this state should be protected and conserved; and . . . their numbers should be maintained and enhanced to insure their perpetuation as viable components of their ecosystems for the benefit of the people of New Hampshire." To compile a list of the species requiring protection, the NH Natural Heritage Bureau collaborated with knowledgeable botanists and identified the most imperiled taxa as "endangered" and those likely to become endangered as "threatened." The most recent revision to the list was completed in 2010.

In addition to endangered and threatened, state watch and indeterminate categories exist for taxa appearing vulnerable to extirpation where current information does not justify designating them endangered or threatened.

Endangered (E): Native plant taxa vulnerable to extirpation based on having five or fewer natural occurrences in the state observed within the last 20 years, or taxa with more than five occurrences that are, in the judgment of experts, vulnerable to extirpation due to other important rarity and endangerment factors (population size and trends, area of occupancy, overall viability, geographic distribution, habitat rarity and integrity, and/or degree of protection). A rare native plant taxon that has not been observed in over 20 years is considered endangered unless there is credible evidence that all previously known occurrences of the taxon in the state have been extirpated.

Threatened (T): Native plant taxa vulnerable to becoming endangered based on having 6–20 natural occurrences in the state observed within the last 20 years, or taxa that are, in the judgment of experts, vulnerable to becoming endangered due to other important rarity and endangerment factors (population size and trends, area of occupancy, overall viability, geographic distribution, habitat rarity and integrity, and/or degree of protection).

Watch (W): Native plant taxa vulnerable to becoming threatened based on having 21–80 natural occurrences in the state observed within the last 20 years, or taxa that are, in the judgment of experts, vulnerable to becoming threatened due to other important rarity and endangerment factors (population size and trends, area of occupancy, overall viability, geographic distribution, habitat rarity and integrity, and/or degree of protection).

Indeterminate (Ind): Plant taxa under review for listing as endangered, threatened, or watch, but their rarity, nativity, taxonomy, and/or nomenclature are not clearly understood.

Rare (endangered and threatened) species listed in this document are followed by an asterisk (*).

APPENDIX 3. Key to natural community systems.

Introduction

The purpose of this key is to provide the user with a step-by-step way to identify the natural community systems described in this document. It is divided into two major groups: *wetlands*, such as marshes, swamps, and fens, and *uplands*, which include forests, bare mountain tops, coastal sand dunes, and other open, non-forested habitats.

The sequence of keys in this document is designed to aid in the identification of major system groups and specific natural community system types by reducing detailed differences down to a series of consecutive, dichotomous ("either-or") decisions between two sets of characteristics. Each pair of choices (only one of which is selected for a given study area) shares the same number. The first choice in each numbered couplet is designated "a" and the second "b." The user selects the most accurate description from the two options, and this description then leads either to another couplet (and another decision) or to a solution (a major group or natural community system name). If variability in the composition of natural community types within a system sometimes makes more than one choice appropriate for different examples of a system, that system is listed accordingly in more than one part of the key.

KEY TO NATURAL COMMUNITY SYSTEMS IN NEW HAMPSHIRE

1a. Systems on moderately well to excessively well drained, non-hydric soils that are never or rarely flooded.

Key to Upland Natural Community Systems

1b. Systems on saturated to somewhat poorly drained soils or regularly inundated organic or mineral soils (hydric), and supporting wetland (hydrophytic) vegetation; low floodplain forests may be hydric or non-hydric, but are included in this key; communities in the system may only be temporarily flooded but support wetland vegetation and soils.

Key to Wetland Natural Community Systems

KEY TO UPLAND NATURAL COMMUNITY SYSTEMS

1a. Tree canopy cover generally >60% (forests) **2**
1b. Tree canopy cover generally <60% cover, or less than 2 m tall (woodlands, krummholz**,** and barrens)..... **9**

2a. Forests on enriched sites dominated by hardwood species such as *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), or *Carya* spp. (hickories); *Betula alleghaniensis* (yellow birch) and *Fagus grandifolia* (American beech) may be present but are not dominant; conifers such as *Pinus strobus* (white pine), *Tsuga canadensis* (hemlock), and *Picea rubens* (red spruce) are generally sparse or absent; enriched site indicators include white ash, *Tilia americana* (basswood), *Polystichum acrostichoides* (Christmas fern), *Anemone americana* (blunt-lobed hepatica), *Actaea* spp. (baneberries), and wide-leaved sedges (*Carex* spp.)..... **3**
2b. Forests on till, sand or other fluvial soils without notable nutrient enrichment (rich site indicators in 2a absent); dominant species can include *Pinus strobus* (white pine), *Tsuga canadensis* (hemlock), *Fagus grandifolia* (American beech), *Betula alleghaniensis* (yellow birch), *Picea rubens* (red spruce), or *Abies balsamea* (balsam fir)……..... **5**

3a. Enriched hardwood forest system with few or no oaks species on mesic to wet-mesic loamy soils; sugar maple dominates; generally not on talus and not as dry as the alternate choice; consistent suite of indicator herb species that includes *Adiantum pedatum* (northern maidenhair fern), *Caulophyllum thalictroides* (blue cohosh), *Solidago flexicaulis* (zig-zag goldenrod), *Actaea* spp. (baneberries), *Dicentra cucullaria* (Dutchman's breeches), Aralia racemosa (American spikenard), *Botrychium virginianum* (rattlesnakefern), and *Osmorhiza claytonii* (bland sweet-cicely), among many others. ..... **Rich mesic forest system**
3b. Forests (occasionally woodlands) on shallow, rocky substrates (talus and other rocky slopes); *Quercus rubra* (red oak), *Acer saccharum* (sugar maple), and *Ostrya virginiana* (ironwood) are characteristic; other characteristic species include *Clematis virginiana* (virgin's-bower), *Geranium robertianum* (mountain crane's-bill), and *Piptatherum racemosum* (black-seeded mountain-rice grass) **4**

4a. Forests (occasionally woodlands) dominated by Appalachian species such as *Quercus alba* (white oak), *Carya ovata* (shagbark hickory), *Carya glabra* (pignut hickory), and *Benthamidia florida* (flowering dogwood); only found in the southern third of the state…… .....**Rich Appalachian oak rocky woods system**
4b. Forests (occasionally woodlands) dominated by rich-site cool temperate (Laurentian) and/or northern hardwoods such as *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), and *Tilia americana* (basswood) ..... ……..... **Rich temperate rocky woods system**

5a. Dominant tree species are *Picea rubens* (red spruce) and *Abies balsamea* (balsam fir); *Betula papyrifera* (paper birch) and/or *Betula cordifolia* (heartleaf birch) are frequent successional associates; other hardwood species generally sparse or absent…… **6**
5b. Appalachian oak and other southern species, other hardwoods, hemlock, and/or pine are dominant; when present, spruce and fir are at most co-dominant along with the northern hardwoods *Betula alleghaniensis* (yellow birch), *Fagus grandifolia* (American beech), and *Acer saccharum* (sugar maple)…… **7**

6a. Well drained fir and spruce-fir forests on mountain slopes and summits usually at elevations between 2,500-4,500 ft.), and occasionally on rocky slopes at lower elevation. ..... **High-elevation spruce - fir forest system**
6b. Spruce and spruce-fir forests in lowland valley bottom settings, mostly at elevations between 1,000-2,500 ft. north of the White Mts., occasionally at higher elevations in valley bottoms in the White Mts.; soils are typically somewhat poorly to moderately well drained .....**Lowland spruce - fir forest system**

7a. Forests with an abundance of Appalachian oak and other southern species such as *Quercus alba* (white oak), *Q. velutina* (black oak), *Q. coccinea* (scarlet oak), *Q. montana* (chestnut oak), *Carya* spp. (hickories), and *Sassafras albidum* (Sassafras); mainly limited to less than 1,000 ft. elevation in southern NH, with some disjunct examples in south-central NH on steep, south-facing hills..... **Appalachian oak - pine forest system**

7b. Forests with few or no Appalachian species listed in the alternate choice **8**

8a. Northern hardwood and mixed forests dominated by *Betula alleghaniensis* (yellow birch), *Acer saccharum*, (sugar maple), and *Fagus grandifolia* (American beech); *Quercus rubra* (red oak), *Pinus strobus* (white pine), and *Betula lenta* (cherry birch) are usually absent or in low abundance; characteristic herbs include *Clintonia borealis* (yellow bluebead-lily), *Huperzia lucidula* (shining firmoss), *Oxalis montana* (northern wood sorrel), and Oclemena acuminata (sharp-toothed nodding-aster); the dominant forest type from 1,400-2,500 ft. elevation in northern and central NH; patchy further south and at lower elevations on mesic or enriched sites..... .... **Northern hardwood - conifer forest system**

8b. Transitional hardwood and mixed forests characterized by the presence of *Tsuga canadensis* (hemlock), *Fagus grandifolia* (American beech), *Pinus strobus* (white pine), and *Quercus rubra* (red oak) in varying amounts; *Acer saccharum* (sugar maple) and *Betula alleghaniensis* (yellow birch) are usually absent or in low abundance, except as inclusions on mesic or enriched sites (e.g., drainages, concavities, etc.); the dominant forest type below 1,400 ft. elevation in central and much of southern NH..... **Hemlock - hardwood - pine forest system**

9a. Systems occur exclusively in coastal settings on sand or bedrock that is being directly influenced by ocean winds, salt spray, and/or storm surge..... **10**

9b. Systems on bedrock, talus, till, or sand not directly influenced by maritime conditions..... **11**

10a. System occurs on shifting sands between the ocean and estuarine or upland systems.. . **Coastal sand dune system**

10b. System occurs on the Isles of Shoals, small rocky islands off the NH coast ., and locally in high-energy settings on the mainland's coastline..... **Maritime rocky shore system**

11a. Systems in alpine or subalpine settings above 3,000 ft. elevation in the White Mtns; woody vegetation, when present, is stunted (<2m tall); mat forming shrubs, graminoids, mosses and lichens are the dominant life forms; alpine/subalpine-restricted species include *Vaccinium uliginosum* (alpine blueberry), *Vaccinium vitis-idaea* (mountain cranberry), *Carex bigelowii* (Bigelow's sedge), and *Empetrum* spp. (crowberries); alpine occurs above treeline beginning around 4,900 ft.; subalpine occurs at lower elevations where exposure, shallow soils, and sometimes fire allow for the development of these system types..... **12**

11b. Systems on bedrock, talus, or sand that are not in alpine or subalpine settings, generally below 3,000 ft. (talus and cliff systems up to 4,000 ft.)..... **14**

12a. System occurs in high-elevation ravines, usually above 4,000 ft., in the Presidential Range of the White Mts., with large, deep snowpacks, and are often wet throughout the growing season; characterized by a mix of alpine-restricted species and lowland herbs (e.g., *Chamaepericlymenum canadense* (bunchberry), *Lysimachia borealis* (starflower))..... **Alpine ravine/snowbank system**

12b. Systems not in alpine ravine settings; generally drier than in the alternate choice; lowland herbs absent **13**

13a. System mostly found above 4,900 ft. elevation in the White Mts.; one or more or the following alpine species, these largely restricted to the alpine zone, are common: *Carex bigelowii* (Bigelow's sedge), *Diapensia lapponica* (diapensia), *Solidago leiocarpa* (Cutler's goldenrod), *Vaccinium cespitosum* (dwarf blueberry), and *Juncus trifidus* (highland rush)..... **Alpine tundra system**

13b. System from 3,000 to 4,900 ft. elevation; mix of dwarf shrub and krummholz patches; above alpine indicators absent or sparse; dwarf heaths *Rhododendron groenlandicum* (Labrador-tea), *Kalmia angustifolia* (sheep laurel), and *Vaccinium myrtilloides* (velvet-leaved blueberry) are frequent shrubs..... ..... **Subalpine heath - krummholz/rocky bald system**

14a. Systems on cliffs (exposed bedrock at least three meters in height and with a slope of 65° or more) **15**
14b. Systems not on cliff settings……. **16**

15a. Cliffs primarily above 1,200 ft. elevation in the White Mts. and northward; southern species absent; usually surrounded by northern hardwoods or spruce - fir forest..... **Montane - subalpine cliff system**
15b. Cliffs primarily below 1,200 ft. elevation south of the White Mts.; northern species absent; usually surrounded by hemlock - beech - oak - pine forest or Appalachian oak - pine forest ..... **Temperate ridge - cliff - talus system**

16a. Systems on talus slopes, typically (but not always) below cliffs **17**
16b. Systems on bedrock or sand, not on talus slopes..... **18**

17a. Talus slopes at mid to high elevations in the White Mts. (mostly above 2,200 ft., occasionally down to 1,500 ft.); spruce, birches, and *Sorbus* spp. (mountain ash) present or in vicinity; oaks and *Betula lenta* (cherry birch) absent…….....**Montane talus slope system**
17b. Talus slopes at low to mid elevations in southern and central NH (below 2,200 ft.); spruce and *Sorbus* spp. (mountain ash) absent or sparse; oaks and *Betula lenta* (cherry birch) present or in vicinity..... ……..... **Temperate ridge - cliff - talus system**

18a. Woodland (or forest) system on lowland sand plain settings with abundant pitch, red or white pine..... ….....**Pitch pine sand plain system**
18b. Open, woodland, (and forest) systems on rocky ridges **19**

19a. Rocky ridge system below 1,200 ft. in southern NH; characterized by the presence of Appalachian oak species such as *Quercus alba* (white oak), *Quercus velutina* (black oak), and *Quercus montana* (chestnut oak)..... … ……..... **Temperate ridge - cliff - talus system**
19b. Rocky ridge system at mid-elevations (1,300-3,000 ft.) in western and northern NH; Appalachian species in the alternate choice are absent; red oak, red pine, and red spruce are the dominant trees..... ……..…….....**Montane rocky ridge system**

KEY TO WETLAND NATURAL COMMUNITY SYSTEMS

1a. Systems subjected to diurnal or periodic tidal inundation (subtidal and tidal habitats); halophytic (salt-loving) vegetation present such as *Spartina* spp. (cordgrasses), *Ruppia maritima* (widgeon-grass), *Juncus gerardii* (saltmarsh rush), *Triglochin maritima* (saltmarsh arrow-grass), *Typha angustifolia* (narrow-leaved cat-tail), *Bolboschoenus robustus* (sea-coast tuber-bulrush), and *Salicornia* spp. (glassworts) **2**

1b. Systems not influenced by tidal inundation; halophytic vegetation listed in the alternate choice not present; includes emergent marshes, peatlands, swamps, floodplains, riverbanks, and seeps **6**

2a. Tidal marsh systems dominated by vascular plants; grasses and/or sedges form a dense cover **3**

2b. Subtidal and intertidal systems which are sparsely vegetated to unvegetated; vascular plant cover is less than 25%……..... **5**

3a. Isolated basins that receive primarily fresh water inputs, except during storm events when salt water input from wave overwash may occur…….. .....**Coastal salt pond marsh system**

3b. Tidal marsh systems that are open to the ocean, bays, estuaries or rivers, and experience regular flooding..... 4

4a. Tidal marsh system that is moderately to strongly saline (18-50 ppt); the grasses *Spartina alterniflora* (smooth cordgrass) and/or *Spartina patens* (saltmeadow cordgrass) are typically dominant; brackish indicators, if present, restricted to upland margins or freshwater input areas .....**Salt marsh system**

4b. Tidal marsh system with lower salinity levels (0.5-18 ppt) that receives inputs of freshwater from the watershed above; brackish indicators such as *Bolboschoenus robustus* (sea-coast tuber-bulrush) and *Typha angustifolia* (narrow-leaved cat-tail) are dominant along with a variable mix of other graminoids and forbs; rare indicators include *Limosella australis* (Atlantic mudwort), *Lilaeopsis chinensis* (eastern grasswort), and *Samolus valerandi* ssp. *parviflorus* (seaside brookweed) …….....**Brackish riverbank marsh system**

5a. Intertidal areas with sparse vascular vegetation that occur between tidal marshes or upland systems landward and subtidal systems seaward; includes intertidal shores along rivers, coastal shoreline strands on mineral sediments, intertidal rocky shores, and intertidal flats on gently sloped sand and silt substrates..... ……..…….....**Sparsely vegetated intertidal system**

5b. Subtidal system below the reach of low tides; vascular plants are absent or sparse; seaweeds, eelgrass, and oysters are important diagnostic biota……..... **Subtidal system**

6a. Wetland systems directly associated with periodic flooding along a river or large stream (third order or higher); forested floodplains and open riverbanks and shores **7**

6b. Wetland systems not directly associated with a river or large stream (third order or higher); occurs in wet depressions or sloped settings, along pond or lake shores, or along drainages of small streams (i.e., first and second order)……..... **12**

7a. Open systems below the bankfull stage of a river; on higher-energy rivers, the substrate is coarse (gravel to boulder), while lower-energy rivers generally have finer sediments (sand or silt); vegetation is often sparse, but frequently includes a mixture of shrub and herbaceous communities..... **8**

7b. Primarily forested systems above the bankfull stage of a river, that receive periodic overbank flooding; *Acer saccharinum* (silver maple) is characteristic on larger rivers, *Acer rubrum* (red maple) and other tree species on smaller rivers and streams; herbaceous and shrubby wetland communities may also be present in micro-topographic depressions, such as oxbows, sloughs, and vernal pools…… **10**

8a. Low gradient river channels and riverbanks with fine-grained (silt or sand) sediments; gravel and cobble bars are rare or absent; aquatic bed and emergent marsh communities are common; shrubbier portions of this system are characterized by alder, dogwoods, and viburnums..... **Low-gradient silty-sandy riverbank system**

8b. Moderate- to high-gradient riverbanks with either frequent sand, gravel, and cobble bars, or with boulders and bedrock as the dominant substrate; vegetation is generally sparse as a result of ice and flood scour; silty deposits are rare or absent, as are aquatic bed and emergent marsh communities..... **9**

9a. Moderate gradient riverbanks with frequent sand, gravel, and cobble bar deposits, but without extensive deposits of boulders and areas of bedrock; vegetation has sparse to moderate cover of herbs and shrubs on coarse substrates……..…….. ..... **Moderate-gradient sandy-cobbly riverbank system**

9b. High-gradient riverbanks with boulders and bedrock as the dominant channel substrate; meanders and bars of gravel and finer sediments are sparse or limited in extent; sparsely vegetated areas and some cobble are characteristic; riverbank fern glades, alder alluvial thickets, or other vegetation occurs on slightly higher riverbanks; riverside seeps are rare…… .....**High-gradient rocky riverbank system**

10a. Floodplains of montane and northern rivers that often have higher gradients compared to other river systems; diagnostic communities are sugar maple and balsam fir floodplain forests; when silver maple forests are present, they are not the dominant forest type and may be limited to river edges; herbaceous openings and alder shrublands are often associated with the floodplain forest communities ..... **Montane/near-boreal floodplain system**

10b. Floodplains of major and minor rivers, primarily in central and southern New Hampshire; *Acer saccharinum* (silver maple) or *Acer rubrum* (red maple) are the dominant trees, with *Acer saccharum* (sugar maple) absent or rare……. **11**

11a. Floodplain system of major rivers, with *Acer saccharinum* (silver maple) forests dominating; shrubs are generally sparse, although vines are often abundant; *Matteuccia struthiopteris* ssp. *pensylvanica* (ostrich fern) and/or *Laportea canadensis* (Canada wood-nettle) may be abundant; shrub thickets and herbaceous meadows may occur on low floodpains and riverbanks; aquatic beds and emergent marshes may also occur in oxbows and are typically flooded annually…….……. .....**Major river silver maple floodplain system**

11b. Floodplain system of minor rivers, with *Acer rubrum* (red maple) forest communities typically dominating, and occasionally other types (sycamore, swamp white oak, and balsam fir); silver maple floodplain forests may be present, but do not dominate extensive areas; the understory is often shrubbier than in the alternate choice, and ferns are typically abundant, but *Matteuccia struthiopteris* ssp. *pensylvanica* (ostrich fern) and/or *Laportea canadensis* (Canada wood-nettle) are rarely abundant; low, medium, and high floodplain variants are distinguishable in many occurrences…….……. ... **Temperate minor river floodplain system**

12a. Wetland systems with primarily organic soils (peatlands) (muck or peat >16" deep); hummocks and hollows often well developed; dominant vegetation type may be forest, shrubland, or herbaceous, but *Sphagnum* mosses are almost always present; sedges or heath shrubs generally more abundant than grasses and forbs; *Onoclea sensibilis* (sensitive fern) absent or in low abundance (except **14a**)..... **13**

12b. Wetland systems with primarily mineral soils (organic layer absent or < 16" deep); hummocks and hollows usually poorly developed except in some swamps; *Sphagnum* mosses may be present, but generally do not develop extensive peat layer; sedges and heath shrubs generally less abundant than grasses, forbs, and non-heath shrubs..…… **23**

13a. Peatland systems with trees as the dominant vegetative stratum (generally >25% cover); shrubby openings may be present, but the wetlands are primarily forest **14**

13b. Open peatland systems dominated by shrubs, herbs, or bryophytes; trees, if present, typically have a cover of less than 25%……..……..... **17**

14a. Minerotrophic peat swamp system in northern New Hampshire with *Thuja occidentalis* (northern white cedar) present, often as a dominant canopy species; *Fraxinus nigra* (black ash) is a frequent associate; organic soils are generally circumneutral (pH 4.9-7.5), and often well decomposed; the sloping margins of the swamp may have mineral soils with a shallow organic layer; often very high diversity of both vascular and non-vascular plants; *Onoclea sensibilis* (sensitive fern) often present in abundance..... ……..... **Montane/near-boreal minerotrophic peat swamp system**

14b. Acidic peat swamp systems, generally without *Thuja occidentalis* (northern white cedar) or *Fraxinus nigra* (black ash)…….. ..... **15**

15a. Swamp system is dominated by hardwood tree species, particularly *Acer rubrum* (red maple); *Nyssa sylvatica* (black gum) can be frequent in sites in southeastern New Hampshire; patches of tall shrub fens are common as part of the swamp mosaic; soils are typically organic, although some examples may occur on mineral soils in depressions with a seasonally fluctuating water table ..... **Temperate peat swamp system**

15b. Swamp systems are dominated by coniferous tree species, usually either *Chamaecyparis thyoides* (Atlantic white cedar) or *Picea mariana* (black spruce)……..... **16**

16a. Peatland swamp system in central and southern New Hampshire dominated by *Chamaecyparis thyoides* (Atlantic white cedar), and occasionally *Pinus rigida* (pitch pine); coastal plain and/or southern species are present, including *Clethra alnifolia* (sweet pepperbush), *Rhododendron maximum* (giant rhododendron), and *Sphagnum flavicomans* (peat moss)…….. ..... **Coastal conifer peat swamp system**

16b. Peatland swamp system primarily in central and northern New Hampshire and dominated by *Picea mariana* (black spruce); *Larix laricina* (eastern larch) and *Picea rubens* (red spruce) are both occasionally to locally abundant; patches of tall shrub thickets are common; the system often surrounds open peatlands ..... …….. .....**Black spruce peat swamp system**

17a. Peatland systems at higher elevations (above 2,500 ft.), in montane, subalpine, and alpine areas **18**

17b. Peatland systems in lower elevations (generally below 2,900 ft.) that lack alpine/subalpine-restricted species **19**

18a. Oligotrophic, level or sloping peatland system in subalpine and alpine areas with a mixture of low elevation peatland species and alpine/subalpine-restricted species like *Empetrum nigrum* (black crowberry) and *Vaccinium uliginosum* (alpine blueberry); red sphagna (*Sphagnum rubellum* and *S. magellanicum*) often prominent ..... ……..……..... **Alpine/subalpine bog system**

18b. Weakly minerotrophic sloping to almost level shrub-sedge fen system in openings within montane spruce-fir forests in the upper East Branch of the Pemigewasset River watershed in the White Mountains above 2,400 ft. elevation and below subalpine zones; dominated by *Calamagrostis pickeringii* (Pickering's reed grass), sphagnum mosses (mostly non-red), and heath shrubs…….**Montane sloping fen system**

19a. Peatland system exhibiting patterned arrangement of hummock ridges and long hollows; only in extreme northern New Hampshire…….. ..... **Patterned fen system**

19b. Peatland systems do not exhibit patterned hummock-hollow arrangement of alternate choice..... **20**

20a. Weakly to strongly minerotrophic peatland systems; pHs from 4.1-8.2; weakly minerotrophic system indicators include *Myrica gale* (sweet gale), *Spiraea alba* var. *latifolia* (meadowsweet), *Carex lasiocarpa* ssp. *americana* (wire sedge), *Carex utriculata* (swollen-beaked sedge), and *Carex stricta* (tussock sedge); strongly minerotrophic system indicators include *Carex interior* (inland sedge), *Carex flava* (yellow-green sedge), and *Carex hystericina* (porcupine sedge)……..... **21**

20b. Oligotrophic peatland systems; pHs generally ≤ 4.1; absence or rarity of weak to strong minerotrophic indicators in alternate choice; dominance of peatland shrubs *Chamaedaphne calyculata* (leatherleaf), *Andromeda polifolia* var. *glaucophylla* (bog rosemary), and *Rhododendron groenlandicum* (Labrador-tea) **22**

21a. Weakly to moderately minerotrophic peatland system; indicator species *Carex lasiocarpa* ssp. *americana* (wire sedge), *Carex utriculata* (swollen-beaked sedge), and *Carex stricta* (tussock sedge) in a mosaic with peatland shrubs *Chamaedaphne calyculata* (leatherleaf) and *Myrica gale* (sweet gale)..... **Medium level fen system**

21b. Strongly minerotrophic peatland system; indicator species include *Carex interior* (inland sedge), *Carex flava* (yellow-green sedge), and *Carex hystericina* (porcupine sedge); only in northern New Hampshire..... ..... **Calcareous sloping fen system**

22a. Peatland system in kettle hole landscape setting (usually round or oval-shaped depressions that generally lack significant inlet or outlet streams); "mud bottoms" of *Cladopodiella fluitans* (liverwort) are typical..... .....**Kettle hole bog system**

22b. Peatland system not in kettle holes, usually with some sort of inlet or outlet stream; "mud bottoms" of *Cladopodiella fluitans* (liverwort) generally not present..... **Poor level fen/bog system**

23a. Oligotrophic wetland systems in sand plain settings along lake and pond shores and in closed basins with no inlets or outlets, and widely fluctuating water levels; diagnostic flora herbaceous, with characteristic species *Rhexia virginica* (Virginia meadow-beauty), *Cladium mariscoides* (twig-rush), *Viola lanceolata* (lance-leaved violet), and *Cyperus dentatus* (bulblet umbrella sedge) **24**

23b. Minerotrophic wetland systems not specifically associated with sand plain settings; vegetation may be forest, shrubland, or herbaceous..... ..... **25**

24a. Wetlands system on sandy shores of permanent ponds or lakes that experience pronounced wave action and ice scour; diagnostic species include *Cladium mariscoides* (twig-rush) and *Euthamia graminifolia* (common grass-leaved-goldenrod), with *Lobelia dortmanna* (water lobelia) frequent in the aquatic zone; may occasionally be associated with the *Hudsonia inland beach strand* community..... **Sandy pond shore system**

24b. Wetlands system in shallow, closed basins experiencing widely fluctuating water levels, where vegetation zonation is typical and wave and ice action are absent; many examples may be seasonally dry; *Rhexia virginica* (Virginia meadow-beauty), *Viola lanceolata* (lance-leaved violet), and *Eleocharis tenuis* (slender spikesedge) are characteristic species..... .....**Sand plain basin marsh system**

25a. Open wetland system dominated by a mix of shrub and herbaceous communities; may be associated with forested wetlands, but trees are not dominant stratum.....**Drainage marsh - shrub swamp system**

25b. Forested swamp systems on primarily mineral soils; shrubs thickets may be present, but are not the dominant vegetative stratum..... ..... **26**

26a. Small (<5 acres) forested wetland system on or at the base of slopes or along drainages, characterized by groundwater seepage or seepage discharge zones; herbaceous species indicative of seepage zones include *Tiarella cordifolia* (foam-flower), *Chrysosplenium americanum* (golden-saxifrage), and *Carex scabrata* (eastern rough sedge); in more acidic examples, herbs such as *Veratrum viride* (American false hellebore) and *Oclemena acuminata* (sharp-toothed nodding-aster) form a sparse to moderate cover over a dense *Sphagnum* layer; *Onoclea sensibilis* (sensitive fern) is usually present..... **Forest seep/seepage forest system**

26b. More extensive forested wetland systems on level terrain, not characterized by groundwater seepage; *Onoclea sensibilis* (sensitive fern) may or may not be present..... **27**

27a. System characterized by a mosaic of wetland and upland spruce forest, typified by *Picea rubens* (red spruce) dominated swamps to moderately well drained uplands; most common north of the White Mtns; *Onoclea sensibilis* (sensitive fern) typically absent.....**Lowland spruce - fir forest/swamp system**

27b. Primarily hardwood swamps dominated by *Acer rubrum* (red maple), although *Tsuga canadensis* (hemlock) and *Betula alleghaniensis* (yellow birch) may be locally abundant; *Ilex verticillata* (common winterberry) and *Vaccinium corymbosum* (highbush blueberry) shrub layer is usually well developed; *Onoclea sensibilis* (sensitive fern) is typically common..... .....**Temperate minerotrophic swamp**