Natural Communities of New Hampshire

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New Hampshire Natural Heritage Bureau
and
The Nature Conservancy

New Hampshire Natural Heritage Bureau

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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, exemplary natural community systems, 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. The Nature Conservancy provides ecology staff and other services to the bureau through a cooperative agreement with the state of New Hampshire.

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COVER PHOTOS: Daniel Sperduto

LEFT: A *dwarf shrub - bilberry - rush barren* on the trail-less subalpine summit of Whitewall Mtn. in the White Mountains. The rare plant *Paronychia argyrocoma* (silverling) grows in bedrock cracks in the foreground.

TOP RIGHT: A stand of the state rare tree *Betula nigra* (river birch) on the edge of a *swamp white oak floodplain forest* (river birch variant) along Beaver Brook in Pelham.

BOTTOM RIGHT: *Salt marsh* at Odiorne State Park in Rye.

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INTRODUCTION

NATURAL COMMUNITIES are recurring assemblages of plants and animals found in particular physical environments. New Hampshire has a fascinating and complex variety of natural communities, from tidal marshes to alpine meadows, riverbanks to mountain forests, and streams to lakes. Each type of natural community has a unique set of environmental conditions that support certain species adapted to those conditions. For example, a rich hardwood forest typically has a canopy of sugar maple and white ash underlain by Dutchman's breeches, blue cohosh, and certain other plants, animals, and microbes. This natural community occurs on moist soils enriched with nutrients, and many of the species present grow only under these conditions. Pitch pine - scrub oak barrens, in contrast, develop on extremely dry, nutrient-poor sands and gravels, and are characterized by drought- and fire-resistant pitch pine, scrub oak, low-bush blueberries, and a variety of rare moths and butterflies that depend upon these plants and conditions.

Just as individual organisms can be classified into species, plant assemblages can be classified into natural community types. Classifying natural communities is a useful way of viewing the landscape because it allows us to distill the broad range of complex interactions between species and their environments into a limited number of units that share certain key features. Natural communities are distinguished from one another using three primary characteristics. Each has:

- a definite plant species composition;
- a consistent physical structure (such as forest, shrubland, or grassland); and
- a specific set of physical conditions (such as nutrient level, water availability, and climate conditions).

Natural community types are usually defined in terms of plants because they are easy to study, often compose the physical structure to which most other organisms respond, and are sensitive indicators of physical *and* biological factors that influence many types of organisms. Since plant assemblages often correspond closely to other groups of organisms, natural communities can be used as "coarse filters" that "capture" many of the species and processes in the community even if they have not been specifically identified.

WHY CLASSIFY NATURAL COMMUNITIES?

The need to classify natural communities is fundamentally pragmatic: people need a way to sort out, understand, and communicate about nature's complexity in order to be good stewards. Naturalists have known for centuries that some species are more common than others, and that not all land has the same capacity to support all species. In fact, humans have classified the land in one way or another for thousands of years in order to identify where food, medicinal plants, and other resources could be obtained. Modern demands for resources and land have increased the pressure on natural ecosystems, and society has become increasingly concerned about preserving biodiversity not only for human benefits (current and future), but for the maintenance of ecosystems for their own sake. Natural communities can be thought of as the natural arenas where populations of different species interact, respond to selective pressures, and continue to evolve. If these natural contexts can be maintained, it will benefit all other forms of life; if they cannot, the species they contain may be in jeopardy.

Classification, therefore, attempts to describe variation and pattern in the landscape and gives us a powerful way of lending context to a site. Classifying the landscape into discrete natural communities allows us to: (1) compare one area to another and say something about how they are similar or different, (2) determine whether an area is unique or common, (3) know if it is a big or small example of its type, (4) identify the combination of circumstances that likely affect the organisms present, (5) infer how management and stewardship may influence the mix, and (6) ensure the conservation of ecological processes and species that occur in a community, whether they are presently known or not. Together, these functions allow us to develop conservation and management strategies that ensure the survival of all species.

Classification Approach and Limits

The spectrum of ecological influences affecting vegetation at many scales presents unique challenges in classifying natural communities. Below we describe our conceptual approach to classification issues (succession, size, scale, methods) and relationships to other classification systems.

Succession. This classification strives to define late-successional associations or those that are maintained by natural disturbance (e.g., fire in pitch pine - scrub oak woodlands and red oak rocky ridges, or flooding in alder thickets or river channels). Early successional occurrences or those significantly disturbed or manipulated by humans may be difficult to key out based solely on current vegetation composition, particularly for forests. In these cases, the best indicators of future conditions may be soil attributes, landform, and late-successional dominants in the understory.

Community size. Communities have different size ranges. Some common communities tend to cover large areas and form the "matrix" of a landscape. Other communities are imbedded in this matrix as large or small patches. The great majority of the landscape area consists of relatively few common community types, whereas the majority of the community types occupy a minority of the area. Large areas occupied by common communities may harbor relatively low community and plant species diversity, but they contribute important ecosystem processes and functions.

Scale and comprehensiveness. Ideally, a classification system would be comprehensive and have both similar magnitudes of variation *within* community types as well as distinct and definable differences *between* community types. However, no classification system can perfectly reflect community diversity in the landscape. In part, this is because of limitations in our knowledge: some types are too broad and poorly defined to account for real variation seen in the field; some may be too fine and idiosyncratic; and some types are simply missing because they have not yet been described. Although there are these inherent scale and knowledge limitations, this guide attempts to provide a comprehensive classification scheme that can be modified as we learn more. Examples of gaps in our knowledge that require additional sampling include aquatic beds and streambank communities at the aquatic-terrestrial interface.

Data analysis. The data available for community definition vary in quantity and quality depending on the community. Each description notes sources and gives literature references to equivalent or related community types that have been described in NH, when possible. Many communities were delineated from quantitative analyses of robust data sets using TWINSPAN, DECORANA, and CANOCO (Hill 1979). The remaining communities were delineated by comparing sets of data manually (i.e., by constructing and interpreting "raw" vegetation tables to compare data). Taken together, these data consist of thousands of vegetation plots collected by the New Hampshire Natural Heritage Bureau and its collaborators, as well as from literature sources. Some descriptions are based on more limited or qualitative data. A classification confidence ranking system was devised to indicate the relative robustness of data supporting community concepts and descriptions (see Classification Format section).

Other classification systems. Many other classification systems for habitats, cover types, and communities have been employed in New Hampshire. These include previous New Hampshire Natural Heritage Bureau classifications (Rawinski 1986; Sperduto 1994; Sperduto 1997; Sperduto 2000; Nichols et al. 2001) and research on particular habitats within certain regions of the state (Leak 1982; Fincher 1991; Smith 1992; Fincher and

Smith 1994; and numerous reports cited in this document). Significant national-scale classifications include the Society of American Foresters (SAF) cover types, U.S. Forest Service Ecological Land Types (ELT), U.S. Fish and Wildlife Service's wetland classification (Cowardin et al. 1979), and the U.S. National Vegetation Classification System (NVC) maintained by NatureServe in collaboration with the Ecological Society of America. The NVC is periodically revised in part on the basis of more specific natural community classifications developed at the state level by natural heritage programs (including NH). The "association" level of the NVC is similar in scale and concept to the natural communities found in this document. The NVC has been adopted by the Federal Geographic Data Committee for use by all federal agencies.

Relationships to soil types. Community types described here are usually coarser than most soil types (i.e., many soil series might correspond to one community type). Some soil types, however, particularly wetland soil series, are more broadly defined and may correspond to different community types. Soil descriptions in this guide often include texture, drainage class, and fertility attributes rather than identified soil series. We hope to develop more specific relationships with soil series in future iterations of the classification.

Field Identification of Natural Communities

Many communities can be identified with only a modest level of familiarity with plants, but some require more in-depth botanical knowledge. For people that have relatively little experience with plants, simply using the broad classes of communities, such as floodplain forests, talus slopes, and rocky ridges, is a way to begin grasping the diversity of landscape types that strongly influence vegetation.

You do not need to be a botanist to identify many natural communities in New Hampshire, but you do need a working knowledge of New Hampshire's common flora and the ability to identify ("key out") some of the less common plants. Fortunately, excellent field guides are available. For common or rare herbs and shrubs, *Newcomb's Wildflower Guide* (Newcomb 1977) has a simple, user-friendly identification system. Although it does not cover trees, ferns, grasses, sedges, and many aquatic plants, other manuals are available for these groups. For some hard-to-identify plants and communities, you'll need to use botanical manuals, review plant collections at herbaria, or consult an expert.

Spending time in the field with knowledgeable people can rapidly expand your identification skills. Several groups in the state offer short courses or seminars on wildflowers and natural community identification, including the New England Wild Flower Society, Society for the Protection of New Hampshire Forests, Audubon Society of New Hampshire, New Hampshire Natural Heritage Bureau, University of New Hampshire Cooperative Extension, and a variety of schools (such as the University of New Hampshire and Antioch University). In many cases you can visit exemplary natural communities on your own. Many good examples of communities are on public lands or private lands with public access. Whenever possible, community descriptions in this classification include specific locations of good examples.

Exemplary Natural Communities

The Natural Heritage Bureau places particular emphasis on and gives conservation priority to "exemplary" natural communities. Exemplary natural communities include nearly all examples of rare types (such as most alpine communities) and high-quality examples of common types. High-quality natural communities are identified as having relatively little human impact. These areas have greater potential to contain or achieve natural dynamics that are characteristic of the original community types. A forested natural community need not be "old growth" to obtain exemplary status. Typical exemplary forested natural communities have a variety of characteristic species, natural regeneration within forest gaps, multiple age classes, diverse structural characteristics, abundant standing and fallen woody debris, intact soil processes, and little direct evidence of human disturbance. Exemplary natural communities represent the best remaining examples of New Hampshire's flora, fauna, and underlying ecological processes. If you think you have found an exemplary natural community, you can use the reporting form included in Appendix 2 of this document.

CLASSIFICATION FORMAT

The classification uses broad biophysical categories to provide a hierarchical context for individual communities. There are five categories at the highest level based on the physical structure of the vegetation and the permanence of water near the surface. At lower levels, six major physical attributes are used to structure the classification: 1) landforms or landscape position (e.g., floodplain forests, rocky ridge woodlands, river channels); 2) geographic distribution or climate regions; 3) nutrient status; 4) drainage class or flood regime; and 5) dominant plant structure or life form (herbaceous, shrubland). This approach groups communities that are functionally similar due to shared environmental factors, and provides a reference point for communities that are not yet well understood. Overviews throughout the guide discuss both the five larger categories (e.g., open uplands, estuarine communities, etc.) and various smaller natural groups of communities (e.g., landform classes such as talus slopes, rocky ridges, alpine tundra, and floodplain forests). Technical terms are defined in an appended glossary.

The individual natural community descriptions are divided into discrete segments to facilitate access to the information within. Below is a brief description of the segments you will find, and what information to expect in each:

COMMUNITY NAME: The common name of the natural community, often referring to the geographic region (e.g., Appalachian), primary associated habitat or landform, and dominant or characteristic plants. Following the community name in parentheses is the Natural Heritage Bureau's rarity rank, assigned at the state level (indicated with an S) on a scale of one to five. A five indicates that the community is demonstrably secure in the state (e.g., sugar maple - beech - yellow birch forests are S5). A one indicates that the community is critically imperiled in the state, generally having only one to five occurrences (e.g., dry river-bluff openings are S1). See Appendix 1 for a complete explanation of ranking definitions.

GENERAL DESCRIPTION: Summary or "word picture" of the main characteristics of the natural community, including important ecological attributes (e.g., flooding, fire, erosion, geology, hydrology, and soil characteristics). Similarities and differences in comparison to related natural communities are also noted where applicable.

CHARACTERISTIC VEGETATION: List of the dominant and diagnostic (characteristic, differential, and indicator) species. In most cases, the italicized scientific name of a species is followed by the common name in parentheses [e.g., *Trientalis borealis* (starflower)]. Rare species are noted with an asterisk(*).

VARIANTS: Variants describe a lower level of variation within a natural community type, where the variation is not substantial enough to be distinguished at the community level. A variant of a natural community is analogous to a subspecies of a species. They are environmentally based (as opposed to successionally based), such as relatively minor vegetation differences and either minor or major soil differences. A variant might reflect a shift in dominant tree species where the understory vegetation remains identical, or a shift in abundance of one or more species and corresponding environmental conditions. For example, a high-elevation variant of sugar maple - beech - yellow birch forest is floristically similar to lower-elevation examples but has higher percent cover and biomass of understory species, particularly ferns, with lower tree-canopy cover and biomass.

CLASSIFICATION CONFIDENCE: A number is assigned to each community to reflect the robustness of data that support the community concept and its description. These ranks are defined as follows:

1. Strong. Classification is based on quantitative analysis of verifiable field data (plots, species lists, and associated environmental information) consisting generally of more than ten samples that have been compared to similar community types. Samples are generally from different community locations or sites.
2. Moderate. Classification is based on more limited field data in terms of number of samples (generally 5-9) and/or level of quantitative detail or analysis.
3. Weak. Classification is based on few samples (1-4), largely qualitative field descriptions and analysis (i.e., species lists with little abundance information), or other data limitations.

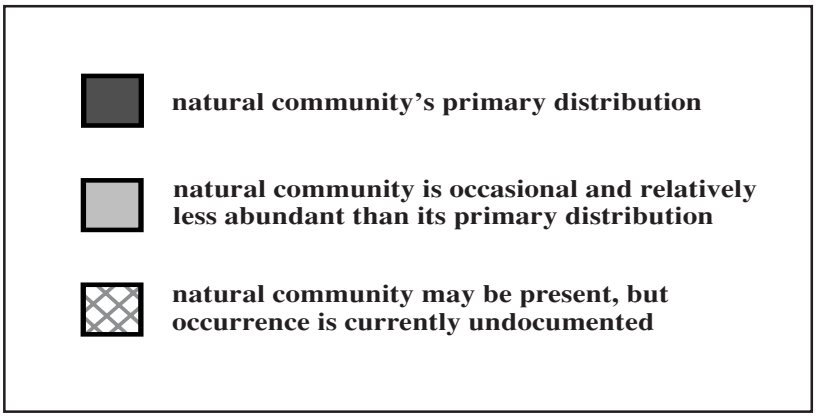
It is occasionally acceptable to have fewer samples than those stated above for a given level when the occurrences sampled are very large, the environment and vegetation are distinct, and/or the community type is corroborated by well-described vegetation types in other states. For example, New Hampshire has only two large pitch pine - scrub oak occurrences, but they are absolutely distinct and corroborated by descriptions from other states. All community descriptions in this guide are based solely on data from New Hampshire from occurrences that can be relocated.

DISTRIBUTION: Description of the community's distribution in New Hampshire, using ecoregional subsections or geographic regions/features (see Figures 1 and 2, pages 12–13). Includes elevation range where appropriate. Known good examples in New Hampshire are listed when possible.

SOURCES: Information sources used in the creation of natural community descriptions.

For each natural community description, there is a distribution map indicating its relative abundance within different ecoregions in the state. Three symbol patterns occur on the maps: dark gray, light gray, and hatch (see legend below). Dark gray represents the community's primary distribution. This is not to be confused with rarity. All communities have a primary distribution in the state, regardless of rarity. Light gray indicates subsections in which the community is only occasional and relatively less abundant than its primary distribution. Hatch indicates uncertainty. It may be present in these subsections, but its occurrence is not documented.

Legend for natural community distribution maps.



PATTERNS IN THE LANDSCAPE: THE NATURAL DIVISIONS OF NEW HAMPSHIRE

We can view patterns in the landscape at many spatial scales—from broad regions that cross state borders or entire continents to natural communities that occur at a site level. As we shift from one scale to another, different patterns come into focus. The pattern we see depends not only on what features we choose to emphasize (i.e. physical or biological), but also on what factors have the greatest influence at that scale.

Combining the patterns of physical features, such as climate, landforms, and soils, with those observed for biological features, such as the distribution of trees and other species, leads us to the description of biophysical units. In this section we review these major physical and biological features, their patterns in the landscape, and ultimately the ten biophysical units (or ecoregions) that we can define for New Hampshire. These ecoregions are referred to throughout this document in community distributions.

Climate and regional vegetation patterns

Climate is a dominant physical influence that affects vegetation and soil development over large geographic areas. New Hampshire has major climate variation along both latitudinal (north-south) and elevational (high-low) gradients. Climate controls the amount of solar energy and water that is available to all organisms, which produces broad zones of vegetation that correspond to different major climate regions. At the continental scale, these zones are called biomes. The three biomes in New Hampshire are alpine tundra, boreal forest, and eastern deciduous forest. These biomes can be divided into regional units based on the distribution patterns shared by many species that are centered in different parts of the biome.

ALPINE BIOME

Alpine and subalpine tundra vegetation in New Hampshire is restricted to largely treeless, high-elevation peaks and ravines of the White Mountains, a few scattered high-elevation monadnocks in central and southern New Hampshire, and several lower-elevation, cold microhabitats. Many of the plants here are disjunct from their primarily arctic distribution in northern Canada. Subalpine vegetation is intermediate between alpine tundra and spruce - fir forests and is generally characterized by stunted spruce and fir trees (krummholz) and a limited number of alpine species.

BOREAL FOREST BIOME

The spruce - fir - northern hardwood region in New Hampshire is dominated by red spruce, balsam fir, and the so-called northern hardwoods (sugar maple, yellow birch, and American beech). Species in this region include those with both boreal and broad eastern United States distributions. Forests in this region are different from other North American boreal forests because many species have an Alleghanian distribution, a range that stretches from the glaciated northeastern United States and adjacent southern Canada to the Great Lakes region, with an extension southward along the Appalachian Mountains. Alleghanian species include red spruce, yellow birch, heartleaf paper birch, white pine, and hemlock. The spruce - fir - northern hardwood

forest region also has boreal species such as balsam fir and quaking aspen. These species are characteristic of the boreal forest, a subarctic conifer forest that dominates the polar regions of North America, Europe, and Asia. These forests are found in the White Mountains and northern New Hampshire at mid- to high-elevations (roughly 1000-2500 feet for hardwoods, 2500-4900 feet for spruce - fir).

EASTERN DECIDUOUS FOREST BIOME

The eastern deciduous forest biome covers much of eastern North America south of the boreal forest. Several regions within this biome can be distinguished in New Hampshire.

The central hardwood forest region has oaks, hickories, flowering dogwood, sassafras, and numerous other plant species that are found in the Appalachian states and reach their northern limit in or near southern New Hampshire. The natural communities of this region are restricted to the southeastern part of the state and low elevations of the Connecticut River valley, and include what is referred to as oak - pine and Appalachian oak - hickory forests in this document.

The transitional forest region in New Hampshire is a "tension zone" that generally lacks both boreal species and central hardwood species, but has many Alleghanian species such as white pine and hemlock. Most of the other species of this region are common throughout eastern United States. Transitional forests are found throughout the state below elevations of 1500 feet, from the White Mountains south.

The distributions of coastal plain communities and plants overlap with the central hardwood forests in southeastern New Hampshire, where they near their northeastern range limit. Regionally, coastal plain communities and plants are restricted to a band about 10 to 100 miles wide along the Atlantic and Gulf of Mexico coasts, with disjunct locations found in the Maritime Provinces and the Great Lake states. Most of New Hampshire's coastal plain communities are wetlands such as Atlantic white cedar swamps. Many plants in New Hampshire grow only near the coast (e.g., dwarf huckleberry, yellow thistle, narrow-leaved-blue flag).

Four other distribution types in New Hampshire either do not correspond to regional units or occur in small patches. Midwestern prairie grassland plants occur in New Hampshire in coastal sand plain areas and on gravel bars of major rivers. These areas are too small and isolated to be considered a regional unit.

LANDFORMS

Under the umbrella of climatic influence and the regional vegetation patterns it controls, local physical features become important in shaping the distribution of plants and communities. These features include landforms, bedrock, surficial sediment deposits, soils and nutrients, and water. Landforms and surficial deposits and their patterns across the state are discussed here in this section because of their importance in defining both ecoregions and finer-scale natural communities referred to in this classification. More subtle variations in soil conditions, nutrients, and water availability also have a critical influence on natural communities, but these are discussed in more detail in appropriate sections of the classification.

The overall shape of the land surface is the product of millions of years of upheaval, erosion, and repeated glaciation of ancient rock formations. This history sets the stage for present-day New Hampshire's varied landscapes of broad valleys and lowlands, rolling hills, and large mountains. As the most recent glaciers retreated, they left in their wake an extensive layer of debris covering the underlying bedrock with ice or water-deposited sediments and rock fragments of various sizes. This mantle of debris is referred to collectively as *glacial drift*, which dominates New Hampshire's surficial deposits. Marine sediments, other water-deposited sediments of postglacial origin (e.g., floodplains), and small areas of other types of post-glacially modified deposits also occur. Thus, surficial deposits can be grouped into three broad depositional types: (1) glacial till, (2) water-deposited soils, and (3) other deposits modified since glaciation. Each type is discussed in more detail below.

GLACIAL TILL

Glacial till covers most of New Hampshire's landscape and consists of extremely variable mixes of stones, gravel, sand, silt, and clay dumped by glaciers. Till can form from deposits pushed around and compressed under a glacier (*basal till*) or from material deposited on the ground inside, next to, in front of, or on a glacier during its final down-wasting (*ablational till*). Basal till is compact and often has a *hardpan* layer that may impede the movement of water or penetration of roots. Ablational till usually consists of looser sediments. Tills are found across the New Hampshire landscape, on high and low slopes of hills and mountains and in high-gradient drainages in narrow valleys. *Drumlins* are elliptical hills formed from till, typically with a steep face on the lee-side of the direction of glacial travel. They are most common in central and southern New Hampshire. The bases of drumlins are often characterized by compact basal till.

WATER-DEPOSITED SEDIMENTS

Water-deposited soils develop from sediments in river, stream, lake, or marine environments. *Fluvial* soils develop from sediments transported, sorted, and deposited by streams or rivers. Thus, they appear mostly in valleys, particularly in relatively flat landscapes. Fluvial processes are active today in our streams and rivers, although over much less of the landscape than when glacial ice was melting and transporting sediments. Sediments deposited by rivers and streams during deglaciation are referred to as *glacio-fluvial*.

Sorting refers to the tendency of sediments of different sizes to settle out of moving water at different levels of turbulence. Stones and gravel particles are heavy enough to settle to the streambed under turbulent conditions where the gradient is steep (usually high in a watershed), whereas sand, silt, and clay settle out at progressively greater distances downstream as water slows. Since the turbulence or energy of a river at any one place may change over time, the layers that develop tend to be *stratified* by size, depending on the prevailing conditions when they were deposited.

Deposits of stratified coarse sand and gravel indicate a fairly high-energy environment in streams within a melting glacier, along its melting margin, or at its terminus. *Ice-contact deposits* include such features as eskers and kames. *Eskers* are long, narrow, sinuous ridges of stratified sand and gravel that formed from deposits in a stream channel in or along the margin of a melting glacier. As glacial ice and meltwaters subsided, the sediments deposited in the former streambed settled down in place to form the long ridges. *Kames* are irregular short ridges or hills of stratified glacial drift formed in meltwater pockets within or along the margin of the glacier, or alongside meltwater streams away from the glacier margin. *Outwash* is glacial drift that has been transported, reworked, and stratified by glacial meltwater beyond the margin of the glacier, and usually occurs in broad plains or wide river valleys. Outwash is often associated with former river deltas or with the broad valleys of former glacial lakes, as is found in the Ossipee Lake area. *Kettle holes* are depressions that developed when giant ice blocks embedded in outwash finally melted away. *Dunes* are wind-blown sand deposits formed in coastal or inland areas that had a substantial supply of loose sand left behind by melting glaciers.

River terraces are former floodplains, either deposited when rivers had larger volumes of water during glacial meltwater periods, or that no longer flood due to channel down-cutting. River terraces may consist of coarse or fine sediments and typically have a terrace slope, or escarpment, where the river has eroded the deposits. *Floodplains* are river terraces by active river channels that are flooded at some regular interval. Sediments accumulate on the flats during these periodic floods. Floodplains may consist of coarse or fine sediments; the sediments usually grow finer with increasing distance from the scour zone in the channel. *Oxbows* are former river channels that were abandoned when a river changed its course, leaving a depression in the terrace. Occasionally, oxbow ponds develop in the old river-channel depressions; they are persistently full of water and have species and processes similar to upland ponds.

Glacial lakebed deposits consist of fine sediments (primarily clay and silt) that settled out in the quiet-water environments at the bottom of former glacial lakes. Huge glacial lakes once filled major valleys while smaller

watersheds held smaller lakes. Lake Hitchcock and Lake Merrimack were large glacial lakes along the Connecticut River and the Merrimack River, respectively. The lakes have since drained, and the rivers have down-cut into these and other fluvial deposits to form steep river-terrace slopes. In other areas, ice or debris dams formed in broad valleys, creating a temporary quiet-water environment, where silts and fine sediments settled out into stratified deposits.

Marine deposits are usually fine sediments that were deposited in near-coastal marine environments when the surface of the ocean was higher than its current level. At the time, the earth's surface had not fully rebounded from the weight of the glaciers. These marine silts and clays are found today in the lowlands and valleys of coastal New Hampshire, where they overlap with outwash deposits.

DEPOSITS MODIFIED AFTER DEGLACIATION

Small areas of the landscape are composed of deposits that have developed since glaciers melted. These include talus and scree slopes, bedrock exposures, felsenmeer, and landslides. *Talus* is a sloping mass of debris derived from rock that fell from a cliff. In most cases the cliff still rises above the talus. In some cases the cliff has largely wasted away, leaving a sloping jumble of rock. *Scree* forms like talus but from smaller debris (less than 3"). *Bedrock* exposures are found in areas where till was not deposited, or areas where till was very shallow and eroded away. Such exposures are frequent on convex mountain ridges and some summits. *Felsenmeer* describes an area of frost-shattered stony debris in alpine tundra and may include areas of patterned-ground vegetation caused by freeze-thaw cycles. A *landslide* is an area of mountain slope that collapsed and slid downslope, removing all vegetation in its path.

ECOREGIONS

When we synthesize our knowledge of variation in plant distributions with our knowledge of variation in the physical environment — climate, landforms, and soils — we can define useful natural divisions of New Hampshire. The U.S. Forest Service has extensively studied and mapped these divisions in the United States (Keys and Carpenter 1995) as a hierarchical system of progressively smaller units. Three regional Divisions are defined for eastern United States, two of which occur in New Hampshire (Warm and Hot Continental Divisions). In turn, New Hampshire contains three sections, which typically range across several states. The three sections in New Hampshire are: (1) the Lower New England section, (2) the Vermont-New Hampshire Upland section, and (3) the White Mountain section (see Figure 1). Each section breaks into subsections, the next smaller natural division, according to physical and biological attributes. There are ten subsections in New Hampshire, breaking the state into intuitive units according to major changes in both its physical and biological attributes. Each subsection is described briefly below within its respective section.

LOWER NEW ENGLAND SECTION

The Lower New England section covers the southeastern third of New Hampshire. It is composed of three subsections: (1) Gulf of Maine Coastal Lowland, (2) Gulf of Maine Coastal Plain, and (3) Sebago-Ossipee Hills and Plain.

The Gulf of Maine Coastal Lowland is narrow zone along the immediate coast. This subsection is characterized by low topographic relief and is underlain by metamorphic bedrock, including schists and gneisses. The Atlantic Ocean has a significant moderating effect on the climate of the subsection. Soils in this part of the state are mostly sandy and coarse textured, although silt and clay soils of marine origin are common in lower landscape positions. Tidal marshes, dunes, beaches, and rocky coastline are unique features of this region.

The Gulf of Maine Coastal Plain stretches across most of this section in New Hampshire. Soils are moderately deep tills deposited by glaciers, and are underlain by both igneous (e.g., granite) and metamorphic (gneiss and

schist) bedrock. Glacial drumlins are common in this part of the state, producing the characteristic rolling topography of this subsection. The large Merrimack River valley, filled with glacial outwash and glacial lake deposits, is a distinctive feature of this subsection.

The Sebago-Ossipee Hills and Plain subsection is characterized by more rugged, mountainous topography interspersed with numerous lakes and glacial outwash features. A unique geologic feature is the ring-dike of the Ossipee Range, which is carved from an ancient collapsed volcano, giving this range its notable circular shape. Hills and ridges of glacial till, extensive plains of glacio-fluvial deposits, large wetlands, and the state's largest natural lakes are distinctive features of this subsection.

VERMONT-NEW HAMPSHIRE UPLAND SECTION

The Vermont-New Hampshire Upland section covers the southwestern portion of the state. From maximum elevations of 2200 feet, it slopes southeastward to its boundary with the Gulf of Maine Coastal Plain. It is a sloping plateau dissected by steep, narrow valleys and underlain by granite, gneiss, and schist. This region is divided into four subsections: (1) Sunapee Uplands, (2) Hillsboro Inland Hills and Plains, (3) Vermont Piedmont, and (4) Northern Connecticut River Valley.

The Sunapee Uplands, Hillsboro Inland Hills and Plains, and Vermont Piedmont subsections are characterized by isolated hills and peaks of hard, resistant rock (mostly granite) commonly referred to as monadnocks. Numerous small lakes and narrow valley streams are scattered through the area. Drumlins are also distinctive glacial features. Soils are typically shallow and stony. Soils in the Vermont Piedmont subsection, derived from metamorphic (phyllites and schists) bedrock, yield finer textured soils with higher nutrient status than soils of the Sunapee or Hillsboro subsections (except the extreme western border area of the Sunapee subsection). This is reflected in the composition and distribution of plant communities.

The narrow Northern Connecticut River Valley subsection, like the Merrimack Valley to the east, is filled with glacial outwash and glacial lake deposits that abut lower slopes of adjacent hills comprised of glacial till. The processes of erosion and sedimentation over time have formed distinctive river terraces in these glacial deposits. There is much metamorphic bedrock in this section that yields soils with relatively high nutrient status.

WHITE MOUNTAIN SECTION

The White Mountain section includes the Presidential Range, the Franconia Mountains west of them, and the hilly country of northern New Hampshire. Elevations range from about 1000 feet to over 6000 feet. This section has three subsections: (1) White Mountain, (2) Mahoosuc-Rangeley Lakes, and (3) Connecticut Lakes.

Dominated by the rugged Presidential Range, the White Mountain subsection is underlain by granite and schist. The bare, rounded summits of these mountains, and the steep "gulfs" or cirques carved into their flanks, are perhaps the most striking legacy of the last glaciation. Soils in this region are mostly moderately deep, well-drained glacial tills.

Although still mountainous, topographic relief steadily decreases north of the White Mountains in the Mahoosuc-Rangeley Lakes and Connecticut Lakes subsections. Bedrock geology is more complex as phyllites and slates become intermingled with granitic rocks, particularly in the Connecticut Lakes region. The low grade pellite bedrock in the Connecticut Lakes subsection weathers to form extensive silty soils in this part of the state. With increasing latitude, species and communities characteristic of more northern climates occur at lower elevations. The Connecticut Lakes subsection is characterized by drumlins and other glacial deposits such as kames and eskers.

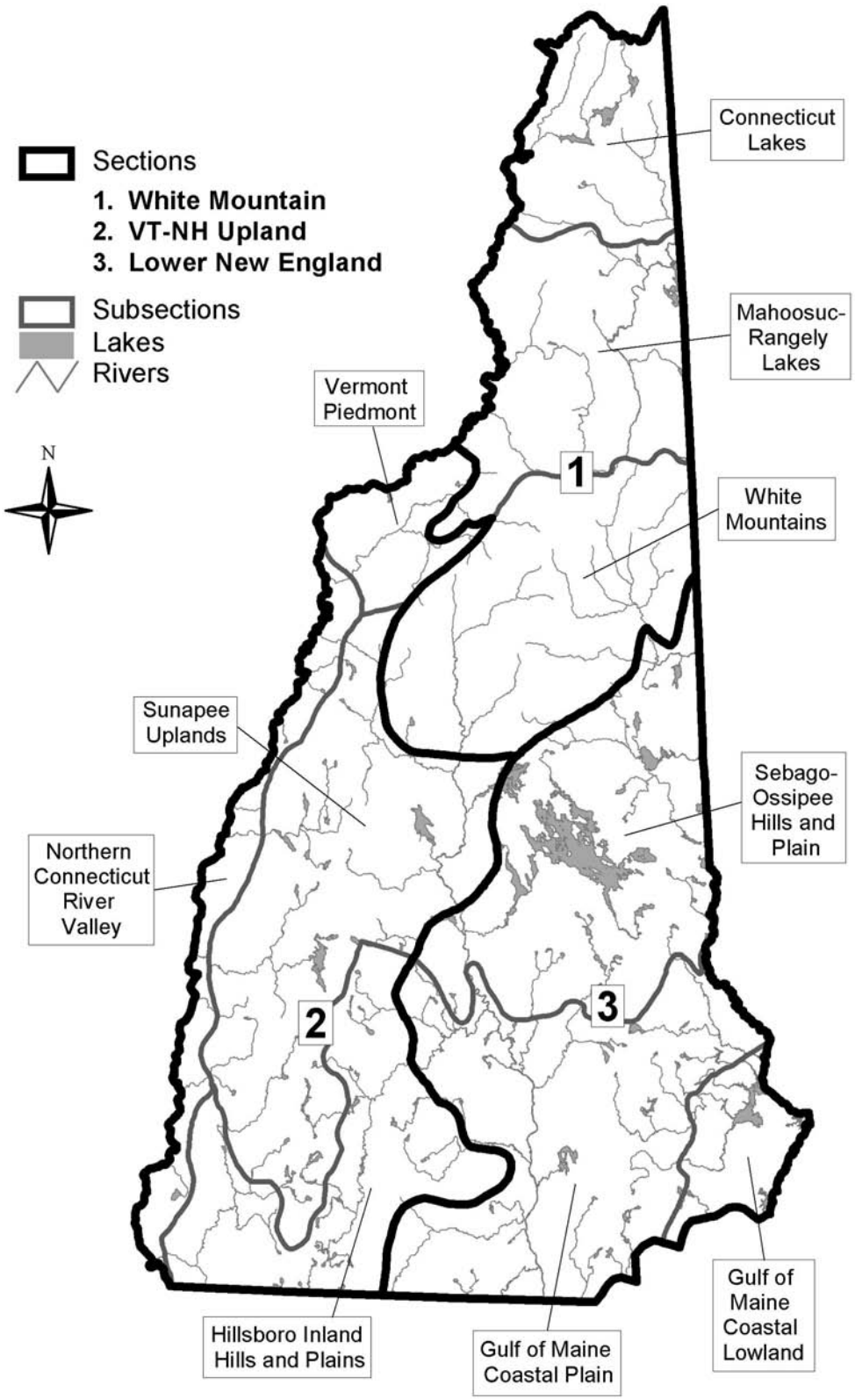


Figure 1. Ecological sections and subsections in New Hampshire.

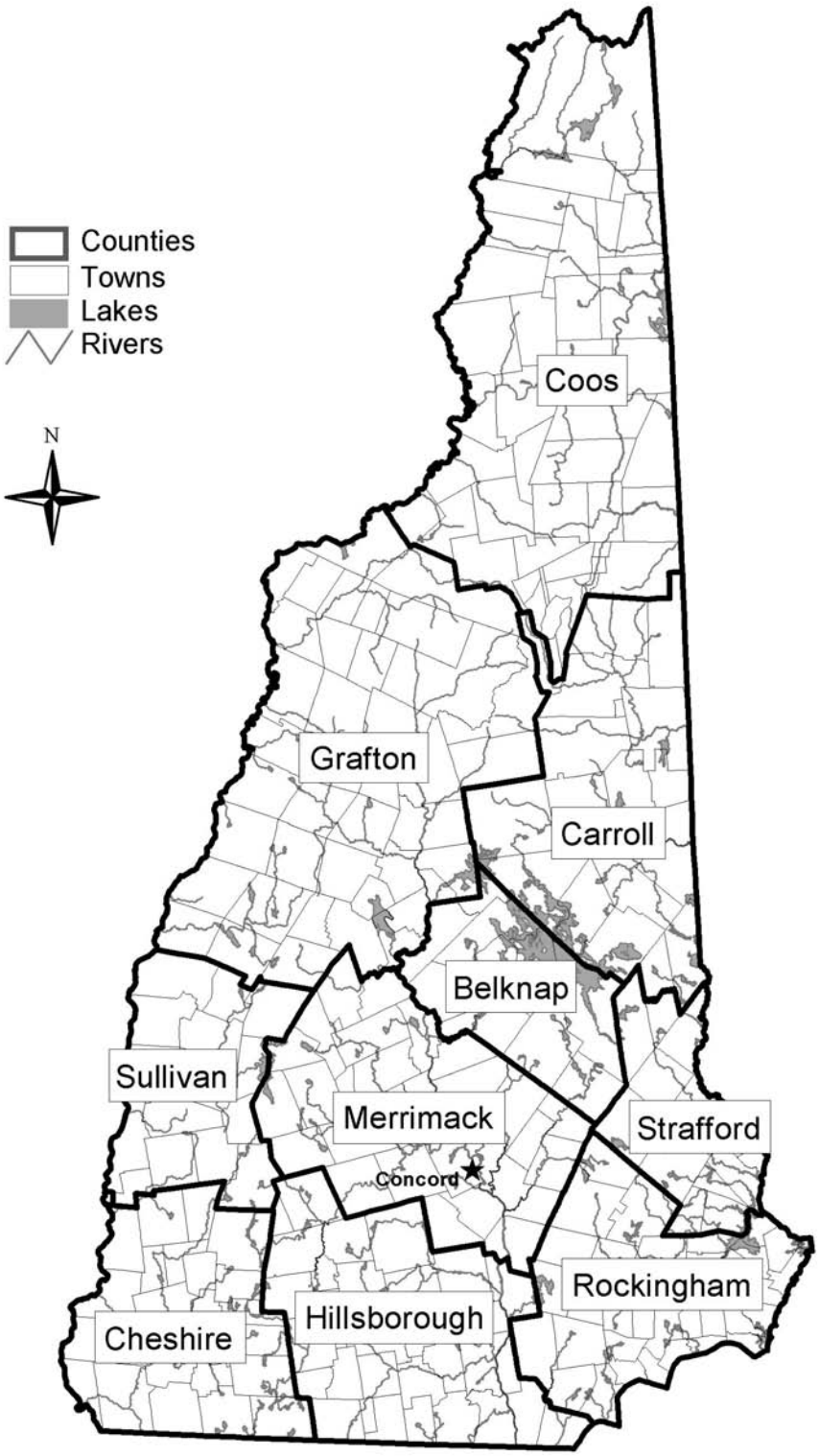


Figure 2. Political divisions (counties, towns, and state capital) in New Hampshire.

OPEN UPLANDS

This section contains descriptions of alpine and subalpine communities, landslides and talus barrens, cliffs, coastal dunes, and inland beach strand communities. These "open" upland communities are all characterized by the absence or low abundance of trees (<25% cover) and occur in harsh physical settings characterized by some combination of cold climate, high disturbance intensity, or extremely nutrient-poor conditions with little soil development. Open outcrops on rocky ridges below the subalpine zone are described as part of the mosaic of wooded rocky ridges (see wooded uplands section). Alpine wetland communities are described in this section to maintain the tight continuity of these communities seen in this unique New Hampshire landscape.

ALPINE AND SUBALPINE COMMUNITIES

The alpine zone of New Hampshire occurs at high elevations above treeline in the White Mountains where severe climatic conditions prevail and communities of low mat-forming shrubs, sedges, rushes, grasses, mosses, and lichens dominate. The flora is most similar to that of the eastern Canadian Arctic and coastal barrens. Sixty-two percent of the plant species in the Presidential Range are restricted to alpine tundra. Among these, *Prenanthes boottii* (Boott's rattlesnake-root)* is endemic to northeastern U.S. alpine areas, *Potentilla robbinsiana* (dwarf cinquefoil)* is endemic to the White Mountains, and *Geum peckii* (mountain avens)* is endemic to the White Mountains and several stations in Nova Scotia, giving New Hampshire and other New England tundra a distinct floristic signature. Permafrost and frost phenomena characterize parts of the Presidential Range, the largest and most diverse of the region's alpine areas. The vegetation is exposed to high winds, a short growing season, low temperatures, heavy cloud cover and fog, high precipitation, and fog interception, and occurs on mostly well drained soils with low nutrient availability and high organic matter content.

At a global scale, treeline follows a latitudinal gradient corresponding approximately to the 10-12°C July isotherm, and, consequently, declines in elevation with increasing latitude (Cogbill and White 1991; Cogbill et al. 1997). In New Hampshire, climatic treeline occurs at approximately 4900 ft. elevation. However, alpine and subalpine vegetation can be found at lower elevations due to local compensating factors (e.g., wind-exposed ridges and summits with shallow, poorly developed soils, or fire histories). These lower elevation alpine areas are generally smaller and have communities with fewer alpine-restricted species.

As treated here, alpine and subalpine areas include treeless and partially wooded exposures with krummholz (trees <1.5-2 m height) that contain species absent from low to mid elevations. The most broadly distributed of these species, present in some combination at nearly all sites, include *Vaccinium uliginosum* (alpine bilberry), *Empetrum atropurpureum* (purple crowberry)* and/or *Empetrum nigrum* (black crowberry)*, and the lichen *Cetraria islandica*. Slightly lower elevation ridges (e.g., red spruce and red pine woodlands) with taller trees generally lack these species but occasionally have *Vaccinium vitis-idaea* (mountain cranberry), which is ubiquitous at higher elevations. The larger and higher peaks have more alpine-restricted species such as *Carex bigelowii* (Bigelow's sedge)*, *Juncus trifidus* (highland rush), *Hierochloe alpina* (alpine sweet grass)*, *Diapensia lapponica* (diapensia)*, *Solidago cutleri* (Cutler's goldenrod)*, *Salix uva-ursi* (bearberry willow)*, and *Betula minor* (small birch)*. High elevation ledges and landslides in forested settings, "cold-air talus slopes," and lower elevation rocky mountain stream or river banks may also harbor what are generally considered alpine species (*Juncus trifidus, Empetrum atropurpureum, Agrostis mertensii, Geum peckii*) or other species that reach the southern terminus of their North American distribution in montane areas of northern New

England, including *Draba incana* (lance-leaved draba), *Hieracium robbinsonii* (Robbin's hawkweed), and *Pinguicula vulgaris* (common butterwort)*.

There has been relatively little study of bryophytes and lichens in alpine and subalpine areas of the White Mountains, with the exception of *Sphagnum* mosses (Cleavitt et al. 1999). Limited collections from some of these peaks by the authors and N. Cleavitt have revealed alpine species that are rare in northeastern North America, including *Cynodotium schisti* on Mt. Success (by Sperduto in 1995) and *Sphagnum lindbergii* on Mt. Jackson (by Cleavitt in 1995). These collections are indicative of a high potential for other important non-vascular species from alpine areas in the region.

Some subalpine summits or ridgelines may have been originally opened by fires of natural or human origin, sometimes pushing the ecosystem over the "resiliency threshold" (Bormann and Likens 1979) where recovery to original forest could take centuries due to loss of soil. Other examples, particularly many subalpine sites with severe exposures, appear to have been open for at least many centuries based on the earliest accounts, although fire may have altered the proportion of forest versus open and woodland area (Whitney and Moeller 1982).

There are five broad groups of vegetated communities that comprise the spectrum of variation in the alpine zone. These groups relates to major differences in soil moisture and substrate, longevity of snowpack, elevation, and degree of exposure. These five groups of communities are:

1. Diapensia shrublands on the most exposed, snow-free sites;
2. moist to wet herb and herb - heath communities often in lee positions associated with late-melting snowpacks;
3. bogs on poorly drained concavities on ridges and sometimes on slopes;
4. dwarf shrub - sedge - rush tundra without trees; and
5. heath - krummholz communities on somewhat lower peaks where a broader diversity of montane shrubs mix with krummholz and alpine shrubs.

Within this array, higher and lower elevation counterparts can be recognized. In addition to these five groups of vegetated communities, there are several sparsely vegetated communities that occur in rocky habitats.

Alpine herbaceous snowbank and other wet-mesic alpine communities

Most of New Hampshire's alpine tundra is associated with well drained to excessively well drained soils. Exceptions are poorly drained peat bogs dominated by heath shrubs and peat mosses that occur on concavities and occasionally on slopes (see alpine/subalpine bogs section). Alpine herbaceous snowbanks and other mesic to wet-mesic alpine communities are moderately well to poorly drained, and more minerotrophic compared to bogs. They are typically sloped, have shallow organic soils, and are associated with late-melting snowbank areas, seeps, rills (streambanks), and ravine settings in the alpine zone.

• Alpine herbaceous snowbank/rill (S1)

General Description: This alpine zone community is associated with late-melting snowbanks with mesic to hydric soils. It is dominated by a diverse mixture of alpine and lowland herbs and shrubs that converge where deep snowbanks occur. Late-melting snowbanks both abbreviate the growing season and limit the exposure of plants to the extreme weather and desiccating conditions of the alpine environment. Snow-free dates occur from about mid-May to late June. Snowbanks form at small and large scales ranging from several square meters to tens of acres in lee positions of summits, ridges, outcrops, ravines, drainages, and at the alpine-treeline interface. The biggest examples are found in the larger alpine ravines where they occur on slopes, benches, and drainages leading into ravines, in and along headwall gullies and streams, and immediately below headwalls where snow accumulation can be greatest (i.e., more than 50 feet in Tuckerman Ravine).

Composition varies from herb dominated to herb and shrub dominated mixes with up to 65% robust shrub cover (willows and mountain alder). Denser shrub cover (>65%) marks the transition to the alpine ravine shrub thicket community with a less dense herbaceous layer and fewer snowbank indicators.

Soils are primarily Histosols or Entisols with shallow organic O and/or A horizon layers (7-30 cm, rarely to 50 cm; n=29) over bedrock or boulders with slopes ranging from five to 55 degrees. Soil conditions range from seepy, well decomposed peat in perennial seepage zones; to organic-rich mineral soil in other mesic to wet settings (A horizons with substantial sand content); to wet bedrock ledges and gullies on headwalls. pHs range from 4.9-6.3 (n=7).

CHARACTERISTIC VEGETATION: Alpine herbaceous snowbank/rills are both diverse and variable: 90 vascular plants have been documented from 28 plots in three examples, with only a few species having >5% cover in half or more of these plots. The most abundant and frequent species (often 5% or greater cover) include *Geum peckii* (mountain avens)*, *Solidago macrophylla* (large-leaved goldenrod), *Calamagrostis canadensis* (blue-joint), *Veratrum viride* (false hellebore), *Vaccinium cespitosum* (dwarf bilberry), *Houstonia caerulea* (bluets), *Scirpus cespitosus* (tussock bulrush), *Aster puniceus* (purple-stemmed aster), *Phegopteris connectilis* (long beech fern), *Deschampsia flexuosa* (common hair-grass), *Lonicera villosa* (mountain fly honeysuckle), *Spiraea septentrionalis* (alpine meadowsweet), and *Alnus crispa* (mountain alder). The first three of these species were found in almost every plot, the remainder in 1/3 or more.

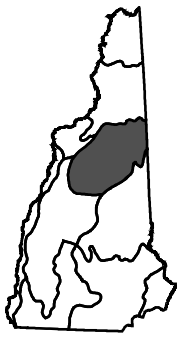
Frequent but only occasionally abundant species include *Rubus pubescens* (dwarf raspberry), *Calamagrostis pickeringii* (Pickering's reed bent-grass)*, *Streptopus amplexifolius* (white mandarin), *Ledum groenlandicum* (Labrador-tea), *Vaccinium uliginosum* (alpine bilberry), *Carex bigelowii* (Bigelow's sedge)*, *Athyrium filix-femina* (northern lady fern), *Carex brunnescens* (brownish sedge), *Thalictrum pubescens* (tall meadow-rue), *Coptis trifolia* (goldthread), *Clintonia borealis* (blue-bead lily), *Platanthera dilatata* (tall white bog orchid), *Sphagnum girgensohnii* (peat moss), other Sphagna, and a high diversity and constancy of non-*Sphagnum* bryophytes.

Less frequent but sometimes locally abundant rare species in this community include *Salix argyrocarpa* (silver willow)*, *Viola palustris* (alpine marsh violet)*, *Arnica lanceolata* (arnica)*, *Oxyria digyna* (mountain sorrel)*, *Phleum alpinum* (alpine timothy)*, *Veronica wormskjoldii* (alpine speedwell)*, *Epilobium hornemannii* (Hornemann's willow-herb)*, *Polygonum viviparum* (viviparous knotweed)*, *Prenanthes boottii* (Boott's rattlesnake-root)*, *Deschampsia atropurpurea* (mountain hairgrass)*, *Stellaria borealis* (northern stitchwort), and *Streptopus X oreopolus* (mountain twisted stalk).

VARIANTS: Three variants are described below.

1. **Peaty variant (typic)**: This is the typic variant as described above, which is generally saturated, seepy, or otherwise wet for much of the growing season. Soils consist of shallow sapric O horizons or mucky A horizons. It has a high constancy of peat mosses, mountain avens, blue-joint, false hellebore, bluets, hairgrass, deer's hair sedge, dwarf bilberry, purple-stemmed aster, and narrow beech fern. Some examples are more shrubby and characterized by silver willow, dwarf birch, and alpine meadowsweet, with relatively little peat moss (up to 25% cover); others have abundant peat moss (usually >50% cover) and fewer shrubs. Numerous rare alpine species can occur in this variant.
2. **Tea-leaved willow - alpine herb variant:** This variant lacks many of the dominant lowland herbs and peat mosses characteristic of the other two variants. Non-*Sphagnum* bryophytes are abundant. Soils are moderately well to well-decomposed, seepy peats along or near perennial alpine streams in relatively exposed alpine snowbank settings (e.g., Alpine Garden). It does share several species with one or both of the other two variants, including large-leaved goldenrod, mountain avens, false hellebore, blue-joint, and deer's hair sedge, but differentiates itself by the presence of tea-leaved willow, *Campanula rotundifolia* (harebell), viviparous knotweed, and Boott's rattlesnake-root. Numerous other alpine plants may be present. This variant is transitional to less wet but still mesic areas further from rills described as the moist alpine herb - heath meadow community that lacks snowbank indicators.

3. **Mesic lowland herb variant:** This variant corresponds to more well drained mineral soils (A horizons) with mesic conditions in mid to late summer (e.g., not seepy or hydric). A few lowland herbs dominate along with only a few alpine plants. Dominants include large-leaved goldenrod, common hair-grass, dwarf bilberry, blue-bead lily, and bunchberry. Bigelow's sedge and bilberry may also be present.



CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is restricted to the higher alpine peaks of the White Mountains, from about 4400-5500 feet in elevation. Good and large examples occur in the Alpine Garden, Tuckerman Ravine, Oakes Gulf, Great Gulf, and other ravines of the Presidential Range.

SOURCES: Bliss 1963a; Cogbill 1994; Sperduto and Cogbill 1999; Sperduto and Neid 2003.

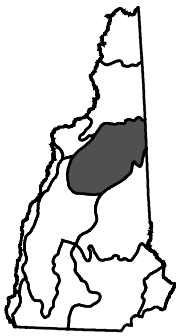
• Moist alpine herb - heath meadow (S1)

GENERAL DESCRIPTION: This is a diverse, moist alpine tundra community restricted to Mount Washington. It is dominated by a mix of forbs, sedges, and heath shrubs, many of which are rare elsewhere in the alpine zone. While it has some plants in common with herbaceous snowbank/rill meadows, and may occur adjacent to them, it lacks many of the key diagnostic species of snowbanks including *Solidago macrophylla* (large-leaved goldenrod), *Deschampsia flexuosa* (common hair-grass), and *Vaccinium cespitosum* (dwarf bilberry).

Soils are moist organic turfs (O and A horizons) near drainages, snowbanks, and on sloping benches. Harebell and scirpus-like sedge (diagnostic of this community) are found in circumneutral soils elsewhere in NH and may indicate higher base-cation status. Bliss (1963) documented the highest pH (4.7-4.9) and calcium levels (70-1500 ppm) in this community, compared to all other alpine communities.

This type corresponds to the drier end of the spectrum that Bliss (1963) describes for his Streamside community. Wetter streamside areas in Bliss' classification correspond better to the herbaceous snowbank/rill community described above due to the presence of such species as *Calamagrostis canadensis* (blue-joint), *Veratrum viride* (false hellebore), *Houstonia caerulea* (bluets), and other snowbank species.

CHARACTERISTIC VEGETATION: Diagnostic plants include *Geum peckii* (mountain avens)*, *Scirpus cespitosus* (tussock bulrush), *Polygonum viviparum* (viviparous knotweed)*, *Salix uva-ursi* (bearberry willow)*, *Campanula rotundifolia* (harebell), *Solidago cutleri* (Cutler's goldenrod)*, *Carex scirpoidea* (scirpus-like sedge)*, Prenanthes boottii (Boott's rattlesnake-root)*, and *Hierochloe alpina* (alpine sweet grass)*. Species found in other alpine communities that are also frequent in this community include *Carex bigelowii* (Bigelow's sedge)*, *Agrostis mertensii* (boreal bent-grass)*, *Juncus trifidus* (highland rush), *Vaccinium uliginosum* (alpine bilberry), *Vaccinium vitis-idaea* (mountain cranberry), and *Potentilla tridentata* (three-toothed cinquefoil).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: In New Hampshire, this community is found only on Mt. Washington in the Alpine Garden, from 5000-5500 ft.

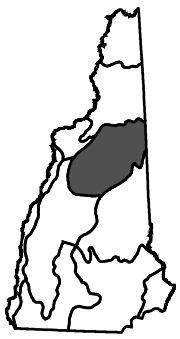
SOURCES: Bliss 1963a; Sperduto and Cogbill 1999.

• Alpine ravine shrub thicket (S1S2)

GENERAL DESCRIPTION: This community is found in wet-mesic conditions of alpine ravines above 4000 ft. where snow accumulation can be substantial. It is dominated primarily by *Alnus crispa* (mountain alder) and

other deciduous shrubs. Herbaceous forbs found in alpine herbaceous snowbank/rill communities are characteristic in the understory. It forms on steep to nearly level rock, talus, and cobbly substrates where streams are common. This community has not been sampled extensively, but is distinct and forms huge thickets in Tuckerman Ravine.

CHARACTERISTIC VEGETATION: Mountain alder forms dense thickets (>65% cover) in this community. *Spiraea septentrionalis* (alpine meadowsweet) or *Spiraea alba* (eastern meadowsweet) is common, and *Salix argyrocarpa* (silver willow)*, *Amelanchier bartramiana* (Bartram's serviceberry) and other *Salix* spp. (willows) are occasional along streams. Lowland plants characteristic of herbaceous snowbank/rill and spruce - fir forest communities are present in low to moderate abundance. These include *Deschampsia flexuosa* (common hair-grass), *Athyrium filix-femina* (northern lady fern), *Solidago macrophylla* (large-leaved goldenrod), *Dryopteris intermedia* (intermediate wood fern), *Dryopteris campyloptera* (mountain wood fern), and *Aster puniceus* (purple-stemmed aster). Areas with less than about 65% mountain alder appear to have a more robust herb layer and are treated as shrubby examples of herbaceous snowbank/rill communities.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community occurs in alpine ravines of the Presidential Range. A good example is found in Tuckerman Ravine, particularly on its north facing slopes.

SOURCES: NHB field surveys.

DIAPENSIA SHRUBLANDS

The most exposed alpine areas, having little winter snow cover due to very high winds, are characterized by an abundance of *Diapensia lapponica* (diapensia)* and other dwarf shrubs on rock or gravel substrate. These dwarf shrubs are less abundant or absent in other alpine communities. Higher elevation examples appear to have a greater diversity of alpine heath shrubs than those on lower peaks, but the community is absent from subalpine peaks below 4000 ft.

• Diapensia shrubland (S1)

GENERAL DESCRIPTION: *Diapensia lapponica* (diapensia)* and other dwarf shrubs are the dominant plants in this community where wind exposure is severe and snow cover is light or absent in winter. The dwarf shrubs form low compact mats and domes that reduce exposure to desiccating winds. Overall, dwarf shrubs are more abundant than graminoids, and forbs are in very low abundance.

Soils are well drained gravel or gravel and stone mixes in wind-exposed positions where snow cover is minimal, soils freeze deeply, and active frost heaving of the soil is common.

CHARACTERISTIC VEGETATION: This community is indicated by the dominance of *Diapensia lapponica* (diapensia)* (usually >5% cover) along with mixtures of *Vaccinium uliginosum* (alpine bilberry), *Juncus trifidus* (highland rush), *Vaccinium vitis-idaea* (mountain cranberry), *Potentilla tridentata* (three-toothed cinquefoil), *Minuartia groenlandica* (mountain sandwort), *Carex bigelowii* (Bigelow's sedge)* and *Agrostis mertensii* (boreal bent-grass)*. On higher peaks some combination of *Rhododendron lapponicum* (Lapland rosebay)*, *Loiseleuria procumbens* (alpine azalea)*, and *Solidago cutleri* (Cutler's goldenrod)* is also found. In contrast to sedge - rush - heath meadows, diapensia is usually more abundant than Bigelow's sedge, and Lapland rosebay and alpine azalea are much more frequent. In contrast to the alpine heath snowbank community, *Ledum groenlandicum* (Labrador-tea) and *Vaccinium cespitosum* (dwarf bilberry) are absent.

VARIANTS: Two variants are described:

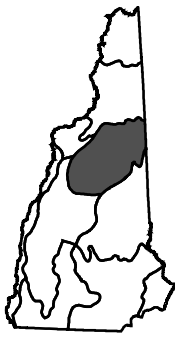
1. **Lapland rosebay variant:** This variant occurs in the Presidential Range from 4400-5500 ft. and is

characterized by a more diverse composition of alpine species compared to diapensia shrublands on smaller and lower elevation peaks. Alpine azalea and Lapland rosebay are diagnostic, and *Salix uva-ursi* (bearberry willow)*, Cutler's goldenrod, and Bigelow's sedge are frequent.

2. **Bilberry variant**: This variant corresponds to less diverse diapensia shrublands found on lower alpine peaks from 4000 to 4600 ft. Alpine azalea and Lapland rosebay are absent, and bearberry willow, Cutler's goldenrod, and Bigelow's sedge are less frequent and abundant.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Found on exposed alpine summits of the White Mountains, mostly above 4300 ft. on open windblown ridges. Good examples of the Lapland rosebay variant occur on Mt. Eisenhower, Mt. Franklin, Monroe Flats, Bigelow Lawn, and Alpine Garden. Good examples of the Bilberry variant occur on Mt. Guyot, the north ridge of Mt. Lafayette, and Bondcliff.



SOURCES: Bliss 1963a; Cogbill 1994; Sperduto and Cogbill 1999.

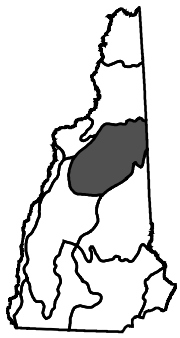
DWARF SHRUB - SEDGE - RUSH MEADOWS

This group of communities dominates much of the vegetated portion of the alpine zone on the higher peaks of the White Mountains. The communities are characterized by various mixtures of bilberry and cranberry dwarf heaths, *Carex bigelowii* (Bigelow's sedge)*, and *Juncus trifidus* (highland rush). Krummholz is absent or in low abundance. All are well drained and mesic in contrast to herbaceous snowbank/rill, moist alpine herb - heath meadow, and alpine/subalpine bog communities that are wetter.

• Alpine heath snowbank (S1S2)

GENERAL DESCRIPTION: The transition to alpine heath snowbanks from the classic sedge - rush - heath mixture is marked by the appearance of *Ledum groenlandicum* (Labrador-tea), *Empetrum nigrum* (black crowberry)*, *Vaccinium cespitosum* (dwarf bilberry), and various lowland plants restricted to snowbank areas. Dwarf shrubs and lowland plants are in greater abundance than in sedge - rush - heath meadows, and total vegetative cover is high. This community occurs in more well drained snowbank areas such as lee positions of rocks or ledges or just above the transition to krummholz. In contrast to wetter herbaceous snowbank/rills they lack wet-site species such as peat mosses, *Veratrum viride* (false hellebore), and *Calamagrostis canadensis* (blue-joint). This community is equivalent to Bliss' (1963) dwarf shrub heath community.

CHARACTERISTIC VEGETATION: *Vaccinium uliginosum* (alpine bilberry), *Vaccinium vitis-idaea* (mountain cranberry), *Carex bigelowii* (Bigelow's sedge)*, and *Juncus trifidus* (highland rush) are present as in other alpine communities. This community differs by having relatively low sedge and rush cover, and by the presence of some combination of dwarf bilberry, Labrador tea, black crowberry, *Deschampsia flexuosa* (common hair-grass), *Trientalis borealis* (starflower), *Lycopodium annotinum* (stiff clubmoss), *Cornus canadensis* (bunchberry), and *Maianthemum canadense* (Canada mayflower). *Phyllodoce caerulea* (mountain-heath)*, *Cassiope hypnoides* (moss bell-heather)*, *Arctostaphylos alpina* (alpine bearberry)*, *Diapensia lapponica* (diapensia)*, *Betula glandulosa* (dwarf birch)*, and *Salix herbacea* (dwarf willow)* may also occur.



CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is restricted to the Presidential Range and Franconia Ridge from 4600-5500 ft.

SOURCES: Bliss 1963a; Cogbill 1994; Sperduto and Cogbill 1999.

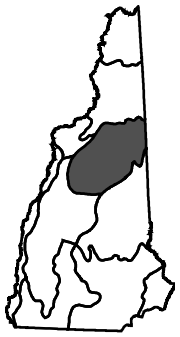
• Bigelow's sedge meadow (S1)

General Description: This community is distinguished from other alpine communities by the prominence of Bigelow's sedge and the low diversity and abundance of other species. It is found at high elevations on the larger Presidential Range peaks, particularly on north and west slopes where high precipitation and fog drip are apparently prevalent, and at scattered locations elsewhere. Snow accumulation is typically minimal or ephemeral due to high winds. These conditions are favorable for *Carex bigelowii* (Bigelow's sedge)* to dominate to the near exclusion of other species, in part because of its photosynthetic efficiency in low-light conditions. Bigelow's sedge meadows are most well developed between 5800-6200 ft. elevation. Smaller patches occur rarely outside the Presidential Range in New England as low as 4300 feet.

Soils consist of a shallow organic-rich A horizon turf (0-8 cm) over gravelly or stony sandy loams. Although soils are well drained, soil moisture availability remains high due to high precipitation and fog-interception and thus reduced solar radiation and evapotranspiration.

Bigelow's sedge meadows found in high precipitation/fog drip areas with low snow cover form one extreme in the range of variation found among mesic, well drained alpine tundra communities: the other extreme is marked by alpine heath snowbanks in more protected areas with longer lasting snow cover, while the central part of this gradient is occupied by sedge - rush - heath meadows.

Characteristic vegetation: Bigelow's sedge is the dominant species, scattered *Minuartia groenlandica* (mountain sandwort), *Vaccinium vitis-idaea* (mountain cranberry), *Vaccinium uliginosum* (alpine bilberry), and *Juncus trifidus* (highland rush). Mosses and lichens are common and include *Polytrichum juniperum* var. *alpestre*, *Calliergon stramineum*, *Cetraria islandica*, and *Cetraria mitis*.



Classification confidence: 1

Distribution: This community is mostly restricted to the Presidential Range in NH, but may occur in small patches on some outlying peaks. Good examples are on the north and west sides of the cone of Mt. Washington, on the upper slopes of Mt. Adams, and on Monticello Lawn and upper other slopes of Mt. Jefferson.

Sources: Bliss 1963a; Sperduto and Cogbill 1999.

• Sedge - rush - heath meadow (S1)

General Description: This community is the ubiquitous alpine meadow community found in the Presidential Range and other high alpine areas of New England, occurring mostly above 4800 ft. It is dominated by various mixtures of *Carex bigelowii* (Bigelow's sedge)*, *Juncus trifidus* (highland rush), dwarf heaths and other dwarf shrubs. This community forms the central part of the gradient occupied by alpine tundra communities of mesic, well drained conditions: Bigelow's sedge meadows found in high precipitation/fog drip, low snow cover areas are at one extreme; and alpine heath snowbanks in more protected areas with longer lasting snow cover mark the other extreme. The sedge - rush - heath community described here is intermediate between these two extremes, both floristically and environmentally. Within this central type, there is considerable variation in the relative abundance of Bigelow's sedge, highland rush, and dwarf heaths, treated as two variants here. This variation has alternatively been treated as three separate communities by Bliss (1963), who attributes these differences to edaphic conditions controlled by moisture and exposure gradients.

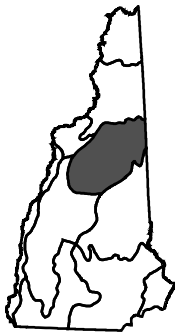
Soils have 0-11 cm of A horizon loamy sand with moderate to high amounts of organic matter (26-46%) over sandy loams with considerable gravel and stone content.

Characteristic vegetation: The dominant plants are Bigelow's sedge, highland rush, and dwarf shrubs including *Vaccinium uliginosum* (alpine bilberry), *Vaccinium vitis-idaea* (mountain cranberry), and *Potentilla tridentata*

(three-toothed cinquefoil). *Minuartia groenlandica* (mountain sandwort) is frequent but occurs in low abundance. *Scirpus cespitosus* (tussock bulrush), *Agrostis mertensii* (boreal bent-grass)*, *Diapensia lapponica* (diapensia)*, *Huperzia appalachiana* (Appalachian fir clubmoss)*, and *Hierochloe alpina* (alpine sweet grass)* are occasional; *Rhododendron lapponicum* (Lapland rosebay)* is rare. *Empetrum atropurpureum* (purple crowberry)* is absent and *Empetrum nigrum* (black crowberry), *Abies balsamea* (balsam fir), and *Betula papyrifera* var. *cordifolia* (heartleaf birch), indicative of dwarf shrub - bilberry - rush barrens, are absent or sparse. *Cetraria islandica* (lichen), *Cladina rangiferina* (lichen), and *Cladonia uncialis* are prominent lichens, and *Polytrichum piliferum* var. *alpestre* is a common moss.

VARIANTS: Two variants are described that include three of Bliss' (1963) community types.

1. **Sedge - heath - rush variant:** Bigelow's sedge is more prominent in this variant, which reaches its best development high on west and north exposures of the Presidential Range. Vascular plant cover is relatively low and lichen, soil, and exposed rock cover are relatively high. This variant includes Bliss' (1963) sedge - dwarf shrub heath and sedge - rush - dwarf shrub heath communities.
2. **Heath - rush variant:** The heath - rush variant is much more common and averages lower in elevation, often starting just above heath snowbank or krummholz near treeline. Bigelow's sedge is present but is of decreased in importance in this variant relative to heaths and conspicuous clumps of highland rush. This variant corresponds to Bliss' (1963) Dwarf shrub heath - rush community, and is restricted in NH to above 4600 ft. on the Presidential Range, Franconia Ridge, and Mt. Moosilauke. This variant is transitional to but considered distinct from the dwarf shrub - bilberry - rush community, which lacks Bigelow's sedge and occurs on lower peaks (from 3400-4800 ft.) in association with heath/krummholz communities.



CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community occurs mostly between 4800-5600 ft. in the Presidential Range and as low as 4600 ft. on Franconia Ridge and Mt. Moosilauke.

SOURCES: Bliss 1963a; Cogbill 1994; Sperduto and Cogbill 1999.

• Dwarf shrub - bilberry - rush barren (S2)

GENERAL DESCRIPTION: This community is found on exposed well drained summits, slopes, and ridges from 3400-4800 ft., primarily on peaks outside the Presidential Range. It is often found in association with heath - krummholz communities, but in locally more exposed settings. Floristically, it is intermediate between heath - krummholz and sedge - rush - heath communities; it lacks the abundance of *Kalmia angustifolia* (sheep laurel), *Ledum groenlandicum* (Labrador-tea), and krummholz of heath - krummholz *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 and diapensia shrubland communities that occurs in exposed settings with shallow or ephemeral snow cover. Vegetation is typically dwarfed (less than 20 cm, and often less than 10 cm in height) and dominated by crowberries, subalpine *Vaccinium* species, and *Potentilla tridentata* (three-toothed cinquefoil).

Soils consist of well drained gravel and stone in a sand matrix with or without a shallow organic-rich A horizon turf (usually <10 cm). Open exposures of rock, stone, or gravel typically consist of 25% or more of the ground surface. Like diapensia shrublands, snow cover is probably thin and melts early, and freeze-thaw influence is probably significant.

This community reaches its best development on the most exposed sites of subalpine and alpine peaks where it can occupy patch sizes of more than one acre. It also occurs as smaller patches in shallow, well drained soil areas around bedrock outcrops within heath krummholz complexes. Purple crowberry appears to be more

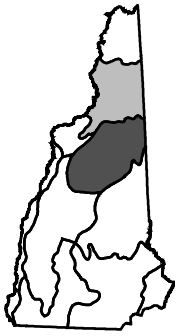
abundant where highland rush and three-toothed cinquefoil are either absent or less abundant, perhaps indicating very well drained sites on stone or bedrock transitional to heath - krummholz areas.

CHARACTERISTIC VEGETATION: This community is dominated by *Vaccinium uliginosum* (alpine bilberry) and *Vaccinium vitis-idaea* (mountain cranberry), along with other dwarf shrubs, particularly *Empetrum atropurpureum* (purple crowberry)* and/or *Potentilla tridentata* (three-toothed cinquefoil), and a moderately low cover of highland rush, *Minuartia groenlandica* (mountain sandwort), and stunted specimens of *Betula papyrifera* var. *cordifolia* (heartleaf birch) and *Abies balsamea* (balsam fir). Lichens are common and include *Cetraria islandica* (lichen) and *Cladina rangiferina* (lichen), among others. Occasional to rare species that are generally more diagnostic of other communities include *Carex bigelowii* (Bigelow's sedge)*, *Diapensia lapponica* (diapensia)*, *Vaccinium angustifolium* (lowbush blueberry), *Ledum groenlandicum* (Labrador-tea), *Solidago cutleri* (Cutler's goldenrod)*, *Empetrum nigrum* (black crowberry)*, and *Solidago simplex* ssp. *randii* var. *racemosa* (riverbank goldenrod). *Paronychia argyrocoma* (silverling)* is occasional in low elevation examples of this community.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Restricted to White Mountain peaks outside the Presidential Range, from 3400-4800 ft. Good examples occur on Mt. Guyot, South and North Baldface, Bondcliff, Mt. Chocorua, Whitewall Mtn., Franconia Ridge, and the southeast ridge of Carter Dome.

SOURCES: Cogbill 1994; Sperduto and Cogbill 1999.



KRUMMHOLZ AND HEATH - KRUMMHOLZ

Krummholz is wind-dwarfed and pruned clumps and thickets of trees found near or at timberline, and also in protected areas within the higher alpine zone. Krummholz is a German word meaning "crooked wood" and refers here to stunted trees of approximately 1.5-2 m or less in height. The primary krummholz-formers in the alpine and subalpine zone are *Picea mariana* (black spruce) and/or *Abies balsamea* (balsam fir). Krummholz is found in large patches and as a continuous zone at treeline, or may intermix at a fine scale with heath shrubs referred to as "heath - krummholz."

Heaths that characterize the two heath/krummholz communities described here include bilberry, cranberry, and blueberry heaths joined by various mixtures of *Ledum groenlandicum* (Labrador-tea) and *Kalmia angustifolia* (sheep laurel). Higher elevation alpine species such as *Carex bigelowii* (Bigelow's sedge)*, *Juncus trifidus* (highland rush), *Diapensia lapponica* (diapensia)*, *Rhododendron lapponicum* (Lapland rosebay)*, and *Loiseleuria procumbens* (alpine azalea)* are absent. These species are occasional in more exposed adjacent areas corresponding to dwarf shrub - bilberry - rush barren or subalpine rocky bald communities. The lichens *Cladina rangiferina*, *Cetraria islandica*, and *Cladina alpestris* are common and often abundant. Both community types occur as nearly pure dwarf shrublands (<10-15 cm tall) to mixtures of 20-60% krummholz and are generally found on peaks lower than the climatic treeline at 4900 ft. Heath/krummholz usually has substantial rock, talus, gravel, or stone exposure (>25%).

In parts of the White Mountains heath - krummholz communities form a mosaic with alpine/subalpine bog and heath snowbank communities that have collectively been referred to as "heath balds" (Fahey 1976; Doyle 1987). They are found on flat to gently sloping ridgetops of the Mahoosuc, Carter-Moriah, and Baldface Ranges, with smaller examples found in several other scattered locations. These heath balds occur mostly below 4000 feet in elevation.

• Black spruce/balsam fir krummholz (S2S3)

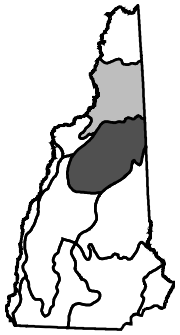
General Description: Black spruce/balsam fir krummholz corresponds to pure or nearly pure krummholz (>60% cover) areas that form either extensive patches or long, more or less continuous zones at treeline. It is distinguished here from heath - krummholz communities in which krummholz occurs as small patches within a fine-scaled mosaic along with heath shrubs. Krummholz typically forms a narrow transition zone to alpine tundra on steep slopes or a wider transition on relatively shallow slopes. Snow tends to accumulate in and around krummholz, affording protection to leaves and branches from wind, snow, and ice-blasting. As exposure increases, snow accumulation is reduced, and tree growth cannot keep up with physical losses. Stunted balsam fir krummholz can reach at least 130-140 years of age. Climatic treeline occurs at 4900 ft., although balsam fir and black spruce krummholz occur as low as 3500 feet, and red spruce krummholz occurs as low as 3000 feet.

The dominant soils of krummholz are organic Histisols or mineral soils with deep A horizons.

Characteristic vegetation: *Abies balsamea* (balsam fir) and *Picea mariana* (black spruce) are the primary krummholz-forming trees, with balsam fir usually being more common. *Betula papyrifera* var. *cordifolia* (heartleaf birch) is also frequently present, with *Picea rubens* (red spruce) common at the low-elevation limits of krummholz. Species of lower elevation spruce - fir forests are often present, such as *Cornus canadensis* (bunchberry), *Clintonia borealis* (blue-bead lily), *Trientalis borealis* (starflower), *Gaultheria hispidula* (creeping snowberry), *Solidago macrophylla* (large-leaved goldenrod), and various mosses. Pease (1964) notes that balsam fir "scrub" is a preferred habitat of the rare *Listera cordata* (heart-leaved twayblade)*, although this may refer to slightly more robust balsam fir below dwarfed krummholz.

Classification confidence: 1

Distribution: Krummholz occurs at the interface of the alpine zone and high-elevation balsam fir forest on essentially all alpine peaks and some subalpine peaks. Good examples can be found throughout the Presidential Range. Mt. Guyot has a very large example of knee-high black spruce krummholz that covers several acres.



Sources: NHB field surveys; Cogbill and White 1991; Pease 1964; Sperduto and Engstrom 1995; Sperduto and Cogbill 1999.

• Labrador tea heath - krummholz (S2)

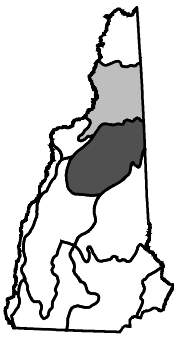
General description: Labrador tea heath - krummholz is the higher elevation of two heath - krummholz communities in NH, ranging from 3500-4900 feet in elevation. It is characterized by a patchy, low krummholz layer intermixed with a dense dwarf shrub layer and a variable rock and gravel component. *Kalmia angustifolia* (sheep laurel), *Rhododendron canadense* (rhodora), and *Nemopanthus mucronatus* (mountain holly) are prominent in the lower elevation sheep laurel - labrador tea heath - krummholz but are usually absent in this community. The krummholz averages less than 0.5 m in height, with occasional taller islands to approximately 1.5 m. The dwarf shrub layer is typically dwarfed and does not exceed 15-20 cm height (max 30). Moderately shallow snowpacks are probably associated with heath - krummholz communities (deeper than in very exposed areas and shallower than in heath snowbank communities). At lower elevations for the range of this community, or in more protected positions, red spruce can predominate and achieve somewhat taller heights than in higher elevation, more exposed positions.

Soils tend to be shallow organic turfs (O and A horizons) on steep boulder talus, stone or gravel mixtures, or bedrock. Exposed rock, stone, and/or talus are common.

This community is transitional to the dwarf shrub - bilberry - rush barren in more exposed positions with more ephemeral or shallow snowpack, and wooded subalpine bog/heath snowbank communities in more sheltered

and less well-drained positions with a deeper snowpack.

CHARACTERISTIC VEGETATION: *Abies balsamea* (balsam fir) and *Betula papyrifera* var. *cordifolia* (heartleaf birch) are common krummholz trees, with *Picea rubens* (red spruce) occasional at the lower end and *Picea mariana* (black spruce) more frequent at the higher end of the elevation range. Frequent and dominant dwarf shrubs include *Empetrum atropurpureum* (purple crowberry)*, *Vaccinium uliginosum* (alpine bilberry), *Vaccinium vitis-idaea* (mountain cranberry), and occasionally *Vaccinium boreale* (alpine blueberry)*, *Empetrum nigrum* (black crowberry), and *Vaccinium angustifolium* (lowbush blueberry). Lichens are common and often abundant, including *Cladina rangiferina*, *Cetraria islandica*, and *Cladina alpestris*. Mosses are frequent but poorly documented. The regionally rare moss *Cynodontium schisti* has been documented from one example of this community.



CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is restricted to high elevation peaks in the White Mountains from 3500-4900 ft. Good examples are found on Signal Ridge on Mt. Carrigain, the west ridge of Mt. Bond, Mt. Guyot, Imp Mtn., Mt. Hight, Mt. Isolation, Mt. Moriah, and Mt. Garfield.

SOURCES: Sperduto and Cogbill 1999.

• Sheep laurel - labrador tea heath - krummholz (S2)

GENERAL DESCRIPTION: Sheep laurel - labrador tea heath - krummholz is the lower elevation type of two heath - krummholz communities in NH. It ranges from about 3000-3500 ft, and rarely slightly higher or lower. Structurally it is very similar to the Labrador tea type with a characteristic patchy, low krummholz layer intermixed with a dense dwarf shrubs (20-100% cover; 7-30 cm tall) and variable rock, stone, and gravel exposure. *Kalmia angustifolia* (sheep laurel), *Rhododendron canadense* (rhodora), *Nemopanthus mucronatus* (mountain holly), and *Picea rubens* (red spruce) are prominent members of this community that help distinguish it from its higher elevation counterpart. Fire may have had some influence on the formation of some examples, or modified the proportion of open vs. forest area.

Soils tend to be shallow (10-35 cm; rarely more), well-drained organic-rich turfs on moderate to steep slopes (3-30 degrees) over bedrock or occasionally talus. O horizons are hemic and average about 15 cm depth over shallow mineral A and B horizons.

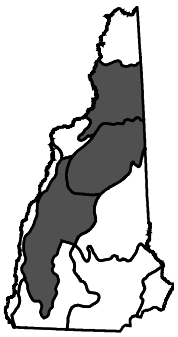
This community occurs with the wooded subalpine bog/heath snowbank and wet alpine/subalpine bog communities to form mosaics referred to as “heath balds” found on flat to gently sloping ridgetops of the Mahoosuc, Carter-Moriah, and Baldface Ranges, as well as in several other scattered locations. Here, sheep laurel - labrador tea heath - krummholz occurs on more well drained soils adjacent to poorly drained or deep snowbank areas that are have deeper organic soils, less rock exposure, and more wet-site plants (subalpine wooded bog/heath snowbank and wet subalpine bogs). Doyle (1987) and Fahey (1976) describe this same gradient from the Mahoosuc Range in Maine near the NH, breaking it into five association units compared to three communities in this classification. Heath balds form a distinct and distributionally limited set of communities similar to vegetation of certain coastal peatlands in Maine and heathlands of the Canadian Maritime Provinces.

CHARACTERISTIC VEGETATION: *Betula papyrifera* var. *cordifolia* (heartleaf birch), *Abies balsamea* (balsam fir), and *Picea rubens* (red spruce) are the primary krummholz trees; *Picea mariana* (black spruce) is rare or absent below 3500 ft. on well-drained soils. Diagnostic plants include abundant *Kalmia angustifolia* (sheep laurel) and less frequent rhodora, mountain holly, and *Aronia melanocarpa* (black chokeberry). Other prominent heaths and other dwarf shrubs include *Vaccinium uliginosum* (alpine bilberry), *Vaccinium vitis-idaea* (mountain cranberry), *Vaccinium angustifolium* (lowbush blueberry), *Vaccinium boreale* (alpine blueberry)*, and

Empetrum atropurpureum (purple crowberry)* or *Empetrum nigrum* (black crowberry). *Ledum groenlandicum* (Labrador-tea) is frequent but on average less abundant than in Labrador tea heath - krummholz. *Potentilla tridentata* (three-toothed cinquefoil) is occasional. *Cladina rangiferina*, *C. alpestris* and *Cetraria islandica* are common. Mosses are common but poorly documented. A very rare moss, *Cynodontium schisti*, was found in this community on a boulder interspersed among the heath/krummholz. This moss has been documented from only a few sites east of the Rocky Mountains. *Geocaulon lividum* (northern comandra)* is another rare plant known from the Mahoosuc Range examples in Maine and NH.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community occurs on subalpine summits, ridges, and slopes in the White Mountains (White Mountain and Mahoosuc-Rangeley Lakes subsections) and locally on Mt. Cardigan and Mt. Monadnock in the Sunapee Uplands subsection. Good examples include North and South Baldfaces, Mt. Success, Mt. Chocorua, Shelburne-Moriah Mtn., Mt. Moriah, the lip of Cannon Cliff, Imp Mtn., Lower Baldy, Moat Mtns., and Eagle Crag.



SOURCES: Fahey 1976; Whitney and Moeller 1982; Doyle 1987; Sperduto and Cogbill 1999.

ALPINE/SUBALPINE BOGS AND SUBALPINE HEATH SNOWBANKS

Sloping and level peatlands occur in concavities on ridges, and on moderate to steep slopes over bedrock where some combination of limited drainage, the "fog-belt" subalpine climate, late melting snowpacks, and self-maintaining *Sphagnum* (peat moss) mats contribute to peat accumulation. These peatlands are dominated primarily by lowland bog plants, but are usually accompanied by subalpine plants including *Vaccinium uliginosum* (alpine bilberry) and *Empetrum nigrum* (black crowberry)*.

There are three alpine/subalpine peatland types described here. Many examples of these peatlands are sloping. Sloping peatlands are largely restricted to northern climates, and in NH they're restricted to the White Mountains and the northern part of the state. Here the cold wet climate and low evapotranspiration combine to allow peat to accumulate on sloping ground. While sloping peatlands are a unique characteristic of some alpine/subalpine peatlands, degree of wetness appears to be a more important determinant of species composition than slope. Wet alpine/subalpine bogs are very poorly drained and occur in concavities and occasionally on slopes. They have several wet-site bog species that are absent in wooded subalpine bog/heath snowbanks. Wooded subalpine bog/heath snowbanks occur on sloping to level ground, are less wet, but still have thick, peaty organic soils. They are often associated with late melting snowbanks or can occur as a border zone around wetter bogs. Subalpine sliding fens are boggy peat mats on the brow of some high elevation cliffs that are subject to sloughing off the cliff-edge. Alpine/subalpine peatlands are restricted to the White Mountains and range from 2900-4900 ft. elevation.

In parts of the White Mountains alpine/subalpine bog and heath snowbank communities form a mosaic with heath - krummholz communities that have collectively been referred to as "heath balds" (Fahey 1976; Doyle 1987). These "heath balds" occur mostly below 4000 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.

• Wet alpine/subalpine bog (S1)

GENERAL DESCRIPTION: This *Sphagnum* (peat moss)-dominated community occurs on mostly level to sloping peatlands, generally above 3500 feet elevation. It is differentiated from lowland peatlands by subalpine plants such as *Empetrum nigrum* (black crowberry)*, *Vaccinium uliginosum* (alpine bilberry), and *Rubus chamaemorus*

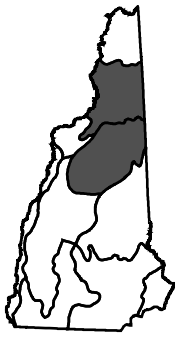
(baked apple berry)*. Species composition and abundance patterns indicate more permanently saturated conditions than are found in wooded subalpine bog/heath snowbank communities: peat moss is abundant, wet bog species including sedges are common or more abundant, and trees are absent or sparse. The shrub layer is dwarfed and typically less than 20 cm high.

Peats are moderately deep ranging from 45-75 cm, and are poorly decomposed near the surface. Slopes are mostly 0-8 degrees, but occasionally as steep as 35 degrees.

CHARACTERISTIC VEGETATION: This community is distinguished from lowland peatlands by the presence of subalpine plants including *Empetrum nigrum* (black crowberry)*, *Vaccinium uliginosum* (alpine bilberry), and *Rubus chamaemorus* (baked apple berry)*. Saturated conditions are indicated by the presence of *Vaccinium oxycoccos* (small cranberry), *Eriophorum vaginatum* (cotton grass), and an abundance and high constancy of *Sphagnum* spp. (peat mosses). *Sphagnum fuscum* and *S. capillifolium* are the most common species; *Sphagnum rubellum, S. russowii,* and *S. lescurii* may also be present. *Ledum groenlandicum* (Labrador-tea) is nearly constant and other heath shrubs are frequent, including *Chamaedaphne calyculata* (leather-leaf), *Kalmia angustifolia* (sheep laurel), and *Kalmia polifolia* (bog laurel). Sheep laurel is not abundant, typically <10% cover. Leather-leaf is usually >10% cover in contrast to <10% in wooded subalpine bog/heath snowbank. *Drosera rotundifolia* (round-leaved sundew) is occasional. *Cladina rangiferina* and *Cetraria islandica* are occasional and sometimes abundant.

VARIANTS: Two variants are recognized:

1. **Cloudberry - bilberry variant**: This variant differs from the next by a higher frequency of *Vaccinium uliginosum* (alpine bilberry), *Rubus chamaemorus* (baked apple berry)*, and *Scirpus cespitosus* (tussock bulrush). *Vaccinium vitis-idaea* (mountain cranberry) is occasional. *Rhododendron canadense* (rhodora) is absent. *Cetraria islandica* and *Cladina rangiferina* are common. This variant can occur at higher elevations (up to ca. 4900 ft.) than the one described below.
2. **Rhodora - shrub heath variant**: This variant tends to lack *Scirpus cespitosus* (tussock bulrush) and *Rubus chamaemorus* (baked apple berry)*, has less *Vaccinium uliginosum* (alpine bilberry), and often has a denser cover of dwarf shrubs. *Empetrum nigrum* (black crowberry)* is occasional, while *Rhododendron canadense* (rhodora) is frequent. *Picea mariana* (black spruce) is more frequent and abundant compared to the preceding variant. The Rhodora/shrub heath variant occurs at a maximum elevation of ca. 3700 ft. and is transitional to the wooded subalpine bog/heath snowbank community at some sites.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Occurs on mostly level to slightly sloping peatlands in the White Mountains, generally above 3500 ft. Good examples occur on Bald Cap, Imp Mtn., Mt. Success, Shelburne-Moriah Mtn, Mt. Jackson, and Mt. Adams.

SOURCES: Sperduto and Cogbill 1999; Sperduto et al. 2000a.

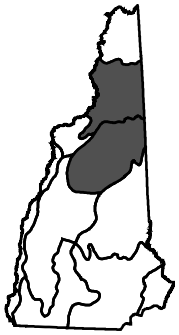
• Wooded subalpine bog/heath snowbank (S1S2)

GENERAL DESCRIPTION: This community is found in subalpine settings where deeper snows accumulate (e.g., on lee slopes of peaks or near krummholz margins), on drier borders of bogs, and on slopes where *Sphagnum* maintains growth and peat accumulates. This community is intermediate between wet bogs and heath/krummholz communities. In contrast to wet bogs trees are more prominent, sedges and wet bog species are absent, and peat moss is often but not always present. The shrub layer is typically 25-30 cm high (slightly taller than in wet alpine/subalpine bogs).

Peat depths are typically 25-50 cm, and occasionally deeper (to 80 cm). Peat is poorly to moderately well decomposed near the surface. Slopes are mostly 0-8 degrees, but occasionally as steep as 35 degrees.

This community differs from the sheep laurel - labrador tea heath - krummholz community by a shallow to moderately deep peat layer (0.25-0.80+ m), the presence of *Picea mariana* (black spruce) in abundance, and often the presence of bog-indicator species such as peat moss and leather-leaf.

CHARACTERISTIC VEGETATION: Wooded subalpine bog/heath snowbanks differ from wet alpine/subalpine bogs by a generally higher cover of stunted *Picea mariana* (black spruce) and *Abies balsamea* (balsam fir) (<2m in height) and the absence of plants indicative of permanently saturated conditions, such as *Vaccinium oxycoccos* (small cranberry), *Eriophorum vaginatum* (hare's-tail), and *Kalmia polifolia* (bog laurel). *Ledum groenlandicum* (Labrador-tea), *Kalmia angustifolia* (sheep laurel), and *Vaccinium vitis-idaea* (mountain cranberry) are common, with Labrador tea being the most common shrub. Sphagnum moss is often common but not always present. *Chamaedaphne calyculata* (leather-leaf) is occasional but not abundant (<10% cover compared to >10% in wet alpine/subalpine bogs). *Cladina rangiferina* and *Cetraria islandica* are infrequent.



CLASSIFICATION CONFIDENCE: 2

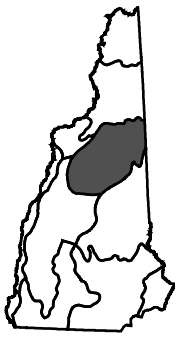
DISTRIBUTION: This community occurs in the White Mountains, generally above 2900 ft. Good examples occur on Mt. Success, Eagle Crag, the lee slope of Mt. Hight summit, Imp Mtn., Mt. Jackson, and Mt. Moriah.

SOURCES: Sperduto and Cogbill 1999; Sperduto et al. 2000a.

• Subalpine sliding fen (S1)

GENERAL DESCRIPTION: This shallow peat community occurs on 5-30° slopes along the brow of alpine/subalpine cliffs. Peatland formation is probably influenced by some combination of runoff from higher on the mountain and high cloud cover and fog intercept. Similar fens in the Adirondacks presumably can periodically become super-saturated from a major rain event and slide off the cliff, hence the name (David Hunt, pers. comm. 1999). The environmental setting of this community is unique, but the species composition is similar to other subalpine/alpine peatlands. Soils are shallow peat (1-35 cm) over bedrock.

CHARACTERISTIC VEGETATION: This community is floristically similar to other wet alpine/subalpine bogs but differs by an abundance of *Calamagrostis pickeringii* (Pickering's reed bent-grass)*, *Sphagnum compactum*, and *Geum peckii* (mountain avens)*. *Sphagnum compactum* is a pioneer peat moss species on seepy, exposed bedrock or sand. *Scirpus cespitosus* (tussock bulrush), *Sphagnum russowii, S. capillifolium*, and *S. girgensohnii* are abundant, along with various shrubs including *Kalmia angustifolia* (sheep laurel), *Ledum groenlandicum* (Labrador-tea), *Vaccinium oxycoccos* (small cranberry), *Empetrum nigrum* (black crowberry)*, and *Kalmia polifolia* (bog laurel).



CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: Documented from just one site in NH, above Cannon Cliff in the White Mountains. A few other high-elevation cliffs in the White Mountains may also contain examples of this rare community and deserve further research (e.g., Huntington Ravine, Shinning Rocks and other sites on the east side of Franconia Notch).

SOURCES: Sperduto et al. 2000a; David Hunt, pers. comm. 1999.

Sparsely vegetated alpine and subalpine communities

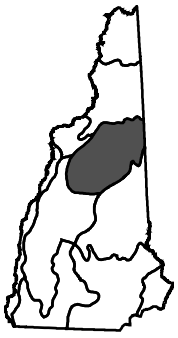
Several high-elevation natural communities are characterized by a complete lack of trees, very little herbaceous vegetation, and, in some communities, an abundance of lichens. Alpine boulder fields, called felsenmeer, result from frost action in alpine settings. Subalpine rocky balds are severely exposed, rugged peaks that are sparsely vegetated. Alpine cliffs are distinct from their lowland counterparts by the presence of alpine plant species. All are associated with distinct physical settings that have not been studied as thoroughly as more well-vegetated alpine and subalpine communities.

• Felsenmeer (S2)

General description: Extensive fields of huge, angular, frost-cracked boulders, covered by lichens but supporting few or no vascular plants, are found above timberline in the Presidential Range. These boulder fields, found in alpine and arctic environments around the world, are referred to as "felsenmeer," a German word meaning "sea of rocks." Felsenmeer in NH formed from intense freeze-thaw cycles following the glacial retreat when the climate was more severe, although frost action is still important in today's alpine zone. These boulder fields have been described as "fossil," meaning they are inactive, although some scientists have concluded that they still move by slow "felsenmeer creep" on top of a slurry of silty, stony soils. Boulders show signs of weathering and are covered with lichens on their upper surfaces, which is consistent with slow felsenmeer creep or inactive frost action. Felsenmeer occurs over hundreds of acres in parts of the Presidential Range.

Numerous other surface features that have resulted from frost action are still evident today. These include rock rings, rock stripes, soil boils, and stone terraces. All of these features, as well as felsenmeer, have resulted from the differential movement of coarse and fine material as the ground freezes and thaws. In contrast to tens and hundreds of acres of felsenmeer found in the alpine zone, rock rings and stripes, boils and stone terraces typically occur on a smaller scale and are interspersed among patches of vegetation that correspond to one of the other alpine plant communities. The term felsenmeer has been used more narrowly to refer only to flat arctic/alpine boulder fields, and more broadly in other climate regions to any accumulation of coarse, angular blocks where precipitation soaks in. As described here, the term includes alpine boulder fields on flat and sloped terrain where precipitation soaks in without apparent runoff.

Characteristic vegetation: Lichens are the dominant life form in felsenmeer. Crustose, umbillicate, and foliose lichens are common, including *Arctoparmelia centrifuga* (target lichen), *Melanelia hepatizon* (rimmed camouflage lichen), *M. stygia* (alpine camouflage lichen), *Umbilicaria proboscidea* (netted rock tripe), *U. torrefacta* (punctured rock tripe), *Lasillia papulosa* (toadskin lichen), *U. polyphylla* (petaled rock tripe), *U. hyperborea* (blistered rock tripe), *Lecanora polytropa* (granite-speck rim lichen), *Ophioparma ventosa* (alpine bloodspot), *Rhizocarpon geographicum* (map lichen), *Porpidia flavocaerulescens* (orange boulder lichen), *Tremolecia atrata* (rusty-rock lichen), *Lecidea lapicida* (gray-orange disk lichen), *Protoparmelia badia* (chocolate rim lichen), *Orphniospora moriopsis* (black-on-black lichen), and *Stereocaulon* spp. (foam lichens). Scattered vascular alpine plants such as *Diapensia lapponica* (diapensia)* and *Carex bigelowii* (Bigelow's sedge)* are evident where small patches of soil have accumulated.



Classification confidence: 2-3

Distribution: Apparently restricted to the Presidential Range. Good examples occur on the cone of Mt. Washington, on Bigelow Lawn, and on other high peaks of the Presidential Range.

Sources: Goldthwait 1940; Thompson 1960; Bliss 1963a; Bliss 1963b; Pope 2003.

• Subalpine rocky bald (S2)

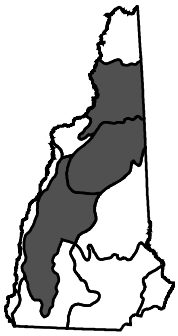
General description: This natural community corresponds to rugged, granitic subalpine summits and ledges with extensive, sparsely vegetated bedrock exposures (at least several acres with less than 5-10% plant cover). Plants are limited to cracks and benches that retain thin soils, and the natural community is essentially a poorly developed or truncated version of the heath - krummholz and dwarf shrub - bilberry - rush barren communities that dominate more vegetated subalpine peaks. The extent of bedrock exposure on some of these peaks appears to have been expanded by historic fires, but all appear to have always had some subalpine communities.

Bedrock is typically granitic (e.g., granite, syenite). This is the best community in which to see exfoliation sheets, which are big slabs of rock that separate along a series of concentric shells or layers similar to cabbage leaves. This occurs in massive, buried igneous rocks like granite that tend to expand upward and outward as overlying bedrock is eroded away. This process is aided in cold climates by frost wedging. South Baldface Mtn. and Percy Peaks are excellent examples of "exfoliation domes" similar to those in the Sierra Nevada of California and other parts of the world.

Characteristic vegetation: Scattered dwarf shrubs may include *Potentilla tridentata* (three-toothed cinquefoil), *Vaccinium uliginosum* (alpine bilberry), *V. angustifolium* (early low blueberry), *V. vitis-idaea* (mountain cranberry), *Vaccinium boreale* (alpine blueberry)*, *Empetrum nigrum* (black crowberry)*, *E. atropurpureum* (purple crowberry)*, *Kalmia angustifolia* (sheep laurel), and *Rhododendron canadense* (rhodora). Herbs may include *Agrostis mertensii* (boreal bent-grass)*, *Juncus trifidus* (highland rush), *Minuartia groenlandica* (mountain sandwort), and *Deschampsia flexuosa* (common hair-grass). Stunted trees may include *Picea rubens* (red spruce), *Abies balsamea* (balsam fir), and *Betula papyrifera* var. *cordifolia* (heartleaf birch). *Paronychia argyrocoma* (silverling)* is found in cracks and on gravel benches on several peaks.

Classification confidence: 2

Distribution: This community is found in the White Mountains, parts of the North Country, and on several outlying peaks of central and southwest NH. Good examples include portions of Mt. Chocorua (Albany), Mt. Cardigan (Orange), Mt. Monadnock (Jaffrey), Percy Peaks (Northumberland), and South Baldface (Chatham).



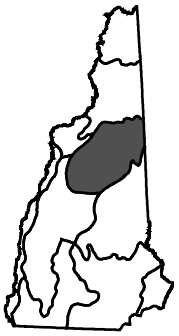
Sources: NHB field surveys; Sperduto and Cogbill 1999; Cogbill (pers. comm. 2000).

• Alpine cliff (S2)

General description: Cliffs in the alpine zone are clearly different than their counterparts at lower elevations, although this is a broadly defined community that has had fairly little sampling completed. Plant cover is typically sparse and consists mostly of disturbance- and exposure-tolerant species also found in other communities. Most cliffs in the alpine zones of NH are acidic and dry or dry-mesic, with a few small circumneutral or cliff seep areas. More data are needed to enumerate differences among alpine cliffs.

Characteristic vegetation: Commonly found species include *Minuartia groenlandica* (mountain sandwort), *Juncus trifidus* (highland rush), *Diapensia lapponica* (diapensia)*, *Agrostis mertensii* (boreal bent-grass)*, *Loiseleuria procumbens* (alpine azalea)*, and *Geum peckii* (mountain avens)*. On moist microsites, *Scirpus cespitosus* (tussock bulrush), *Poa fernaldiana* (wavy bluegrass)*, and *Cardamine bellidifolia* (alpine bitter-cress)* are occasional, the latter two typically under overhangs. On moist to wet circumneutral cliffs, *Carex scirpoidea* (scirpus-like sedge)*, *Campanula rotundifolia* (harebell), *Saxifraga aizoon* (livelong saxifrage)*,

and *Saxifraga cernua* (nodding saxifrage)* may be found. The globally rare *Potentilla robbinsiana* (dwarf cinquefoil)* is documented from one alpine cliff.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Restricted to the White Mountains above 4000 ft. Good examples occur on Cannon Cliff (Cannon Mtn.), on the west face of the north ridge of Mt. Lafayette (Franconia Ridge), and in Huntington and Tuckerman Ravines (Mt. Washington).

SOURCES: NHB field surveys.

LANDSLIDES AND TALUS BARRENS

Montane landslides occur as either narrow linear tracks or broad swaths on mountain slopes where rock, soil, and vegetation have slumped catastrophically and slid down the mountain. Reasons for slides vary from simple gravity acting on over-steepened slopes to such mass wasting phenomena as the weakening of slope material by heavy water saturation, heavy snow accumulation triggering slope failure, and earthquakes loosening already weak slopes. The remaining substrate of the source areas for landslides typically consists of bare rock, scree or talus, with debris being deposited below on a debris cone. This community can range from sparsely vegetated to wooded.

Talus barrens are open slopes with large, lichen-covered rocks with little or no soil accumulation or vascular plant cover. Talus barrens correspond to either active talus areas where rockfall, avalanches, rock movement, or landslides are prevalent or to areas of large-block talus with little intervening soil formation.

• Montane landslide (S3S4)

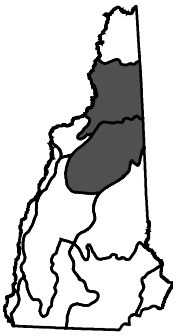
GENERAL DESCRIPTION: Landslides, also called "debris avalanches," are a common phenomenon in the White Mountains. They occur as either narrow linear tracks or broader swaths of mountain slopes where rock, soil, and vegetation have slumped catastrophically and slid down the mountain. The remaining substrate of the source areas for landslides typically consists of bare rock, scree or talus, with debris being deposited below on a debris cone. Some landslide tracks correspond to steep stream valleys and avalanche tracks, whereas others have occurred on non-entrenched slopes. Freeze-thaw processes, heavy rainfall, and saturation of soil materials are all important contributing factors to the occurrence of landslides. This community can range from sparsely vegetated to wooded.

CHARACTERISTIC VEGETATION: Landslides revegetate at different rates depending on the nature of the remaining substrate and frequency and intensity of recurring disturbance (i.e., from avalanches or runoff). Common pioneer woody species include *Betula papyrifera* var. *cordifolia* (heartleaf birch), *Betula papyrifera* var. *papyrifera* (paper birch), *Prunus pensylvanica* (pin cherry), *Abies balsamea* (balsam fir), and *Acer spicatum* (mountain maple). Understory species include a variable array of weedy disturbance colonizers including numerous grasses, composites, *Rubus* spp. (raspberries and blackberries), and *Dennstaedtia punctilobula* (hay-scented fern), among others. Moss and lichen pioneer species are also evident. At higher elevations, alpine/subalpine species may occur, such as *Minuartia groenlandica* (mountain sandwort), *Vaccinium uliginosum* (alpine bilberry), *Juncus trifidus* (highland rush), *Potentilla tridentata* (three-toothed cinquefoil), and *Agrostis mertensii* (boreal bent-grass)*.

CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: Montane landslide scars occur throughout the White Mountains. Good Examples occur in Franconia and Crawford Notches, on North and South Tripyramid, Mt. Osceola, Mt. Flume, and Mt. Guyot/West Bond. Both Franconia and Crawford Notches have particularly high concentrations of landslide scars, in various stages of revegetation, that have resulted from the many debris avalanches recorded over the last 200 years.

SOURCES: NHB field surveys; Flaccus 1959.



• Montane lichen talus barren (S3)

GENERAL DESCRIPTION: Lichen talus barrens are open slopes with large, lichen-covered rocks with little or no soil accumulation and vascular plant cover (generally <5% cover). Talus barrens correspond to either active talus areas where rockfall, avalanches, rock movement or landslides are prevalent or to areas of large-block talus with little intervening soil formation. Montane lichen talus barrens occur in association with spruce - birch - mountain maple wooded talus and subalpine cold-air talus barrens. Scattered individuals of species found in these communities may be found in montane lichen talus barrens. While this is a physically distinct community, there has been little specific documentation on lichens, invertebrates, and small mammals that probably characterize this community.

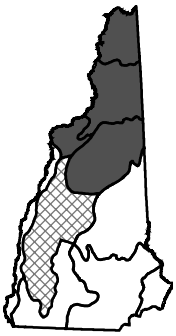
Little soil has accumulated to support the growth of higher plant life, and draughty conditions are likely to prevail during much of the growing season due the lack of moisture-holding capacity. Very nutrient poor (oligotrophic) conditions prevail.

CHARACTERISTIC VEGETATION: Lichens are the dominant life form including crustose, umbillicate, and foliose growth forms. Although data on lichens have not been collected specifically in this community, it is likely that the species present are more montane in distribution as are the vascular plants found in or around this community. Occasional montane vascular plant species may include *Picea rubens* (red spruce), *Abies balsamea* (balsam fir), *Betula papyrifera* var. *cordifolia* (heartleaf birch), *B. papyrifera* var. *papyrifera* (paper birch), *B. alleghaniensis* (yellow birch), and *Acer spicatum* (mountain maple). Both temperate and montane lichen talus barrens may have such species as *Polypodium virginianum* (rock polypody), *Ribes* spp. (gooseberries and currents), and *Deschampsia flexuosa* (common hair-grass).

CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: This community is found above 2200 ft. elevation (occasionally as low as 1500-1800 ft.) in lower and mid slope positions on the White Mountains in the White Mountain, Mahoosuc-Rangeley Lakes, and Connecticut Lakes subsections. It may also occur on some of the higher elevations south of the White Mountains. Good examples are found on Cannon Mtn. (Franconia), Whitewall Mtn. (Zealand Notch), and King Ravine (Thompson and Meserves Purchase).

SOURCES: NHB field surveys.



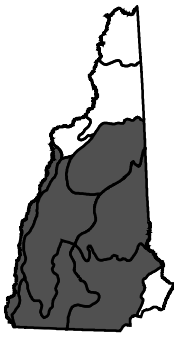
• Temperate lichen talus barren (S2S3)

GENERAL DESCRIPTION: Lichen talus barrens are open slopes with large, lichen-covered rocks with little or no soil accumulation and vascular plant cover (generally <5% cover). Talus barrens correspond to either active talus areas where rockfall, avalanches, rock movement or landslides are prevalent or to areas of large-block talus with little intervening soil formation. Temperate lichen talus barrens occur in association with red oak -

black birch wooded talus. Scattered individuals of species characteristic of the wooded talus community often occur in temperate lichen talus barrens. While this is a physically distinct community, there has been little specific documentation on lichens, invertebrates, and small mammals that probably characterize this community.

Little soil has accumulated to support the growth of higher plant life, and draughty conditions are likely to prevail during much of the growing season due the lack of moisture-holding capacity. Very nutrient poor (oligotrophic) conditions prevail.

CHARACTERISTIC VEGETATION: Lichens are the dominant life form. Although data on lichens have not been collected specifically in this community, it is likely that species are more temperate in distribution as are the scattered vascular plants found in or around this community. Temperate lichen talus barrens have few northern hardwood and spruce - fir associates, and more *Quercus rubra* (red oak), *Betula populifolia* (gray birch), *B. lenta* (black birch), *Corydalis sempervirens* (pale corydalis), and other species found at lower elevations (see red oak - black birch wooded talus description). Both the montane and temperate types may have such species as *Polypodium virginianum* (rock polypody), *Ribes* spp. (gooseberries and currents), and *Deschampsia flexuosa* (common hair-grass).



CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: This community is found primarily below 1800 ft. elevation south of and including the White Mountain subsection. A good example occurs on Mt. Wantastiquet (Hinsdale).

SOURCES: NHB field surveys.

CLIFFS

Cliffs are steep rock outcroppings that exceed three meters in height and 65 degrees in slope. High-angle outcrops less than 65 degrees are referred to as "rock slabs" and are more similar in terms of vegetation and ecological characteristics to rocky ridge/rock outcrop communities. Cliffs are distinct from other outcrops in many ways: they are often more fractured, have more limited accumulation of soil, cannot accumulate a significant snowpack, are generally more exposed to the elements, and are sometimes overhanging and protected from terrestrial runoff. Circumneutral cliffs are associated with at least two circumstances: 1) where the matrix bedrock is intermediate, mafic, calc-silicate or carbonate-bearing; and/or 2) where fractured rock groundwater (particularly under overhangs) transports base-cations to the cliff face. Many cliffs have both acidic and circumneutral zones that result from substantial small-scale variation in fractured rock groundwater inputs of base-rich water. Several species are preferential or restricted to cliffs.

• Montane acidic cliff (S5)

GENERAL DESCRIPTION: Cliffs are steep rock outcroppings that exceed three meters in height and 65 degrees in slope. High-angle outcrops less than 65 degrees are referred to as "rock slabs" and are more similar in terms of vegetation and ecological characteristics to rocky ridge/rock outcrop communities. This cliff community is characterized by a mixture of species indicative of acidic and montane conditions. Higher elevation examples may contain subalpine species. Circumneutral indicators are absent.

CHARACTERISTIC VEGETATION: Characteristic vegetation includes *Deschampsia flexuosa* (common hair-grass), *Potentilla tridentata* (three-toothed cinquefoil), *Cystopteris fragilis* (fragile fern), *Solidago simplex* ssp. *randii* (Rand's goldenrod), *Danthonia spicata* (poverty oat-grass), *Corydalis sempervirens* (pale corydalis), and *Paronychia argyrocoma* (silverling)*.

Other plant species include *Solidago bicolor* (silverrod), *Solidago nemoralis* (northern gray goldenrod) and other goldenrods, *Danthonia compressa* (tufted oat-grass), *Agrostis* spp. (bent-grasses), *Achillea millefolium* (European yarrow), *Aquilegia canadensis* (wild columbine), *Poa compressa* (Canada bluegrass), *Aster* spp. (asters), *Panicum* spp. (panic-grasses), *Elytrigia repens* (quack-grass), *Dennstaedtia punctilobula* (hay-scented fern), and *Cystopteris tenuis* (Mackay's brittle fern).

Shrubs that may be present in low cover include *Diervilla lonicera* (bush honeysuckle), *Vaccinium myrtilloides* (velvet-leaf blueberry), *Vaccinium angustifolium* (lowbush blueberry), *Vaccinium vitis-idaea* (mountain cranberry), *Spiraea alba* (eastern meadowsweet), *Kalmia angustifolia* (sheep laurel), *Ledum groenlandicum* (Labrador-tea), *Sorbus americana* (American mountain ash), *Sorbus decora* (showy mountain ash), *Acer pensylvanicum* (striped maple), *Acer spicatum* (mountain maple), *Rubus* spp. (brambles), and *Amelanchier* spp. (shadbushes).

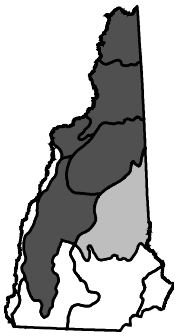
Scattered saplings or stunted older trees can occur on benches or other areas where soil accumulation is sufficient. These include *Betula papyrifera* var. *papyrifera* (paper birch), *Betula papyrifera* var. *cordifolia* (heartleaf birch), *Quercus rubra* (red oak), *Pinus resinosa* (red pine), *Pinus strobus* (white pine), *Populus tremuloides* (quaking aspen), *Populus grandidentata* (big-toothed aspen), *Juniperus virginiana* (eastern red cedar), *Acer saccharum* (sugar maple), *Picea mariana* (black spruce), *Picea rubens* (red spruce), *Abies balsamea* (balsam fir), *Tsuga canadensis* (hemlock), and *Betula alleghaniensis* (yellow birch).

Sites with *Agrostis mertensii* (boreal bent-grass)*, *Juncus trifidus* (highland rush)*, and *Scirpus cespitosus* (tussock bulrush) indicate the subalpine end of the spectrum. Some of these also have *Empetrum atropurpureum* (purple crowberry)* and *Vaccinium uliginosum* (alpine bilberry)* on shelves or cliff brows.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community occurs north of and including the Sunapee Uplands and Sebago-Ossipee Hills and Plain subsections at 1200-3500 ft. elevations (locally to 1000 ft. and 4000 ft.). Good examples include Cannon Cliff (Franconia), Cathedral Ledge (North Conway), and Ice Gulch (Randolph).

SOURCES: NHB field surveys; Bailey 2001; Sperduto 2001; Sperduto 2002.



• Montane circumneutral cliff (S2S3)

GENERAL DESCRIPTION: Cliffs are steep rock outcroppings that exceed three meters in height and 65 degrees in slope. High-angle outcrops less than 65 degrees are referred to as "rock slabs" and are more similar in terms of vegetation and ecological characteristics to rocky ridge/rock outcrop communities. Circumneutral cliffs may occur where the bedrock is intermediate, mafic, calc-silicate, or carbonate-bearing and where fractured rock groundwater transports base-cations to the cliff face (particularly under overhangs).

CHARACTERISTIC VEGETATION: Vascular plants diagnostic of montane circumneutral cliffs include *Dryopteris fragrans* (fragrant fern)*, *Woodsia glabella* (smooth woodsia)*, *Campanula rotundifolia* (harebell), *Woodsia ilvensis* (rusty woodsia), *Cryptogramma stelleri* (slender cliff-brake)*, *Thuja occidentalis* (northern white cedar), *Carex scirpoidea* (scirpus-like sedge)*, *Aster ptarmicoides* (snowy aster)*, *Draba lanceolata* (lance-leaved draba)*, *Arabis drummondii* (Drummond's rock-cress), *Carex eburnea* (ebony sedge)*, *Sambucus racemosa* (red elderberry), and *Potentilla floribunda* (shrubby cinquefoil). Other circumneutral indicators of this community that may be somewhat more diagnostic of lowland circumneutral cliffs include *Pellaea atropurpurea* (purple cliff-brake)*, *Saxifraga virginiensis* (early saxifrage), and *Asplenium trichomanes* (maidenhair spleenwort). Generally only a few of these circumneutral indicators are present at any one site.

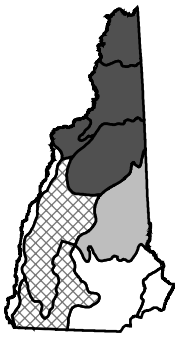
Bryophytes may be better indicators of calcareous and circumneutral conditions than vascular plants based on

detailed samples of nine circumneutral cliffs in the White Mountains (44% of all bryophytes were calciphilic or base-rich indicators compared to 14% of vascular plants). The most characteristic strict calciphiles were *Distichium capillaceum**, *Gymnostemum aeruginosum**, and *Tortella tortuosa**; other base-rich or circumneutral indicators included *Amphidium mougeotii**, *Diplophyllum apiculatum**, *Mnium thomsonii**, and *Myurella siberica**. *Polytrichastrum* (Pogonatum) *alpinum* is frequent but probably not restricted to circumneutral cliffs.

Other plant species include *Potentilla tridentata* (three-toothed cinquefoil), *Antennaria* spp. (pussytoes), *Cystopteris fragilis* (fragile fern), *Cystopteris tenuis* (Mackay's brittle fern), *Cystopteris bulbifera* (bulblet bladder fern)*, *Trisetum spicatum* (spiked false oats)*, *Arabis hirsuta* var. *pycnocarpa* (hairy rock-cress)*, *Epilobium ciliatum* (ciliated willow-herb)*, *Aster radula* (rough-leaved aster) and other asters, *Solidago arguta* (northern toothed goldenrod), *Solidago bicolor* (silverrod), *Solidago nemoralis* (northern gray goldenrod) and other goldenrods, *Danthonia spicata* (poverty oat-grass), *Danthonia compressa* (tufted oat-grass), *Agrostis* spp. (bent-grasses), *Achillea millefolium* (European yarrow), *Aquilegia canadensis* (wild columbine), *Poa compressa* (Canada bluegrass), *Panicum* spp. (panic-grasses), *Elytrigia repens* (quack-grass), *Deschampsia flexuosa* (common hair-grass), and *Dennstaedtia punctilobula* (hay-scented fern).

Shrubs that may be present in low cover include *Potentilla floribunda* (shrubby cinquefoil), *Juniperus horizontalis* (creeping juniper)*, *Diervilla lonicera* (bush honeysuckle), *Spiraea alba* (eastern meadowsweet), *Acer pensylvanicum* (striped maple), *Acer spicatum* (mountain maple), *Cornus rugosa* (round-leaved dogwood), *Rubus* spp. (brambles), and *Amelanchier* spp. (shadbushes).

Scattered saplings or stunted older trees can occur on benches or other areas where soil accumulation is sufficient. These include *Betula papyrifera* var. *papyrifera* (paper birch), *Betula papyrifera* var. *cordifolia* (heartleaf birch), *Quercus rubra* (red oak), *Pinus strobus* (white pine), *Populus tremuloides* (quaking aspen), *Populus grandidentata* (big-toothed aspen), *Juniperus virginiana* (eastern red cedar), *Thuja occidentalis* (northern white cedar), *Acer saccharum* (sugar maple), and *Picea rubens* (red spruce).



Classification Confidence: 2

Distribution: This community is generally found above 900 ft. and up to 3500 ft. (locally to 4000 ft.). Good examples include Holts Ledge (Lyme), Rattlesnake Mtn. (Rumney), and the east face of Mt. Osceola (Livermore).

Sources: NHB field surveys; Bailey 2001; Sperduto 2001; Sperduto 2002.

• Lowland acidic cliff (S4)

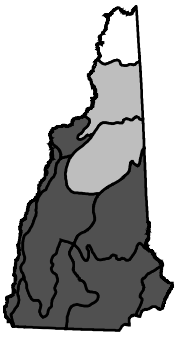
General description: Cliffs are steep rock outcroppings that exceed three meters in height and 65 degrees in slope. High-angle outcrops less than 65 degrees are referred to as "rock slabs" and are more similar in terms of vegetation and ecological characteristics to rocky ridge/rock outcrop communities. Montane, subalpine, and circumneutral indicator species are absent.

Characteristic vegetation: Characteristic vegetation includes *Deschampsia flexuosa* (common hair-grass), *Dryopteris marginalis* (marginal wood fern), *Aureolaria pedicularia* var. *intercedens* (fern-leaved false-foxglove)*, *Dryopteris intermedia* (intermediate wood fern), *Asplenium trichomanes* ssp. *trichomanes* (maidenhair spleenwort)*, *Polypodium virginianum* (rock polypody), *Dennstaedtia punctilobula* (hay-scented fern), *Cystopteris tenuis* (Mackay's brittle fern), *Solidago nemoralis* (northern gray goldenrod), *Solidago juncea* (early goldenrod), *Solidago bicolor* (silverrod), *Corydalis sempervirens* (pale corydalis), *Danthonia spicata* (poverty oat-grass), *Danthonia compressa* (tufted oat-grass), *Agrostis* spp. (bent-grasses), *Achillea millefolium* (European yarrow), *Aquilegia canadensis* (wild columbine), *Aster* spp. (asters), *Poa compressa* (Canada bluegrass), *Panicum* spp. (panic-grasses), and *Elytrigia repens* (quack-grass).

Shrubs that may be present in low cover include *Diervilla lonicera* (bush honeysuckle), *Vaccinium angustifolium*

(lowbush blueberry), *Spiraea alba* (eastern meadowsweet), *Kalmia angustifolia* (sheep laurel), *Acer pensylvanicum* (striped maple), *Acer spicatum* (mountain maple), *Rubus* spp. (brambles), and *Amelanchier* spp. (shadbushes).

Scattered saplings or stunted older trees can occur on benches or other areas where soil accumulation is sufficient. These include *Betula papyrifera* var. *papyrifera* (paper birch), *Quercus rubra* (red oak), *Pinus strobus* (white pine), *Populus tremuloides* (quaking aspen), *Populus grandidentata* (big-toothed aspen), *Juniperus virginiana* (eastern red cedar), *Acer saccharum* (sugar maple), and *Picea rubens* (red spruce).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is generally found below 1000 ft. and south of the White Mountains. A good example occurs on Joe English Hill (New Boston).

SOURCES: NHB field surveys.

• Lowland circumneutral cliff (S2)

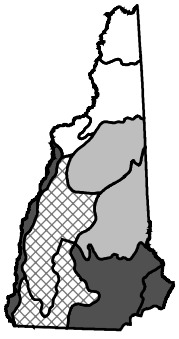
GENERAL DESCRIPTION: This community corresponds to circumneutral cliffs at low elevations (below 1000 ft.) in southern or central NH. It occurs where the parent bedrock is intermediate, mafic, calc-silicate or carbonate-bearing and/or where fractured rock groundwater (particularly under overhangs) transports base-cations to the cliff face. Montane and subalpine indicator species are absent.

CHARACTERISTIC VEGETATION: Plants characteristic of lowland circumneutral cliffs include *Cryptogramma stelleri* (slender cliff-brake)*, *Asplenium trichomanes* ssp. *quadrivalens* (Meyer's maidenhair spleenwort)*, *Woodsia obtusa* (blunt-lobed woodsia)*, *Pellaea atropurpurea* (purple cliff-brake)*, *Saxifraga virginiensis* (early saxifrage), and *Woodsia ilvensis* (rusty woodsia).

Other plant species include *Solidago bicolor* (silverrod), *Solidago nemoralis* (northern gray goldenrod) and other goldenrods, *Campanula rotundifolia* (harebell), *Achillea millefolium* (European yarrow), *Aquilegia canadensis* (wild columbine), *Aster* spp. (asters), *Antennaria* spp. (pussytoes), *Danthonia spicata* (poverty oat-grass), *Danthonia compressa* (tufted oat-grass), *Agrostis* spp. (bent-grasses), *Poa compressa* (Canada bluegrass), *Panicum* spp. (panic-grasses), *Elytrigia repens* (quack-grass), *Deschampsia flexuosa* (common hair-grass), *Dennstaedtia punctilobula* (hay-scented fern), and *Cystopteris tenuis* (Mackay's brittle fern).

Shrubs that may be present in low cover include *Potentilla floribunda* (shrubby cinquefoil), *Diervilla lonicera* (bush honeysuckle), *Spiraea alba* (eastern meadowsweet), *Acer pensylvanicum* (striped maple), *Acer spicatum* (mountain maple), *Cornus rugosa* (round-leaved dogwood), *Sambucus racemosa* (red elderberry), *Rubus* spp. (brambles), and *Amelanchier* spp. (shadbushes).

Scattered saplings or stunted older trees can occur on benches or other areas where soil accumulation is sufficient. These include *Betula papyrifera* var. *papyrifera* (paper birch), *Quercus rubra* (red oak), *Pinus strobus* (white pine), *Populus tremuloides* (quaking aspen), *Populus grandidentata* (big-toothed aspen), *Juniperus virginiana* (eastern red cedar), *Thuja occidentalis* (northern white cedar), *Acer saccharum* (sugar maple), and *Picea rubens* (red spruce).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is generally found below 1000 ft. and south of the White Mountains. Good examples occur at Jarvis Hill (Claremont) and Mt. Pawtuckaway (Nottingham).

SOURCES: NHB field surveys; Bailey 2001; Sperduto 2001; Sperduto 2002.

COASTAL DUNES AND INLAND BEACH STRANDS

Coastal dune systems with actively shifting sand consist of several community types, corresponding to three broad zones: the foredune, the interdune, and the backdune. The foredune is most exposed to onshore winds and salt spray and is typically dominated by *Ammophila breviligulata* (beach grass)* with few other species. The interdune is usually dominated by beach grass with a broader diversity of species. The more protected portions of the dune (backdune) are characterized by maritime (sunken) forests, shrub thickets, and interdunal swales. The beach grass and shrub thicket communities are treated in this section while the sunken forest (maritime forest on dunes) and interdunal swale communities are treated elsewhere in the document. The two primary physical processes that produce these different communities are (1) the degree of exposure or protection to on-shore winds and therefore degree of sand stabilization, and (2) soil moisture.

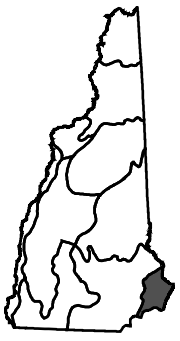
Inland beach strands occur only on Ossipee Lake in NH, where ice-push and wave action have created large berms around portions of the lakeshore. These berms are comprised of sand from the extensive sand plain in and around Ossipee Lake mixed with organic matter deposited by waves. Dry site and coastal plain species are characteristic.

OPEN COASTAL DUNE COMMUNITIES

• Beach grass grassland (S1)

GENERAL DESCRIPTION: This community is typically found on the foredune and other dune areas with 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 significant coastal dune systems (Coastal beach strand community (e.g., Odiorne State Park), where it may support a less diverse flora than that found on intact foredune communities.

CHARACTERISTIC VEGETATION: *Ammophila breviligulata* (beach grass)*, the dominant species, creates extensive colonies by spreading underground rhizomes. *Solidago sempervirens* (seaside goldenrod) is also usually abundant, and the rare *Hudsonia tomentosa* var. *tomentosa* (hairy hudsonia)* forms occasional, sometimes extensive, mats. Hairy hudsonia dominated areas may alternatively be described as a separate community type, although it is not as well developed in NH as elsewhere in the region. Other species include *Danthonia spicata* (poverty oat-grass), *Schizachyrium scoparium* (little bluestem), *Lathyrus japonicus* (beach pea), *Lechea maritima* (seabeach pinweed), *Polygonella articulata* (jointweed), and *Cyperus lupulinus* (perennial umbrella-sedge). Other rare species may include *Aristida tuberculosa* (sea-beach needlegrass)* and *Cyperus grayi* (Gray's umbrella-sedge)*.



CLASSIFICATION CONFIDENCE: 1

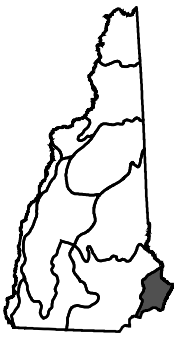
DISTRIBUTION: Mostly restricted to the Seabrook Dunes (a.k.a. The Sands) in Seabrook (NH Coastal Lowland subsection).

SOURCES: NHB field surveys; Dunlop et al. (1983); Dunlop and Crow (1983).

• Bayberry - beach plum maritime shrubland (S1)

GENERAL DESCRIPTION: This community is primarily found in the backdune but may also occur in small protected hollows in the interdune. Sandy soils are typically a bit more stable than those found in the foredune and exposed areas of the interdune. Recreational and developmental pressures continue to be a major threat to the viability of the dune system and its flora in the region, and particularly at NH's only example.

CHARACTERISTIC VEGETATION: This community is characterized by short to moderate height shrub thickets dominated by *Myrica pensylvanica* (northern bayberry) and *Prunus maritima* (beach plum). Other species include *Toxicodendron radicans* (climbing poison ivy), *Rosa virginiana* (Virginia rose), *Oenothera perennis* (small sundrops), *Achillea millefolium* (yarrow), and *Polygonum scandens* (large climbing false buckwheat). *Artemisia campestris* ssp. *caudata* (tall wormwood)* is occasionally found at the edge of these thickets. Other maritime-influenced shrublands in the seacoast region are dominated primarily by bayberry (without the beach plum) and may be a distinct variant or type.



CLASSIFICATION CONFIDENCE: 1-2

DISTRIBUTION: Restricted to the Seabrook Dunes (a.k.a. The Sands) in Seabrook (NH Coastal Lowland subsection).

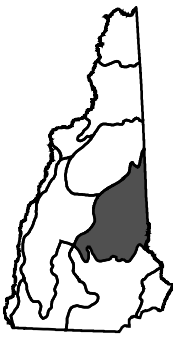
SOURCES: NHB field surveys; Dunlop and Crow 1985; Dunlop et al. (1983).

INLAND BEACH STRANDS

• Hudsonia inland beach strand (S1)

GENERAL DESCRIPTION: This community occurs only on Ossipee Lake in NH where ice-push and wave action have created large berms around portions of the lakeshore. These berms are comprised of sand from the extensive sand plain in and around Ossipee Lake mixed with organic matter deposited by waves. These berms are open, wind-blown sands with scattered shrubs and herbs that occur from 1-1.5m above late summer water levels. They are associated with several other regionally rare sandy pond shore communities that form narrow bands at different elevations along the shore line. Dry site and coastal plain species are characteristic.

CHARACTERISTIC VEGETATION: This community is characterized by a regionally rare assemblage of species that includes *Hudsonia tomentosa* var. *intermedia* (hairy hudsonia), *Hudsonia ericoides* (golden-heather)*, the rare hybrid *Hudsonia* x *spectabilis*, *Quercus ilicifolia* (scrub oak), and *Schizachyrium scoparium* (little bluestem). Other frequent and characteristic species include *Prunus pumila* var. *susquehannae* (dwarf cherry), *Vaccinium macrocarpon* (large cranberry), *Panicum virgatum* (switch-grass), *Gaylussacia baccata* (black huckleberry), *Aronia melanocarpa* (black chokeberry), *Lechea intermedia* (pinweed), *Danthonia spicata* (poverty oat-grass), *Juniperus communis* var. *depressa* (ground juniper), *Panicum boreale* (purplish northern panic-grass), *Panicum clandestinum* (deertongue). An interrupted canopy of trees may be present, including *Pinus rigida* (pitch pine), *Acer rubrum* (red maple), and *Betula populifolia* (gray birch).



CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: Found only around the margins of Ossipee Lake at several locations, including Ossipee Lake Natural Area (Ossipee). This community may occur on the shores of sandy lakes in adjacent areas of Maine.

SOURCES: NHB field surveys; Sperduto 1994b; Sperduto 2000c.

WOODED UPLANDS

Variation within wooded uplands (>25% tree cover) in New Hampshire can be related to major forest regions or zones. At a continental scale, the Boreal Forest biome intersects with the Eastern Deciduous Forest biome in New Hampshire. At the finer New England regional scale a distinct transition or "tension" zone emerges between the two biomes that is expressed both latitudinally and elevationally. This pattern of three major units in New England is described and referred to variously as forest formations, regions, or zones by different authors (i.e., Westveld et al. 1956; Bormann et al. 1970; Cogbill and White 1991; Cogbill et al. 2002). In this classification, we break this gradient into three zones in a way that emphasizes the extremes and facilitates organizing wooded upland communities in a practical way for New Hampshire. These zones are: 1) a spruce - fir zone, characterized by northern conifers, 2) a transition zone that includes northern hardwoods and transition hardwood - conifer forests, and 3) an oak - pine zone, characterized by central or Appalachian hardwoods that mix with pines. Each of these zones is described in more detail preceding the set of communities that correspond to them.

Within and throughout these three zones, various surficial landscape features exert important influences on the distribution of vegetation and natural communities. Landforms such as rocky ridges (shallow to bedrock areas with abundant rock outcrops), talus slopes, and glacial till each influences the vegetation in a significant way.

SPRUCE - FIR ZONE

Spruce - fir forests are conifer-dominated forests of cool climates. In New Hampshire, they occur in both high elevation and low elevation settings (sometimes referred to as montane spruce - fir to emphasize differences with boreal spruce - fir further north). High elevation spruce - fir forests in New Hampshire typically occur between 762 m (2500 ft.) and 1490 m (4890 ft.) elevation (Leak and Graber 1974; Cogbill and White 1991). Spruce - fir forests also occur at lower elevations in situations influenced by cold-air drainage (Cogbill and White 1991), on shallow or poorly drained soils (Flaccus 1959; Leak 1982; Cogbill and White 1991), and on deep, coarse valley bottom sediments. These "inverted" spruce - fir forests, located elevationally below northern hardwoods, are often associated with lake basins, streamsides, river and kame terrace sediments, and peatlands.

Spruce - fir forests in New England are transitional between the transcontinental boreal forest to the north and high-elevation spruce - fir forests of the Appalachian Mountains to the south. Montane spruce - fir forests in New England differ from the northern boreal forest both climatically and floristically. The various spruce - fir forest communities in New England support a vascular flora of approximately 280 species (20 more than boreal forests), 25 of which are ubiquitous (Cogbill 1987). Eighty-seven species of vascular plants and 26 species of mosses and lichens were identified in this community complex in the Nancy Brook RNA (Royte et al. 1996). A number of species prominent in montane spruce - fir forests of New England have Alleghanian distributions, which includes the glaciated northeastern United States, Great Lake states, and adjacent southern Canadian provinces, with a southern extension along the Appalachians. Species with Alleghanian distributions include *Picea rubens* (red spruce), *Betula papyrifera* var. *cordifolia* (heartleaf birch), *Betula alleghaniensis* (yellow birch), *Pinus strobus* (white pine), *Populus grandidentata* (big-toothed aspen), *Acer spicatum* (mountain maple), and *Acer pensylvanicum* (striped maple). All of these species are absent in the transcontinental boreal forest. The dominant red spruce trees of montane forests are replaced by black spruce (*Picea mariana*) and white spruce (*Picea glauca*) in the boreal forest, and heartleaf birch of montane forests is replaced by *Betula*

papyrifera var. *papyrifera* (paper birch) to the north. *Abies balsamea* (balsam fir) occurs in both forest regions. Deciduous shrubs and trees tend to be more prevalent in montane spruce - fir forests than in boreal forests to the north (La Roi 1967).

Fire and insect dieback are major disturbance factors in the boreal forest (Cogbill 1985). In contrast, montane spruce - fir forests lack significant large-scale (large area) fires and frequent fire return intervals. They are instead characterized by large blow-down disturbances resulting from periodic hurricanes and smaller-scale, single-tree mortality phenomena (Reiners and Lang 1979; Foster and Reiners 1983). Small-scale fires, probably of both natural and human origin, are occasional in the White Mountains and have longer natural return intervals compared to boreal forests. Cloud intercept is significantly higher than in hardwood forests at lower elevations.

Balsam fir and paper birches are generally more successful gap colonizers than red spruce, with their fast-growing and short-lived characteristics. The average age of balsam fir is approximately 70 years, with older specimens occasionally reaching 130-140 years. Paper and heartleaf birches reach approximately 130 years. Red spruce can exceed 400 years of age.

The disturbance history of mountain spruce - fir forests appears to have substantial influence on their overstory and understory expression. Disturbances include harvesting, catastrophic windthrow (e.g., hurricanes), local patch windthrow, and fir-wave phenomena. Larger gap areas formed by these agents tend to regenerate even-aged canopies, sometimes heavily weighted towards a single species that had established regeneration in the understory or toward species able to colonize large areas rapidly from seed (e.g., heartleaf and paper birches). Herbaceous and bryophyte plant cover is closely correlated with light availability; canopy gaps tend to have greater understory plant cover, whereas dense, closed canopies tend to reduce it. Ground surface cover of mosses and liverworts appears to be closely correlated with high moisture availability and moderate light levels (e.g., a more open canopy may produce drier conditions that impede bryophyte growth). In regenerating stands, bryophyte and herbaceous plant cover may be limited by some combination of high canopy density and high litter accumulation from windthrow-debris and hardwood leaf-litter production (i.e., in birch-colonized gaps). In contrast, the multi-aged, multi-sized, and multi-layered woody vegetation structure (including dead woody material in various stages of decomposition) that is found in many old-growth stands tends to support a correspondingly more varied ground cover. In the Nancy Brook RNA, moss and liverwort cover was more abundant in old-growth spruce - fir and higher elevation balsam fir ("scrub") forests than in younger, more recently disturbed spruce - fir forests (Royte et al. 1996).

Spruce - fir forests (particularly red spruce) have been widely noted as being subject to decline as a result of acid deposition, or "acid rain." The mechanisms for this have been variously attributed to reduced frost hardiness, nitrogen-saturation (with a resulting short-term elevation of nitrogen levels and subsequent loss from the system), depletion of soil calcium levels, and other contributing factors.

Four upland spruce - fir communities are described in this section. Two high elevation types (high elevation spruce - fir forest and balsam fir forests) are based on the general pattern of increasing prominence of balsam fir and heartleaf birch with increasing altitude, and a corresponding decrease in prominence of yellow and paper birches characteristic of the northern hardwood forests below. The third and fourth types are lowland spruce - fir forest and black spruce - red spruce forest that generally occur from low to mid elevations below northern hardwood forests.

SPRUCE - FIR FORESTS

• High-elevation spruce - fir forest (S4)

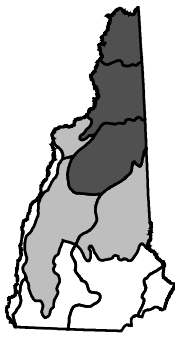
GENERAL DESCRIPTION: High-elevation spruce - fir forests are found from 2500-3500 ft. in elevation on upper mountain slopes and ridgetops in New Hampshire. It occurs locally lower on ridges and other infertile sites, and locally higher on relatively protected sites (e.g., ravines). The composition of these forests appears to be much influenced by the disturbance history, and to a lesser extent by soils and elevations within the zone. Variation in species composition does appear to occur along a moisture gradient. In drier conditions the community has more heaths and other dry-site species (transitional to the red spruce - heath - cinquefoil rocky ridge community on shallow-to-bedrock sites); and in moister conditions it has greater bryophyte cover. This community is generally found from 2500-3500 ft. in elevation (locally higher and lower). Characteristic birds include arctic three-toed woodpecker, black-backed woodpecker, spruce grouse, black poll warbler, yellow-rumped warbler, boreal chickadee, and others.

Soils 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 high-elevation spruce - fir forest. 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.

CHARACTERISTIC VEGETATION: Woody tree species include various combinations of red spruce, balsam fir, and heartleaf, paper, and yellow birches. Common understory plants shared with northern hardwood forests include *Dryopteris intermedia* (intermediate wood fern), *D. campyloptera* (spinulose wood fern), *Oxalis acetosella* (northern wood sorrel), *Huperzia lucidula* (shining clubmoss), *Trientalis borealis* (starflower), *Maianthemum canadense* (Canada mayflower), *Clintonia borealis* (blue-bead lily), and *Phegopteris connectilis* (long beech fern). Plants more restricted to or more abundant in spruce - fir forests include *Cornus canadensis* (bunchberry), *Linnaea borealis* (twinflower), *Amelanchier bartramiana* (Bartram's serviceberry), *Coptis trifolia* (goldthread), *Sorbus decora* and *S. americana* (mountain ashes), *Picea mariana* (black spruce), *Nemopanthus mucronatus* (mountain holly), *Vaccinium myrtilloides* (velvet-leaf blueberry), and *Gaultheria hispidula* (creeping snowberry). The woody understory is usually sparse. Mosses and liverworts are often abundant and commonly include *Bazzania trilobata, Dicranum scoparium, Hypnum curvifolium, Pleurozium schreberi*, and *Ptilium crista-castrensis*. Others bryophytes include *Brotherella recurvans, Bazzania denudata, Scapania nemoria, Drepanocladus uncinatus, Pohlia nutans, Sphagnum russowii, S. girgenshonii,* and others. The bryophyte floras of coastal and montane spruce - fir forests are very different, with numerous species restricted to one type. In contrast, there are only minor differences among vascular plants. Potential rare species of spruce - fir forests include *Listera cordata* (heart-leaved twayblade)*, *L. convallarioides* (lily-leaved twayblade)*, and *Geocaulon lividum* (northern comandra)*.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Primary distribution is in the White Mountain, Mahoosuc-Rangeley Lake, and Connecticut Lake subsections, and locally at higher elevations of central/south-central New Hampshire subsections. Good examples include Nancy Brook RNA (Livermore), The Bowl RNA (Waterville Valley), Jennings Peak/Dry Brook (Waterville Valley), and Whaleback Mtn. (Lincoln).



SOURCES: NHB field surveys; Pease 1964; Cogbill and White 1991; Royte et al. 1996.

• High-elevation balsam fir forest (S3S4)

General description: At higher elevations within the spruce - fir zone there is a transition to *Abies balsamea* (balsam fir) dominance and absence or lower abundance of *Picea rubens* (red spruce) and *Betula papyrifera* var. *cordifolia* (heartleaf birch). The canopy height here is typically in the 2-10 m range, reduced from the taller stature trees at lower elevations (which grow to 20-25 m height). These short trees ultimately diminish to krummholz stature (<2 m) at treeline.

On average, high-elevation balsam fir forests in New Hampshire occur between approximately 3500 and 4500 ft. in elevation, where the transition to black spruce/balsam fir krummholz or heath/krummholz occurs. The range varies considerably with topography and exposure, with the upper limit occurring as low as ~3500 ft. on exposed ridges and summits, or as high as 5200 ft. in more protected valleys or cirques. Pease's (1964) concept of balsam fir "scrub" probably includes both krummholz and the upper portion of balsam fir forest zone where the fir trees are scrubby in nature and of low stature from about 4200-4500 ft. in elevation.

Higher elevation fir forests are often characterized by patches of wind-induced mortality known as "fir-waves." Fir waves are linear patches of blowdown 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.

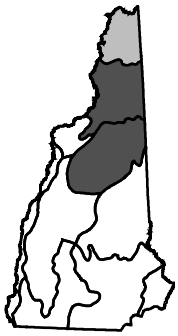
Certainly some or many of these natural communities in the White Mountains are "virgin" in a strict sense, although their age structure and dynamics are poorly understood and studied. Balsam fir typically declines and dies after 70 years, often as a result of fir-wave phenomena. Tree cores of "scrub" fir indicate higher maximum ages, with some trees attaining 90-140 or more years.

Soils 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 is of low nutrient quality and contributes to organic matter accumulation. Cloud-intercept contributes a significant amount of moisture to the high-elevation spruce - fir zone, especially in this higher elevation balsam fir forest. 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.

High elevation balsam fir forests may grade into black spruce/balsam fir krummholz, red spruce - heath - cinquefoil rocky ridge, alpine/subalpine communities, or heath - krummholz communities.

Characteristic vegetation: Balsam fir is the dominant tree. Heartleaf birch and red spruce are occasional but are often sparse or absent at higher elevations. *Picea mariana* (black spruce) is occasional at higher elevations. Moss and liverwort cover can be quite high (as much as 80-100%), forming a deep, spongy carpet over thick (9-20+ cm) organic humus. Dominant bryophyte species include *Bazzania trilobata*, *Mylia taylori*, *Hypnum imponens*, and *Dicranum scoparium*. *Cladonia* spp. and other lichens are present on ground surfaces, tree roots, stems, lower branches and decaying logs. These moist moss carpets sometimes form a natural habitat for the rare *Listera cordata* (heart leaved twayblade)*. The herb and shrub layer may be sparse, but is usually characterized by some combination of shrubs including *Sorbus decora* (showy mountain ash), *Nemopanthus mucronatus* (mountain holly), *Vaccinium myrtilloides* (velvet-leaf blueberry), *Gaultheria hispidula* (creeping snowberry), *Dryopteris campyloptera* (mountain wood fern), *Streptopus roseus* (rosey twisted stalk), *Coptis trifolia* (goldthread), *Mitella nuda* (naked miterwort), *Linnaea borealis* (twinflower), and a low diversity of herbs including *Oxalis acetosella* (northern wood sorrel), *Trientalis borealis* (starflower), *Clintonia borealis* (blue-bead lily), and *Maianthemum canadense* (Canada mayflower). Pease (1964) also notes that in sheltered openings of this community other species may be encountered, including *Lycopodium annotinum* (stiff clubmoss), *Ribes lacustre* and *R. glandulosum* (wild-currents), *Kalmia angustifolia* (sheep laurel), *Ledum groenlandicum* (Labrador-tea), *Rhododendron canadense* (rhodora), *Vaccinium uliginosum* (alpine bilberry),

V. caespitosum (bilberry), *V. angustifolium* (lowbush blueberry), *V. vitis-idaea* (mountain cranberry), and *Solidago macrophylla* (large-leaved goldenrod). Potential rare species of spruce - fir forests include *Listera cordata* (heart-leaved twayblade)*, *L. convallarioides* (lily-leaved twayblade)*, and *Geocaulon lividum* (northern comandra)*.



CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Balsam fir forests are found from approximately 3500-4500 ft. (occurs as high as 4900 ft.) elevation throughout the White Mountains, with locally higher or lower limits depending on exposure. Most peaks above 3500 ft. in NH have decent examples.

SOURCES: NHB field surveys; Pease 1964; Cogbill and White 1991; Sneddon and Metzler 1992; Royte et al. 1996; Sperduto and Cogbill 1999.

• Montane black spruce - red spruce forest (S1)

GENERAL DESCRIPTION: This is an uncommon to rare forest type in New Hampshire, characterized by mixtures of black and red spruce that form on poorly to moderately well drained soils. It occurs in the North Country and as the dominant matrix community around certain unique heathlands and sloping and level fens restricted to mid- to high-elevation valley bottoms from about 2500-3000 ft. elevation in the White Mountains. Compared to black spruce - larch swamps, it occurs on mineral soil, has a lower abundance of heaths, and a broader diversity of shrubs and conifers.

Known examples from the upper Pemigewasset River valley have formed on glacio-lacustrine deposits with a significant silt component, and have a moderately shallow organic layer. These are cryic soils (the coldest soil temperature regime in NH). The silt component in the mineral soil impedes drainage, contributing to a higher moisture status. The cold air-drainage positions of these mid- to high-elevation valleys also contribute to the cold, nutrient-poor conditions. Examples in the North Country occur on firm, gravelly silt loams with a histic epipedon (shallow organic layer).

CHARACTERISTIC VEGETATION: *Picea mariana* (black spruce) and *Picea rubens* (red spruce) are the dominant trees, apparently mixing freely in various combinations. *Abies balsamea* (balsam fir) is less abundant or locally absent. Characteristic species common to other spruce - fir communities include *Osmunda cinnamomea* (cinnamon fern), *O. claytoniana* (interrupted fern), *Kalmia angustifolia* (sheep laurel), *Ledum groenlandicum* (Labrador-tea), *Gaultheria hispidula* (creeping snowberry), *Cornus canadensis* (bunchberry), *Amelanchier bartramiana* (Bartram's serviceberry), and various bryophytes.

CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: This type is documented from the silty glacio-lacustrine sediment areas in the upper East Branch Pemigewasset River valley in the White Mountains (2500-3000 ft. elevation), the North Country, and possibly the Cypress Brook drainage. It potentially occurs in similar situations elsewhere in northern New Hampshire on lower to middle mountain slopes or valley bottoms with silty or hardpan (densipan) soils. Good examples can be found in the vicinity of Ethan Pond and Shoal Pond (Livermore).

SOURCES: NHB field surveys; Sperduto and Engstrom 1995.

• Lowland spruce - fir forest (S3)

GENERAL DESCRIPTION: Lowland spruce - fir forests generally occur below northern hardwood forests in valley bottom or stream drainage settings of northern New Hampshire. These "inverted" conifer forests are influenced

by some combination of the cold northern climate, cold-air drainage in depressions and river valleys, imperfect soil drainage, and otherwise well drained but nutrient poor soils. The composition of lowland spruce - fir forests often varies in a complex way on the landscape in response to differences in drainage class, which ranges from somewhat poorly to well drained conditions. Wetland plants are frequent at the wetter end of this gradient, but are not as ubiquitous or abundant as in spruce - fir swamps. Lowland spruce - fir forests are often associated with spruce - fir swamps and open peatlands.

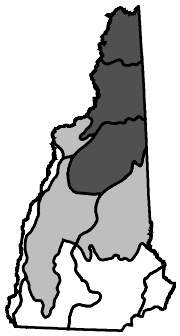
Spruce budworm infestations are a major disturbance factor in this community in extreme northern New Hampshire, occurring on 40-70 year cycles. Windthrow is also a major disturbance factor, although the frequency and intensity of windthrow may be less than in the high-elevation spruce - fir forest community.

Soils are poor to very nutrient poor and are derived from ice-contact deposits, glacio-fluvial sediments in flat valleys deposited behind ice-dams or on lake-bottoms, river terraces, and glacial tills. Silty, compact basal tills with impeded drainage are frequent north of the White Mountains, often associated with low-grade pellite bedrock. Coarse, well drained ice-contact deposits include outwash, esker, and kame features. In the White Mountains region it occurs mostly on till derived from siliceous igneous or metamorphic bedrock (e.g., granite or schist). Sites north of the White Mountains generally have a higher base saturation and, in combination with the more northern latitude and boreal climate, tend to support *Picea glauca* (white spruce).

Characteristic vegetation: The vascular species composition of lowland spruce - fir forests is similar to that found in high elevation spruce - fir forest, including most of the same understory herbaceous plants. *Picea rubens* (red spruce) and *Abies balsamea* (balsam fir) dominate in various combinations, with *Betula papyrifera* var. *papyrifera* (paper birch) and *B. alleghaniensis* (yellow birch) being common associates. *Betula papyrifera* var. *cordifolia* (heartleaf birch) is occasional, and *Tsuga canadensis* (hemlock) and *Pinus strobus* (white pine) are infrequent or absent (see hemlock - spruce - northern hardwoods). *Picea glauca* (white spruce) is characteristic north of the main core of the White Mountains, where it replaces white pine as an old-field species. *Populus tremuloides* (quaking aspen) and *Larix laricina* (eastern larch) are occasional. Species absent or uncommon in the high elevation spruce - fir that are occasional in this community include *Aralia nudicaulis* (wild sarsaparilla), *Acer pensylvanicum* (striped maple), *Trillium erectum* (wakerobin), and *Tiarella cordifolia* (foamflower). Characteristic species also found in high elevation spruce - fir include *Dryopteris campyloptera* (mountain wood fern), *D. intermedia* (intermediate wood fern), *Cornus canadensis* (bunchberry), *Linnaea borealis* (twinflower), *Amelanchier bartramiana* (Bartram's serviceberry), *Coptis trifolia* (goldthread), *Sorbus decora* and *S. americana* (mountain ashes), *Picea mariana* (black spruce), *Nemopanthus mucronatus* (mountain holly), *Vaccinium myrtilloides* (velvet-leaf blueberry), and *Gaultheria hispidula* (creeping snowberry). The woody understory is usually sparse. Mosses and liverworts can be abundant and include *Bazzania trilobata, Dicranum scoparium, Hypnum curvifolium, Pleurozium schreberi*, *Ptilium crista-castrensis, Brotherella recurvans, Bazzania denudata, Scapania nemoria, Drepanocladus uncinatus, Pohlia nutans, Sphagnum russowii, S. girgenshonii,* and others. Potential rare plants include *Listera cordata* (heart-leaved twayblade)* and/or *L. convallarioides* (lily-leaved twayblade)* in moist or seepy mossy areas.

Classification confidence: 1

Distribution: Found at low to mid elevations (generally below 2500 ft.) in northern New Hampshire (in the White Mountain, Mahoosuc-Rangeley Lakes, and Connecticut Lakes subsections) on valley bottom and lower till side-slope settings. Also found locally in adjacent subsections to the south in valley bottoms. Good examples occur near Norton Pool (Pittsburg), Spruce Brook/Upper Ammonoosuc River (Kilkenny), Elbow Pond (Woodstock), and Big River (Barnstead).



Sources: NHB field surveys; Baldwin et al. *in* Lyon 1971.

WOODED TALUS SLOPES

• Spruce - birch - mountain maple wooded talus (S3)

GENERAL DESCRIPTION: This community consists of talus slopes of New Hampshire's middle and higher elevations that are characterized by spruce, fir, and various other northern species. The exposed, higher elevation situations exclude species more characteristic of central and southern New Hampshire. This community tends to have an open woodland character, with frequent or large canopy gaps and lichen dominated talus barren openings. Talus gorges and slopes occur as inclusions in low to mid-slope till landscapes of low to high mountains.

Talus slopes are derived from acidic or intermediate bedrock yielding acidic soil conditions. Soil development is variable, and moisture conditions range from dry to mesic. Large talus slopes may have subsurface cold-air drainage and late-melting ice at their base that produce a colder and moister microclimate.

CHARACTERISTIC VEGETATION: Characteristic dominant or frequent trees include *Picea rubens* (red spruce), *Abies balsamea* (balsam fir), *Betula papyrifera* var. *papyrifera* (paper birch), *B. papyrifera* var. *cordifolia* (heartleaf birch), *B. alleghaniensis* (yellow birch), *Sorbus americana* or *S. decora* (mountain ashes), and *Acer spicatum* (mountain maple). Herbs and shrubs include species typical of many talus communities including *Polypodium virginianum* (rock polypody), *Parthenocissus quinquefolia* (Virginia creeper), *Polygonum cilinode* (fringed bindweed), *Ribes glandulosum* (skunk currant), *Vaccinium angustifolium* (lowbush blueberry), and *Deschampsia flexuosa* (common hair-grass), as well as species preferential to northern or higher elevation areas such as *Vaccinium myrtilloides* (velvet-leaf blueberry), *Solidago randii* (Rand's goldenrod), *Juncus trifidus* (highland rush), *Vaccinium vitis-idaea (*mountain cranberry*), Clintonia borealis* (blue-bead lily), and numerous others. Mosses and lichens are often present but have not been specifically studied or documented.

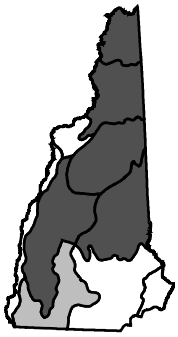
VARIANTS: There are two variants described here. Typic variant occurs on mid to upper talus slope positions and on more southerly aspects; the mossy cold-air variant often occurs on lower portions of large talus slopes or in deep talus gorges or ravines. Examples of both variants are found in the deep talus gorge of Ice Gulch. Here the typic variant occurs on the south facing slope, the mossy cold-air variant occurs on the north facing slope, and a subalpine cold-air talus barren community occurs at the base of the talus (where the coldest microclimate occurs).

1. **Typic variant**: The typic variant occurs on mid and upper talus slope positions and ranges from dry to mesic conditions and typically southerly to western exposures. It is usually less densely vegetated by bryophytes and vascular plant ground cover. A disjunct, low elevation cold-air talus slope on Mt. Wantastiquet in Hinsdale (1200 ft.) closely approximates this typic variant, otherwise it is apparently restricted to higher elevations further north.
2. **Mossy cold-air variant**: This variant has refrigerator- to truck-sized talus boulders at the bases of major talus slopes or in deep, talus-filled gorges at moderate elevations and is influenced by late-melting ice and cold-air drainage. This produces a cold montane microclimate that supports a spruce and fir community far below the average lower elevation limit of mountain spruce - fir (similar to elevation range of lowland spruce - fir). This variant occurs in association with the subalpine cold-air talus barren community at a few sites. Documented examples occur at elevations ranging from 700-2200 ft. This variant has a woodland to open forest tree canopy structure characterized by *Picea rubens* (red spruce), *Abies balsamea* (balsam fir), *Tsuga canadensis* (hemlock), *Betula papyrifera* var. *papyrifera* (paper birch), and *B. alleghaniensis* (yellow birch). *Picea mariana* (black spruce) may also be present in some areas. A lush carpet of mosses and *Polypodium virginianum* (rock polypody) often festoon the large boulders and fallen logs. Bryophytes include *Hylocomium splendens* (moss) and *Bazzania trilobata* (liverwort), although many other species are undoubtedly present. Characteristic shrubs and herbs include *Ledum groenlandicum* (Labrador-tea), *Gaultheria hispidula* (creeping snowberry), *Vaccinium angustifolium* (lowbush blueberry), *Polypodium virginianum* (rock polypody), *Ribes* spp. (gooseberries and currents), and *Mitella nuda* (naked miterwort). Rare species may include *Listera convallarioides* (lily-leaved twayblade)*, *Galium kamtschaticum* (northern wild licorice)*,

and historic reports of *Epilobium hornemannii* (Hornemann's willow-herb)* and other subalpine plants (Pease 1964).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: The typic variant is generally restricted to central and northern New Hampshire (in Sunapee Uplands, the three northern subsections, and possibly Sebago-Ossipee subsection) at elevations above 2200 ft., but may occasionally be found down to 1500 ft. The low elevation cold-air talus variant is restricted to the White Mountain subsection and proximal areas of adjacent subsections. Good examples of the typic variant occur on Cannon Mountain (Franconia Notch), Whitewall Mountain (Zealand Notch), and Lost River Gorge (Woodstock). Good examples of the low elevation cold-air talus variant occur at Devil's Hopyard (Stark), Ice Gulch (Randolph), and at the base of Rattlesnake Mountain (Rumney).



SOURCES: NHB field surveys; Mohlenbrock 1987.

• Subalpine cold-air talus barren (S1)

GENERAL DESCRIPTION: This rare talus community is typically found at the base of large talus slopes and is profoundly influenced by ice-cooled air moving over late-melting ice beneath the talus and perhaps downslope drainage of cold air over and through the talus from above. Even on hot mid-summer days, cold air can be felt rushing out from under the talus. The subalpine microclimate supports black and red spruce, heaths and evergreen shrubs, and lichen and mosses characteristic of alpine and montane habitats. Elevations are significantly lower than alpine and subalpine communities on mountain summits of the region.

Ice forms and persists late into the summer beneath large boulder talus. Late snow and ice melt shortens the effective growing season, reduces average yearly temperatures, and influences the development of soils and vegetation. Soils vary from open rock to shallow or moderately well developed peaty duff layer. Soils are very nutrient-poor (oligotrophic).

This community is quite distinct and well defined but similar to, if not synonymous with, subalpine heath/krummholz communities. Areas of talus in deep mountain ravines with boreal but few subalpine shrubs are presently treated as boreal cold-air talus communities (e.g., Devil's Hopyard and Ice Gulch).

Communities associated with late-melting ice of southern New Hampshire talus slopes are not considered to be this community type and may best be described as disjunct southern occurrences of boreal cold-air talus or spruce - birch/mountain maple talus (e.g., Mt. Wantastiquet in Hinsdale).

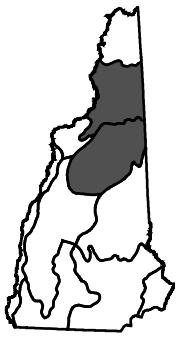
CHARACTERISTIC VEGETATION: Characteristic vegetation includes a sparse, stunted tree canopy (generally <10-20 ft.) composed of *Picea mariana* (black spruce) and/or *P. rubens* (red spruce), and lesser amounts of *Betula papyrifera* var. *cordifolia* (heartleaf birch), *Sorbus americana* (American mountain ash), and *Abies balsamea* (balsam fir). The shrub layer is well-developed and comprised of short or ground-hugging species ranging in height from less than 20 cm to 50 cm or more in some areas. Characteristic species include *Ledum groenlandicum* (Labrador-tea), *Kalmia angustifolia* (sheep laurel), *Empetrum nigrum* (black crowberry)*, *E. atropurpureum* (purple crowberry)*, *Vaccinium vitis-idaea* (mountain cranberry), *V. uliginosum* (alpine bilberry), *V. myrtilloides* (velvet-leaf blueberry), *V. angustifolium* (early low blueberry), and infrequently *Rhododendron canadense* (rhodora) and *Gaultheria hispidula* (creeping snowberry). Mosses and lichens are abundant but not well documented to the species level. Herbaceous species are notably sparse or absent. Crevice or ledge species may grow nearby on otherwise unvegetated large talus blocks or bedrock exposures including *Paronychia argyrocoma* (silverling)* and *Juncus trifidus* (highland rush). Topics worthy of research include local and

microclimate patterns and the relationship of this community to similar floristics of boreal heath barrens and subalpine heathland communities.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Limited to the White Mountain subsection on mid to lower slope positions of ravines and bases of large cliffs and notches. Elevations of known examples range from 2300-3400 ft. Good examples of this community can be found at Cannon Mtn. (Franconia), Zealand Notch (Lincoln), the Ramparts of Carter Notch (Bean's Purchase), King Ravine (Low & Burbanks Grant), and Castle Ravine (Low & Burbanks Grant).

SOURCES: NHB field surveys.



WOODED ROCKY RIDGES AND OUTCROPS

• Red spruce - heath - cinquefoil rocky ridge (S3S4)

GENERAL DESCRIPTION: This is a woodland community found on rocky ridgelines in the mountainous regions of New Hampshire with shallow soils and frequent canopy openings and outcrops. It occurs from 1700-3000 ft. elevation and is characterized by *Picea rubens* (red spruce), heath shrubs and herbs, lichens and *Potentilla tridentata* (three-toothed cinquefoil). This community lacks both Appalachian or southern plants, and alpine or subalpine plants. The tree canopy is moderately short (10-30 ft. tall), and ranges from a woodland structure (25-60% cover) with small glade-like openings and sparsely-treed rock outcrops (generally 25-50% rock cover), to larger open barrens of several acres or more with extensive outcrops.

Soils are thin, dry, and acidic mineral soils with a shallow O horizon over coarse gravelly or sandy A and B horizons or bedrock. Most examples occur on acidic bedrock or occasionally on intermediate bedrock.

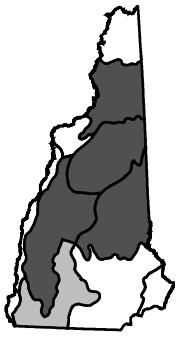
This community transitions to oak - pine rocky ridge woodlands at lower elevations and sheep laurel - Labrador tea heath - krummholz at higher elevations. Jack pine rocky ridge woodlands are floristically similar to this community.

CHARACTERISTIC VEGETATION: This dry, conifer woodland has a dense low heath shrub layer, abundant lichens and mosses on outcrops, and a sparse herb layer including various crevice-loving herbs and grasses. Many of these species and characteristics also occur in other rocky ridge communities. The woodland tree canopy is dominated by *Picea rubens* (red spruce). *Abies balsamea* (balsam fir) is occasional and sometimes codominant and *Pinus resinosa* (red pine) is frequent but not dominant. Other trees may include *Betula papyrifera* var. *papyrifera* (paper birch), *B. papyrifera* var. *cordifolia* (heartleaf birch), *Pinus strobus* (white pine), and *Sorbus* spp. (mountain ashes). *Quercus rubra* (red oak) is occasional only at lower elevation transitions to other communities. A prominent low heath shrub layer is dominated by *Vaccinium angustifolium* (lowbush blueberry), with variable amounts of *V. myrtilloides* (velvet-leaf blueberry) and *Kalmia angustifolia* (sheep laurel). *Rhododendron canadense* (rhodora) is also occasional, particularly in moister microhabitats. Tall shrubs are generally sparse but may include *Amelanchier bartramiana* (Bartram's serviceberry) and *Viburnum nudum* (witherod) in more protected areas. Herbs are relatively sparse to locally abundant and may include *Deschampsia flexuosa* (common hair-grass), *Solidago randii* (Rand's goldenrod), *Potentilla tridentata* (three-toothed cinquefoil), *Aralia hispida* (bristly sarsaparilla), *Danthonia spicata* (poverty oat-grass), and *Maianthemum canadense* (Canada mayflower). The rare *Paronychia argyrocoma* (silverling)* may be found in cracks of open ledges. Lichens and mosses are common, including an abundance of *Cladonia rangiferina* (reindeer lichen) and *Polytrichum* spp. (haircap mosses), but are poorly documented.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Found primarily on cold, dry, acidic northern rocky ridges, summits, or other shallow to bedrock slopes at elevations 1700-3000 ft. in the White Mountain region, and other mid-high elevation ridges in central and southern New Hampshire. Good examples occur on Mt. Monadnock (Jaffrey), Grantham Mtn. (Grantham), North and South Baldface Mtns. (Chatham), Peaked Mtn. (North Conway), and Percy Peaks (Stark).

SOURCES: NHB field surveys; Baldwin 1974; Baldwin 1977; Bormann and Likens 1979; Sperduto and Cogbill 1999.



• Montane heath woodland (S2)

GENERAL DESCRIPTION: Montane heath woodlands are characterized by a woodland to shrubland structure with short- to moderate-height spruce and fir trees and a robust shrub layer consisting of heaths and other montane shrubs. They are found on mesic to wet-mesic sites on exposed, high-elevation (2500-4000 ft.) flat or gently sloping ridges, on slopes near the transition to subalpine heath - krummholz and subalpine bogs in the White Mountains. Soils are shallow peat over bedrock or silty gravel. Some occurrences are associated with historic fires.

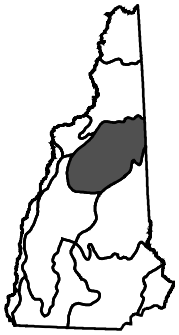
The community occurs in several locations at the transition to subalpine communities and in association with montane sloping fens in the upper Pemigewasset River valley. It is distinguished from subalpine heath snowbanks by a lack of subalpine species, a taller woodland structure (trees >2 m), and a robust (0.4-1.5 m tall) shrub layer. Also, it is distinguished from red spruce - heath - cinquefoil rocky ridge by more mesic (wet-mesic) conditions, shallow peaty soils, fewer bedrock outcrops, and a more robust heath layer.

CHARACTERISTIC VEGETATION: Trees in the sparse woodland canopy include *Picea mariana* (black spruce) and/or *P. rubens* (red spruce) and *Abies balsamea* (balsam fir). A well-developed, medium to tall heath shrub layer is characterized by *Rhododendron canadense* (rhodora), *Nemopanthus mucronatus* (mountain holly), *Ledum groenlandicum* (Labrador-tea), *Kalmia angustifolia* (sheep laurel), and *Viburnum nudum* (witherod). *Alnus incana* (speckled alder) is absent or in low abundance in this natural community.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community occurs in several locations in the White Mountains at elevations ranging from 2500-4000 ft. Good examples include Zealand Ridge (Lincoln), Shoal and Ethan Pond vicinity (Bethlehem and Lincoln), North Bald Cap (Success), and the transition zone to the subalpine zone on several peaks (e.g., Mt. Chocorua and the Baldfaces).

SOURCES: NHB field surveys.



• Jack pine rocky ridge woodland (S1)

GENERAL DESCRIPTION: Only a few acidic rocky summits at moderately high elevations in the White Mountains support populations of *Pinus banksiana* (jack pine)*, a boreal tree that reaches its southern, disjunct limit in New Hampshire. This woodland occurs on mid to high elevation (1800-3900 ft.) mountain ridges in the White Mountains and 1250 ft. elevation on lakeside ledges in the North Country. Lakeshore occurrences with abundant jack pine are included in this community type. Floristically, this community is similar to red pine- and red spruce-dominated woodlands. It is considered distinct from them due to differences in dominant tree species as well as probable differences in ecological histories and circumstances that contribute to the apparently

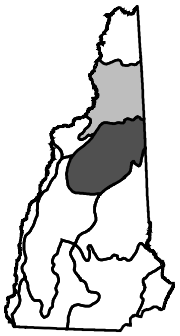
different "steady states" found on rocky ridges in the White Mountains.

Soils are thin, dry, acidic mineral soils with a shallow O horizon over bedrock or over coarse gravelly or sandy horizons. All examples occur on bedrock that has weathered to produce acidic soils.

CHARACTERISTIC VEGETATION: Jack pine is abundant in combination with *Picea rubens* (red spruce), *Pinus resinosa* (red pine), *Abies balsamea* (balsam fir), *Betula papyrifera* var. *cordifolia* (heartleaf birch), and *B. papyrifera* var. *papyrifera* (paper birch). A low heath shrub layer is characterized by *Vaccinium angustifolium* (lowbush blueberry), *V. myrtilloides* (velvet-leaf blueberry), and *Kalmia angustifolia* (sheep laurel). Tall shrubs are generally sparse but may include *Amelanchier bartramiana* (Bartram's serviceberry) and *Viburnum nudum* (witherod). Herbs are relatively sparse to locally abundant and may include *Deschampsia flexuosa* (common hair-grass), *Solidago randii* (Rand's goldenrod), *Potentilla tridentata* (three-toothed cinquefoil), *Danthonia spicata* (poverty oat-grass), and *Maianthemum canadense* (Canada mayflower). Rare species other than jack pine may include *Paronychia argyrocoma* (silverling)* and *Minuartia glabra* (smooth sandwort)*.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Occurs on shallow-to-bedrock landscapes of mid to high elevation (1800-3900 ft.) mountain ridges in the White Mountain subsection, and ledgy lakeside woodlands of Lake Umbagog in the Mahoosuc-Rangeley Lakes subsection (approximately 1250 ft. elevation). Good examples occur on Welch Mtn. (Waterville Valley), Carter Ledge (Albany), and at Lake Umbagog (Errol and Cambridge).



SOURCES: NHB field surveys; Baldwin 1979.

• Red pine rocky ridge (S2)

GENERAL DESCRIPTION: Red pine dominated forests and woodlands are most prominent on dry, montane rocky ridges, outcrops, and summits where acidic, nutrient-poor conditions prevail. Red pine stands are often even-aged and have park-like understories with a low heath shrub layer. Even-aged cohorts typically develop following an intense fire. This community is most common on southerly aspects, ranging from west to south to east, between 750-2700 ft. elevation. Typical examples consist of mosaics of open or partially vegetated rock outcrops interspersed with a scattered or patchy tree canopy. Rock exposures generally cover 25-50% of the ground surface. In some areas, particularly those with deeper soils or ones that have only a distant fire-history, red pine may form an essentially closed canopy. Red pine trees may exceed 60-70 ft (18-21 m) in height, but are, on average, shorter in woodland settings and at higher elevations. A closed forest canopy may form in the absence of fire for long periods or where soils are more well developed. Shade-intolerant species tend to be less abundant or absent in forested examples [e.g., *Corydalis sempervirens* (pale corydalis), *Potentilla tridentata* (three-toothed cinquefoil), *Deschampsia flexuosa* (common hair-grass), and *Danthonia spicata* (poverty oat-grass)].

Fire plays an important role in the formation and maintenance of this community, and controlled burns or wildfire may be required for substantial regeneration of red pine, whether or not harvesting is performed. Red pine can exceed 200 years of age, and its thick, platy bark affords mature trees some protection from fire when trees reach about 70 years of age. Younger trees have thinner bark and may not survive an intense fire.

Several native red pine forests occur in central New Hampshire on deep sandy kame terraces with very little bedrock exposure. These are classified as red pine - white pine - balsam fir forests. Red pine is less frequent in sand plain settings relative to montane outcrops. Although individual red pine trees may be found in southern New Hampshire, native stands are rare or absent. Some outcrops in other landscape positions, such as along rocky lake shores, exhibit similar vegetation and are included in this type.

Soils are thin, dry, and acidic with turfy (fibric) organic surface horizons and gravelly and/or coarse sand mineral layers over acidic to intermediate bedrock (oligotrophic).

This is a distinct, narrowly defined community that intergrades with other northern rocky ridge communities. It is considered distinct from the red oak and jack pine types due to differences in dominant tree species and probable differences in ecological histories or circumstances.

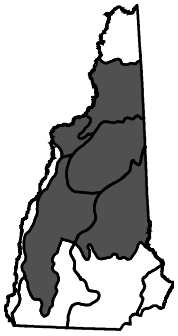
CHARACTERISTIC VEGETATION: *Pinus resinosa* (red pine) is dominant in the woodland canopy. Other tree species may include *Quercus rubra* (red oak) and *Pinus strobus* (white pine) at lower elevations (generally <1900 ft.), and *Picea rubens* (red spruce), *Betula papyrifera* var. *papyrifera* (paper birch), *B. papyrifera* var. *cordifolia* (heartleaf birch), and *Abies balsamea* (balsam fir) at higher elevations (above 1900 ft.). *Acer rubrum* (red maple) is occasional at low to middle elevations. A sparse or scattered tall shrub layer may be present, consisting of species such as *Amelanchier bartramiana* (Bartram's serviceberry), *Viburnum nudum* (witherod), *Sorbus americana* (American mountain ash), *Aronia arbutifolia* (red chokeberry), *Nemopanthus mucronatus* (mountain holly), and *Acer pensylvanicum* (striped maple). A low heath shrub layer is ubiquitous. Common shrubs include *Vaccinium angustifolium* (lowbush blueberry), *V. myrtilloides* (velvet-leaf blueberry), *Gaylussacia baccata* (black huckleberry), *Kalmia angustifolia* (sheep laurel), and *Diervilla lonicera* (bush honeysuckle). The herb layer is often sparse, but can occasionally be moderately dense, and includes such species as *Pteridium aquilinum* (bracken), *Deschampsia flexuosa* (common hair-grass), *Danthonia spicata* (poverty oat-grass), *Epigaea repens* (trailing arbutus), *Polypodium virginianum* (rock polypody), *Oryzopsis asperifolia* (rough-leaved rice-grass), *Corydalis sempervirens* (pale corydalis), *Carex lucorum* (distant sedge), and *Cypripedium acaule* (pink lady's-slipper). Mosses and lichens are typically abundant on rock outcrop areas.

VARIANTS: Two variants are described:

1. **Low elevation variant**: Lower elevation examples (ca. 900-2000 ft.) have a more frequent occurrence of southern species such as huckleberries, red oak, pink corydalis, trailing arbutus, *Solidago arguta* (northern toothed goldenrod), pink lady's slipper, *Gaultheria procumbens* (wintergreen), *Carex lucorum* (distant sedge), and *Oryzopsis pungens* (slender mountain rice-grass). This variant is more likely to contain such rarities as *Polygonum douglasii* (Douglas' knotweed)* and *Minuartia glabra* (smooth sandwort)*. It is floristically similar overall to the red oak - pine rocky ridge type.
2. **High elevation variant**: Northern species prevail at somewhat higher elevations (1900-2700 ft.), such as *Picea rubens* (red spruce), *Solidago randii* (Rand's goldenrod), *Potentilla tridentata* (three-toothed cinquefoil), *Sorbus americana* (American mountain ash), and *Amelanchier bartramiana* (Bartram's serviceberry). This variant is fairly similar floristically to the red spruce - heath - cinquefoil rocky ridge type.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Red pine approaches its southern limit in New Hampshire and this community is known only from middle elevations of 750-2700 ft. in the White Mountain, Sunapee Upland, and Sebago-Ossipee subsections. It is most common, and reaches its best development, between 1400 ft. and 2400 ft. in the White Mountains. Good examples are on Owls Head/ Blueberry Mtn. (Benton), Mt. Stanton (Bartlett), Iron Mtn. (Bartlett), Peaked Mtn. (Conway), and White's Pinnacle (East Haverhill).



SOURCES: NHB field surveys; Lyon 1971; Engstrom 1988; Carleton et al. 1996.

• Circumneutral rocky ridge (S1)

GENERAL DESCRIPTION: This is a rare community in New Hampshire, restricted to two locations where either base-rich or calcareous bedrock yields conditions suitable for calcicoles not found on rocky ridges comprised

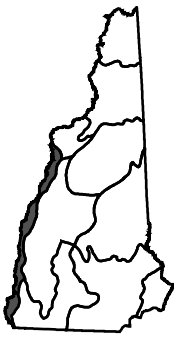
of acidic bedrock. Ecological processes and species composition is most similar to the red oak and red spruce/heath/cinquefoil rocky ridge communities described elsewhere, with which it shares many species (see these descriptions). Soils are similar to other rocky ridges with thin, turfy organic and A horizons over thin, gravelly or sandy B or C horizons. They are well to excessively well drained and of low overall productivity.

CHARACTERISTIC VEGETATION: Species diagnostic of the base-rich conditions that characterize this community include *Juniperus horizontalis* (creeping juniper)*, *Aster ptarmicoides* (snowy aster)*, *Lonicera dioica* (wild honeysuckle) and *Orobanche uniflora* (one-flowered cancer-root). The calcicoles *Potentilla floribunda* (shrubby cinquefoil) and *Carex scirpoidea* (scirpus-like sedge)* may be found on nearby cliffs. Species characteristic of sites with intermediate bedrock can also be present including *Woodsia ilvensis* (rusty woodsia) and *Campanula rotundifolia* (harebell). New Hampshire examples tend to have fewer calcicoles than other New England examples. Other characteristic species (not restricted to basic soils) include *Arctostaphylos uva-ursi* (bearberry), *Potentilla tridentata* (three-toothed cinquefoil), *Vaccinium angustifolium* (lowbush blueberry), *Sorbus americana* (American mountain ash), *Alnus crispa* (mountain alder), *Deschampsia flexuosa* (common hair-grass), *Danthonia spicata* (poverty oat-grass), and *Lechea intermedia* (pinweed).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: There are two examples of this community in New Hampshire and both are found on the brow of large ledges in the Northern Connecticut River subsection around 1900-2100 ft. elevation. A good example is at Holt's Ledge (Lyme).

SOURCES: NHB field surveys.



NORTHERN AND TRANSITION HARDWOOD - CONIFER ZONE

Northern hardwood - conifer forests

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 species can mix variously with *Picea rubens* (red spruce), *Tsuga canadensis* (hemlock), and *Pinus strobus* (white pine). At a regional scale, these forests correspond to the northern hardwood - conifer formation and are positioned latitudinally and elevationally between the spruce - fir and transitional hardwood forest formations (Westveld et al. 1956). The northern hardwood forest formation is generally characterized by species with distributions corresponding to the Eastern Deciduous Forest, although more northern species are often present, including Alleghanian species such as yellow birch and white pine.

The ecotone to spruce - fir forest is marked by increased prominence of red spruce, *Abies balsamea* (balsam fir), and yellow birch while the ecotone to transitional hardwoods is typically accompanied by more *Quercus rubra* (red oak), white pine, *Ostrya virginiana* (ironwood) and decreased dominance of beech, yellow birch, and sugar maple (Westveld et al. 1956; Sperduto 1992). *Fraxinus americana* (white ash), red oak, hemlock, and *Tilia americana* (basswood) are occasional or frequent on the lower reaches of northern hardwood forests.

Northern hardwood forests are generally found between 1000-2500 ft. in elevation, although the tolerance range of individual species varies. Bormann (1970) summarizes approximate elevational limits for some trees in New Hampshire including white pine 455 m (1500 ft), hemlock 610 m (2000 ft.), and red oak 457 m (1500 ft). Cogbill and White (1991) presents these limits graphically. On southern slopes, red oak can reach 1800-2000 ft. in elevation, and upon occasion as high as 2200 ft. (e.g., Mt. Parker in Bartlett). White pine seedlings and saplings are occasionally found as high as 3600 ft. (Mahoosuc Range and top of Cannon Cliff). *Larix laricina* (eastern larch) is not commonly found at higher elevations in the White Mountains, but has been observed at 5000 ft. on Mt. Lincoln.

Herbs such as *Aralia nudicaulis* (wild sarsaparilla) and *Trientalis borealis* (starflower) are common to both transitional and northern hardwood forests. Species of the northern hardwood forests generally not found in transitional forests include *Dryopteris campyloptera* (mountain wood fern), *Lonicera canadensis* (Canadian honeysuckle), *Polystichum braunii* (Braun's holly fern), and other northern herbs also found in the spruce - fir forest. Other species may be present in transition hardwood conifer forests but tend to be more abundant in northern hardwoods including *Oxalis acetosella* (northern wood sorrel), *Huperzia lucidula* (shining clubmoss), *Clintonia borealis* (blue-bead lily), and *Streptopus* spp. (twisted stalks).

Transition hardwood - conifer forests

Transitional hardwood - conifer forests (hereafter transitional forests) are positioned latitudinally and elevationally between northern hardwoods and central hardwoods or oak - pine forests. Plants with Eastern Deciduous Forest and Alleghanian distributions such as red oak, white pine, and hemlock, are most prominent in transitional hardwood - conifer forest, and tend to be present in greater proportions than in northern hardwood forests. Sugar maple and beech are usually absent as primary hardwood dominants, as are boreal and higher-elevation Alleghanian species including balsam fir, red spruce, and yellow birch. Central hardwood/Appalachian representatives are essentially absent (e.g., (*Carya* spp.) hickories, southern oaks, and southern herbs) or at least are not primary dominants. Plants that tend to be more prominent in transitional forests include *Hamamelis virginiana* (witch hazel), *Ostrya virginiana* (ironwood), *Viburnum acerifolium* (maple-leaved viburnum), *Gaultheria procumbens* (wintergreen), and *Gaylussacia baccata* (black huckleberry). However, numerous herbs are ubiquitous and found in both regions, including *Trientalis borealis* (starflower), *Aralia nudicaulis* (wild sarsaparilla), and *Maianthemum canadense* (Canada mayflower). Transitional forests are found throughout central and southern New Hampshire and at lower elevations in the White Mountain region (generally below 1500 ft.), particularly low elevation river valley bottoms and lower south facing mountain slopes extending into the mountains (e.g., the Saco, Androscoggin, and Baker Rivers). These river valleys harbor outposts of various southern species.

Most of the northern hardwood and transitional forests in New Hampshire are characteristic of the nutrient poor (oligotrophic) end of the spectrum due to the prominence of granitic and other low base-cation yielding glacial drift (Leak 1982; Bailey and Hornbeck 1992). Enriched northern hardwood forests are often confined to small areas of certain topographic positions and/or drift areas with higher base-cation contributions to the soil (Leak 1982; Sperduto 1992). Numerous herbaceous species are restricted to these habitats conditions in contrast to the more ubiquitous herbs typical of northern hardwood forests.

Hemlock and beech are the primary late-successional species in these forests, with maximum ages of hemlock exceeding 500 years and that of beech exceeding 300 years. Sugar maple is of lesser importance in these transitional forests in New Hampshire, but may be more abundant in mixed stands elsewhere in New England or the Midwest.

Acidic, primarily nutrient-poor forests

• Northern hardwood - spruce - fir forest (S4)

General Description: Northern hardwood spruce - fir forests are a transitional forest type found at intermediate elevation positions between beech - maple - yellow birch forests and spruce - fir forests. This community occurs in cool, mesic, and typically rocky till or talus settings in the mountains with shallow rooting-depths. These forests generally have lower productivity, increased moisture availability, and a higher percent cover of herbaceous species compared to lower elevation forests. Soils are poor to very nutrient poor.

Characteristic vegetation: *Acer saccharum* (sugar maple) and *Fagus grandifolia* (American beech) are generally dominant, with abundant *Betula alleghaniensis* (yellow birch) and modest amounts of *Picea rubens* (red spruce) and/or *Abies balsamea* (balsam fir). Spruce and fir are generally in lower abundance than the

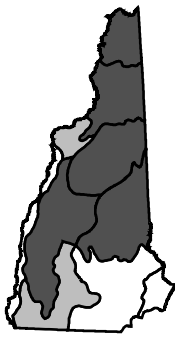
hardwoods, but become dominant with increased elevation, where yellow or sometimes *Betula papyrifera* var. *papyrifera* (paper birch), tends to become the primary hardwood. Understory plants are similar to the beech - maple - birch forest described, but may achieve higher average cover, particularly of *Dryopteris intermedia* (intermediate wood fern) and *D. campyloptera* (mountain wood fern). Common characteristic species include *Oxalis acetosella* (northern wood sorrel), *Clintonia borealis* (blue-bead lily), *Acer spicatum* (mountain maple), and *Viburnum alnifolium* (hobblebush). Characteristic species more frequent or abundant in this type than in lower elevation hardwood forests include *Sorbus americana* and *S. decora* (mountain ashes) and *Lonicera canadensis* (Canadian honeysuckle).

VARIANTS: Two variants are described:

1. **Typic variant**: As described above.
2. **Yellow birch variant**: This variant occurs in a narrow elevation zone between hardwood and spruce - fir forests, along high gradient stream drainages or ravines, or associated with large boulders or talus. Yellow birch is well adapted to establishing itself on large boulders. Boulders are festooned with bryophytes and herbs including *Polypodium virginianum* (rock polypody), *Aster acuminatus* (whorled aster), *Oxalis acetosella* (northern wood sorrel), *Dryopteris campyloptera* and *D. intermedia* (mountain and intermediate wood ferns), *Hylocomnium splendens* (feather moss), and *Bazzania trilobata* (liverwort). While some sites may have had spruce harvested, there are some indications that yellow birch can persist on some of these sites for relatively long time frames as a stable community.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Occurs on upper mountain side-slopes in the White Mountains and locally on other high elevation mountains, generally at elevations from 2100-2800 ft. (locally higher or lower). Good examples are found along Lafayette Brook (Franconia), below the cliffs of East Osceola (Waterville Valley), and above Gentian Pond (Success).



SOURCES: NHB field surveys.

• Sugar maple - beech - yellow birch forest (S5)

GENERAL DESCRIPTION: This is the most common hardwood forest type in northern New Hampshire, dominated by *Acer saccharum* (sugar maple), *Fagus grandifolia* (American beech), and *Betula alleghaniensis* (yellow birch). It is transitional to high-elevation spruce - fir forests at higher elevations and lowland spruce - fir forests, hemlock - spruce - northern hardwood forests, or hemlock - beech - oak - pine forests at lower elevations. Small windthrow gaps of one to many trees are the primary disturbance in these forests. Although yellow birch is not as shade tolerant as beech and sugar maple, it is long-lived and consequently is an important late-successional dominant (approximately 200-380 years). It is successful in establishing itself in single tree gaps.

Rapid and high-density growth of *Prunus pensylvanica* (pin cherry) can occur from buried seeds in clearcut and other large-gap disturbance patches. Pin cherry is an important nutrient-sink on these sites, effectively retaining nutrients and organic matter within the system.

Soils are from generally moderately well drained fine tills (fine sandy loams) of moderately low productivity. This includes compact basal till and firm or loose ablational tills. Till is typically derived from crystalline igneous rocks and metamorphic schists and gneiss yielding soils with relatively low base-saturation. Soils are generally drier than in rich mesic forests and high elevation spruce - fir forests, but more mesic than at some sites dominated by more beech.

CHARACTERISTIC VEGETATION: Sugar maple and beech are the primary mid and late successional dominants,

with yellow birch next in importance. Other seral hardwood species are common or occasional and include *Betula papyrifera* var. *papyrifera* (paper birch), *Acer pensylvanicum* (striped maple), *A. spicatum* (mountain maple), and *Fraxinus americana* (white ash). *Viburnum alnifolium* (hobblebush) is frequent and often abundant in the shrub layer. *Lonicera canadensis* (Canadian honeysuckle) may be present but is infrequent and more likely to be encountered in more enriched and/or moist forests. *Dryopteris intermedia* (intermediate wood fern) is frequent and often abundant in the herbaceous layer, particularly at higher elevations. *Dryopteris campyloptera* (mountain wood fern), largely absent from lower elevation forests, is frequent but usually less abundant than intermediate wood fern. *Huperzia lucidula* (shining clubmoss) is frequent and generally more abundant than in lower elevation forests. Other characteristic species with high constancy include *Clintonia borealis* (blue-bead lily), *Maianthemum canadense* (Canada mayflower), *Oxalis acetosella* (northern wood sorrel), *Trientalis borealis* (starflower), *Aster acuminatus* (whorled aster), and *Uvularia sessilifolia* (sessile-leaved bellwort). Occasional (low constancy) species include *Aralia nudicaulis* (wild sarsaparilla), *Trillium erectum* (wakerobin), *T. undulatum* (painted trillium), *Streptopus roseus* (rosey twisted stalk), *Cinna latifolia* (drooping woodreed), *Thelypteris noveboracensis* (New York fern), *Solidago macrophylla* (large-leaved goldenrod), and *Medeola virginiana* (Indian cucumber-root). Species that are generally more abundant in either higher elevation spruce - fir or lower elevation hemlock and/or hardwood forests include *Mitchella repens* (partridge-berry), *Cornus canadensis* (bunchberry), *Coptis trifolia* (goldthread), *Monotropa uniflora* (Indian pipes), *Cypripedium acaule* (pink lady's-slipper), and *Gaultheria procumbens* (wintergreen).

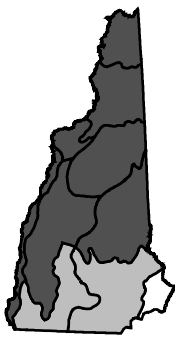
This type corresponds most closely to Leak's (1982) fine till, fine till over compact till, and silty fine till habitats.

Variants: Two variants are described:

1. **Typic variant**: As described above.
2. **High elevation fern glade variant**: At higher elevations (1900-2600 ft.), total biomass of the herbaceous layer often increases while productivity of the overstory decreases, although total floristic composition may not change significantly. *Dryopteris intermedia* (intermediate wood fern) and/or *D. campyloptera* (mountain wood fern) are often the most abundant species, and may form a "fern glade" appearance or otherwise lush understory with other herbs. Increased browse is evident in some examples. Some combination of increased light reaching the understory, increased browse of woody regeneration, and/or increased moisture interception at higher elevations probably contributes to the increased productivity and cover of herbs in this variant.

Classification confidence: 1

Distribution: This forest type is primarily found on upper mountain slopes in the White Mountains at elevations of 1400-2500 ft. (although both higher and lower locally), in the North Country, and southward into the Sunapee Uplands and Sebago-Ossipee subsection. Good examples are found at Mountain Pond (Chatham), The Bowl RNA (Waterville Valley), Spruce Brook (Beans Purchase), and Province Pond and Langdon Brook North (Chatham).



Sources: NHB field surveys; Bormann et al. 1970; Siccama et al. 1970; Marks 1974; Bormann and Likens 1979; Covington and Aber 1980; Covington 1981; Leak 1982; Carbonneau 1981; Fincher 1991; Smith 1992; Fincher and Smith 1994.

• Hemlock - spruce - northern hardwood forest (S3S4)

General Description: This community is characterized by *Tsuga canadensis* (hemlock) and *Picea rubens* (red spruce), with a variable component of northern hardwoods including *Acer saccharum* (sugar maple), *Betula*

alleghaniensis (yellow birch), and *Fagus grandifolia* (American beech). It is found at moderate elevations between spruce - fir and transition hardwood - conifer forests, ranging from less than 1000 ft. up to 2000 ft. It also occurs on river and kame terrace sites where former and current stream channels cut through terraces of variable elevations, moisture levels, and sediment textures.

Soils are typically mesic, moderately well to well drained, and generally more nutrient poor soils than northern hardwoods. Soils range from wet to dry compact tills to sandy sediments and outwash, and less frequently on rocky outcrop sites. Corresponding soil series include Adams, Colton, Au Gres, Salmon, Nicholville, Pillsbury, and Cabot.

This type occurs on several of Leak's (1982) habitat types, including wet compact till, dry compact till, sandy sediment, softwood washed till, outwash, and lake sediment types.

CHARACTERISTIC VEGETATION: *Tsuga canadensis* (hemlock) and *Picea rubens* (red spruce) are dominant, in contrast to hemlock - northern hardwood forests that have little or no spruce and considerably more beech. Birches, particularly *Betula alleghaniensis* (yellow birch) more than *B. papyrifera* var. *papyrifera* (paper birch) and *B. populifolia* (gray birch), are frequent and sometimes abundant. The dominant trees are typically found reproducing in the understory. *Abies balsamea* (balsam fir) may be present but is usually not prominent other than on the terrace flat variant described below. Yellow birch is frequent in both the over and understory while *Fagus grandifolia* (American beech) is occasional but not prominent. The woody understory frequently contains *Viburnum alnifolium* (hobblebush) and *Acer pensylvanicum* (striped maple). Herbaceous plant composition is variable, with few or no herbs being present in all known examples of this community. However, northern plants such as *Oxalis acetosella* (northern wood sorrel), *Huperzia lucidula* (shining clubmoss), *Clintonia borealis* (blue-bead lily), *Streptopus roseus* (rosey twisted stalk), and *Dryopteris campyloptera* (mountain wood fern) tend to be more abundant than in hemlock - hardwood forests without spruce. Other common acidic-flora species are frequent including *Aralia nudicaulis* (wild sarsaparilla), *Trillium undulatum* (painted trillium), *Dryopteris intermedia* (intermediate wood fern), *Lycopodium* spp. (clubmosses), *Trientalis borealis* (starflower), *Viburnum nudum* (witherod), and various mosses.

VARIANTS: Four narrowly defined variants are described.

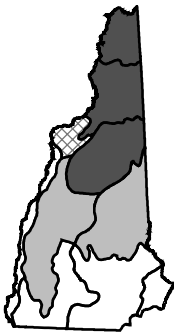
1. **Typic variant**: Found primarily on somewhat to very rocky compact till soils and occasionally on shallow to bedrock or river and kame terrace flats. This variant is most closely aligned with hemlock - spruce types described by Fincher (1991) and Fincher and Smith (1994), and with Leak's (1982) wet and dry compact till habitats. Beech is occasional and perhaps most characteristic of this variant, although usually not prominent. Pit and mound topography is more well-developed on till sites than on terrace flats.
2. **Ravine/terrace slope variant**: This variant is found in moist ravines and steep slope-faces of river and kame terraces, with hemlock and red spruce forming the primary canopy and understory tree dominants. Balsam fir, sugar maple, and beech are sparse or absent. Yellow birch is usually present in the canopy and understory. May be found from less than 1000 ft. to over 1500 ft. elevation in hilly and mountainous sites, particularly in the White Mountains. Corresponds to Leak's (1982) sandy sediment and shallow bedrock habitats.
3. **Conifer terrace flat variant**: Deep, coarse, loamy sand and sandy loam soils of river and kame terraces along streams (particularly in the White Mountains subsection) are often dominated by softwoods. Trees present in quantity include red spruce, hemlock, and balsam fir. Species mixtures are variable and many of our other native conifers may be present in lesser abundance. White pine is rarely a dominant species in northern examples, but is often present in low quantities, particularly on drier or former agricultural sites (usually absent in the other two variants described above). *Larix laricina* (larch) may be occasional on lower terraces with shallower water tables. Red spruce dominates strongly on some sites, making the distinction from lowland spruce - fir difficult. Understory vegetation includes *Viburnum alnifolium* (hobblebush), *Aralia nudicaulis* (wild sarsaparilla), *Trientalis borealis*

(starflower), and mosses. The rare plant *Pyrola asarifolia* (pink wintergreen)* occurs on somewhat enriched lower river terraces or abandoned stream channels. This variant corresponds to Leak's (1982) sandy sediment habitat.

4. **Conifer - hardwood terrace flat variant**: Similar to the softwood variant described above but with a true mixture of mid and late successional softwoods and hardwoods. Sugar maple, red maple, and yellow, paper and gray birches, and to a lesser extent beech mix freely with softwoods and common acid understory flora. This variant may correspond to terrace flats with somewhat finer textures. Somewhat poorly drained terraces (not floodplains) dominated by hemlock are described elsewhere as hemlock/cinnamon fern forest. This variant probably corresponds best to Leak's (1982) sandy sediment and lake sediment habitats.

Classification Confidence Rating: 1-2

Distribution: This type is primarily found on valley bottom and lower elevation till landscapes in northern subsections including the White Mountain, Sebago-Ossipee, Mahoosuc-Rangeley Lakes, and probably Sunapee Upland and northern portions of NE Coastal Plain subsections from 700-2000 ft. elevation. Good examples of the typic variant include Bartlett Experimental Forest (Bartlett) and along Dry Brook (Waterville Valley). Ravine/terrace slope variant examples include McDonnough Brook (Chatham) and Devil's Hopyard (Stark). Conifer terrace flat variant examples include Peabody River (Gorham), Swift River (Albany), and Big River (Barnstead). A conifer - hardwood terrace flat variant example occurs along the Peabody River (Gorham).



Sources: NHB field surveys; Leak 1982; Fincher 1991; Fincher and Smith 1994.

• Hemlock forest (S4)

General Description: *Tsuga canadensis* (hemlock) is an important component in many other types of forest communities, but achieves maximum dominance in this forest type. Floristically, hemlock forests are remarkably similar throughout the region. A dark, relatively open understory with few herbaceous species is typical. Hemlock appears to be maintained by out-competing other tree species for light and nutrients. It persists in low abundance in the understory for decades and then can take advantage of periodic canopy gaps. Few other species can persist under such dense shade. Older forests tend to have more tip-up mounds that provide bare mineral soil and fallen "nurse" logs important for successful hemlock regeneration. Maximum hemlock ages in the region can exceed 500 years. Deer often winter in these areas where movement in light snow cover is easier. This community is distinct, but grades into mixed association with hardwoods and softwoods described as other communities.

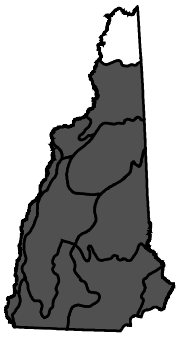
Hemlock has long term persistence at some sites (on a scale of centuries or possibly millennia). However, there is some debate as to the relative importance of soil conditions vs. site disturbance on present day composition. Hemlock dominated sites in the midwest that have been cut significantly often regenerate to hardwoods.

Hemlock forests typically occur on rocky, coarse, and/or thin soils poor in nutrients, including ravines, gorges, river and kame terraces, and other microsites below 2000 ft. elevation. Soils typically have well-developed E horizons (classic Spodosols), are very acidic, high in exchangeable aluminum, and low in available nitrogen and other nutrients. Unlike many other plants, hemlock may cycle aluminum. Soils may freeze more deeply than sites with hardwoods due to interception of snowfall by the dense hemlock canopy.

CHARACTERISTIC VEGETATION: *Tsuga canadensis* (hemlock) is strongly dominant in the canopy, to the near exclusion of other species. The deep shade and acidic soils of hemlock forests create a typically sparse or absent woody and herbaceous understory. Species characteristic of (but not exclusive to) hemlock forests include *Oxalis acetosella* (northern wood sorrel), *Dryopteris* spp. (wood ferns), *Maianthemum canadense* (Canada mayflower), *Monotropa uniflora* (Indian pipes), *Mitchella repens* (partridge-berry), *Acer rubrum* (red maple), *Betula alleghaniensis* (yellow birch), and mosses and liverworts such as *Bazzania trilobata*. Other species characteristic of northern and transition hardwood - conifer forests may be present in low frequency.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Found throughout the state south of and including the White Mountains, generally below 2000 ft. elevation on till landscapes of lower mountainside slopes and occasionally in valley bottom landscapes (e.g., river and kame terraces). Good examples are at Shingle Pond (Chatham), North Peak Mt. Pawtuckaway (Nottingham), and parts of Hemenway State Forest (Tamworth).



SOURCES: NHB field surveys; Rogers 1978; Rogers 1980; Sneddon and Rawinski 1989; Davis et al. 1996; Scott Bailey, pers. comm. 1996.

• Beech forest (S4)

GENERAL DESCRIPTION: Beech forests occur on coarse till soils and are characterized by the dominance and perpetuation of beech to the near exclusion of other woody species. Understory vegetation is typically sparse or absent. Beech saplings may colonize the understory in gaps that are created by blowdowns, and the species' ability to stump and root sprout affords it an additional regenerative advantage on harvested sites. Beech trees produce mast crops of beech-nuts that are important to many animals, including black bear. American beech was considerably more abundant in the presettlement forests of northern New England than they are today (Cogbill et al. 2002). Beech-scale nectria canker has had a significant effect on beech in the region in all community types where it occurs.

Soils are from coarse washed till and sandy sediments. They are well to extremely well drained, are light textured, have moderate to low water holding capacity, and dry-mesic to mesic water availability. Some soils are Spodosols with significant E horizons. The high lignin and low nitrogen content of beech litter contributes to the unproductive soils with low nutrient availability and sparse herbaceous growth.

Forests with a wider diversity and abundance of other canopy species and corresponding increase in herbaceous species are more indicative of hemlock - beech - oak - pine, hemlock - beech - northern hardwood, or sugar maple - beech - yellow birch forest types.

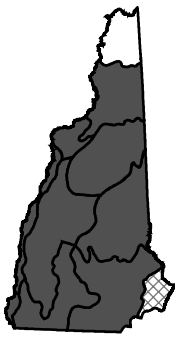
CHARACTERISTIC VEGETATION: *Fagus grandifolia* (American beech) tends to be the primary or exclusive dominant in the overstory and woody understory. Other northern and transition hardwoods may be present, but in relatively low percentages. Vegetation in the understory is decidedly sparse, with a low abundance, diversity, and frequency of herbs. The saprophytic plant *Epifagus virginiana* (beech-drops) is exclusive to beech and is present in this community and others that have some abundance of beech. *Lycopodium* spp. (clubmosses) and other species noted to occur in hemlock - beech - northern hardwood forests may be present.

Beech stands seem to be the preferred habitat for the rare *Triphora trianthophora* (three-bird orchid)*. This orchid remains below ground the entire season until approximately 4-5 days after the first night in late summer approaching 40˚ F. It then emerges, flowers, and sets fruit over the course of a week to ten days. It is most readily discovered (although still inconspicuous!) during the 2-3 day period it is flowering.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This type is found on till uplands at low to mid elevations south of and including the White Mountain subsection, generally at elevations of <500-1400 ft. Good examples are at Chase Hill (Albany), Hammond Trail (Albany), and The Basin (Chatham).

SOURCES: NHB field surveys; Leak 1982; Sue Williams, pers. comm. 1993.



• Hemlock - white pine forest (S4)

GENERAL DESCRIPTION: This is a conifer forest on dry-mesic and infertile till or glacio-fluvial soils characterized by the co-dominance of *Tsuga canadensis* (hemlock) and *Pinus strobus* (white pine). It is narrowly distinguished from hemlock - beech - oak - pine forests, but classified as its own community due to strong conifer dominance, its correspondingly poorly developed herbaceous understory, and the apparent longevity of the association (200+ year old pine and hemlock occur at several sites). It is also distinguished from hemlock - spruce - northern hardwoods by the rarity or lack of red spruce, balsam fir, and sugar maple.

Soils are acidic, moderately to extremely well drained, dry-mesic to mesic, coarse loamy sands and sandy loams of varying degrees of stoniness. Soils are derived from glacial till, river terraces, and ice-contact deposits (eskers, kames, and outwash).

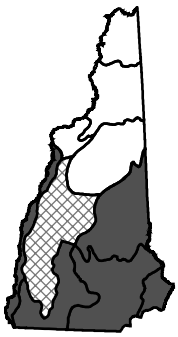
CHARACTERISTIC VEGETATION: Hemlock and white pine are the primary dominants in this community. *Betula lenta* (black birch), *Quercus rubra* (red oak), and *Betula papyrifera* var. *papyrifera* (paper birch) are occasional, but these and other hardwoods are not abundant (generally <5–10% total cover).

Shrubs and herbs are typically sparse but may include *Hamamelis virginiana* (witch hazel), *Gaultheria procumbens* (wintergreen), *Viburnum acerifolium* (maple-leaved viburnum), *Dryopteris intermedia* (intermediate wood fern), *Medeola virginiana* (Indian cucumber-root), *Lycopodium* spp. (clubmosses, other than *Huperzia lucidula*), *Thelypteris noveboracensis* (New York fern), *Aralia nudicaulis* (wild sarsaparilla), *Mitchella repens* (partridge-berry), *Trientalis borealis* (starflower), *Monotropa uniflora* (Indian pipes), and *Maianthemum canadense* (Canada mayflower).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is found in central and southern NH south of the White Mountains from 50–1000 ft. elevation. Good examples occur at Great Hill Pond and Hemingway State Reservation (Tamworth), College Woods (Durham), Boulder Trail in Pawtuckaway State Park (Nottingham), Sheldrick Forest (Wilton), and part of east side of Pine River Esker (Ossipee).

SOURCES: NHB field surveys.



• Hemlock - beech - northern hardwood forest (S4)

GENERAL DESCRIPTION: This is a mixed coniferous - deciduous forest community characterized by *Tsuga canadensis* (hemlock) and northern hardwood tree species [*Acer saccharum* (sugar maple), *Betula alleghaniensis* (yellow birch), and *Fagus grandifolia* (American beech)]. It is found in low to mid elevations till landscapes and some valley bottom soils from 800-2000 ft. elevation (at the same elevation range or below northern hardwood forests and below northern hardwood - spruce forest). This community is fairly distinct but transitions

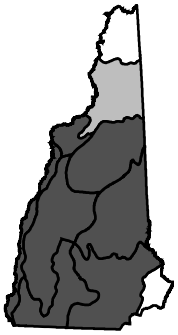
to hemlock - beech - oak - pine at lower elevations and south of the mountains, where sugar maple and yellow birch drop out of the mix.

This community is found primarily on moderately well to well drained soils (occasionally somewhat poorly drained) of coarser parent materials, particularly compact till and firm ablation tills and sometimes on outwash, kame-terraces, and shallow-to-bedrock soils. Soils are generally acidic and moderately nutrient-poor.

CHARACTERISTIC VEGETATION: *Tsuga canadensis* (hemlock) and *Fagus grandifolia* (American beech) are the primary late-successional tree species. *Betula alleghaniensis* (yellow birch) is often present as an associate. Hemlock and/or beech may only be present in the understory in successional examples. Other trees are less constant and more variable in prominence including *Acer saccharum* (sugar maple) (although it tends not to dominate in New Hampshire examples), *Fraxinus americana* (white ash), *Acer rubrum* (red maple), *Picea rubens* (red spruce), and *Abies balsamea* (balsam fir). Red oak, white pine, and other transitional hardwoods are sparse or absent. The most consistent plants in the shrub layer are *Acer pensylvanicum* (striped maple) and *Viburnum alnifolium* (hobblebush) but they are typically somewhat sparse. Herbs that are more abundant or frequent than in typical northern hardwoods include *Medeola virginiana* (Indian cucumber-root), *Mitchella repens* (partridge-berry), and *Coptis trifolia* (goldthread). Herbs that are more abundant than in most hemlock - beech - oak - pine forests include *Dryopteris intermedia* (intermediate wood fern), *Oxalis acetosella* (northern wood sorrel), and *Huperzia lucidula* (shining clubmoss).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This forest occurs throughout New Hampshire from the White Mountain subsection southward, but sparingly or probably absent in the coastal lowland. A good example can be found at Bartlett Experimental Forest (Bartlett).



Sources: NHB field surveys; Leak 1982; Fincher 1991; Fincher and Smith 1994.

• Hemlock - beech - oak - pine forest (S5)

GENERAL DESCRIPTION: This is a very common, broadly defined community found on glacial till and terrace soils of low to mid elevations in central and southern New Hampshire with extensions into the White Mountains. It is latitudinally, elevationally, and floristically transitional between northern hardwood forests and Appalachian oak - hickory forests. As with most upland forests of the region, single-tree windthrow is the primary natural disturbance, with occasional larger blowdown from hurricanes. Both soil and disturbance related variation is apparent.

Soils are moderately to extremely well drained, dry-mesic to mesic loamy sands and sandy loams of varying degrees of stoniness and seasonal water availability. Source bedrock tends to be igneous or siliceous metamorphic rock producing acidic soils with low nutrient availability. Common soil series include Skerry, Paxton, Charlton, Hollis, Canton, Sudbury, Suncook, and Ninigret.

This community grades into oak - pine forest on more droughty soils, to northern hardwoods (sugar maple - beech - yellow birch forest) in the mountains and at higher elevations, and to mesic Appalachian oak - hickory forest in southern New Hampshire. The low abundance and frequency of sugar maple and yellow birch help distinguish this community from hemlock - beech - northern hardwood forests.

Important studies that relate to the dynamics of this or related forest types include Henry and Swan (1972), Foster (1988), Whitney and Foster (1988), and Davis et al. (1994).

CHARACTERISTIC VEGETATION: *Tsuga canadensis* (hemlock), *Fagus grandifolia* (American beech), *Quercus rubra* (red oak), and *Pinus strobus* (white pine) are the primary mid to late successional tree species, and each is

present in fully intergrading degrees of prominence. Since most examples in the state are early to mid successional, hemlock and beech may be present primarily in the understory or otherwise increase in prominence over time. At the extreme ends of the canopy-gradient, either hemlock or beech dominates to the exclusion of nearly all other tree species (these types are described as separate types). Other abundant or frequent early to mid- successional tree species include *Betula papyrifera* var. *papyrifera* (paper birch), *Acer rubrum* (red maple), and *A. pensylvanicum* (striped maple). Other occasional species that can be present in low abundance may include *Prunus serotina* (black cherry), *Betula lenta* (black birch), *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), *B. alleghaniensis* (yellow birch), and *B. populifolia* (gray birch). Red spruce and balsam fir are uncommon or absent.

Canopy dominance combinations vary and may yield hardwood, hardwood - conifer or mostly conifer-dominated stands. To some extent, variation may reflect several factors including 1) the preference of hemlock for more mesic to wet-mesic, coarse or infertile soils, or those with distant fire histories (Davis et al. 1996); 2) the tendency of beech to occur on drier to mesic coarse soils (e.g., washed tills); and 3) the success of white pine on early to mid-successional sites of all types (particularly those with an agricultural history) and longer term on drier, coarse soils or those with fire histories. Black birch reaches its best development on mesic sites, but may be present on somewhat drier sites.

The understory woody and herbaceous plant association is reasonably distinct from northern hardwood and spruce - fir types. Reasonably good differential species that are found primarily in this type include *Hamamelis virginiana* (witch hazel) and *Gaultheria procumbens* (wintergreen). Species that are less frequent or abundant than in northern hardwoods include *Oxalis acetosella* (northern wood sorrel), *Huperzia lucidula* (shining clubmoss), *Lonicera canadensis* (Canadian honeysuckle), *Dryopteris campyloptera* (mountain wood fern), *Clintonia borealis* (blue-bead lily), and *Streptopus* spp. (twisted stalks). Other characteristic species, many of which also occur in northern hardwood forests, include *Aralia nudicaulis* (wild sarsaparilla), *Uvularia sessilifolia* (sessile-leaved bellwort), *Dryopteris intermedia* (intermediate wood fern), *Epifagus virginiana* (beech-drops), *Mitchella repens* (partridge-berry), *Trientalis borealis* (starflower), *Monotropa uniflora* (Indian pipes), and *Maianthemum canadense* (Canada mayflower).

The globally rare *Isotria medeoloides* (small whorled pogonia)* is preferential to this forest type, and seems to prefer compact till sites with a shallow hardpan (densipan) and seasonally (temporarily) elevated water table, sometimes producing shallow, vernal, surface-drainage channels (M. Sperduto 1993; Sperduto and Congalton 1996). These densipan soils tend to occur on lower slopes of hills or low mountains, including drumlins, where glacial ice often produced compact basal tills.

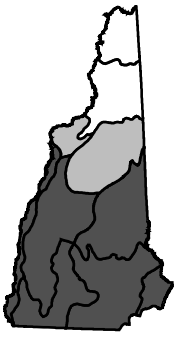
VARIANTS: Two variants are currently described.

1. **Typic variant**: This variant is found on dry-mesic to mesic terrace flats and ablation till soils, generally with no seasonally high water table.
2. **Compact till/low river terrace variant**: This variant has a seasonally high water table and is found on low river and kame terraces or on compact basal till soils with a densipan. Soils include Paxton, Woodbridge, Skerry, Scituate soil series, including drumlin landscapes, or mesic river and kame terrace soils also with seasonally high water tables (e.g., Ninigret or Sudbury soil series). In addition to many of the understory plants described for the typic variant, ferns can be prominent on these sites including *Thelypteris noveboracensis* (New York fern), *Osmunda cinnamomea* (cinnamon fern), *Osmunda claytoniana* (interrupted fern), *Athyrium filix-femina* (lady fern), and *Dennstaedtia punctilobula* (hay-scented fern; especially in gaps). *Lycopodium* spp. (clubmosses) are frequent. *Fraxinus americana* (white ash) is often present in low abundance on compact till sites, and *Goodyera* spp. (rattlesnake plantains) are occasional. *Corylus americana* (American hazel-nut) or *C. cornuta* (beaked hazelnut) are frequent on river terraces (beaked hazelnut extends further north).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is found from the White Mountain subsection and southward at 50-1400 ft. elevation (locally to 1800 ft. or slightly higher on south facing and/or shallow bedrock sites). Good examples are found at Five Finger Point (Sandwich), Great Hill Pond and Hemenway State Forest (Tamworth), College Woods (Durham), parts of Primeval Hardwoods (Stoddard), Wilton Forest (Wilton), Chase Hill (Albany), Sugarloaf Mtn. (Benton), and Dinsmore Mtn. (Sandwich).

SOURCES: NHB field surveys; Sperduto 1993.



• Northern white cedar forest/woodland (S1)

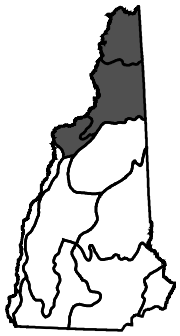
GENERAL DESCRIPTION: This community is a northern white cedar dominated upland forest found on ledgy ridges, mesic till uplands and occasionally on river terrace slopes and flats. It corresponds to more well drained northern white cedar sites than found in northern white seepage forests or northern white cedar swamps. Some examples are associated with intermediate or calcareous soils.

CHARACTERISTIC VEGETATION: *Thuja occidentalis* (northern white cedar) is dominant along with lower quantities of *Abies balsamea* (balsam fir), *Betula alleghaniensis* (yellow birch), *Acer spicatum* (mountain maple), and *Betula papyrifera* var. *cordifolia* (heartleaf birch). Understory vegetation is typically sparse but includes *Aralia nudicaulis* (wild sarsaparilla), *Dryopteris intermedia* (intermediate wood fern), *Trientalis borealis* (starflower), *Maianthemum canadense* (Canada mayflower), *Aster acuminatus* (whorled aster), *Oxalis acetosella* (northern wood sorrel), *Rubus idaeus* (red raspberry), and *Dryopteris marginalis* (marginal wood fern).

CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: This distribution of this community is limited to the Vermont Piedmont, Mahoosuc-Rangeley Lakes, and Connecticut Lakes subsections. Good examples include sites at Beaver Brook Falls (Colebrook) and in the Bishop Brook vicinity (Stewartstown).

SOURCES: NHB field surveys.



ENRICHED FORESTS

• Semi-rich mesic sugar maple forest (S3S4)

GENERAL DESCRIPTION: This community is intermediate between sugar maple - beech - yellow birch forest and rich mesic forest in terms of nutrient availability, diversity of rich-site species, productivity, and possibly moisture availability. Sugar maple is dominant, with a variable presence of *Fagus grandifolia* (American beech) and *Fraxinus americana* (white ash). This community is distinguished from rich mesic forests by a more limited diversity of rich-site indicator species and lack of indicators of strong enrichment. Many of New Hampshire's "sugarbushes" are semi-rich mesic or rich mesic forests. Although it is clear that there is a gradient of enrichment represented from rich to semi-rich forests, harvesting practices have probably affected the composition of some of these forests due to the sensitivity of many of the constituent species to disturbance. The degree of enrichment in forests is a function of a complex suite of interacting factors including: mineral composition of bedrock and till; topographic position (including colluviation); hydrologic flow through soil and fractured bedrock; moisture status; other soil characteristics (base saturation, texture, organic matter content); and biological interactions (litter quality, soil and rock mychorrizae).

Soils are typically loam or fine sandy loams with generally more A horizon development than most northern hardwood soils. Bedrock or till source material may be derived from intermediate or base-rich bedrock types (e.g., syenite, diorite, Ammonoosuc volcanics) that have yielded subacid to circumneutral soil conditions, or the community may be in a colluvial position and thus accumulates nutrient-bearing sediments and organic matter washed from above. Soils generally have higher nutrient availability, productivity, and base-saturation than acidic northern hardwoods, but less than rich mesic hardwood forests. Some sites appear to be seasonally drier than most rich mesic forests.

CHARACTERISTIC VEGETATION: This community is characterized by moderately or somewhat enriched forests typically dominated by sugar maple and sometimes beech. *Fraxinus americana* (white ash) is occasional and abundant in some examples, but not present in all examples. *Tilia americana* (basswood) may be present in low abundance. Differential species of semi-rich conditions (e.g., differentiates from more acidic and/or drier northern hardwoods) include *Arisaema triphyllum* (Jack-in-the-pulpit), *Viola rotundifolia* (round-leaved violet), *Actaea* spp. (baneberries), *Tiarella cordifolia* (foamflower), *Solidago flexicaulis* (zigzag goldenrod), *Deparia acrostichoides* (silvery spleenwort), *Milium effusum* (millet-grass), *Osmorhiza claytonii* (Clayton's sweet-cicely), *Panax quinquefolius* (ginseng)*, and *Polystichum acrostichoides* (Christmas fern). Semi-rich shrub differential species include *Cornus alternifolia* (alternate-leaved dogwood), *Sambucus racemosa* (red elderberry), and *Ostrya virginiana* (ironwood). Typically, there are only one to a few of these species present at any one site. For this reason, it is difficult to select a single species that has a high frequency or constancy in these forests. Other characteristic species (not restricted to enriched conditions) include *Dryopteris intermedia* (intermediate wood fern), *Athyrium filix-femina* (lady fern), *Uvularia sessilifolia* (sessile-leaved bellwort), *Trillium erectum* (wakerobin), and *T. undulatum* (painted trillium). Various other species of northern hardwood and transition hardwood forests may also be present. The broader range of enriched site species noted for rich mesic forests tend to be lacking. However, all of the above mentioned species may also be present in a rich mesic forest.

VARIANTS: Four variants are described:

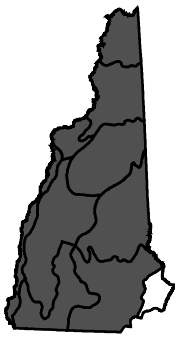
1. **Typic sugar maple - beech till variant** (as described above): This variant is found on till soils at low to mid elevations (up to 1600 ft. and locally higher). Herbaceous cover is generally sparse to moderate, or occasionally abundant.
2. **High-elevation/near-boreal variant**: This variant occurs at higher elevations (1600-2600 ft.) in the White Mountains and somewhat lower in the North Country. Herbaceous cover is generally quite dense and often contains significant fern cover. Yellow birch is more prominent, white ash is rare above 2000 ft., and basswood and *Ostrya virginiana* (ironwood) are generally absent compared to other variants. Species which are usually frequent or in higher abundance include foamflower, zig-zag goldenrod, red elderberry, *Carex intumescens* (inflated sedge), *Clintonia borealis* (blue-bead lily), *Huperzia lucidula* (shining clubmoss), *Dryopteris campyloptera* (mountain wood fern), *D. intermedia* (intermediate wood fern), *Athyrium filix-femina* (lady fern), *Streptopus roseus* (rosey twisted stalk), *Polystichum braunii* (Braun's holly fern), and *Cinna latifolia* (drooping woodreed).
3. **Terrace flat variant**: This variant occurs on loamy river or stream terraces and is dominated by northern hardwoods (sometimes a few softwoods). It may occur in complex mosaics with other river terrace communities. *Acer saccharum* (sugar maple) and *Betula alleghaniensis* (yellow birch) are usually important canopy species, with variable mixes of other hardwoods, including *Fraxinus americana* (white ash), *Acer rubrum* (red maple), *Prunus serotina* (black cherry), and *Betula* spp. (birches). Understory plants that appear to distinguish this variant from more infertile or drier terraces include *Corylus cornuta* (beaked hazel-nut), *Cornus alternifolia* (alternate-leaved dogwood), *Lonicera canadensis* (Canadian honeysuckle), *Arisaema triphyllum* (Jack-in-the-pulpit), *Uvularia sessilifolia* (sessile-leaved bellwort), *Solidago flexicaulis* (zigzag goldenrod), *Trillium erectum* (wakerobin), *Gymnocarpium dryopteris* (oak fern), and *Carex intumescens* (inflated sedge). Potential rare species include *Pyrola asarifolia* (pink wintergreen)*, primarily known from the White Mountain region,

and, to the north, on alluvial soils such as abandoned overflow channels. Most examples known are described from the White Mountain region.

4. **Red oak till variant**: Semi-rich mesic forests in the central and southern parts of the state often approximate this variant. It includes sugar maple and sugar maple - beech forests with more transition hardwood species such as *Quercus rubra* (red oak), *Betula lenta* (black birch), and *Prunus serotina* (black cherry).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is most common in regions with intermediate or base-rich rocks that yield subacid to circumneutral soils, particularly the Connecticut River, Vermont Upland, north and west sides of White Mountain, Mahoosuc-Rangeley Lakes, and Connecticut Lakes subsections. The typic variant is found on till soils in most subsections of the state from ~500-1600 ft. elevation. Good examples are Langdon Brook North (Chatham) and parts of Mountain Pond RNA (Chatham). The high-elevation/near-boreal variant occurs primarily on till in the Vermont Upland, White Mountain, Mahoosuc-Rangeley Lakes, and Connecticut Lakes subsections from 1600-2000 ft. elevation, but may occur locally to the south. Good examples occur on Sugarloaf Mtn. and Black Mtn. (Haverhill). The terrace flat variant is documented from valley bottom landscapes of the White Mountain subsection (800-1200 ft. elevation) but probably occurs elsewhere. Good examples are Peabody River (Gorham), Zealand River (Twin Mountain), Swift River (Albany), and Wild River (Beans Purchase). The red oak till variant becomes more prevalent in southern and central New Hampshire at elevations of <500-1200 ft.



SOURCES: NHB field surveys; Fincher 1991; Sperduto and Engstrom 1995.

• Rich mesic forest (S3)

GENERAL DESCRIPTION: Enriched hardwood forests occur on low to mid-elevation slopes below 2600 ft. on moist, often rocky soils with a relatively high nutrient status compared to other forests. Rich mesic forests are indicated by a diverse set of rich-site indicators that are absent in other forest types, including many of New Hampshire's rare upland forest plants. "Sugarbushes" are usually associated with either semi-rich mesic sugar maple or rich mesic forests. The degree of enrichment in forests is a function of a complex suite of interacting factors including: mineral composition of bedrock and till; topographic position (including colluviation); hydrologic flow through soil and fractured bedrock; moisture status; other soil characteristics (base saturation, texture, and organic matter content); and biological interactions (litter quality, soil and rock mychorrizae). Generally, rich mesic forests have higher base saturation, calcium, and nitrogen availability levels than other forest types.

Topographic position and degree of colluviation affect the extent of accumulated nutrient-rich organic matter, which is particularly pronounced below cliffs or at slope-bases, in ravines, coves, and in other concave slope positions. The effect of colluvial position can be significant: rich mesic forests can occur even on granitic bedrock and till sites where colluvial action is distinct. Rich mesic forests occur on slopes of all aspects in New Hampshire, although prominent ledgy cliff and talus areas in New Hampshire are most common on south and east exposures due to the prevailing direction of glacial movement and resultant "plucking" of the down-glacier sides of hills and mountains. Southern aspects and cliff-bases with pronounced solar reflection off cliff faces may create a modified micro-climate that certain vernal or southern species characteristic of this community respond to.

Soils are variable in terms of depth, stoniness, organic matter content, texture, and moisture status. They range from deep to shallow, nearly stoneless to extremely gravelly/stony loams, very fine to medium sandy loams, and silt loams. These soils are well to moderately well drained, and range from mesic to wet-mesic. Organic

matter is usually comprised of high-quality litter produced by the low C:N ratios of litter from most of the characteristic tree species. An organic-rich "mull" A horizon is found at some sites that presumably result from the rapid decomposition of high-quality litter and humus, subsequent incorporation into the lower mineral horizons, and significant mixing by soil-animal activity. Measured pH of upper B horizons from a limited sample of sites ranged from 5.0-5.5.

Soil parent materials are primarily derived from bedrock, till, or talus that weathers to yield subacid to circumneutral conditions. Rich mesic forests are most often associated with carbonate-bearing, calc-silicate, mafic, and intermediate bedrock types found in such formations as the Ammonoosuc Volcanics, Frontenec (formerly Waits River), Fitch, Elliot, Berwick, and Madrid formations, and various syenites, diorites, basalt or diabase and perhaps gabbros. These rocks generally have higher concentrations of calcium compared to granitic rocks, and/or are more weatherable (including hornblende and hastingsite). These and other base-rich New Hampshire rocks are largely concentrated in the seacoast area, along the state's western margin within 25 miles of the Connecticut River, in broader areas north of the White Mountains, and at smaller isolated locations throughout the rest of the state (e.g., ring dikes that contain diorite and mafic rocks). Fractured bedrock may also transport base-cations from intermittent groundwater discharge.

CHARACTERISTIC VEGETATION: *Acer saccharum* (sugar maple) is the primary dominant, with *Fraxinus americana* (white ash) and *Tilia americana* (basswood) frequent associates. *Fagus grandifolia* (American beech) and *Betula alleghaniensis* (yellow birch) are less frequent. *Ostrya virginiana* (ironwood) is occasional and *Juglans cinerea* (butternut) is infrequent in lower elevation examples (<1500 ft.).

Any or all species listed for semi-rich mesic forests may be present, although rich mesic forests typically have a broader compliment of enriched-site indicator species that are restricted to the most nutrient-rich end of the gradient. Many of these species are "vernal herbs" in that they flower and fruit early in the season before tree canopies have fully emerged.

Most rich mesic forests are indicated by any combination of at least several of the following species that can be used to distinguish rich mesic hardwood forests from essentially all others in New Hampshire: *Adiantum pedatum* (northern maidenhair fern), *Caulophyllum thalictroides* (blue cohosh), *Deparia acrostichoides* (silvery spleenwort), *Botrychium virginianum* (rattlesnake-fern), *Dryopteris goldiana* (Goldie's fern)*, *Dicentra canadensis* (squirrel-corn)*, *D. cucullaria* (Dutchman's breeches), *Asarum canadense* (wild ginger), *Carex platyphylla* (flat-leaved sedge), *C. plantaginea* (plantain-leaved sedge), *Eupatorium rugosum* (white snakeroot), *Oryzopsis racemosa* (blackseed rice-grass), *Rubus odoratus* (purple-flowering raspberry), *Sanguinaria canadensis* (bloodroot), *Cypripedium pubescens* (large yellow lady's-slipper)*, *Viola canadensis* (Canada violet), *V. pubescens* (downy yellow violet), and *Aralia racemosa* (spikenard). Potential rare species in northern examples may include *Pyrola asarifolia* (pink wintergreen)*, *Osmorhiza chilensis* (mountain sweet-cicely)*, *Carex albursina* (Sheldon's sedge)*, *Solidago calcicola* (rock goldenrod)*, *Carex aestivalis* (summer sedge)*, and *Trillium grandiflorum* (large-flowered trillium)*. Numerous forest-sedges are restricted to rich forests, particularly the "wide-leaved" sedges (Laxiflorae and Careyanae groups). Sedges include flat-leaved sedge, plantain-leaved sedge, *Carex leptonervia* (faint-nerved sedge), *C. laxiflora* (lax sedge), *C. blanda* (bland sedge), *C. sprengelii* (long-beaked sedge), *C. hirtifolia* (hairy-leaved sedge), *C. pedunculata* (peduncled sedge), and *C. rosea* (star sedge). There are numerous other herbs that occur in rich mesic forests not listed here, including those found in more nutrient-poor hardwood forests (see sugar maple - beech - yellow birch forest list).

Occurrences in the Connecticut River valley have the potential to contain certain species absent from the remainder of the state, including *Galearis spectabilis* (showy orchis)*, *Hydrophyllum virginianum* (northern waterleaf)*, *Staphylea trifolia* (bladdernut)*, and *Adlumia fungosa* (climbing fumitory)*.

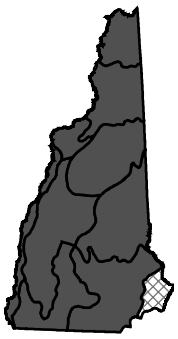
VARIANTS: Two variants are described:

1. **Typic variant**: This variant is found at low to mid elevations from ~500-1800+ ft. (as described above). With additional documentation, rich river terraces in northern New Hampshire may warrant distinction at the variant level as with semi-rich mesic sugar maple forest.

2. **High elevation/near-boreal variant**: The variant is found at elevations ranging from 1800-2600 ft. Ash, ironwood, basswood, and numerous understory species present at lower elevations are absent, although an enriched character is still evident. High percent cover in the herb layer is typical, particularly of ferns. Many known examples have light woody understories. Tall canopies are occasional but generally decrease in height and cover with increasing elevation. Species usually present in higher frequency and abundance than in lower enriched forests include *Huperzia lucidula* (shining clubmoss), *Carex intumescens* (inflated sedge), *Clintonia borealis* (blue-bead lily), *Streptopus roseus* (rosey twisted stalk), *Dryopteris campyloptera* (mountain wood fern), and *Cinna latifolia* (drooping woodreed). Ferns include *Deparia acrostichoides* (silvery spleenwort), *Athyrium filix-femina* (lady fern), *Matteuccia struthiopteris* (ostrich fern), *Dryopteris intermedia* (intermediate wood fern), and *Polystichum braunii* (Braun's holly fern). Other enriched site species include *Milium effusum* (millet-grass), *Laportea canadensis* (wood nettle), and *Allium tricoccum* (wild leek)*. *Osmorhiza chilensis* (mountain sweet-cicely)* and *Solidago calcicola* (rock goldenrod)* (both historic) may occur in this variant.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Found throughout the state on low to mid elevation till landscapes and potentially on steep river terrace slopes of certain valley bottom at elevations from <500-2600 ft. Most frequent in the Connecticut River, Vermont Uplands, Mahoosuc-Rangeley Lakes, Connecticut Lakes, and the north and west sides of the White Mountain subsections, and locally elsewhere. High elevation variant examples occur from approximately 1800-2600 ft. elevation, but mostly above 2000 ft. Good examples are at Black/Sugarloaf/Jeffers Mtns. (Haverhill/Benton), Weeks State Park (Lancaster), and Sugarloaf Cove and Sundown Ledge (Albany).



SOURCES: NHB field surveys; Bailey and Hornbeck 1992; Sperduto and Engstrom 1995; Jongmans et al. 1997; Bailey 2001.

OAK - PINE ZONE

In central and southern New Hampshire, forests dominated by various combinations of oak, hickory, and pine species (*Quercus* spp., *Carya* spp., and *Pinus* spp.) fall within the northern extent of the central hardwood forest region. These forests are referred to as central hardwoods due to the prominence of species whose geographic ranges are centered further to the south in Appalachian regions. In the state, communities of this character are most frequent at low elevations of the lower Connecticut River valley, lower Merrimack River valley, and southeastern New Hampshire. These forests occur on dry to dry-mesic soils of ridges and slopes on till landforms and on sand plain features (e.g., outwash, eskers, kame terraces, and other ice-contact deposits). In many settings, fire is likely an important factor in the maintenance of prominent oak and pine.

Species indicative of the more southern character of these forests include *Quercus velutina* (black oak), *Q. coccinea* (scarlet oak), *Q. alba* (white oak), *Carya* spp. (hickories), *Sassafras albidum* (sassafras), *Kalmia latifolia* (mountain laurel), *Desmodium* spp. (tick-trefoils), *Cornus florida* and *C. rugosa* (flowering and round-leaved dogwoods), *Solidago odora* (sweet goldenrod)*, *Aureolaria* spp. (foxgloves), and *Baptisia tinctoria* (wild indigo). Many of these species reach the northeastern end of their ranges in central New England. Plants restricted to the Atlantic coastal plain region also occur in this central hardwood zone, but are more prominent in wetland, tidal, and open sand plain communities (such as Atlantic white cedar swamps).

Oak woodlands containing bedrock exposures and ledges often occur in mosaics with upland forests of more northern character. They may also grade into mesic forests in lower or moister landscape positions where *Tsuga canadensis* (hemlock), *Acer* spp. (maple), and *Betula* spp. (birches) tend to be more abundant. In

general, the Appalachian oaks [*Quercus alba* (white oak), *Q. prinus* (chestnut oak), *Q. velutina* (black oak), *Q. coccinea* (scarlet oak)], and *Pinus rigida* (pitch pine) decrease in prominence or drop out all together at moderate elevations (800-1000 ft.) and/or in more northerly locations of central New Hampshire. Red oak and white pine climb to 1500 ft., and less frequently occur even higher on southern ridges and slopes of the White Mountains.

Three broad community groups are distinguished and described here within the oak - pine zone:

1) **dry forests and woodlands**, with a variable but often prominent heath layer;

2) **mesic to dry-mesic forests and woodlands**, with a broad diversity of Appalachian and transitional forest trees and herbs; and

3) **enriched forests and woodlands**, with numerous species diagnostic of enriched conditions, and usually without a prominent heath layer.

Dry forests and woodlands

Some species are common to nearly all dry acidic oak - hickory - pine forests. Shrub and herbaceous species which are generally characteristic of the dry acidic types include *Ostrya virginiana* (ironwood), *Vaccinium angustifolium* (lowbush blueberry), *V. pallidum* (hillside blueberry), *Gaylussacia frondosa* (dangleberry), *G. baccata* (black huckleberry), *Viburnum acerifolium* (maple-leaved viburnum), *Comptonia peregrina* (sweet fern), *Hamamelis virginiana* (witch hazel), *Gaultheria procumbens* (wintergreen), *Carex pensylvanica/lucorum* (Pennsylvania and woodland sedges), *Deschampsia flexuosa* (common hair-grass), *Oryzopsis asperifolia* (rough-leaved rice-grass), *Danthonia spicata* (poverty oat-grass), *Pteridium aquilinum* (bracken), *Lysimachia quadrifolia* (whorled loosestrife), and *Lechea intermedia* (pinweed). *Vaccinium myrtilloides* (velvet-leaf blueberry) and *Kalmia angustifolia* (sheep laurel) are occasional, but are also characteristic of dry to wet high elevation ridges, alpine tundra, and bogs. Also frequently present are *Acer rubrum* (red maple), *Betula papyrifera* var. *papyrifera* (paper birch), and *B. populifolia* (gray birch).

Forests and woodlands on glacial till, terraces, dunes, or sand plains

• Dry red oak - white pine forest (S3S4)

General description: Forests with considerable red oak and/or white pine are common in the region. Many are classic old-field situations, successional to hemlock or beech dominance over time. These communities typically occur on mesic sites and are successional examples of the hemlock - beech - oak - pine community. However, some red oak - white pine forests on coarse, sandy or rocky till or shallow-to-bedrock soils appear to perpetuate red oak and pine for extended periods due to draughty soils or recurring fire regimes. These forests typically have a "thin woods" aspect to them, created by a somewhat sparse canopy cover transitional to a woodland structure and a sparse tall woody layer in the understory. The draughty soils and increased light on the forest floor allow dry-site species to help distinguish this community from more mesic early successional examples of hemlock - beech - oak - pine. White pine is sparse or absent in some examples, particularly on ridges in the White Mountains; in contrast, abandoned pastures are often strong to white pine.

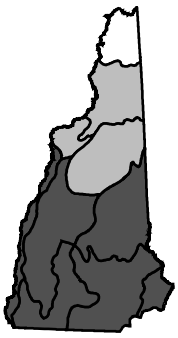
The ability of many oak species to root or stump sprout contributes to their perpetuation under regular fire regimes. Oak forests appear to be fire-dependant over long periods in other regions of the country. Some of these forests may succeed to other overstory species in time due to lack of adequate red oak regeneration, and increases in beech on drier sites and sugar maple and beech on more mesic sites. Repeated fire would tend to knock back fire-sensitive beech and sugar maple. Barton and Schmelz (1987) showed a loss of dominance from oak - hickory towards sugar maple and beech in an older oak - hickory forest in Indiana over a thirty-year period (soil moisture regime not known). Blowdown gaps may also play a role in creating openings for red oak regeneration, but the relative importance compared to other factors in the region is unknown.

Soils are typically dry, well to excessively drained and derived from various parent materials. These include shallow tills over bedrock, coarse washed tills, outwash, river and kame terraces, and other ice-contact deposits. They are generally derived from siliceous (silica rich) bedrock and are therefore acidic and low in available nutrients.

This community is reasonably distinct, but can be difficult to distinguish from early- to mid-successional red oak - white pine stands on mesic sites. The type of woody regeneration, soil drainage and texture, the prominence of dry-site species, and site history may be important in classifying examples of this community correctly. This community is often associated with red oak rocky ridge woodlands. Return of natural, semi-natural, and/or controlled fire regimes may be necessary for the long-term maintenance of red oak on some sites.

This community is more widespread in the state than other types of dry forest, and may succeed to late successional species such as *Fagus grandifolia* (American beech) and/or *Tsuga canadensis* (hemlock) in the absence of fire.

Characteristic vegetation: This community includes forests on acidic dry sites dominated by either red oak or white pine, or both. In northern examples (White Mountain region), red oak is often more prominent than white pine on southern or western exposures, particularly on shallow-to-bedrock sites. Pine may be relatively more prominent and successful on the deeper, generally coarser soils of eskers, other glacial outwash features, and dry river terraces, as well as on former agricultural soils. This community may grade into oak - pine woodlands. It shares numerous species with other oak - pine forests, but lacks the rich-site indicators of dry rich forests. Characteristic dry-site species include *Vaccinium angustifolium* (lowbush blueberry), *Gaylussacia baccata* (black huckleberry) and other heaths, *Pteridium aquilinum* (bracken), *Viburnum acerifolium* (maple-leaved viburnum), *Comptonia peregrina* (sweet fern), *Carex pensylvanica/lucorum* (Pennsylvania and woodland sedges), and *Oryzopsis asperifolia* (rough-leaved rice-grass) (see more complete list under general discussion of dry oak - pine forests above). Other trees may include *Acer rubrum* (red maple), *Betula papyrifera* var. *papyrifera* (paper birch), *B. populifolia* (gray birch), and *B. lenta* (black birch). *Quercus ilicifolia* (scrub oak), *Pinus resinosa* (red pine), and *P. rigida* (pitch pine) are sparse or absent. Beech and hemlock may be present, but are in low abundance and/or found with the dry-site herbaceous and shrub species absent or infrequent in mesic hemlock - beech - oak - pine forests.



Classification confidence: 2

Distribution: Occurs throughout central and southern New Hampshire on shallow to bedrock till soils of low elevation till uplands and coarse, dry valley bottom sediments. Good examples are at Dinsmore Mtn. (Sandwich) and Ames Mtn. (Wentworth).

Sources: NHB field surveys.

• Dry Appalachian oak - hickory forest (S1S3)

General description: These oak - hickory and oak forests occur in southern and south-central New Hampshire and are characterized by southern species that reach the northern extent of their ranges in this region. It is distinguished from dry red oak - white pine forests, which tend to lack significant representation of southern or Appalachian species.

The ability of many oak species to root or stump sprout contributes to their perpetuation under regular fire regimes. Oak forests appear to be fire-dependant over long periods in other regions of the country. Some of these forests may succeed to other overstory species in time due to lack of adequate red oak regeneration, and from increases in beech on drier sites and sugar maple and beech on more mesic sites. Repeated fire would tend to knock back fire-sensitive species like beech and sugar maple. As such, any natural, semi-natural, and/or controlled fire regimes may be necessary for the long-term maintenance of oak and hickory on some sites.

These forests are typically found on middle and upper slopes of low hills with acidic, well to excessively drained soils of low available nutrient status (oligotrophic). They are also common on slopes with south or west aspects. Known or potential soil series include Hollis, Shapleigh, Brimfield, Charlton, Canton, and perhaps Paxton soils.

CHARACTERISTIC VEGETATION: Oaks include *Quercus velutina* (black oak), *Q. coccinea* (scarlet oak), *Q. alba* (white oak), *Q. prinus* (chestnut oak), and *Q. rubra* (red oak). Common hickories include *Carya ovata* (shagbark hickory), *C. ovalis* (sweet pignut hickory), and *C. glabra* (pignut hickory). The hickories are typically less prevalent than the oaks, with red, white, and black oak being most common. *Pinus strobus* (white pine) is frequently present. *Betula lenta* (black birch), *Acer rubrum* (red maple), *Sassafras albidum* (sassafras), and *Pinus rigida* (pitch pine) are occasional. *Betula alleghaniensis* (yellow birch) tends to be more common on mesic sites. Any of the canopy species may exhibit local dominance, although the oaks are generally most abundant. *Tsuga canadensis* (hemlock) occurs occasionally, although primarily as an understory tree, indicating its potential future prominence on some sites.

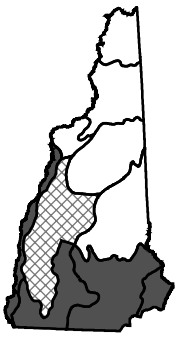
In addition to the characteristic shrubs and herbs mentioned above which are common to most acidic oak - pine communities, several other southern species may occur. *Carex pensylvanica* (Pennsylvanian sedge) may form extensive "lawns" resulting in a park-like appearance of the forest understory. Other characteristic species may include *Cornus florida* (flowering dogwood), *Kalmia latifolia* (mountain laurel), *Corylus americana* (American hazel-nut), *Solidago odora* (sweet goldenrod)*, *Carex foenea* (bronzy sedge), *Antennaria plantaginifolia* (pussy-toes), *Baptisia tinctoria* (wild indigo), *Viola pedata* (bird's-foot violet)*, *Hieracium venosum* (rattlesnake weed), *Helianthemum canadense* (Canadian frostweed), *Comandra umbellata* (bastard toad-flax), *Galium pilosum* (hairy bedstraw)*, *Oryzopsis pungens* (slender mountain rice-grass), *Spiranthes lacera* (slender ladies' tresses), *Aureolaria pedicularia* var. *intercedens* (fern-leaved false-foxglove)*, *Carex retroflexa* (reflexed sedge)*, *Polygonum tenue* (slender knotweed)*, *Tephrosia virginiana* (goat's-rue)*, *Desmodium marilandicum* (Maryland tick-trefoil)*, and *D. rotundifolium* (prostrate tick-trefoil)*. *Quercus prinoides* (dwarf chestnut oak) and *Q. ilicifolia* (scrub oak) are occasional.

VARIANTS: Two variants are described:

1. **Herbaceous variant**: This is the typic variant, where heath shrubs are scarce while other herbs, grasses, and sedges are most prominent. Sites with turfy sedge "lawns" deserve consideration as a separate variant.
2. **Heath variant**: This variant has a strong heath understory with *Vaccinium angustifolium* (lowbush blueberry), *V. pallidum* (hillside blueberry), *Gaylussacia baccata* (black huckleberry), *G. frondosa* (dangleberry), and *Kalmia angustifolia* (sheep laurel). Herbaceous species are infrequent.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Found at low elevations in shallow to moderately deep till landscapes of the Gulf of Maine Coastal Plain, Coastal Lowland, and Connecticut River subsections (at approximately 50-900 ft. elevation, although hickories may drop out at elevations slightly lower than 900 ft.). Good examples occur at Jeremy Hill State Forest (Pelham) and Pawtuckaway State Park (Nottingham).



SOURCES: NHB field surveys.

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

GENERAL DESCRIPTION: This is a mixed forest with *Pinus rigida* (pitch pine) and various Appalachian oak tree species, found on glacial sand plain deposits or dry till habitats. It differs from Appalachian oak - hickory forests by having considerable pine in the canopy, particularly pitch pine. This community appears to be limited to the lower Merrimack River valley region in the state, where it is uncommon to rare.

This community is reasonably distinct but similar to or may grade into other oak and pine types, including pitch pine - scrub oak barrens. It is undoubtedly fire-adapted and fire-prone, and may require maintenance of an adequate fire-regime for long-term perpetuation. Presumably this community may support the diverse insect assemblages specific to pitch pines, scrub oaks, and other oaks, including particularly diverse butterfly and moth faunas.

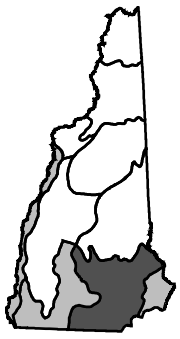
Primarily occurs on Hinckley and Windsor soils of glacial deposits, particularly outwash plains, eskers, moraine and kame features, outwash, and other sand plain formations with coarse, draughty soils and low nutrient availability (oligotrophic). May also occur on ridges and slopes with shallow till soils.

CHARACTERISTIC VEGETATION: Dominants consist of *Pinus rigida* (pitch pine), *P. strobus* (white pine) and Appalachian oaks including *Quercus coccinea* (scarlet oak), *Q. velutina* (black oak), *Q. alba* (white oak), and *Q. prinus* (chestnut oak). *Pinus resinosa* (red pine) may be present in low abundance, but southern species distinguish this community from the more northern pitch pine - red pine - white pine - red oak community. Pines may be locally abundant or dominant to the near exclusion of tree oaks, while other examples are heavy to oak. *Quercus ilicifolia* (scrub oak), *Q. prinoides* (dwarf chestnut oak), and *Comptonia peregrina* (sweet fern) may also be present, but they are usually not dense under forested canopies. In addition to dry acidic plants characteristic of most oak - pine forests, southern plants which are generally absent from more northern oak - pine types may include *Solidago odora* (sweet goldenrod)*, *Lespedeza capitata* (round headed bush-clover), *Aster linariifolius* (stiff-leaved aster), and *Desmodium* spp. (tick-trefoils). In openings, such species as *Liatris borealis* (northern blazing star)* and *Lupinus perennis* (wild lupine)* may be present.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Found in low elevation valley bottoms and shallow till landscapes of the Coastal Plain and Coastal Lowland subsections. Primarily documented from the lower Merrimack River valley sand plain system. The few documented sites are found at 200-600 ft. elevations, although they may be found slightly higher. Good examples are at Derryfield Park (Manchester) and Ponemah Plain (Amherst).

SOURCES: NHB field surveys.



• Maritime wooded dune (S1)

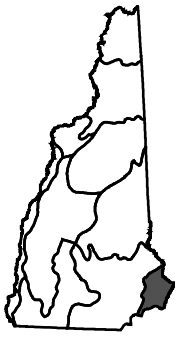
GENERAL DESCRIPTION: This community has a densely wooded forest or woodland thicket structure and is found in more protected hollows of dune systems. The trees attain substantial size in the most protected forested areas and grade to a shorter woodland tree canopy with a dense shrub layer in less protected areas. Soils are dry to mesic sands (oligotrophic). This is a fairly distinct and very rare community in New Hampshire, and apparently similar to other maritime forests in the region. It is threatened by ongoing developmental and recreational pressures.

CHARACTERISTIC VEGETATION: This community is dominated by a tree canopy of *Prunus serotina* (black cherry), *Amelanchier stolonifera* (dwarf shadbush), *Populus tremuloides* (quaking aspen), *Acer rubrum* (red maple), and occasional *Pinus rigida* (pitch pine). Other species include *Toxicodendron radicans* (climbing poison ivy), *Parthenocissus quinquefolia* (Virginia creeper), *Viburnum dentatum* (northern arrowwood), and *Rosa virginiana* (Virginia rose). Prominent exotic species include *Lonicera morrowii* (Morrow's honeysuckle) and *Berberis vulgaris* (European barberry). Common herb species include *Maianthemum canadense* (Canada mayflower), *Aralia nudicaulis* (wild sarsaparilla), *Moehringia lateriflora* (grove sandwort), and *Smilacina stellata* (starry Solomon's seal).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Restricted to remaining sandy dunes in the seacoast region (Gulf of Maine Coastal Lowland subsection). An example can be found at Seabrook Dunes (Seabrook).

SOURCES: Dunlop et al. 1983.



• Pitch pine - scrub oak woodland (S1S2)

GENERAL DESCRIPTION: This community occurs on droughty, excessively well drained soils and is characterized by *Pinus rigida* (pitch pine) and *Quercus ilicifolia* (scrub oak). Pitch pine forms a discontinuous canopy with dense shrub stratums of scrub oak and low heaths. Several successional or 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 a 50-100 year fire return interval to maintain community composition. Logging history also influences canopy structure. A large number of rare Lepidoptera are associated with this community.

CHARACTERISTIC VEGETATION: This community is dominated by *Pinus rigida* (pitch pine) and a tall shrub layer of *Quercus ilicifolia* (scrub oak). Common associates are *Vaccinium angustifolium* (lowbush blueberry), *Carex lucorum* (distant sedge), *Oryzopsis pungens* (slender mountain rice-grass), *Vaccinium pallidum* (hillside blueberry), *Comptonia peregrina* (sweet fern), and *Pteridium aquilinum* (bracken). Other species include *Corylus americana* (American hazel-nut), *Gaultheria procumbens* (wintergreen), *Schizachyrium scoparium* (little bluestem), *Oryzopsis asperifolia* (rough-leaved rice-grass), *Lechea* spp. (pinweeds), *Comandra umbellata* (bastard toad-flax), *Aronia melanocarpa* (black chokeberry), *Solidago* spp. (goldenrods), and *Aster* spp. (asters).

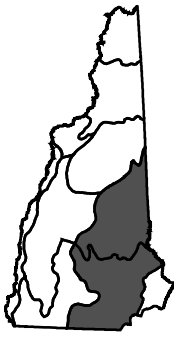
VARIANTS: Two variants are described.

1. **Merrimack Valley variant**: This variant only occurs at the Concord Pine Barrens on deltaic deposits of the post-glacial Lake Merrimack. Impacted by development, it is a remnant of formerly extensive areas of pitch pine and scrub oak in the Merrimack River valley extending into Massachusetts. The diversity of both common and rare vascular plants is greater in this variant and includes such species as *Lupinus perennis* (wild lupine)*, *Asclepias amplexicaulis* (blunt-leaved milkweed)*, *Hudsonia ericoides* (golden-heather)*, *Hieracium venosum* (rattlesnake weed)*, and *Ceanothus americanus* (eastern New Jersey tea). This variant supports a suite of Lepidoptera fauna associated with wild lupine and other plants that are either restricted to or more frequent in this variant. Rare lupine-feeding Lepidoptera include *Lycaeides samuelis* (Karner blue butterfly)*, *Incisalia irus* (frosted elfin)*, and *Erynnis persius* (Persius dusky wing)*.
2. **Ossipee variant**: This variant occurs on deep outwash deposits between Ossipee and Silver Lake (Ossipee Pine Barrens). More northern plants that are diagnostic of this variant, although typically low in cover, are *Arctostaphylos uva-ursi* (bearberry), *Potentilla tridentata* (three-toothed cinquefoil), and *Diphasiastrum* x *sabinifolium* (savin-leaved clubmoss). This variant lacks the rare Lepidoptera found in the southern variant but does support the only New England occurrence of *Lithophane lepida lepida* (pine pinion moth)* and the more northern *Colias interior* (pink-edged sulphur) and *Xylena thoracica* (noctuoid moth).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is limited to the Sebago-Ossipee and Coastal Plain ecoregional subsections in New Hampshire, including on sand plains in the Ossipee region and the lower Merrimack River valley. Good examples occur in the Concord Pine Barrens (Concord) and the Ossipee Pine Barrens (Madison, Ossipee, Tamworth).

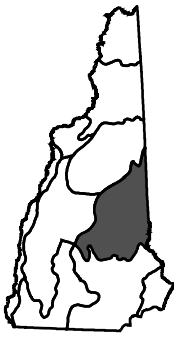
SOURCES: NHB field surveys; Schweitzer et al. 1988; Sperduto 2000a.



• Red pine - white pine - balsam fir forest (S3)

GENERAL DESCRIPTION: This community occurs on sand plains in central New Hampshire that have a longer fire return interval than pitch pine - scrub oak woodland (e.g., >100 years). It is dominated by some combination of red and white pine with little or no pitch pine. Balsam fir is prominent in the understory in many examples, and may relate to mesic sand soils at some sites; other areas have very well drained soils but occur in montane or cold-air drainage settings that favor boreal conifers in the absence of fire.

CHARACTERISTIC VEGETATION: *Pinus resinosa* (red pine), *P. strobus* (white pine), and *Abies balsamea* (balsam fir) are characteristic tree species. Most sites lacked *Quercus ilicifolia* (scrub oak), *Carex lucorum* (distant sedge), *Oryzopsis pungens* (slender mountain rice-grass), and sometimes even blueberries (*Vaccinium* spp.). Mosses are often common.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This type is found in the Sebago-Ossipee and White Mountain subsections. Good examples are found at Pine River State Forest (Ossipee) and in the Big River drainage (Barnstead/Strafford).

Sources: NHB field surveys; Sperduto 2000a.

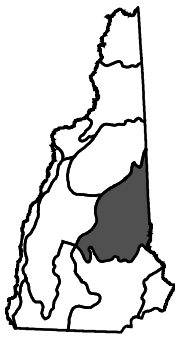
• Mixed pine - red oak woodland (S1)

GENERAL DESCRIPTION: This community is dominated by pitch, red, and white pines, and red oak. It is found on coarse, light textured glacial sand plain features of low elevations (<800 ft.) in central and possibly south-central New Hampshire. It apparently occurs on sand plains that have longer intervals (>100 years) between fires than areas dominated by pitch pine - scrub oak forests and woodlands (50-100 years). Some may have succeeded from pitch pine - scrub oak woodlands, with or without the influence of logging. The composition can be very similar to pitch pine - scrub oak forests and woodlands, with the added components of *Pinus strobus* (white pine) and usually one or both *P. resinosa* (red pine) and *Quercus rubra* (red oak). Fire intolerant hardwoods may be common, including *Betula populifolia* (gray birch), *Populus grandidentata* (big-toothed aspen), and *Acer rubrum* (red maple). This community may grade into pitch pine - scrub oak woodlands and dry red oak - white pine forests.

Likely requires periodic fires for maintenance of vegetation. Areas that burn less frequently within a sand plain system may be the result of discontinuous burn areas. An area may be less likely to burn if it is more marginal or otherwise isolated from the central sand plain area or fire ignition sources.

Soils are well to excessively well drained, coarse textured sand and gravel deposits such as eskers, kames, outwash, moraine deposits, and other ice-contact deposits. Soils are low in available nutrients (oligotrophic). They include Hinckley, Windsor, and possibly Naumberg soil series.

CHARACTERISTIC VEGETATION: Three of our native pines are typically present in quantity, including *Pinus rigida* (pitch pine), *P. resinosa* (red pine), and *P. strobus* (white pine). *Quercus rubra* (red oak) may also be present, and may equal or exceed the pines in abundance in some examples. Southern or Appalachian species are lacking (such as white and black oaks, hickories, and southern herbaceous species found in pitch pine - Appalachian oak forests). Understory vegetation consists of several heath shrubs such as *Vaccinium angustifolium* (lowbush blueberry), *V. pallidum* (hillside blueberry), *Kalmia angustifolia* (sheep laurel), and *Comptonia peregrina* (sweet fern). *Quercus ilicifolia* (scrub oak) is present in some examples. Most of the general species listed for dry, acidic oak - pine types in the beginning of this section may be present.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Primarily known from the Sebago-Ossipee subsection on outwash soils of valley bottoms. Good examples include Pine River State Forest (Ossipee and Effingham), parts of White Lake State Park (Ossipee), various eskers along the Pine River including the Pine River Esker (Ossipee), south of Cedar Swamp Pond (Kingston), and the Moat Brook vicinity (Hales Location).

SOURCES: NHB field surveys; Lyon and Reiners 1971; Sperduto 2000a.

Forests and woodlands on rocky ridges, talus, or coastal headlands

• Red oak - pine rocky ridge (S3S4)

GENERAL DESCRIPTION: This community is characterized by a scattered, moderately short or stunted tree canopy of red oak (25-60% cover and 15-40 ft. tall), a significant short shrub layer (25-70% cover), and a usually sparse to moderately dense herb layer (<1-70% cover). Rock exposures generally cover 25-50% of the ground surface. These communities are fire-prone, and many have fire histories. Fire may be important for regenerating oak on these sites over the long-term and plays an important role in maintaining the structure, composition, and physical features of this community (e.g., shallow rocky soils with frequent outcrops). The glade-like character and ridgeline positions often create good views at these sites, and they are therefore popular hiking destinations.

Surface gravel layers ("grus") that form on bedrock and slide areas appear more frequent in this community than the Appalachian type. The bedrock fracturing that contributes to the formation of "grus" (coarse, angular gravel fragments) is common in some rock of the White Mountain region (e.g., Conway granite and quartz syenites). The Redstone soil series is one soil type that corresponds to this community type.

Ecologically, this community is very similar to the Appalachian oak - pine rocky ridge community, sharing many of the same species, but it is distinct both by the absence of definitively southern and Appalachian species and by the presence of a few northern species. It overlaps elevationally with red pine rocky ridges, with which it may sometimes intergrade.

CHARACTERISTIC VEGETATION: Several key features distinguish this community from the Appalachian oak - pine rocky ridge type: the prominence of red oak, the absence of certain Appalachian or southern species generally found below 1000-1300 ft. elevation, and the occasional presence of certain species restricted to the red oak - pine type or higher elevation rocky ridges.

Several tree species are more abundant and frequent in the red oak - pine versus the Appalachian oak - pine type. These include occasional to abundant *Pinus resinosa* (red pine), occasional *Prunus pensylvanica* (pin cherry), and infrequent *Picea rubens* (red spruce). *Pinus strobus* (white pine) is common. Frequent characteristic shrubs include *Vaccinium angustifolium* (lowbush blueberry)(nearly constant), *V. myrtilloides* (velvet-leaf blueberry), *Gaylussacia baccata* (black huckleberry), *Juniperus communis* (creeping juniper), *Diervilla lonicera*

(bush honeysuckle), and *Comptonia peregrina* (sweet fern). *Arctostaphylos uva-ursi* (bearberry) is infrequent on lower elevation examples. Characteristic and frequent herbaceous species include the lawn forming *Carex lucorum* (distant sedge) as well as *Deschampsia flexuosa* (common hair-grass) (nearly constant), *Pteridium aquilinum* (bracken), *Gaultheria procumbens* (wintergreen), *Schizachyrium scoparium* (little bluestem), *Corydalis sempervirens* (pale corydalis), *Danthonia spicata* (poverty oat-grass), *Maianthemum canadense* (Canada mayflower), *Solidago bicolor* (silverrod), *Melampyrum lineare* (cow-wheat), and *Carex foenea* (bronzy sedge). Lichens and mosses are abundant on rocks.

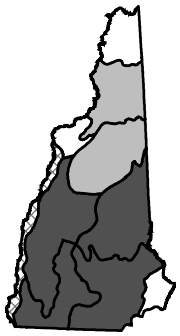
Higher elevation examples (1400-1900 ft.) appear to have more red spruce, three-toothed cinquefoil, and mountain ash, whereas lower elevation examples may have more southern species such as woodland sedge, creeping juniper, and false fern-leaved foxglove. Lower elevation examples have species such as fern-leaved false-foxglove, pink corydalis, and bearberry.

Species characteristic of this community and absent from the Appalachian oak - pine rocky ridge type include *Polygonum douglasii* (Douglas' knotweed)*, *Minuartia glabra* (smooth sandwort)*, *Sorbus americana* (American mountain ash), *Arabis drummondii* (Drummond's rock-cress), and *Potentilla tridentata* (three-toothed cinquefoil). Appalachian trees and shrubs notably absent from or sparse in this community include *Pinus rigida* (pitch pine), oaks other than red oak, hickories, *Juniperus virginiana* (eastern red cedar), *Gaylussacia frondosa* (dangleberry), and *Sassafras albidum* (sassafras). *Ostrya virginiana* (ironwood) and *Schizachyrium scoparium* (little bluestem) may be present but are generally less abundant.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is found from about 1000-1800 ft. elevation in the White Mountains and central New Hampshire (NH Upland, Sebago Ossipee, Coastal Plain, White Mountain, and Mahoosuc-Rangeley Lake subsections). Good examples are on Mt. Stanton-Pickering ridge (Bartlett), Rattlesnake Mtn. (Rumney), Haystack (Albany), Ames Mtn. (Wentworth), Whites Ledge (Albany), and Moat Mtn. (North Conway).

SOURCES: NHB field surveys.



• Appalachian oak - pine rocky ridge (S3)

GENERAL DESCRIPTION: This community is characterized by a scattered, moderately short or stunted tree canopy (25-60% cover, 15-40 ft. tall), a significant short-medium shrub layer (25-70%, 1-7 ft.), and a sparse to moderately dense herb layer (<1-70%). Rock exposures typically cover 25-50% of the ground surface. These communities are fire-prone, and many have fire histories. Fire contributes to the maintenance of shallow, impoverished soils, an open canopy structure, and the presence of species adapted to fire. The attractive, glade-like character and good views found in these communities make them popular hiking destinations. Openings with less than 25% tree cover are considered part of a woodland-barren mosaic due to their generally small size (<0.25 acres).

Soils are typically shallow-to-bedrock sandy loams, draughty (xeric to dry moisture regime), very gravelly or stony, and derived from acidic or intermediate bedrock of glacially scoured summits, ridges and slopes. Surface organic and A horizons are usually moderate to very shallow in depth and form a fibric turf over the sandy, gravelly, or stony B and C horizons (if present). Surface gravel "pads" may form on flat or sloping bedrock surfaces. Soils are very well to excessively drained and very low in nutrients.

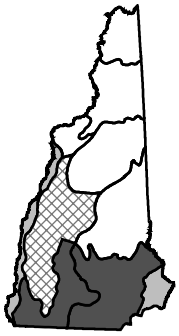
CHARACTERISTIC VEGETATION: Open glades and a patchy tree canopy support a diverse assemblage of plant associations, with *Quercus rubra* (red oak) consistently present in quantity in the tree layer; *Pinus strobus* (white pine) and *Ostrya virginiana* (ironwood) are common. A diverse composition of Appalachian and other transitional tree and understory species characteristic of this community that distinguish it from red oak rocky ridge communities include *Pinus rigida* (pitch pine), *Quercus alba* (white oak), *Q. velutina* (black oak), *Q.*

prinus (chestnut oak), *Q. ilicifolia* (scrub oak), *Q. coccinea* (scarlet oak), *Carya ovata* (shagbark hickory), *Juniperus virginiana* (eastern red cedar), and *Sassafras albidum* (sassafras). *Pinus resinosa* (red pine) is occasional but more frequent on red oak rocky ridges. Forests and woodlands dominated by chestnut oak are classified as chestnut oak forest/woodland.

Other frequent or abundant characteristic shrubs include (in decreasing order of frequency) *Vaccinium angustifolium* (lowbush blueberry; nearly constant), *Gaylussacia baccata* (black huckleberry), *Vaccinium pallidum* (hillside blueberry) (late low blueberry), *Viburnum acerifolium* (maple-leaved viburnum), *Juniperus communis* (creeping juniper), and *Comptonia peregrina* (sweet fern). *Quercus ilicifolia* (scrub oak) is a dominant species and can form extensive shrublands at some sites. Scrub oak ridgetops are more prevalent in southern New England and New York and are classified as a distinct community there. Other occasional characteristic shrubs include *Diervilla lonicera* (bush honeysuckle), *Gaylussacia frondosa* (dangleberry), *Vaccinium myrtilloides* (velvet-leaf blueberry), and *Arctostaphylos uva-ursi* (bearberry). Characteristic and frequent herbaceous species include the lawn forming *Carex pensylvanica* or *C. lucorum* (Pennsylvania and woodland sedges), *Deschampsia flexuosa* (common hair-grass) (nearly constant), *Pteridium aquilinum* (bracken), *Schizachyrium scoparium* (little bluestem), *Corydalis sempervirens* (pale corydalis), *Danthonia spicata* (poverty oat-grass), *Maianthemum canadense* (Canada mayflower), *Solidago bicolor* (silverrod), and *Gaultheria procumbens* (wintergreen). Other characteristic but apparently less frequent herbs include *Comandra umbellata* (bastard toad-flax), *Antennaria plantaginifolia* (pussy toes), *Polypodium virginianum* (rock polypody), *Melampyrum lineare* (cow-wheat), *Aquilegia canadensis* (wild columbine), *Aureolaria pedicularia* var. *intercedens* (fern-leaved false-foxglove)*, *Solidago odora* (sweet goldenrod)*, and *Panicum* spp. (panic grasses). Lichens and mosses are abundant.

Classification confidence: 1

Distribution: This community is found on hills and lower slopes of higher mountains at low to mid elevations from 250-1300 ft. elevation in central and southern New Hampshire. This includes all subsections south of the White Mountain and Vermont Upland subsections. Good examples are on Rocky Ridge in Pawtuckaway State Park (Nottingham), Joe English Hill (New Boston), Mt. Wantastiquet (Hinsdale), and Rattlesnake Mtn. (Rumney).



Sources: NHB field surveys.

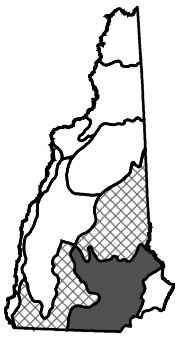
• Chestnut oak forest/woodland (S1S2)

General description: This community is characterized by *Quercus prinus* (chestnut oak) dominated forests and woodlands. Most examples occur on rocky ridges and hilltops with lots of rock outcrops; some occur as more closed-canopy forests with fewer outcrops but on typically dry, shallow-to-bedrock hillsides. Other than dominance or co-dominance by chestnut oak, it is floristically similar to Appalachian oak - pine rocky ridge woodlands and oak - hickory forests. Chestnut oak is uncommon and more restricted in distribution in New Hampshire than other Appalachian oak and central hardwood tree species.

Soils are typically shallow and well to excessively well drained stony sandy loams derived from granitic or other silicious bedrock, with frequent rock outcrops.

Characteristic vegetation: *Quercus prinus* (chestnut oak) is dominant or co-dominant along with *Q. rubra* (red oak), *Q. alba* (white oak), and *Pinus strobus* (white pine). Numerous other trees may be present as well, including *Betula lenta* (black birch), *Quercus coccinea* (scarlet oak), *Q. velutina* (black oak), *Carya ovata* (shagbark hickory), *Acer rubrum* (red maple), *Sassafras albidum* (sassafras), and *Fagus grandifolia* (American beech). Heath shrubs are common in the sparse to moderately well developed understory, including *Vaccinium angustifolium* (lowbush blueberry), *V. pallidum* (hillside blueberry), *Gaylussacia baccata* (black huckleberry),

Kalmia angustifolia (sheep laurel), and sometimes *K. latifolia* (mountain laurel). Other shrubs include *Hamamelis virginiana* (witch hazel) and *Viburnum acerifolium* (maple-leaved viburnum). Herbs and dwarf trailing shrubs include *Aralia nudicaulis* (wild sarsaparilla), *Carex pensylvanica* (Pennsylvanian sedge) or *Carex lucorum* (distant sedge), *Maianthemum canadense* (Canada mayflower), *Aster macrophyllus* (large-leaved aster), *Lysimachia quadrifolia* (whorled loosestrife), *Comandra umbellata* (bastard toad-flax), *Oryzopsis asperifolia* (rough-leaved rice-grass), and *Chimaphila maculata* (striped wintergreen) among many others.



CLASSIFICATION CONFIDENCE: 1-2

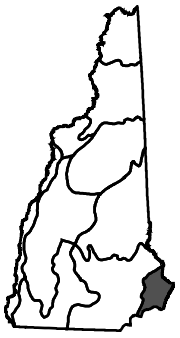
DISTRIBUTION: This community is documented in southern NH in the Coastal Plain subsection on low elevation rocky ridges and hilltops. It should be expected also in the Hillsboro Inland Hills and Plains subsection where chestnut oak has been documented. Good examples occur on North Mtn. in Pawtuckaway State Park (Nottingham), Dumplington Hill (Raymond), and in Brookline and Mason.

SOURCES: NHB field surveys.

• Coastal rocky headland (S1)

GENERAL DESCRIPTION: This community occurs on exposed, rocky, coastal promontories influenced by a maritime climate and salt spray. It is characterized by stunted *Juniperus virginiana* (eastern red cedar), *Quercus velutina* (black oak), other trees, and numerous shrubs. Very few examples have been described from New Hampshire, but more may exist. The community is fairly distinct, but New Hampshire examples are typically impacted by humans and the degree of natural origin is uncertain. Occurs on various types of bedrock with thin, acidic soils in close proximity to tidal action and salt spray.

CHARACTERISTIC VEGETATION: Eastern red cedar and black oak appear to be the most dominant species, with lesser quantities of *Prunus serotina* (black cherry), *Pinus rigida* (pitch pine), *Amelanchier canadensis* (eastern shadbush), and other trees and tall shrubs. Other species present may include *Alnus serrulata* (smooth alder), *Myrica pensylvanica* (northern bayberry), *Juniperus communis* (creeping juniper), *Rhus typhina* (staghorn sumac), *Toxicodendron radicans* (climbing poison ivy), *Comptonia peregrina* (sweet fern), *Linaria canadensis* (blue toadflax), *Ligusticum scothicum* (Scotch lovage), *Lechea intermedia* (pinweed), and *Cakile edentula* (sea-rocket). At its oceanside edge, the community grades into tidal vegetation. Documented New Hampshire examples are disturbed and have numerous exotics including *Rhamnus cathartica* (common buckthorn), *Berberis vulgaris* (European barberry), *Lonicera morrowii* (Morrow's honeysuckle), *Poa pratensis* (Kentucky bluegrass), and *Rumex acetosella* (red sorrel).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Restricted to immediate shoreline areas of the Coastal Lowlands subsection and presently only documented from the Great Bay vicinity. Examples can be found at Thomas Point (Newington), south of Crommet Creek (Durham), and at Odiorne Point State Park (Rye).

SOURCES: NHB field surveys.

MESIC AND DRY-MESIC NUTRIENT-POOR FORESTS AND WOODLANDS

These communities occur on mesic and dry-mesic sites in southern and occasionally central New Hampshire. They are characterized by a broad diversity of trees, including Appalachian (central hardwood) and transitional hardwoods and a variable cover of herbs and shrubs.

• Mesic Appalachian oak - hickory forest (S2S3)

GENERAL DESCRIPTION: This community occurs on mesic and dry-mesic sites in coastal and southern New Hampshire and is characterized by a broad diversity of trees, including Appalachian (central hardwood) oaks, hickories, white pine, and transitional hardwood trees. The shrub and herb layers are sparse to moderately well developed. Heaths and other dry site understory plants are absent or in low abundance, as are species characteristic of more northern forests, such as sugar maple, yellow birch, and wood ferns (*Dryopteris* spp.).

Soils range from well drained sandy to very fine sandy loams (such as Eldridge, Chatfield-Hollis, and Pennichuck series) and moderately well drained silt loams (such as Scitico and Boxford silt loams) on gentle to moderate slopes. The moisture regime of sandy loams tends to be dry-mesic and the silt loams tend to be mesic.

CHARACTERISTIC VEGETATION: This community has a diverse tree canopy, dominated by *Quercus rubra* (red oak), *Pinus strobus* (white pine), *Quercus velutina* (black oak), *Acer rubrum* (red maple), and sometimes *Betula lenta* (black birch). *Carya ovata* (shagbark hickory) is also usually present, but usually not as a dominant. Other frequent trees found in lower abundance in the canopy or sub-canopy include *Prunus serotina* (black cherry), *Quercus alba* (white oak), *Fraxinus americana* (white ash), *Betula papyrifera* var. *papyrifera* (paper birch), *Fagus grandifolia* (American beech), and *Tsuga canadensis* (hemlock). Although beech and hemlock are typically not dominant, they may be expected to increase in importance in later successional examples. *Sassafras albidum* (sassafras), *Tilia americana* (basswood), and *Acer saccharum* (sugar maple) are infrequent. Other enriched site species (e.g., certain herbs) are typically absent.

The tall shrub layer is typically sparse or absent, consisting of *Viburnum acerifolium* (maple-leaved viburnum) and occasionally *Corylus cornuta* (beaked hazel-nut) and *Hamamelis virginiana* (witch hazel). *Vaccinium corymbosum* (highbush blueberry) is infrequent and, when present, in low abundance. Low or trailing shrubs and clubmosses are frequent as a group, but typically constitute low cover. They include *Toxicodendron radicans* (climbing poison ivy), *Mitchella repens* (partridge-berry), *Gaultheria procumbens* (wintergreen), and clubmosses [(*Lycopodium obscurum* (princess pine), *L. hickeyi* (Hickey's tree clubmoss), and *Diphasiastrum digitatum* (southern ground-cedar)]. Infrequent species include *Gaylussacia baccata* (black huckleberry), *Viburnum dentatum* (northern arrowwood), *Juniperus virginiana* (eastern red cedar), *J. communis* var. *depressa* (ground juniper), *Smilax* spp. (greenbriars), and the exotics *Berberis thunbergii* (Japanese barberry), *Rhamnus frangula* (European alder-buckthorn), and *R. cathartica* (common buckthorn). Although *Vaccinium angustifolium* (lowbush blueberry) is occasional, it is always in low abundance (<1 – 5%) and the well-developed heath layer of dry oak - hickory forests is absent. *Kalmia latifolia* (mountain laurel) may be present in low abundance.

Herbaceous species are typically sparse. *Aralia nudicaulis* (wild sarsaparilla) and *Maianthemum canadense* (Canada mayflower) are the only frequent species that often exceed 1% cover. Other frequent species present in low abundance include *Carex pensylvanica* (Pennsylvanian sedge) and/or *C. lucorum* (distant sedge), and occasional species include *Dennstaedtia punctilobula* (hay-scented fern), *Carex debilis* (Rudge's sedge), and *Moneses uniflora* (one-flowered shinleaf). Rich or semi-rich site herbs are absent or in very low abundance. *Isotria verticillata* (large whorled pogonia)* and *Senecio obovatus* (round-leaved ragwort)* are rare species known to occur in this forest type in southwest New Hampshire.

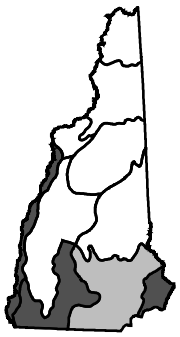
VARIANTS: Two weakly described variants are recognized:

1. **Dry-mesic variant**: This variant typically occurs on well drained fine sandy loam soils where beech, paper birch, and dry-site herbs may be more frequent or abundant.

2. **Mesic variant**: This variant is more likely on silt loam soils with higher moisture holding capacity or at slope-bases. White ash, black cherry, and poison ivy may be more frequent on mesic sites.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community occurs on lower elevation till landscapes of the Gulf of Maine Coastal Lowland, southeastern portion of Coastal Plain, Connecticut River, and southern and southeastern sections of New Hampshire Uplands subsections. Elevations of known examples are 800 ft. or less. Good examples are at Mt. Wantastiquet (Hinsdale), Great Bay National Wildlife Refuge (Newington), and Pawtuckaway Mtn. (Nottingham).



SOURCES: NHB field surveys.

• Appalachian oak - mountain laurel forest (S3)

GENERAL DESCRIPTION: This community consists of various mixtures of Appalachian (central hardwood) and transition hardwood trees, a sparse layer of dry to dry-mesic site herbs, and a shrub understory dominated by *Kalmia latifolia* (mountain laurel). This type is related to deciduous forests more prominent in the southern and central Appalachian Mountains dominated by understories of mountain laurel and *Rhododendron maximum* (giant rhododendron)*. In New Hampshire, mountain laurel is found mostly on drier to somewhat moist upland sites and occasionally hummocks in swamps or along lake shores; great laurel is rare in native settings where it can be found in and along the margins of stagnant basin swamps or along pond shores.

The broadleaf, evergreen character of mountain laurel (leaf longevity averages 2-3 years) and ability to root and butt-sprout contributes to its success on the fairly nutrient-poor sites. Taller growth is more common on moist sites whereas scrubbier forms occupy drier sites. Mountain laurel apparently only flowers with adequate sunlight. Soils are acidic, nutrient-poor to weakly enriched, stony, medium to fine sandy loam soils (oligotrophic to submesotrophic).

The ecological importance of mountain laurel in this community differentiates it from communities that may be similar in terms of overstory composition. A striking and rather impenetrable layer of mountain laurel is characteristic, which often inhibits other vegetation including tree regeneration. This shrub comprises ~9% (up to 32%) of the total forest biomass (standing crop), 32% of the forest leaf biomass, and 13-34% of nutrient stock in similar forests of the Great Smoky Mountains. Mountain laurel may have increased in importance in response to the chestnut blight infestation.

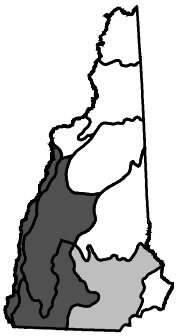
This community is considered distinct from other mesic and dry Appalachian deciduous forests because of the significant effect mountain laurel has on other vegetation and its important role in ecosystem functions and processes (biomass, nutrient cycling, light).

CHARACTERISTIC VEGETATION: Various tree species may be present including *Quercus rubra* (red oak), *Q. alba* (white oak), *Q. prinus* (chestnut oak), *Betula lenta* (black birch), *B. papyrifera* var. *papyrifera* (paper birch), *Tsuga canadensis* (hemlock), *Ostrya virginiana* (ironwood), *Fagus grandifolia* (American beech), *Carya ovata* (shagbark hickory), *Acer rubrum* (red maple), *Sassafras albidum* (sassafras), and to a lesser extent *Acer saccharum* (sugar maple), *Castanea dentata* (American chestnut) sprouts, and *Fraxinus americana* (white ash). Some combination of oak(s), birches, and at least minor amounts of hemlock seem to be constant. *Kalmia latifolia* (mountain laurel) is abundant or dominant in the understory (generally 20-100%), often to the near exclusion of other understory vegetation. Other shrubs contribute a sparse to moderate cover and may include *Viburnum acerifolium* (maple-leaved viburnum), *Hamamelis virginiana* (witch hazel), *Cornus florida* (flowering dogwood), *C. rugosa* (round-leaved dogwood), *Acer pensylvanicum* (striped maple), *Corylus cornuta* (beaked hazel-nut), and *Diervilla lonicera* (bush honeysuckle). Understory herbs are typically sparse and include those found in other dry to dry-mesic transitional and Appalachian oak - hickory forests such as

Pteridium aquilinum (bracken), *Oryzopsis asperifolia* (rough-leaved rice-grass), *Medeola virginiana* (Indian cucumber-root), *Carex pensylvanica* (Pennsylvanian sedge), *Trientalis borealis* (starflower), *Smilacina racemosa* (false Solomon's seal), and *Thelypteris noveboracensis* (New York fern). *Isotria verticillata* (large whorled pogonia)* is a rare species known to occur in this forest type.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Locally abundant on low elevation (800 ft. or less) till landscapes primarily west of the Merrimack River in the southern portion of New Hampshire Upland subsection, southwestern portion of the Coastal Plain subsection, and the extreme southern portion of the Connecticut River subsection; disjunct in the Sebago-Ossipee subsection in the Albany and Squam Lake vicinities. Good examples are at Mt. Wantastiquet (Hinsdale), Sheldrick Forest (Wilton), Beaver Brook (Hollis), New Boston Air Force Base (New Boston); disjunct examples in the Chase Hill vicinity (Albany), and on the margins of Squam Lake (Holderness).



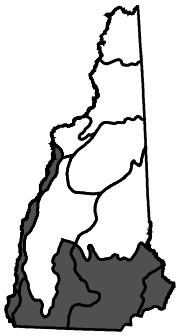
SOURCES: NHB field surveys; Day and Monk 1974; Monk et al. 1985.

• Red oak - hickory wooded talus (S1S2)

GENERAL DESCRIPTION: This community consists of acidic talus slopes at low elevations (<500 ft.) of southern and coastal New Hampshire with southern and Appalachian species absent from higher elevation or more inland talus slopes. Vegetation and processes are otherwise very similar to the red oak wooded talus type. This is a small patch community (in the range of <1-10 acres in size). This is a fairly distinct community, although examples in the field can contain both, or be intermediate between, acidic and enriched types.

Soils are acidic to weakly enriched with talus derived from acidic to intermediate bedrocks (e.g., the Littleton Formation, granites, monzonites, and quartzites).

CHARACTERISTIC VEGETATION: The vegetation of this community is similar overall to that of the acidic red oak talus type. The primary difference is that the Appalachian type described here contains southern species generally absent from the more inland and higher elevation examples that reach the northern margin of their range in New Hampshire. These include any combination of two to three or more of the following species: *Carya ovata* (shagbark hickory), *C. cordiformis* (bitternut hickory), *Quercus alba* (white oak), *Q. velutina* (black oak), *Q. prinus* (chestnut oak), *Q. ilicifolia* (scrub oak), *Sassafras albidum* (sassafras), *Kalmia latifolia* (mountain laurel), and *Cornus florida* (flowering dogwood).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Known from Northern Connecticut River, Coastal Lowland, and southern portion of Coastal Plain subsections. Found on lower elevation till landscapes of southern New Hampshire hills generally below 500 ft. A good example is at Mt. Wantastiquet (Hinsdale).

SOURCES: NHB field surveys.

• Red oak - black birch wooded talus (S3S4)

General description: This community occurs on acidic talus slopes of moderately low to mid elevations (500-1800 ft.) in central and southern New Hampshire, and on lower elevation valleys of the White Mountains. Lower elevation or warmer talus slopes in central and southern New Hampshire are very similar to this community but contain species with distinct southern affinities that are absent from this type.

Talus is derived from acidic to intermediate bedrocks yielding soils that are acidic to weakly enriched and moderately nutrient-poor (submesotrophic). Rock types include the Littleton Formation, granites, monzonites, and quartzites.

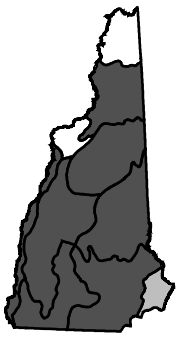
Characteristic vegetation: Acidic and weakly enriched talus slopes have many species in common with rich red oak - sugar maple talus (described elsewhere), but differ by the general absence of enriched-site indicators. Acidic talus slopes have a variable hardwood tree and tall shrub canopy composition, but nearly all have *Quercus rubra* (red oak) in some quantity, though not necessarily abundant or dominant. Other tree and tall shrub associates may include *Betula lenta* (black birch), *Acer saccharum* (sugar maple), *Fagus grandifolia* (American beech), *Ostrya virginiana* (ironwood), *A. rubrum* (red maple), *A. spicatum* (mountain maple), *A. pensylvanicum* (striped maple), *Betula alleghaniensis* (yellow birch), and occasionally *Prunus pensylvanica* (pin cherry). *Betula papyrifera* var. *papyrifera* (paper birch) and *Betula populifolia* (gray birch) may be occasional in gap areas. Softwoods are generally sparse or absent. The shrub layer is also variable, and usually only dense in more open canopy areas (e.g., mountain maple thickets). It is usually characterized by some combination of the following shrubs: *Hamamelis virginiana* (witch hazel), *Rubus* spp. (raspberries and blackberries), *Viburnum acerifolium* (maple-leaved viburnum), *Ribes* spp. (gooseberries and currents), and *Sambucus racemosa* (red-berried elder). Vines (lianas) are more prevalent than in most till forests and may include *Polygonum cilinode* (fringed bindweed), *Parthenocissus quinquefolia* (Virginia creeper), *P. vitacea* (woodbine), *Toxicodendron radicans* (climbing poison ivy), and *Celastrus scandens* (American bittersweet). The herbaceous layer contains many species characteristic of most talus slope communities including *Smilacina racemosa* (false Solomon's seal), *Dryopteris marginalis* (marginal wood fern), and *Polypodium virginianum* (rock polypody). In drier or more open areas, species such as *Corydalis sempervirens* (pale corydalis), patches or lawns of *Carex lucorum*/*pensylvanicum* (woodland and Pennsylvania sedges), *Oryzopsis asperifolia* (rough-leaved rice-grass), *Pteridium aquilinum* (bracken), *Solidago bicolor* (silverrod), and *S. caesia* (blue-stemmed goldenrod) may be present (see also rich red oak talus description for expanded list of dry vs. mesic species.) Ubiquitous herbs of the region are also common including *Maianthemum canadense* (Canada mayflower), *Aralia nudicaulis* (wild sarsaparilla), and *Trientalis borealis* (starflower). Foliose lichens are common on larger rocks.

Variants: Two variants are described.

1. **Mesic variant**: See species list in rich red oak - sugar maple talus, excluding rich-site indicators.
2. **Dry to dry-mesic variant**: See species list in rich red oak - sugar maple talus, excluding rich-site indicators.

Classification confidence: 1-2

Distribution: Occurs on low elevation till landscapes of low to high hills and lower areas of high mountains of central and southern New Hampshire, from 500-1600 ft. elevation**;** in all subsections south of and including the Mahoosuc-Rangeley Lakes, with the possible exception of the Vermont Uplands and Coastal Lowland subsections. No examples have been documented above 1600 ft., but the type may reach 1800-2000 ft. on warm southern exposures in the White Mountains. Good examples are known from White Ledge (Albany), The Basin (Chatham), and Sundown Ledge (Albany).



Sources: NHB field surveys.

ENRICHED FORESTS AND WOODLANDS

Enriched oak forests in the southern part of the state tend to have a substantial presence of Appalachian oaks and other southern plants that are absent further north, where sugar maple is more important, and contain various admixtures of beech, ash, yellow birch, and red oak. Moist, enriched forests with an Appalachian or southern character are presently described from river terrace slopes and flats but may exist in other landscape settings. Some semi-rich mesic forests are described from silt loam till soils. Dry to dry-mesic enriched situations occur on ridges or slopes influenced by circumneutral bedrock, and in colluvial positions where organic matter and fine minerals accumulate, such as bases of steep slopes, ledges, and talus. The vegetation of enriched talus slopes is often distinct enough that the communities are described separately from those on ridges, slopes, or more modest colluvial situations.

Forests on glacial till or river terraces

• Rich sugar maple - oak - hickory terrace forest (S1)

GENERAL DESCRIPTION: This community occurs on steep slopes or flats of river terraces formed from lake-bottom sediments of former glacial lakes, marine intrusion sediments, or high inactive floodplain terrace deposits of more recent origin. These sediments often have considerable silt content that contributes to greater fertility compared to coarse terrace sediments. A broad diversity of tree species may be found in some occurrences of this community, with more than 20 species at a site. Known examples are characterized by Appalachian oaks and hickories, although more northern examples in the Vermont Piedmont subsection lack these southern trees and may be closest to rich mesic forests described elsewhere.

This enriched forest type is a narrowly defined, apparently limited to warm southern or western exposures of steep lakebed sediments/river terrace slopes of the lower Connecticut and Merrimack River valleys. It is similar to but considered distinct from sugar maple floodplain forests that have rich site species and occur on more active floodplains (flooded every 2-10 years).

Soils tend to be deep, loamy, mesic, and fertile. Lakebed sediments range from sands to silts and less frequently clays. Terrace slopes often have silt and clay layers that impede drainage and result in horizontal emergence of water (seeps) on steep banks. The variety of sediment textures and drainage classes on these slopes create a broad diversity of conditions for plant growth. Unadilla, Suffield, Hartland, and Belgrade soil series are all formed from glacio-lacustrine deposits and may support this community. Seeps are common on slope faces within this community.

CHARACTERISTIC VEGETATION: This community probably supports a higher diversity of tree and other woody species than any other natural habitat in the state, and this is one factor that distinguishes this community from other enriched forests. There is often an interesting mix of species characteristic of floodplains, rich mesic forests, upland forests, and seeps.

Tree species may include *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), *F. pennsylvanica* (green ash), *Tilia americana* (basswood), *Juglans cinerea* (butternut), *Tsuga canadensis* (hemlock), *Quercus rubra* (red oak), *Q. alba* (white oak), *Carya ovata* (shagbark hickory), *C. cordiformis* (bitternut hickory), several *Betula* spp. (birches), *Acer rubrum* (red maple), *Prunus serotina* (black cherry), *Ulmus americana* (American elm), and others. Other more southern or Appalachian woody species include *Cornus florida* (flowering dogwood), *C. rugosa* (round-leaved dogwood), *Carpinus caroliniana* (musclewood), and *Ostrya virginiana* (ironwood).

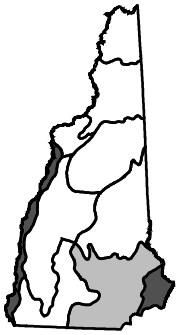
Nutrient-demanding understory species include *Erythronium americanum* (dogtooth violet), *Asarum canadense* (wild ginger), *Matteuccia struthiopteris* (ostrich fern), *Anemone americana* (blunt-lobed hepatica), *A. acutiloba* (sharp-lobed hepatica), *Adiantum pedatum* (northern maidenhair fern), *Dicentra cucullaria* (Dutchman's

breeches), *Asplenium platyneuron* (ebony spleenwort), and *Caulophyllum thalictroides* (blue cohosh). Some examples along the Connecticut River harbor the rare *Staphylea trifolia* (bladdernut)* and *Hydrophyllum virginianum* (northern waterleaf)*.

Other frequent and characteristic species include *Onoclea sensibilis* (sensitive fern), *Toxicodendron radicans* (climbing poison ivy), *Smilacina racemosa* (false Solomon's seal), *Parthenocissus quinquefolia* (Virginia creeper), *Viburnum acerifolium* (maple-leaved viburnum), *Hamamelis virginiana* (witch hazel), and *Alnus incana* (speckled alder). Groundwater emergence is often evident on the slope face above restrictive sediment layers or at the base of the terrace slope, supporting forest seep vegetation including *Equisetum hyemale* (scouring rush), *Carex scabrata* (rough sedge), *Chelone glabra* (white turtlehead), *Impatiens capensis* (spotted touch-me-not), and other seep indicators (see forest seep description).

Classification confidence: 2-3

Distribution: Occurs on valley bottom sediments of river terraces formed from glacial lake bottom sediments along southern and central reaches of major rivers (and possibly along coastal rivers) of Northern Connecticut River, Vermont Piedmont, Coastal Plain and Coastal Lowland subsections. Good examples occur on the riverbluff below the SPNHF Conservation Center (Concord), the riverbluff above Vernon dam (Hinsdale), and in part of Bedell Bridge State Park (Haverhill).



Sources: NHB field surveys.

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

General description: This community is analogous to semi-rich mesic sugar maple forests but occurs at lower elevations and more southern latitudes and contains significant amounts of southern and Appalachian species. A diversity of oaks, hickories, sugar maple, and white ash dominate with a moderate to well developed woody understory and a scattered to moderately abundant herb layer. This community is distinguished from more nutrient poor forest types by having species indicative of weakly enriched conditions, and is distinguished from rich mesic forests in more enriched conditions by the absence of strong enrichment indicators (see below). It also lacks many of the rare and uncommon species diagnostic of dry rich Appalachian oak - hickory forest.

Soils are well to moderately well drained fine sandy loams, loams, or silt loams with a very shallow hemic O horizon (1-2 cm+), shallow very dark gray to brown A horizons (2-10 cm), and brown to yellowish brown upper B horizons. Moisture availability ranges from dry-mesic to mesic and may be at least seasonally drier than most rich mesic forests. Bedrock types include formations that are mafic or have intermediate base-cation content such as diorites and gabbros, and the Elliot, Berwick and Kittery formations. Some sites have silty soils associated with marine deposits. Settings range from flat to moderately sloped terrain or colluvial positions at slope bases.

Characteristic vegetation: This community is characterized by a moderately diverse tree canopy dominated by a combination of *Acer saccharum* (sugar maple), *Carya ovata* (shagbark hickory), *Quercus rubra* (red oak), *Q. velutina* (black oak), and *Fraxinus americana* (white ash). *Pinus strobus* (white pine) is frequent. *Quercus alba* (white oak), *Tilia americana* (basswood), *Betula lenta* (black birch), and *Prunus serotina* (black cherry) are occasionally present in some abundance, but not as constant as the other dominants. *Tsuga canadensis* (hemlock) is occasional but never dominant (<15%), and *Fagus grandifolia* (American beech) is infrequent and not abundant. *Ostrya virginiana* (ironwood) is often abundant or dominant in the understory, and *Carpinus caroliniana* (musclewood) is occasionally abundant. Among these trees sugar maple, ash, basswood, ironwood, and musclewood are usually indicative of at least somewhat enriched conditions.

Tall shrubs include an abundance of *Viburnum acerifolium* (maple-leaved viburnum) and lesser amounts and constancy of *Hamamelis virginiana* (witch hazel), *Viburnum dentatum* (northern arrowwood), *Cornus florida* (flowering dogwood), *Corylus cornuta* (beaked hazel-nut), and in disturbed examples, *Berberis* spp. (barberries).

Any combination of three or more of the following semi-rich differential species will distinguish the type from more acidic forests: *Polystichum acrostichoides* (Christmas fern), *Anemone americana* (blunt-lobed hepatica), *Polygonatum pubescens* (hairy Solomon's seal), wide-leaved sedges (*Carex blanda*, *C. laxiflora*, and *C. laxiculmis*), *Actaea rubra* (red baneberry), *Desmodium glutinosum* (cluster-leaved tick-trefoil), *Phegopteris hexagonoptera* (broad beech fern), *Viola rotundifolia* (round-leaved violet), *Tiarella cordifolia* (foamflower), and *Toxicodendron radicans* (climbing poison ivy). Most sites have only a few of these differential species. The following species may be found on more mesic microhabitats: *Arisaema triphyllum* (Jack-in-the-pulpit), *Onoclea sensibilis* (sensitive fern), *Osmunda claytoniana* (interrupted fern), *Circaea alpina* (small enchanter's nightshade), *Viola* spp. (violets), and *Geum canadense* (white avens).

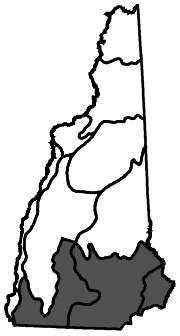
Other characteristic species (not restricted to enriched conditions) include *Mitchella repens* (partridge-berry)(often abundant), *Dryopteris carthusiana* (spinulose wood fern), *Trientalis borealis* (starflower), *Athyrium filix-femina* (lady fern), *Uvularia sessilifolia* (sessile-leaved bellwort), *Solidago caesia* (blue-stemmed goldenrod), *Maianthemum canadense* (Canada mayflower), *Aralia nudicaulis* (wild sarsaparilla), and *Monotropa uniflora* (Indian pipes).

Various other species of northern hardwood and transition hardwood forests tend to be absent. The broader range of enriched site species noted for rich mesic forests are lacking, although all of the above mentioned species may also occur in a rich mesic forest.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Found on low elevation till and marine sediment soils in the Coastal Lowland, Coastal Plain, Connecticut River, and southern portion of the NH Upland subsections. Elevations of known examples are less than 500 ft., and the community probably does not exceed 800 ft. Good examples occur in the Crommet Creek vicinity (Durham), south shore of Great Bay (Greenland), and Pawtuckaway State Park (Nottingham).

SOURCES: NHB field surveys.



Forests and woodlands on rocky ridges, colluvial slopes, or talus

• Rich Appalachian oak rocky woods (S1)

GENERAL DESCRIPTION: This community occurs in southern New Hampshire on somewhat to very rocky till hillsides and talus slopes and is characterized by Appalachian oaks, hickories, and a diverse assemblage of rich-site herbs near their northern distributional limit. The community has a "thin woods" aspect with a partially open forest or woodland canopy and an open understory with few shrubs. This community occupies native habitat for a large number of southern species, many of which are rare in New Hampshire.

It is most frequent on south, southeast and west aspects and occasionally on ridgetops. Soils are often thin and rocky or are comprised of talus, and range from dry to dry-mesic in moisture status. Colluvial sediments and intermediate or base-rich bedrock associated with these forests probably contributes to the elevated nutrient status indicated by the species composition. Bedrock types include various diorites, monzodiorites, mafic bedrock types, and in the seacoast area, the Berwick, Eliot, Rye, and Kittery Formations.

CHARACTERISTIC VEGETATION: Frequent or abundant trees include *Quercus rubra* (red oak), *Ostrya virginiana* (ironwood), *Quercus alba* (white oak), *Fraxinus americana* (white ash), *Carya ovata* (shagbark hickory), *C. ovalis* (sweet pignut hickory), *C. cordiformis* (bitternut hickory), *C. glabra* (pignut hickory), and *Acer saccharum*

(sugar maple). *Acer rubrum* (red maple), *Tsuga canadensis* (hemlock), *Pinus strobus* (white pine), and *Quercus prinus* (chestnut oak) are occasional. *Carex pensylvanica* (Pennsylvanian sedge) may be present, but oak forest dominated by this species are described elsewhere. *Quercus velutina* (black oak) and *Q. coccinea* (scarlet oak) may also be present.

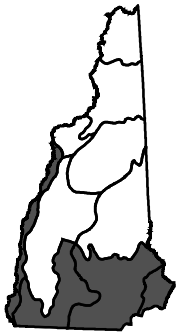
Differential species that are indicative of an elevated nutrient status and that distinguishes this community from other oak - hickory forests include: *Asplenium platyneuron* (ebony spleenwort) (present in most examples in low abundance), *Saxifraga virginiensis* (early saxifrage), *Carex platyphylla* (flat-leaved sedge), *Ranunculus fascicularis* (early buttercup)*, *Anemone americana* (blunt-lobed hepatica), *Aster patens* (skydrop aster)*, *Arabis canadensis* (sickle-pod)*, *A. laevigata* (smooth rock-cress)*, *A. missouriensis* (Missouri rock-cress)*, *Aureolaria virginica* (downy false-foxglove)*, *Carex retroflexa* (reflexed sedge)*, *Lespedeza virginica* (slender bush-clover)*, *Pycnanthemum incanum* (hoary mountain mint)*, *Paronychia canadensis* (smooth-forked chickweed)*, *Anemonella thalictroides* (rue anemone)*, *Asclepias quadrifolia* (four-leaved milkweed)*, and *Woodsia obtusa* (blunt-lobed woodsia)*. Other species present may include *Viburnum rafinesquianum* (downy arrowwood)*, *Muhlenbergia sobolifera* (sprout muhlenbergia)*, *Antennaria plantaginifolia* (pussy-toes), *Viola pedata* (bird's-foot violet)*, *Aureolaria pedicularia* var. *intercedens* (fern-leaved false-foxglove)* as well as many of the other species listed for oak - hickory forests. *Carex pensylvanica* (Pennsylvanian sedge) may occur in this community, but it generally does not form extensive lawns as in the red oak - ironwood / Pennsylvania sedge lawn community.

VARIANTS: Two variants are described:

1. **Till variant**: This variant occurs on rocky till slopes as described above.
2. **Talus variant**: Most of the species mentioned for the typic variant can also occur in the talus variant. Species more frequent or abundant on talus include *Cornus rugosa* (round-leaved dogwood), *Geranium robertianum* (herb Robert), *Juglans cinerea* (butternut), *Betula lenta* (black birch), *Aralia racemosa* (spikenard), *Oryzopsis racemosa* (blackseed rice-grass), *Clematis virginiana* (virgin's bower), *Toxicodendron radicans* (climbing poison ivy), *Rubus odoratus* (purple-flowering raspberry), and *Carex sprengelii* (long-beaked sedge). Species characteristic of both acidic and enriched talus include *Dryopteris marginalis* (marginal wood fern), *Polypodium virginianum* (rock polypody), *Parthenocissus quinquefolia* (Virginia creeper), *P. vitacea* (grape-woodbine), *Polygonum cilinode* (fringed bindweed), *Solidago caesia* (blue-stemmed goldenrod), *Smilacina racemosa* (false Solomon's seal), *Ribes* spp. (gooseberries and wild currants), and *Deschampsia flexuosa* (common hair-grass).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Low elevation till landscapes of the Coastal Lowland, Coastal Plain, and Northern Connecticut River subsections from sea level to 500 ft. elevation. Good examples of the rocky colluvial till slope variant are found at Jeremy Hill (Pelham), and Merrill Hill (Pelham). Good examples of the talus variant occur on Mt. Pawtuckaway (Nottingham), in the Crommet and Johnson Creek watersheds (Newmarket and Durham), and Mt. Wantastiquet (Hinsdale).



SOURCES: NHB field surveys.

• Rich red oak rocky woods (S2S3)

GENERAL DESCRIPTION: This is a woodland or "thin woods" natural community that occurs on enriched colluvial talus and till slopes in central and southern New Hampshire, and into the lower elevation slopes of major valleys in the White Mountains. It is characterized by a variable and diverse mix of woody, fern, graminoid,

and other herbaceous species, including numerous rich site species. This community shares some rich site species with rich mesic forests, but supports certain species preferential to talus or dry-rich rocky habitats, including numerous vines (lianas), and disturbance or open-site tolerant species that occupy gaps.

Soils are rocky, colluvial till or talus from cliffs and have a dry-mesic to mesic moisture regime with inclusions of wetter and drier microhabitats. Source bedrock consists of intermediate to basic bedrock types yielding elevated levels of calcium and/or other base-cations and moderately enriched conditions. Bedrock types include some syenites, diorites, and Ammonoosuc Volcanics Formation. Some examples occur on talus enriched by minor base-cation bearing inclusions within otherwise acidic rock (i.e., injected with dikes or matrix bedrock that has been otherwise altered hydrothermally to produce base-rich weathering products (Bailey 2001)). Organic and mineral colluvium that has accumulated at cliff-bases and on rocky slopes contributes to enrichment.

CHARACTERISTIC VEGETATION: Tree canopy dominants usually include *Acer saccharum* (sugar maple) and *Quercus rubra* (red oak), with lesser amounts of *Tilia americana* (basswood), *Fraxinus americana* (white ash), *Ostrya virginiana* (ironwood), *Betula lenta* (black birch), *Acer rubrum* (red maple), and occasionally *Betula alleghaniensis* (yellow birch) and *B. papyrifera* var. *papyrifera* (paper birch). Softwoods are sparse or absent. Understory shrub and herbaceous species that prefer enriched conditions and differentiate this community from acidic till or talus forests include *Cornus rugosa* (round-leaved dogwood), *Saxifraga virginiensis* (early saxifrage), *Geranium robertianum* (herb Robert), *Juglans cinerea* (butternut), *Asplenium platyneuron* (ebony spleenwort), *Aralia racemosa* (spikenard), *Oryzopsis racemosa* (blackseed rice-grass), *Clematis virginiana* (virgin's bower), *Toxicodendron radicans* (climbing poison ivy), *Corylus cornuta* (beaked hazel-nut), *Asarum canadense* (wild ginger), *Rubus odoratus* (purple-flowering raspberry), *Carex rosea*/*radiata* (rosey sedge), *C. platyphylla* (flat-leaved sedge), and *C. sprengelii* (long-beaked sedge). Potential rare species of rich sites include *Arabis canadensis* (sickle-pod)*, *A. laevigata* (smooth rock-cress)*, *Geranium carolinianum* (Carolina cranesbill)*, *Dentaria laciniata* (cutleaf toothwort)*, *Adlumia fungosa* (climbing fumitory)*, and *Carex aestivalis* (summer sedge)*. *Milium effusum* (millet-grass) is a possible uncommon species that may be found at rich sites.

Species characteristic of both acidic and enriched talus include *Dryopteris marginalis* (marginal wood fern), *Polypodium virginianum* (rock polypody), *Parthenocissus quinquefolia* (Virginia creeper), *P. vitacea* (grape-woodbine), *Polygonum cilinode* (fringed bindweed), *Celastrus scandens* (American bittersweet), *Solidago caesia* (blue-stemmed goldenrod), *Smilacina racemosa* (false Solomon's seal), *Ribes* spp. (gooseberries and wild currants), *Deschampsia flexuosa* (common hair-grass), and *Fragaria vesca* (wild strawberry). Examples in the White Mountain region may have the northern plants *Arabis drummondii* (Drummond's rock-cress), *Clematis occidentalis* (purple clematis), and *Polystichum braunii* (Braun's holly fern).

VARIANTS: Talus and rocky till slopes are inherently diverse and variable, but do exhibit some fairly distinct differences related to the overall moisture status of the soil. The corresponding mesic and dry to dry-mesic variants are described below.

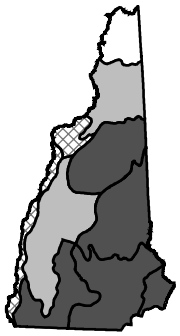
1. **Rich mesic variant**: In moist talus areas, herbs, vines, and ferns may form a lush understory with a glade-like or "fern-glade" appearance with a relatively sparse shrub layer. Moist conditions are often found in gullies or other runoff areas, on lower portions of the talus, or at the base of the cliff. Ferns, sugar maple, and ash may be more prominent, with oak somewhat less prominent, and many species present in rich mesic forests become more common. The distinction from rich mesic forests becomes more subtle in these situations: when characteristic species and talus indicators (listed above) and red oak and yellow birch disappear and rich mesic indicators predominate, the site is best classified as rich mesic forest. These mesic rich-site species include *Erythronium americanum* (dogtooth violet), *Adiantum pedatum* (northern maidenhair fern), *Caulophyllum thalictroides* (blue cohosh), *Eupatorium rugosum* (white snakeroot), *Cardamine diphylla* (broad-leaved toothwort), *Allium tricoccum* (wild leek), *Dicentra canadensis* (squirrel-corn)*, *D. cucullaria* (Dutchman's breeches), *Adlumia fungosa* (climbing fumitory)*, *Deparia acrostichoides* (silvery spleenwort), *Panax quinquefolius* (ginseng)*, and many others. Other moist-site ferns include *Athyrium filix-femina* (lady fern), *Dryopteris intermedia*

(intermediate wood fern), *Polystichum acrostichoides* (Christmas fern), the very rare *Diplazium pycnocarpon* (narrow-leaved spleenwort)*, and, in northern examples, *Polystichum braunii* (Braun's holly fern). Numerous broad-leaved forest sedges (Laxiflorae group) may be present including *Carex platyphylla* (flat-leaved sedge) and *C. plantaginea* (plantain-leaved sedge).

2. **Dry rich variant**: Dry to dry-mesic portions of talus slopes or those that are only seasonally moist tend to have species characteristic of both acidic and rich talus slopes [e.g., *Dryopteris marginalis* (marginal wood fern)], *Polypodium virginianum* (rock polypody), *Parthenocissus quinquefolia* (Virginia creeper)) as well as those that prefer dry conditions. Red oak and ironwood may be more prominent and sugar maple less so. The understory herb layer is generally more sparse. Rich site species that appear to be somewhat tolerant of drier or seasonally moist conditions include *Oryzopsis racemosa* (blackseed rice-grass), *Woodsia ilvensis* (rusty woodsia), *Saxifraga virginiensis* (early saxifrage), *Toxicodendron radicans* (climbing poison ivy), *Carex rosea* (star sedge), *Arabis drummondii* (Drummond's rock-cress), and *Geranium robertianum* (herb Robert). Species characteristic of drier talus (both acidic and enriched) that are sparse or absent on moist talus include *Deschampsia flexuosa* (common hair-grass), *Aralia hispida* (bristly sarsaparilla), *Cardamine parviflora* (narrow-leaved bitter cress), *Antennaria plantaginifolia* (pussy-toes), *Hystrix patula* (bottle-brush grass), *Oryzopsis asperifolia* (rough-leaved rice-grass), *Pteridium aquilinum* (bracken), *Carex lucorum* or *C. pensylvanicum* (woodland and Pennsylvania sedges), *C. tonsa* var. *rugosperma* (shaved sedge), *Chenopodium boscianum* (Bosc's pigweed)*, *C. album* (lamb's quarters), *Hedeoma pulegioides* (American pennyroyal), and *Elymus trachycaulus* (wheatgrass).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community occurs in hilly or mountainous areas of northern and central New Hampshire mostly below 1200 ft. elevation (occasionally 1800-2000 ft. elevation). The major low elevation river valleys in the White Mountains all have examples of this community with assemblages of southern species not found at higher elevation or more interior locations in the White Mountains. Good examples occur at Rattlesnake Mtn. (Rumney), Bald Knob (Moultonboro), Whites Ledge (Bartlett), and Devil's Slide (Stark).



SOURCES: NHB field surveys; Pease 1964.

• Red oak - ironwood - Pennsylvania sedge woodland (S2)

GENERAL DESCRIPTION: This is an uncommon to rare community of central and southern New Hampshire on open ridges and upper slopes of hills and low mountains influenced by intermediate (near circumneutral) bedrock. It is characterized by open park-like stands of stunted or short oaks, hickories, sugar maple, white ash, ironwood and dense lawns of *Carex pensylvanica* (Pennsylvanian sedge) with a variety of rich-site herbs.

This community is often associated with thin, rocky loam or sandy loam soils derived from intermediate, base-rich, or mafic bedrock (including syenite, diorite, and diabase). Soil moisture ranges from dry to dry-mesic. These enriched sites may cover many acres, or may correspond to small areas within larger, acidic rocky ridge or forest communities.

CHARACTERISTIC VEGETATION: Characteristic trees include *Quercus rubra* (red oak), *Carya ovata* (shagbark hickory), *Fraxinus americana* (white ash), *Acer saccharum* (sugar maple), *Ostrya virginiana* (ironwood), and *Pinus strobus* (white pine). The dense lawns of *Carex pensylvanica* (Pennsylvanian sedge) are diagnostic of somewhat enriched conditions and distinguish this community from rich Appalachian oak rocky woods. *Carex lucorum* (distant sedge) is a very similar species that can occur, but is more diagnostic of more nutrient-poor conditions of acidic rocky ridges, sandy soils, and other poor soil conditions. Other herbs characteristic of

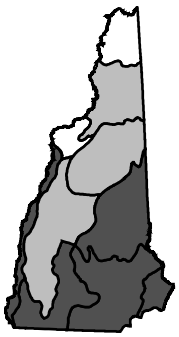
rocky ridges are common such as *Anemone quinquefolia* (wood anemone), *Aquilegia canadensis* (wild columbine), *Deschampsia flexuosa* (common hair-grass), *Oryzopsis asperifolia* (rough-leaved rice-grass), *Antennaria plantaginifolia* (pussytoes), *Solidago caesia* (blue-stemmed goldenrod), and *Dryopteris marginalis* (marginal wood fern). Enriched-site species that differentiate this community from other rocky ridges include *Minuartia stricta* (rock sandwort)*, *Woodsia ilvensis* (rusty woodsia), *Asplenium platyneuron* (ebony spleenwort), *Carex radiata* (stellate sedge), *Anemone americana* (blunt-lobed hepatica), *Campanula rotundifolia* (harebell), *Galium circaezans* (wild licorice), *Tilia americana* (basswood), sugar maple, and *Fraxinus americana* (white ash). At least one occurrence contains species characteristic of mafic "traprock" bedrock and deserves further research. Species here include *Selaginella rupestris* (rock spikemoss), *Agalinis tenuifolia* (slender gerardia), and native occurrences of *Cerastium arvense* (field chickweed).

VARIANTS: Two variants are described.

1. **Appalachian oak - hickory variant**: This variant is characterized by southern oaks (white, black, chestnut), hickories, and numerous species with southern distributions that do not reach central New Hampshire or the White Mountains including *Woodsia obtusa* (blunt-lobed woodsia)*, *Ranunculus fascicularis* (early buttercup)*, *Carex retroflexa* (reflexed sedge)*, *C. cephalophora* (headed sedge), and *Triodanis perfoliata* (Venus's looking-glass).
2. **Red oak variant**: This variant is more prevalent in central New Hampshire and the lower slopes and ridges in major southern valleys of the White Mountains. It lacks many or all of the southern species mentioned in the Appalachian oak variant. *Minuartia stricta* (rock sandwort)* and *Polygonum douglasii* (Douglas' knotweed)* occur in a few examples in the White Mountains.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Found in central and southern New Hampshire subsections south of and including the low elevation river valleys of the White Mountain subsection (Saco River valley). Landscapes are shallow-to-bedrock areas of ridges and slopes on hills, low mountains, and lower slopes of higher mountains. More northern examples may exist but are not well documented. Elevations range from 400-1600 ft. in known examples. Good examples are found on The Rattlesnakes (Holderness), Fall Mtn. (Walpole), Mt. Pawtuckaway (Nottingham), and Harts Ledge (Bartlett).



SOURCES: NHB field surveys.

WOODED WETLANDS AND FLOODPLAIN FORESTS

This section contains descriptions of forested swamps, floodplain forests, and other forests that are temporarily flooded or influenced by a seasonally high water table where the canopy cover of trees exceeds 25%. Forested swamps are generally poorly or very poorly drained and are seasonally flooded to saturated. Floodplain forests are temporarily flooded and range from poorly drained to moderately well drained. Other forests that are influenced by a seasonally high water table are transitional between hydric forested wetlands and uplands and typically have somewhat poorly drained soils, with a range from poorly drained to moderately well-drained. These "low" or wet forests are either temporarily flooded (i.e., along drainage ways), seasonally saturated (i.e., along the upland transition of various wetlands), or otherwise maintain a seasonally high water table (such as on silt soils in coastal or northern New Hampshire).

FLOODPLAIN FORESTS

Floodplain forests are diverse ecosystems that occur at the interface between the aquatic and terrestrial environments in river valley bottomlands adjacent to river channels. River floodplains are dynamic environments affected by periodic, temporary flooding. As water levels rise over riverbanks, sediment is transported from upstream and 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). Soils range from well drained coarse sands on levees, to poorly drained silts and mucks in floodplain sloughs, vernal pools, and microtopographic depressions.

Frequency, intensity and duration of flooding depends on watershed size and the relative elevation of the floodplain terraces (low, medium, and high) above the riverbank (Dollar et al. 1992). Larger watersheds generate greater volumes of flood water and for a longer duration as the land area above drains to the valleys below. Although several definitions exist in the scientific literature (see Rosgen 1996 and Dunn and Leopold 1978), for the purposes of this document, low floodplain forests flood approximately every one to three years, whereas medium and high floodplain forests have longer flood return intervals. High terraces represent inactive floodplains that are essentially isolated from flood dynamics. High terraces are generally characterized by flood intervals that exceed 100 years, which is reflected by greater soil horizon development and a greater proportion of upland species present. Floodplain sloughs, vernal pools, and microtopographic depressions within the floodplain tend to pond flood waters and experience longer flood durations. Different floodplain forest types occur in the various combinations of flood frequency, intensity and duration based on the plant species adapted to the particular hydrologic regimes.

Plant species that occur in floodplain forests are mostly facultative wetland species able to tolerate flooding. Common life history strategies of species in floodplains include strong root systems, either via prolific rhizomes (e.g., some nettle species) or perennial, cespitose growth habit (e.g., *Matteuccia struthiopteris* var. *pensylvanica* (ostrich fern) and some grass species), and production of large quantities of wind- or water-dispersed seeds (e.g., many annual plants). Relatively few woody species are able to endure prolonged inundation. However, *Acer saccharinum* (silver maple) seedlings are adapted to survive long periods of inundation and are, therefore,

able to persist in low floodplains (Burns and Honkala 1990). Rare species documented from floodplain forests include *Cardamine bulbosa* (bulbous bitter-cress)*, *Allium canadense* (wild garlic)*, *Mikania scandens* (climbing hempweed)*, *Carex cristatella* (small crested sedge)*, *Carex seorsa* (separated sedge)*, *Acer nigrum* (black maple)*, and *Betula nigra* (river birch)*.

Historically, floodplain forest natural communities have been fragmented and impacted by agriculture, timber harvesting, and development. The flat, relatively productive soils are prime for alternative land use, especially higher terraces that are no longer regularly flooded. Region-wide, floodplain forests are imperiled, as the natural processes that have created and sustained them have been altered by dam construction and river channelization. Additionally, several floodplain forest types are rare due to New Hampshire's location at the edge of the geographic range of the predominant canopy species.

Floodplain forests of major rivers

Low floodplain forests associated with New Hampshire's major (fourth-order and higher) rivers are typically dominated by *Acer saccharinum* (silver maple) and/or *Acer saccharum* (sugar maple) (Bechtel and Sperduto 1998). The best examples of each of these are larger than 30 acres, with other associated communities along the edges or on higher terraces. There are two silver maple and two sugar maple community types.

Two silver maple floodplain forest types collectively represent classic floodplain forests on large rivers in New Hampshire. Canopies of these forests are strongly 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 (e.g., *Vitis riparia* (river grape) and others) tend to be abundant, especially along edges and in canopy gaps. Average species richness for herbaceous species is intermediate compared to floodplain forests. Although the two types described below are similar in their canopy structure, herbaceous species and floristic patterns are distinct.

Two sugar maple floodplain forest types are characterized by the dominance of sugar maple, or sugar and silver maples. These communities are rare in New Hampshire and primarily occur along northern rivers. These natural communities may be influenced by occasional enriched site conditions, from lower flood frequency, but higher flood intensity, or their occurrence at the transition to upland forests. The sugar maple floodplain types average percent canopy cover is higher than the red and silver maple types, while their total herb cover is lowest among New Hampshire's floodplain forests. However, within-plot species richness tends to be fairly high compared to other types. Vine, shrub, graminoid, and subcanopy cover are all similar to the silver maple types, while fern cover is lowest compared to other types.

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

General description: This is one of two distinct floodplain forest community types in New Hampshire dominated by *Acer saccharinum* (silver maple). These forests are found along large rivers often associated with a confluence between the mainstem and a tributary, although they also develop along river meanders or other slow moving areas of the river course. These riparian forests are flooded annually with peak floods in spring from snowmelt and drainage higher in the watershed. Additionally, flood regimes are now artificially controlled along rivers with this community type. This community occupies lower floodplains with deep, alluvial, silty soils. There is a high degree of microtopographic variation, with sand levees near the river's edge, riparian vernal pools, soil depressions surrounding large tree trunks, and sloughs. Sloughs and drainage channels can be up to two meters deep and often support marsh vegetation soon after floodwaters recede.

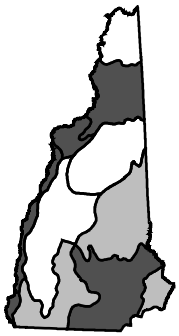
On average, the silver maple - wood nettle - ostrich fern floodplain forest has nearly twice the percent coverage of forbs (contributing to a higher total herb cover), as well as the highest fern coverage compared to other floodplain natural communities. Graminoid, shrub, and sub-canopy tree coverage is low, especially compared to red maple floodplain forests.

Soils are generally somewhat poorly drained to moderately well drained silt loams or very fine sandy loams. Due to the dynamic nature of flooding and almost yearly deposition of new soil material, soil horizon development is virtually absent. Organic debris from leaf litter and flood wash is occasionally buried under new silt and sand deposits creating layers or lenses of slowly decomposing organic matter, interspersed with either orange-red mottled sediments, or pure gray silt. Soil pH is highly variable. Average pH is 5.7, but more basic examples are found along the Connecticut River, perhaps due to the more base-rich bedrock in this part of the state. Watershed size varies widely, but most examples are found where upstream basin size exceeds 2,000 mi^2.

Characteristic vegetation: The tree layer is uniformly dominated by *Acer saccharinum* (silver maple), with *Fraxinus americana* (white ash), *Ulmus americana* (American elm), and *Populus deltoides* (eastern cottonwood) present in varying proportions. *Celtis occidentalis* (hackberry)* and *Juglans cinerea* (butternut) can occur in Connecticut River examples, especially along the river or upland edge. Similar tree species are usually growing in the sub-canopy, however shrubs and vines grow only along edges or in recent gaps created by natural or human-induced disturbance. Otherwise, the shrub layer is typically poorly developed or absent. A rich, thick carpet of herbaceous growth under the over-arching canopy creates an open, high-ceiling, cathedral-like appearance in most examples. The herb layer is often strongly dominated by lush *Matteuccia struthiopteris* var. *pensylvanica* (ostrich fern) and *Laportea canadensis* (wood nettle), both of which can grow 1.8 m (6 ft.) tall. Other herbaceous and vine species are usually present, but never dominant, include *Onoclea sensibilis* (sensitive fern), *Athyrium filix-femina* (northern lady fern), *Cinna arundinacea* (common woodreed), *Boehmeria cylindrica* (false nettle), *Impatiens capensis* (spotted touch-me-not), *Thalictrum pubescens* (tall meadow-rue), *Arisaema triphyllum* (Jack-in-the-pulpit), *Parthenocissus quinquefolia* (Virginia creeper), and *Eupatorium maculatum* (spotted Joe-pye-weed). The rare *Arisaema dracontium* (green dragon)* is found along the Connecticut River at some sites in low floodplain terraces among ostrich fern.

Classification confidence: 1

Distribution: This type is found primarily along major rivers, especially the Connecticut River, although it occurs throughout the state in smaller watersheds, including the Merrimack, Saco, and Dead Diamond Rivers. The largest, most mature and best-developed examples are along the Connecticut River mainstem. Those along the Saco and Dead Diamond tend to be marginal and small relative to upper terrace forests. Good examples can be found at Bedell Bridge State Park (Haverhill), Howard Island (Haverhill), Cheshire County Site (Westmoreland), and portions of the NH Technical Institute floodplain (Concord).



Sources: Bechtel and Sperduto 1998; Sperduto and Crowley 2002b.

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

General description: This type is the most common silver maple floodplain forest in New Hampshire away from the Connecticut River. It is similar to the silver maple - wood nettle - ostrich fern floodplain forest, but it is distinguished by a more diverse ground cover. It also tends to occur on more medium-sized rivers, on sandier and generally more acidic soil. While flooding intensity and frequency are comparable in both of the silver maple types, this one may be characterized by shorter duration, higher disturbance floods. Over-arching *Acer saccharinum* (silver maple) characterizes this type, with *Ulmus americana* (American elm) in association. A lack of *Fraxinus americana* (white ash), *Celtis occidentalis* (hackberry)*, and *Juglans cinerea* (butternut) hint at the more acidic nature of the soils in this type. Herb species diversity and richness is higher and more variable in this type as well. There is a high degree of microtopographic variation, with sand levees near the river's edge, riparian vernal pools, soil depressions surrounding large tree trunks, and sloughs.

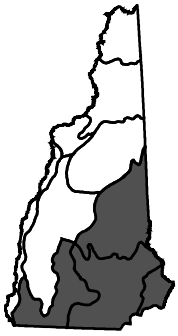
This type has a distinctly higher graminoid % cover, higher total herb species richness, and lower tree species richness than the silver maple - wood nettle - ostrich fern type. Total forb species richness per plot is also higher than in the other type, reflecting the variability of species found within this type, but lower average species richness reflects fewer species encountered from site to site.

Soils are highly variable, ranging from somewhat poorly drained silt loams to well drained sandy loams. Soil pHs tend to be slightly acidic (average pH=5.3), perhaps related to base-poor bedrock in these eastern drainage basins. Although variable, this type is found on rivers with drainage basins less then 1,000 mi^2 in area above site locations, although some Merrimack River examples have upstream basin areas approaching 2,000 mi^2.

Characteristic vegetation: The tree layer is dominated by a nearly pure cover of *Acer saccharinum* (silver maple) with *Ulmus americana* (American elm) as a subcanopy associate. Shrubs are not prevalent in this type, except on edges and canopy gaps; patches of *Spiraea alba* (eastern meadowsweet) can occur in drier microhabitats or *Cephalanthus occidentalis* (buttonbush) in wet sloughs or channels. The herb layer is usually dominated by *Onoclea sensibilis* (sensitive fern) or codominated by sensitive fern and *Boehmeria cylindrica* (false nettle). *Matteuccia struthiopteris* var. *pensylvanica* (ostrich fern) may be present in some examples but there is a notable lack of *Laportea canadensis* (wood nettle). *Toxicodendron radicans* (climbing poison ivy) is prevalent (only occasional in the other silver maple type). Other forbs are similar to the other type, but graminoid species presence, richness, and diversity are all higher in this type, with species such as *Cinna arundinacea* (common woodreed), *Cinna latifolia* (drooping woodreed), *Carex crinita* (drooping sedge), *Leersia virginica* (Virginia cut-grass), and *Carex intumescens* (inflated sedge). The dominance by false nettle and the presence of woodreed are diagnostic of this type.

Classification confidence: 1

Distribution: This community is found primarily in central and southern NH on various medium sized rivers as well as the Merrimack River. Good examples can be found at Merrimack River State Forest (Boscawen), the NH Technical Institute floodplain (Concord), Campton WMA (Campton), along the Ashuelot River near Keene Airport (Keene), Franklin Falls (Franklin), and along the Contoocook River.



Sources: Osgood 1996; Bechtel and Sperduto 1998; Sperduto and Crowley 2002b.

• Sugar maple - ironwood - short husk floodplain forest (S1)

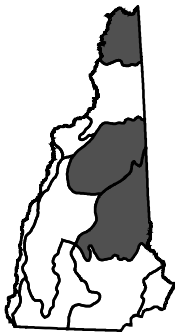
General description: This natural community occurs within the low floodplain terrace of more northern, high gradient rivers. Flood regulation is less common on these rivers. The high-gradient river basins and strong pulse flood regime characteristic of these rivers leads to high disturbance, short duration flooding events. Evidence of high-energy flood pulses includes steep riverbanks, coarse sand deposition, cobble-lined slough channels, patches of cobbles supporting early successional woody vegetation along river edges, and occasional piles of dead woody debris. Plant associations are similar to upland forests, but show considerable evidence of periodic, high intensity flood events that may only temporarily disrupt plant growth. The high variability of flooding intensity and frequency creates multiple microhabitats within sites, and a highly random probability of long-term survival for all plant species present.

This community is distinguished by relatively high percent cover of canopy trees compared to silver maple types. This type has the lowest fern cover of any floodplain forest natural community; cover of upland forbs and grasses is similar to other floodplain forests. This is the primary floodplain forest community along upstream reaches of rivers that drain mountainous terrain.

Soils are somewhat poorly to well drained and generally alluvial, often with buried organic layers beneath fresh sandy alluvium. The upper 15-50 cm of soil is usually finer textured than underlying soil, with a loamy fine sand/fine sandy loam over loamy sand, sand, or less frequently gravel/cobble. Soil pHs consistently range from 5.0-5.4 in the top 50 cm. This community frequently occurs in areas mapped as Suncook, Ondawa, or Colton soil series.

CHARACTERISTIC VEGETATION: The vegetation structure and composition is quite consistent for these maturing (65-100 year-old), second-growth forests. The 20-25 m tall, closed tree canopy is dominated by *Acer saccharum* (sugar maple) and *Quercus rubra* (red oak), with *Fraxinus americana* (white ash) and *Pinus strobus* (white pine; sometimes as supercanopy) of secondary importance. Occasionally *Tilia americana* (basswood), *Acer saccharinum* (silver maple), *Acer rubrum* (red maple), and others occur in the canopy. The subcanopy is variable in height and abundance, but consistently has sugar maple and *Ostrya virginiana* (ironwood) as the principal species. 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. The most abundant or common species were *Solidago caesia* (blue-stemmed goldenrod), *Uvularia sessilifolia* (sessile-leaved bellwort), *Toxicodendron radicans* (climbing poison ivy), *Aralia nudicaulis* (wild sarsaparilla), *Carex pedunculata* (long-stalked sedge), and *Brachyelytrum erectum* (northern short husk grass). The abundance of blue-stemmed goldenrod and northern short husk grass is the most floristically unique aspect in this forest type. A naturalized grass, *Poa nemoralis* (wood bluegrass), is also frequent. The rare *Teucrium canadense* var. *virginicum* (Canadian germander)* is found on medium-height terraces on these floodplains along the Saco River. Overall, the composition of this type indicates somewhat drier conditions than other floodplains.

VARIANTS: Formal variants are not described, but northern floodplain terraces often support softwoods among the hardwoods. At other sites, there may be decreased importance of sugar maple and the increased importance of *Quercus rubra* (red oak), *Tsuga canadensis* (hemlock), and *Fagus grandifolia* (American beech). These also have a notable lack of herb cover, with species composition tending towards that found in acid woods. Furthermore, the soils at these mixed woods sites tend to be coarser (loamy sands over sands and gravel), and hence drier.



CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This forest type occurs along the entire length of the Upper Saco River as well as along moderately sized northern rivers. Good examples are found along the upper reaches of the Saco River, between Bartlett and Conway.

SOURCES: Engstrom 1997; Bechtel and Sperduto 1998; Sperduto and Crowley 2002b.

• Sugar maple - silver maple - white ash floodplain forest (S1S2)

GENERAL DESCRIPTION: This community type occurs primarily along northern rivers and is transitional between pure silver maple floodplain forest and the sugar maple - ironwood - short husk floodplain forest. It generally has the same structural features as these other two communities, with over-arching hardwoods and a fern and forb understory with few shrubs but lower canopy density and higher fern cover than the other sugar maple types. Total and relative species richness values are similar for both sugar maple types. It is found either along the river's edge or on high terraces far from the river, but is flooded during spring runoff.

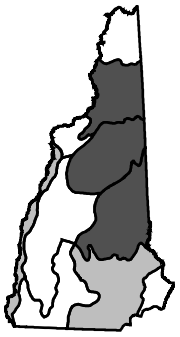
Soils are variable, but tend to be well to moderately well drained sandy loams along northern riverside examples, and somewhat poorly drained silty loams in the back channel landscape position at southern examples. Soils are slightly enriched in some examples, but are not as enriched as the silver maple - wood nettle - ostrich fern floodplain forest. The back-channel examples have little microtopographic variation, instead forming broad

flat terraces that may be lower in elevation than the surrounding landscape; with features suggesting an abandoned river channel. Northern examples are on higher terraces similar to the sugar maple - ironwood - short husk floodplain forest, with evidence of high intensity flood pulses. Some examples have rich-site herbs indicative of enriched conditions.

CHARACTERISTIC VEGETATION: *Acer saccharinum* (silver maple) and *Acer saccharum* (sugar maple) share canopy dominance with *Fraxinus americana* (white ash). The presence of ash is diagnostic and may be related to the somewhat enriched soils of this type. *Prunus serotina* (black cherry) is present in some higher terrace examples, and *Ulmus americana* (American elm) occasionally grows in the sub-canopy, with occasional northern hardwood species, including *Betula alleghaniensis* (yellow birch). *Toxicodendron radicans* (climbing poison ivy) is a common vine, while *Brachyelytrum erectum* (northern short husk grass) and *Carex intumescens* (inflated sedge) are common graminoids. Diagnostic ferns of the pure silver maple types – *Onoclea sensibilis* (sensitive fern) and *Matteuccia struthiopteris* var. *pensylvanica* (ostrich fern) – can be found; however, herbs more commonly found in upland northern forests are also characteristic, including *Uvularia sessilifolia* (sessile-leaved bellwort), *Maianthemum canadense* (Canada mayflower), *Smilacina racemosa* (false Solomon's seal), and *Aster divaricatus* (white wood aster). Rich woods indicator herbs, including *Arisaema triphyllum* (Jack-in-the-pulpit) and *Caulophyllum thalictroides* (blue cohosh) are also occasionally present, especially in sites with primarily sugar maple canopies. These patterns, as well as the presence of graminoids, indicate a distinct, albeit transitional type between silver maple and sugar maple floodplain or upland forests.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Found along mostly central and northern rivers with high energy and chaotic flood regimes. The back terrace type is found as far south as Concord, on the Merrimack, but it is primarily found along the Saco and Androscoggin drainages. Good examples are found at the Campton WMA island and at various sites along the Saco River (Bartlett, North Conway).



SOURCES: Bechtel and Sperduto 1998; Sperduto and Crowley 2002b.

FLOODPLAIN FORESTS OF MINOR RIVERS

Significant stretches of floodplain forest occur on third-order and some fourth-order rivers in New Hampshire. These floodplain forests, frequently dominated by *Acer rubrum* (red maple) and other tree species, have statewide significance and form an integral part of wetland corridors of smaller rivers.

Red maple is generally a common component in the tree canopy of all the forested floodplain community types described below. The range of natural communities that may be present on a floodplain is most likely a result of relative height above the river, distance from the river, and the length of time since the river last flooded or altered its course away from its former channel. Floodplain communities that may form a mosaic with red maple dominated or co-dominated forested floodplains include oxbow marshes and ponds, riverside meadows and emergent marshes, sand and gravel barrens, vernal pools, shrub thickets, and other forested floodplain community types. These floodplain community mosaics are hydrologically similar to those occurring with silver maple dominated floodplain forests in that both are profoundly influenced by spring over-bank floods. However, red maple dominated or co-dominated floodplain forests and associated floodplain communities along large streams and minor rivers probably differ hydrologically from their silver maple counterparts along major rivers by (1) reduced flood intensity, (2) typically shorter flooding periods, and (3) flooding that may occur earlier in the year. These types often have a denser shrub layer than found in silver and sugar maple floodplain forests.

• Swamp white oak floodplain forest (S1)

General description: Floodplain forests dominated or co-dominated by *Quercus bicolor* (swamp white oak) are state and regionally rare. In New Hampshire, they are restricted to within 50 km (30 miles) of the coast at less than 45 m (150 ft.) elevation and are associated with heavy (silty) soils of marine or recent floodplain origin. Swamp white oak, *Fraxinus pennsylvanica* (green ash), and other species indicative of moist, fertile conditions are diagnostic of this type. *Betula nigra* (river birch)* is rare in New Hampshire, but is codominant with swamp white oak in several floodplain forests along tributaries of the lower Merrimack River.

Floodplains along three river systems with this natural community ranged from 0.3-2 m (ca. 1-6 ft.) above the main river channel. The lower floodplain is somewhat poorly drained silt loam or fine sandy silt loam with a thin organic horizon [0-2 cm (0-0.8 in.)]. Medium to high floodplain forests are somewhat poorly to moderately well drained with a similar soil profile. Average soil pH is 5.4.

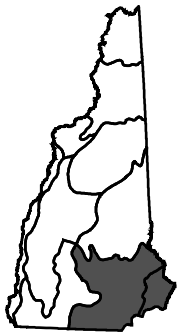
This community type is most similar to the basswood - white ash - black maple floodplain forest and low floodplain examples of the red maple floodplain forest community on fertile soils.

Characteristic vegetation: Both lower and higher floodplains are dominated by a mix of *Quercus bicolor* (swamp white oak) and *Acer rubrum* (red maple), with an understory of *Carpinus caroliniana* (musclewood), abundant *Onoclea sensibilis* (sensitive fern), and variable amounts of *Viburnum dentatum* (northern arrowwood), *Viburnum lentago* (nannyberry), *Ilex verticillata* (winterberry), *Smilax herbacea* (glaucous carrion-flower), and *Toxicodendron radicans* (climbing poison ivy). *Fraxinus americana* (white ash) is occasional. *Carex laxiculmis* (loose-stemmed sedge), an uncommon sedge restricted to silty soils in southern New Hampshire, is also found in this community. There is little or no moss cover.

Variants: Two variants are described based on floristic differences associated with elevation above the river channel, although a continuum of species compositional change is evident across the elevation gradient at most sites. A third variant is described based on the abundance of *Betula nigra* (river birch)*.

1. **Low variant**: The lower floodplain has a moderately dense to dense (40-90%) herbaceous layer, a sparse to moderately dense shrub layer (6-40%), and a light to moderately dense seedling/sapling layer. *Fraxinus pennsylvanica* (green ash) is common to abundant, and apparently unique to this community among non-silver maple floodplain forest communities. Other species that are most frequent and abundant in swamp white oak floodplain forests include *Carex crinita* (drooping sedge), *Cinna arundinacea* (common woodreed), *Thelypteris palustris* (marsh fern), and *Viburnum lentago* (nannyberry). Other herbaceous species indicative of the low floodplain variant include *Cornus amomum* (silky dogwood), *Carex stricta* var. *strictior* (small-tussock sedge), *Iris versicolor* (northern blue flag), *Lysimachia terrestris* (swamp candles), and *Ulmus americana* (American elm).
2. **High variant**: This variant corresponds with medium to high elevation floodplains. The herb layer is moderately dense (40-60%) and the shrub layer is moderately to very dense (30-80%). Tree seedling and sapling regeneration in the shrub layer is sparse. There is a greater abundance of upland tree, shrub, and herb species compared to the low floodplain variant. These include *Carya ovata* (shagbark hickory), *Pinus strobus* (white pine), *Quercus rubra* (red oak), *Prunus serotina* (black cherry), *Ostrya virginiana* (ironwood), *Fagus grandifolia* (American beech), *Thelypteris noveboracensis* (New York fern), *Maianthemum canadense* (Canada mayflower), *Uvularia sessilifolia* (sessile-leaved bellwort), and *Vaccinium angustifolium* (lowbush blueberry). Among floodplain forests in New Hampshire, shagbark hickory is most frequent in this variant.
3. **River birch variant**: All of the species indicative of the low variant of swamp white oak floodplain forest may occur in this variant. Red maple, swamp white oak, *Tilia americana* (basswood), *Fraxinus americana* (white ash), and *Ulmus americana* (American elm) are all common along with abundant *Betula nigra* (river birch)*. *Cardamine bulbosa* (bulbous bitter-cress)* and *Allium canadense* (wild garlic)* are rare plants found in this type. This variant is most similar in species composition to both

the low variant of swamp white oak floodplain forest and the basswood - white ash - black maple floodplain forest community.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Restricted to within 50 km (30 miles) of the coast in the Great Bay watershed and tributaries of the lower Merrimack River. The river birch variant is restricted to the Beaver Brook and Spicket River systems. The Exeter, Lamprey, and Powwow Rivers all contain good examples of the low and high floodplain variants. Beaver Brook and Spicket River contain examples of the river birch variant.

SOURCES: NHB field surveys; Nichols et al. 2000; Sperduto and Crowley 2002b.

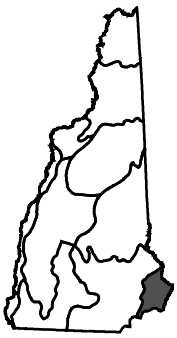
• Basswood - white ash - black maple floodplain forest (S1)

GENERAL DESCRIPTION: This community occurs on narrow floodplains along several streams draining into Great Bay. Stream watersheds are generally less than three square kilometers (two square miles). These forests are flooded during spring runoff periods and perhaps during other peak floods. Hummock-hollow microtopography is absent, but boulders and stones are occasional on the soil surface at some sites. A mixture of species indicative of mesic enriched sites, floodplains, and wetland habitats occur together to distinguish this community from the seepage swamps, rich mesic forests, and river floodplain forests with which it shares some characteristics.

Soils are silty loams with a very shallow or no organic horizon. The water regime is typically somewhat poorly drained but ranges from moderately well drained to poorly drained in local areas.

CHARACTERISTIC VEGETATION: *Tilia americana* (basswood) and *Fraxinus americana* (white ash) are the primary overstory dominants. *Acer saccharum* (sugar maple), *Carya ovata* (shagbark hickory), *Acer rubrum* (red maple), *Quercus rubra* (red oak), and less frequently *Acer nigrum* (black maple)* are occasional or in lower abundance. Although black maple is not present at all occurrences, it appears to be native to this habitat, and it is considered fairly diagnostic of the community. Plant species often found on floodplains and in other wetland communities that are typically common in this community include *Carpinus caroliniana* (musclewood), *Ulmus americana* (American elm), *Cornus amomum* (silky dogwood), *Viburnum lentago* (nannyberry), *Toxicodendron radicans* (climbing poison ivy), *Thalictrum pubescens* (tall meadow-rue), *Onoclea sensibilis* (sensitive fern), *Athyrium filix-femina* (lady fern), *Boehmeria cylindrica* (false nettle), *Impatiens capensis* (spotted touch-me-not), *Ludwigia palustris* (water purslane), and *Solidago rugosa* (rough goldenrod). Several of these plant species are also indicative of soils with higher base status. Other characteristic species are *Aster divaricatus* (white wood aster) and less frequently *Laportea canadensis* (wood nettle), a species of rich alluvial sites.

Non-native and sometimes invasive plants are often present due to the proximity of floodplain habitats to agricultural fields, pastures, and a generally fragmented coastal landscape. These include *Rhamnus cathartica* (common buckthorn), *Berberis vulgaris* (European barberry), *Berberis thunbergii* (Japanese barberry), *Lonicera morrowii* (Morrow's honeysuckle), *Rosa multiflora* (multiflora rose), *Plantago major* (common plantain), and *Sedum* sp. (sedum).



CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: Presently only documented along several streams with small watersheds draining into Great Bay. A good example may be found at Great Bay Wildlife Management Area (Greenland).

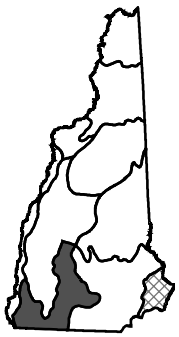
SOURCES: NHB field surveys; Nichols and Sperduto 1997; Nichols et al. 2000; Sperduto and Crowley 2002b.

• Sycamore floodplain forest (S1)

General description: In New Hampshire, this forest community is known only from low floodplains of the Ashuelot River north of Surry Mountain Lake in Surry, the North River in Lee, and Great Brook in Walpole. *Platanus occidentalis* (sycamore) reaches the northeastern limit of its range in southern New Hampshire and southwestern Maine. This type of forested floodplain is regionally uncommon. The Ashuelot River site has a relatively high plant species richness compared to other floodplain forest community types.

The sycamore floodplain forest site along the Ashuelot River is generally restricted to floodplain islands and the bases of steep slopes. In this stretch of the Ashuelot River, the channel substrate is largely cobble and flood events appear to be "flashy" in nature. Soils are sandy loam, sand, or gravelly sand. The pH measured from one soil profile was 5.3.

Characteristic vegetation: This community is characterized by a sparse to moderately well developed canopy dominated by *Platanus occidentalis* (sycamore) with a tall, well developed *Carpinus caroliniana* var. *virginiana* (musclewood) shrub layer. Tree canopy associates include *Acer rubrum* (red maple), *Acer saccharum* (sugar maple), *Ulmus americana* (American elm), *Carya cordiformis* (bitternut hickory), and less frequently *Juglans cinerea* (butternut). Where flooding is more frequent, the woody shrub and sapling layer is often absent. In these areas, there is a tall, dense herbaceous layer dominated by *Polygonum virginianum* (jumpseed), *Matteuccia struthiopteris* var. *pensylvanica* (ostrich fern), and *Calamagrostis canadensis* (blue-joint). The sycamore floodplain forest may form a community mosaic along with several other community types. Associated floodplain communities may include shrub thickets, emergent marshes, riverside sand and gravel barrens, and other types of forested floodplains. In certain areas, sugar maple forest occurs on medium to high floodplain elevations adjacent to sycamore floodplain forest.



Classification confidence: 2

Distribution: This community is documented along the Ashuelot River (Surry), the North River (Lee), and Great Brook (Walpole). A good example is along the Ashuelot River (Surry).

Sources: NHB field surveys; Nichols et al. 2000; Sperduto and Crowley 2002b.

• Red maple floodplain forest (S2S3)

General description: This natural community can be found along major streams and minor rivers, and on floodplains of major rivers above low floodplain forests dominated by *Acer saccharinum* (silver maple). Where *Acer rubrum* (red maple) dominates on the low floodplain, river channels are typically 6-30+ m (20-100+ ft.) wide with average summer water depths of 0.6-0.9+ m (2-3+ ft.). Small to moderate sized watersheds are typical above red maple dominated floodplains.

Soils are usually somewhat poorly drained fine sandy loams and silt loams with very shallow or absent organic horizons. pHs average 5.1. Soil surfaces may be temporarily inundated during spring flood events. Reddish mottles occur at an average depth of 10 cm (4 in.) on the low floodplain to nearly 20 cm (8 in.) on the high floodplain. In contrast to most swamps, hummock-hollow microtopography is absent or poorly developed.

Characteristic vegetation: *Acer rubrum* (red maple) dominates the tree canopy, with varying (but smaller) contributions by other hardwood and softwood species. Tree canopy structure ranges from woodland (25-60% tree cover) to forest (>60% tree cover). Shrub cover is generally low to moderately well-developed and can include *Ilex verticillata* (winterberry), *Viburnum* spp., *Vaccinium corymbosum* (highbush blueberry), and others. The herb layer is most often well developed with a relatively high cover of ferns including *Onoclea sensibilis* (sensitive fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Athyrium filix-femina* (northern lady

fern), and lesser amounts of *Thelypteris* spp. (ferns), *Osmunda cinnamomea* (cinnamon fern), and *O. claytoniana* (interrupted fern). In two examples, *Nyssa sylvatica* (black gum) cover is significant in the tree canopy and understory layers.

VARIANTS: Three variants of this community are recognized. Most of the species mentioned in the descriptions are not individually diagnostic of each variant, but each species assemblage as a whole is distinct.

Most higher floodplain forests are set farther back from the river channel than the lower variants. In other locations, higher floodplains occur along natural levees and other areas adjacent to the main channel, and low floodplains are found farther from the main channel. At many sites, high and low floodplain forests form complex mosaics with other floodplain communities.

1. **Low variant**: Several environmental and floristic characteristics separate this variant from the others. The tree canopy is more open, graminoid cover and vine cover are higher, and depth to mottling is shallower than in the other variants. This variant typically occurs at a lower floodplain elevation and closer to the river, giving this variant a wetter character.

   Acer rubrum (red maple) dominates the tree canopy. Infrequent tree species are *Carya ovata* (shagbark hickory), *Pinus strobus* (white pine), *Quercus rubra* (red oak), and others. Silver maple is usually absent or only found along the immediate river channel. *Quercus bicolor* (swamp white oak), if present, is in low abundance compared to its occurrence in swamp white oak floodplain forests.

   Plant species typical of wetter conditions distinguish this variant from the other two by their presence and/or higher cover, including *Ulmus americana* (American elm), *Cornus amomum* (silky dogwood), and *Impatiens capensis* (spotted touch-me-not). Other characteristic species are *Rubus occidentalis* (western black raspberry), *Sambucus canadensis* (common elderberry), *Alnus incana* (speckled alder), *Parthenocissus quinquefolia* (Virginia creeper), *Vitis labrusca* (fox grape), *Apios americana* (groundnut), *Lycopus uniflorus* (common water horehound), *Boehmeria cylindrica* (false nettle), *Onoclea sensibilis* (sensitive fern), *Chelone glabra* (white turtlehead), *Oxalis stricta* (showy yellow wood sorrel), *Geum laciniatum* (herb bennet), *Geum canadense* (white avens), and *Galium asprellum* (rough bedstraw). *Quercus rubra* (red oak) and *Viburnum nudum* (witherod) are less abundant in this variant.

2. **Low/medium variant**: This variant is closely related environmentally and floristically to the low variant. Both variants may be found adjacent to the channel at relatively low floodplain elevations, although the low/medium variant can also occur at slightly higher elevations and at greater distances from the channel.

   Acer rubrum (red maple) dominates the tree canopy. *Prunus serotina* (black cherry), sparse to absent in the tree canopy on the high floodplain, is generally more common in this variant than in the low variant. Plant species most characteristic of this variant are *Carpinus caroliniana* var. *virginiana* (musclewood), *Viburnum lentago* (nannyberry), and *Aster umbellatus* (tall flat-topped white aster).

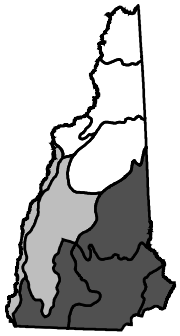
3. **Medium/high variant**: Medium to high floodplain forests are similar to mesic, mixed hardwood - conifer forests of the transitional or central hardwood region, although some of them flood intermittently during peak floods (probably 5-100 year cycles). These forests are typically 0.3-0.9 m (1-3 ft.) higher above the river channel than the lower floodplain forests. *Prunus serotina* (black cherry) and *Ulmus americana* (American elm) are sparse or absent.

   Species with a higher fidelity to this variant compared to the two lower variants include *Quercus rubra* (red oak), *Pinus strobus* (white pine), *Vaccinium corymbosum* (highbush blueberry), *Vaccinium angustifolium* (lowbush blueberry), *Gaultheria procumbens* (wintergreen), *Kalmia angustifolia* (sheep laurel), *Clethra alnifolia* (sweet pepperbush), *Ilex verticillata* (winterberry), *Hamamelis virginiana* (witch hazel), and *Gaylussacia baccata* (black huckleberry). *Viburnum nudum* (witherod) is frequent in this variant and the low/medium variant but is notably infrequent in the low variant. *Toxicodendron*

radicans (climbing poison ivy), *Carpinus caroliniana* var. *virginiana* (musclewood), and *Cornus amomum* (silky dogwood) are sparse or absent.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is found throughout central and southern New Hampshire along major streams and minor rivers, and on some terraces of major rivers above low floodplain forests. Good examples can be found along the Lamprey River (Epping and Lee), Bellamy River and Blackwater Brook (Dover), Baboosuc Brook (Merrimack), Pointer Club Brook (Bedford/Merrimack), Cohas Brook (Manchester), and Soucook River (Concord).



SOURCES: NHB field surveys; Sperduto and Crow 1994; Nichols and Sperduto 1997; Nichols et al. 2000; Sperduto and Crowley 2002b.

• Balsam fir floodplain/silt plain (S2)

GENERAL DESCRIPTION: This is a woodland or forested community type found in northern and occasionally central New Hampshire. It occurs along floodplains of major rivers in the mountains and along minor rivers and major streams (third- and fourth-order) in other settings with local cold-climate conditions, and on silt plains derived from glacial lakebed deposits or stream deposits. *Abies balsamea* (balsam fir), other northern species, and species indicative of low to moderate soil nutrient availability are common. Species indicative of high soil nutrient availability are absent. Woodland examples often have dense shrub and herbaceous layers.

Floodplain soils are fine sandy loams or loams that occur in valley bottoms of montane rivers or other settings with frigid soils or pronounced cold-air drainage (NRCS frigid temperature regime). Flashy montane rivers are associated with several examples of this floodplain type and may be indicative of a more temporary or infrequently flooded regime compared to other floodplain forest community types. Examples occur from 150 m (500 ft.) to more than 370 m (1200 ft.) elevation. Silt plain soils are somewhat poorly drained silt loams.

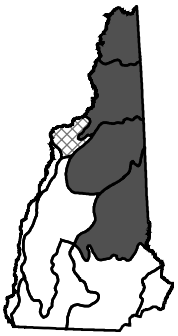
Some examples contain a mixture of red and silver maple and are transitional to silver maple types. These usually occur at sites with one of the silver maple community types on lower floodplain elevations.

CHARACTERISTIC VEGETATION: *Abies balsamea* (balsam fir) is indicative of this type, and it is usually abundant or co-dominant in the canopy or subcanopy along with *Acer rubrum* (red maple). *Prunus serotina* (black cherry) and *Pinus strobus* (white pine) are frequent and occasionally abundant, and *Acer saccharinum* (silver maple) is occasional. *Tsuga canadensis* (hemlock) and *Picea rubens* (red spruce) are infrequent. Species found in other floodplain forest types but more frequent or abundant in this type include *Calamagrostis canadensis* (blue-joint), *Carex stricta* var. *strictior* (small-tussock sedge), *Spiraea alba* (eastern meadowsweet), *Brachyelytrum erectum* (northern short husk grass), *Carex novae-angliae* (New England sedge), *Corylus cornuta* (beaked hazel-nut), and *Carex intumescens* (inflated sedge). Northern or boreal plants are frequent as a group and include *Coptis trifolia* (goldthread), *Cornus canadensis* (bunchberry), and *Aster acuminatus* (whorled aster). Tussock sedge is nearly constant but usually present only in its rhizomatous form (e.g., non tussock-forming).

Common floodplain forest species found in this community include *Onoclea sensibilis* (sensitive fern), *Thalictrum pubescens* (tall meadow-rue), *Viburnum nudum* (witherod), *V. dentatum* (northern arrowwood), *Solidago rugosa* (rough goldenrod), *Osmunda regalis* (royal fern), *Alnus incana* (speckled alder), and *Uvularia sessilifolia* (sessile-leaved bellwort).

1. **Floodplain variant**: As described above.
2. **Silt plain variant**: This variant differs from the floodplain variant by having siltier soils, a moderate cover of *Alnus incana* (speckled alder), and other plants indicative of higher nutrient and moisture availability (presumably a result of the higher silt content of soils). Most examples have a woodland

structure. Many of the species found in the floodplain variant can also occur in this variant. At some sites this variant transitions into alder floodplain/silt plain shrubland. Species most characteristic of the siltplain variant include *Sambucus racemosa* ssp. *pubens* (red elderberry), *Rubus pubescens* (dwarf raspberry), *Tiarella cordifolia* (foamflower), *Carex intumescens* (inflated sedge), *Thalictrum pubescens* (tall meadow-rue), *Geum rivale* (purple avens), *Dryopteris cristata* (crested wood fern), *Chelone glabra* (white turtlehead), *Arisaema triphyllum* (Jack-in-the-pulpit), *Athyrium filix-femina* (northern lady fern), *Matteuccia struthiopteris* (ostrich fern), *Veratrum viride* (false hellebore), *Viburnum opulus* (high-bush cranberry), and *Ranunculus recurvatus* (hooked buttercup).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community occurs primarily along mountain rivers of northern and occasionally central New Hampshire. Good examples can be found along the Magalloway River (Errol), the Swift River (Albany), Pine River (Ossipee), and Big River (Barnstead).

SOURCES: NHB field surveys; Nichols et al. 2000; Sperduto and Crowley 2002b.

BOGGY NUTRIENT-POOR SWAMPS

These swamps are poorly to very poorly drained, occur on shallow to deep muck and peat soils (Histosols, histic epipedons, or mineral histic soils). Seasonal water level fluctuations are characteristic, but there is little or no streambank overflow or pronounced seepage influence. They usually occur in stagnant headwater basins and most types have significant peat accumulation. pHs are typically in the mediacid (4.0-4.9) to low subacid range (5.0-5.3). *Chamaecyparis thyoides* (Atlantic white cedar), *Nyssa sylvatica* (black gum), and *Picea mariana* (black spruce) are often dominant or codominant with *Acer rubrum* (red maple). *Onoclea sensibilis* (sensitive fern), indicative of minerotrophic swaps, is typically absent.

RED MAPLE AND COASTAL CONIFER SWAMPS PRIMARILY OF CENTRAL OR SOUTHERN NH

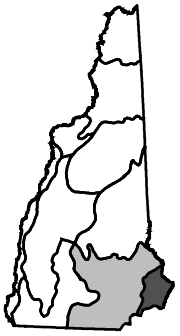
• Atlantic white cedar - yellow birch - pepperbush swamp (S2)

GENERAL DESCRIPTION: This Atlantic white cedar community type generally occurs in wet basins at low elevations (20-350 ft.) within 30 miles of the coast. It is characterized by a mix of *Chamaecyparis thyoides* (Atlantic white cedar)*, *Betula alleghaniensis* (yellow birch), *Acer rubrum* (red maple), *Clethra alnifolia* (sweet pepperbush), and other coastal or southern species. Hummock and hollow topography is pronounced and hollows are often wet throughout the growing season. Soil pH is generally of medium acidity (mediacid) and ranges from 4.0-5.1 (average 4.5, n=11).

CHARACTERISTIC VEGETATION: This community is dominated by Atlantic white cedar. Sweet pepperbush, yellow birch, and red maple are frequent and sometimes abundant. *Tsuga canadensis* (hemlock) is occasionally abundant, although absent at some sites. *Ilex verticillata* (swamp winterberry), *Vaccinium corymbosum* (highbush blueberry), *Nemopanthus mucronatus* (mountain holly), *Sphagnum* spp. (peat mosses), and *Pinus strobus* (white pine) are abundant or frequent. Herbs are frequent on hummocks, especially *Aralia nudicaulis* (wild sarsaparilla), *Trientalis borealis* (starflower), *Maianthemum canadense* (Canada mayflower), and mosses. Other species include *Osmunda cinnamomea* (cinnamon fern), *Coptis trifolia* var. *groenlandica* (goldthread), *Mitchella repens* (partridge-berry), *Osmunda regalis* (royal fern), *Carex trisperma* (three-seeded sedge), *Kalmia*

angustifolia (sheep laurel), and *Thelypteris simulata* (Massachusetts fern). The rare coastal plain species *Carex seorsa* (separated sedge)* and *Carex striata* (Walter's sedge)* occur in some examples.

Carex trisperma (three-seeded sedge) and *Kalmia angustifolia* (sheep laurel) are occasional in this type of Atlantic white cedar swamp (generally absent from the seasonally flooded type). *Thelypteris simulata* (Massachusetts fern) appears to be restricted to this and the Atlantic white cedar - giant rhododendron type. *Rhododendron viscosum,* characteristic of coastal cedar swamps in southern New England, is absent in this type. Species indicative of northern or marshy conditions that characterize the other types are infrequent or absent.



Classification confidence: 1

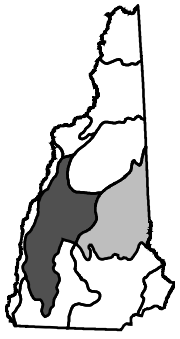
Distribution: This type occurs in the Coastal Lowlands and Coastal Plain subsections. Good examples include Cedar Swamp Pond (Kingston) and Portsmouth Cedar Swamp (Portsmouth).

Sources: Sperduto and Crowley 2002a; Sperduto and Ritter 1994.

• Inland Atlantic white cedar swamp (S1)

General description: This type occurs in inland basins that are more than 30 miles from the coast and >500 ft. elevation. It is characterized by the presence of numerous northern species that are not found in other *Chamaecyparis thyoides* (Atlantic white cedar)* communities, and by the absence of several coastal and southern species. Swamps in the Sunapee Uplands subsection range in elevation from 890-1040 ft.; a single swamp in the Sebago-Ossipee subsection occurs at 520 ft. elevation. Atlantic white cedar is documented from the pollen record at one site from 4,000 years ago through the present, implying that Atlantic white cedar has long-term persistence in some locations. Hummock and hollow topography is pronounced and hollows are often wet throughout the growing season. Soil pH ranges from superacid to mediacid [3.4-4.8 (average 4.1, n=12)].

Characteristic vegetation: *Chamaecyparis thyoides* (Atlantic white cedar)* is diagnostic and dominant in the canopy. *Picea rubens* (red spruce) is abundant at most sites, along with frequent *Clintonia borealis* (blue-bead lily) and *Gaultheria hispidula* (creeping snowberry). Other less frequent but reasonably diagnostic species include *Cornus canadensis* (bunchberry), *Abies balsamea* (balsam fir), *Larix laricina* (eastern larch), *Picea mariana* (black spruce), and *Gaylussacia baccata* (black huckleberry). *Carex trisperma* (three-seeded sedge) and *Kalmia angustifolia* (sheep laurel) are frequent and abundant. *Tsuga canadensis* (hemlock) is only occasionally present but may form locally significant cover. Coastal and southern species common in some other cedar communities are absent in this type including *Clethra alnifolia* (sweet pepperbush), *Symplocarpus foetidus* (skunk cabbage), and *Thelypteris simulata* (Massachusetts fern).



Classification confidence: 1

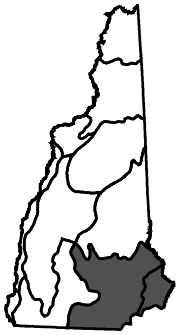
Distribution: This community is found in southern and central New Hampshire more than 30 miles from the coast. Good examples can be found at Cooper Cedar Woods (New Durham) and Loverens Mill (Antrim).

Sources: Belling 1977; Sperduto and Ritter 1994; Sperduto and Crowley 2002a.

• Atlantic white cedar - leather-leaf swamp (S1)

GENERAL DESCRIPTION: This Atlantic white cedar community is essentially a wooded fen. It occurs within 30+ miles of the coast and is characterized by a broken woodland canopy of Atlantic white cedar, sparse cover of *Acer rubrum* (red maple), and a dense heath shrub layer dominated by *Chamaedaphne calyculata* (leather-leaf) and *Kalmia angustifolia* (sheep laurel). Hummock and hollow topography is not as well-developed as in other Atlantic white cedar swamps. Soils are poorly decomposed peat.

CHARACTERISTIC VEGETATION: In addition to Atlantic white cedar, leather-leaf and sheep laurel, this type is characterized by other boggy plants including *Vaccinium macrocarpon* (large cranberry), *Sarracenia purpurea* (pitcher-plant), *Woodwardia virginica* (Virginia chain-fern), *Drosera rotundifolia* (round-leaved sundew), *Eriophorum virginicum* (tawny cotton-grass), and *Carex trisperma* var. *trisperma* (three-seeded sedge). Scattered tall shrubs may include *Vaccinium corymbosum* (highbush blueberry) and *Clethra alnifolia* (sweet pepperbush). *Sphagnum* (peat moss) is abundant, and may include *Sphagnum fallax* and *Sphagnum flavicomans* (peat moss)*.



CLASSIFICATION CONFIDENCE: 3

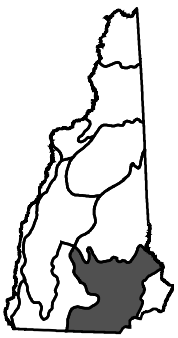
DISTRIBUTION: This type is restricted to the Coastal Lowlands subsection and nearby areas in the Coastal Plain subsection. A good example occurs near Cedar Swamp Pond (Kingston).

SOURCES: Sperduto and Ritter 1994; Sperduto and Crowley 2002a; Sperduto and Neid 2003.

• Atlantic white cedar - giant rhododendron swamp (S1)

GENERAL DESCRIPTION: This Atlantic white cedar swamp is characterized by a canopy of *Chamaecyparis thyoides* (Atlantic white cedar)* with a dense understory of *Rhododendron maximum* (giant rhododendron)*. It is most similar to, but distinguished from, the Atlantic white cedar - yellow birch - pepperbush swamp community for at least four reasons. First, the dominance of giant rhododendron is a striking feature of these sites; it constitutes a majority of the understory biomass and total cover, is a substantial contributor to total site biomass, and therefore probably has a substantial influence on litter and soil quality (see Day and Monk (1974) for biomass-site relations in the central Appalachians). Second, the dense shading by giant rhododendron appears to exert a substantial influence on other vegetation; this community is relatively species-poor compared to other types. Tall shrubs other than giant rhododendron are generally sparse, as is the herbaceous layer. Third, while it occurs only at one site in NH, the type is found at least five different sites in New England, where giant rhododendron can dominate extensive areas (e.g., many acres). Finally, distinguishing these sites as a separate community is consistent with how communities dominated by giant rhododendron or *Kalmia latifolia* (mountain laurel) in the central Appalachians, which is center of the geographic range of this community type [see Day and Monk (1974)].

CHARACTERISTIC VEGETATION: *Acer rubrum* (red maple) is present and sometimes codominant, *Betula alleghaniensis* (yellow birch) is present in low abundance, and *Nyssa sylvatica* (black gum) is occasional. Other than giant rhododendron, there are no species that are unique to this type. Scattered plants characteristic of Atlantic white cedar - yellow birch - pepperbush swamps are also found in this type.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is restricted to the Manchester Cedar Swamp (Manchester) in the Coastal Plain subsection.

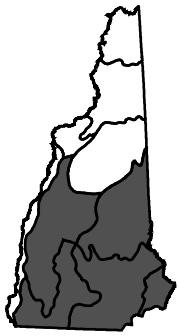
SOURCES: Sperduto and Ritter 1994; Sperduto and Crowley 2002a.

• Red maple - Sphagnum basin swamp (S4)

General description: This is a common type of "red maple swamp" on poorly to very poorly drained peat soils of depressions with minimal influence of groundwater or seasonal overbank stream flow. There are typically no perennial streams running into or through the swamps, although the basins are influenced by seasonal subsurface and ephemeral runoff from surrounding uplands. They occur in perched basins in till landscapes or other low, flat areas with small watersheds of typically 1/4 to 1 mile square or less. Hummock and hollow topography is well developed.

Soils are acidic, nutrient-poor, very poorly drained Histosols (deep peat or muck >40 cm) or poorly to very poorly drained histic epipedons (O horizons are generally <20 cm). Although soils are generally saturated and have limited lateral movement of water, there is seasonal fluctuation resulting from spring runoff from uplands and evapotranspiration over the course of the season. More research is needed to understand the variability in vegetation, soil characteristics, and hydrologic regimes of these swamps.

Characteristic vegetation: The tree canopy is dominated by *Acer rubrum* (red maple) with minor amounts of other wetland and upland trees mixed in. Softwoods are absent or in low abundance, the tall shrub and herb layers are moderately light to dense, and *Sphagnum* mosses form a moderate patchy to dense layer. *Picea rubens* (red spruce) and *Tsuga canadensis* (hemlock) may be present, particularly in the understory. Hemlock appears to attain significance in the overstory only in somewhat more well-drained swamps (see description below). The shrub layer usually contains significant amounts of some combination of *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (swamp winterberry) as primary dominants, with lesser amounts of *Nemopanthus mucronatus* (mountain holly), *Viburnum dentatum* (northern arrowwood), *Ilex laevigata* (smooth winterberry), *Spiraea alba* (eastern meadowsweet) and the short shrubs *Kalmia angustifolia* (sheep laurel) and *Rubus hispidus* (bristly dewberry). The herbaceous layer typically contains a significant component of *Osmunda cinnamomea* (cinnamon fern) with lesser quantities of other herbs. *Carex trisperma* var. *trisperma* (three-seeded sedge), *Thelypteris palustris* (marsh fern), *Lycopus uniflorus* (common water horehound), *Carex folliculata* (follicled sedge), and *C. canescens* (silvery sedge) are frequently present in low abundance. Upland herbs may occupy hummocks, including *Aralia nudicaulis* (wild sarsaparilla), *Coptis trifolia* (goldthread), and *Gaultheria procumbens* (wintergreen). *Sphagnum* mosses are usually dominant or abundant in hollows and on lower sides of hummocks and include *Sphagnum fallax*, *S. girgensohnii*, and *S. papillosum*, among others. Wetter hollows in somewhat open swamps may have a greater abundance of species such as *Carex canescens* (silvery sedge) and *Calla palustris* (wild calla).



Classification confidence: 1

Distribution: Found throughout central and southern New Hampshire. Good examples may be found in the LaRoche Brook vicinity (Durham), and also in the Bloody Brook/Norris Brook vicinity (Exeter).

Sources: NHB field surveys.

• Black gum - red maple basin swamp (S1S2)

General description: Black gum - red maple basin swamps are very similar in vegetation, soils, and hydrology to red maple - *Sphagnum* basin swamps. A principal distinction between these communities is the codominance of black gum with red maple in the canopy of black gum - red maple basin swamps. These swamps typically occur in perched upland till basins with watersheds smaller than one square mile. Species typical of acidic, relatively stagnant conditions are prevalent, but these swamps are highly variable in structure and composition ranging from forest (greater than 65% tree cover) to sparse woodland (10-25% tree cover). The shrub layer

density increases in woodland and sparse woodland examples. Historical logging activities may also have influenced the structure and composition of some examples, and additional research on stand history is needed to clarify the relationships between land use history and current vegetation.

Soils are typically acidic, nutrient-poor, very poorly drained Histosols (deep peat or muck) or poorly to very poorly drained mineral soils with histic epipedons. Peat is well decomposed near the surface, and pHs average approximately 4.4 (range: 3.7–5.3). Hummocks are well developed and average approximately 0.4 m high. There is little evidence of seepage or surface water flow in black gum swamps. Examples in lakeside settings may be influenced somewhat by surface flow, but water sources are generally restricted to precipitation, seasonal runoff or subsurface flow from surrounding uplands. Many of these swamps have stagnant outlet streams but no perennial inlets or streams running through them; others have neither inlets nor outlets.

Characteristic vegetation: In the majority of black gum - red maple basin swamps, *Nyssa sylvatica* (black gum) and *Acer rubrum* (red maple) dominate the tree canopy, with varying but smaller contributions by other hardwood and softwood species. *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (winterberry) are the primary shrub layer dominants, with a variable component of other tall and medium-height shrub species. *Osmunda cinnamomea* (cinnamon fern) is usually abundant in the herb layer, which consists acidic wetland or moist-site species in hollows and drier-site species on hummocks. *Sphagnum* mosses often form a patchy to dense layer, particularly in hollows and on the lower sides of hummocks.

Variants: Four variants are described below that relate mostly to woody structure:

1. **Boggy woodland/tall shrub thicket variant**: This variant includes woodlands or sparse woodlands with a well developed tall shrub layer, a sparse to moderate herbaceous layer, and moderate to dense *Sphagnum* moss cover. The more open woodland or tall shrub structure and frequency of hydrophytic species such as *Sphagnum torreyanum* and *Carex canescens* may indicate a wetter hydroperiod than in other variants. Most lakeside occurrences of black gum swamps correspond to this variant.

   Minor amounts of *Picea rubens* (red spruce) and *Tsuga canadensis* (hemlock) may be found in the canopy or understory. *Sphagnum* moss predominates in the wetter hollows and hummock-sides of this variant and include abundant *Sphagnum magellanicum*; *S. torreyanum,* a predominantly aquatic, coastal plain species, is locally dominant in hollows. These are indicative of oligotrophic to weakly minerotrophic conditions.

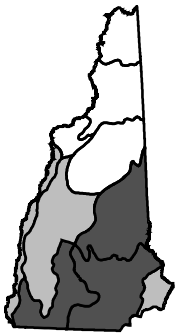
2. **Boggy forest/woodland variant**: This variant has a variable forest or woodland tree canopy of black gum and red maple, frequently with red spruce and/or *Pinus strobus* (white pine) in the canopy and/or subcanopy. Hemlock and yellow birch are typically restricted to the understory. The shrub and herbaceous layers are highly variable but usually well developed and on average lower than in the boggy woodland/tall shrub thicket variant. *Sphagnum* mosses are more abundant on average than in other variants, and the species composition is indicative of more acidic, nutrient-poor conditions than that found in the hemlock forest/woodland variant, giving examples a more boggy character.

   Sarracenia purpurea (pitcher-plant) occurs only occasionally, but its presence can help distinguish this variant from the hemlock forest/woodland variant described below. *Sphagnum* mosses typically form a relatively dense carpet and overall are indicative of oligotrophic to weakly minerotrophic conditions. These include *Sphagnum fallax*, *S. angustifolium*, and/or *S. magellanicum*.

3. **Hemlock forest/woodland variant**: This variant has a forest or woodland structure with a strong hemlock component in the canopy and/or subcanopy. *Betula alleghaniensis* (yellow birch), and *Pinus strobus* (white pine) are typical in the understory. While variable, the shrub layer is sparser on average in this variant than the other two. *Sphagnum* is generally of moderate density, and consists of species indicative of more minerotrophic conditions than are present in the more "boggy" black gum swamp variants. These include *Sphagnum flexuosum*, *S. affine*, *S. centrale*, *S. henryense*, *S. fimbriatum*, *S. palustre*, and *S. recurvum*. Other *Sphagnum* species in this variant include *S. angustifolium*, *S.*

magellanicum, *S. torreyanum*, *S. fallax*, and *S. cuspidatum* indicative of oligotrophic to weakly minerotrophic conditions. Other bryophytes are also more frequent in this variant. Additional minerotrophic indicators that are occasional in this variant include *Osmunda regalis* (royal fern), *Chelone glabra* (white turtlehead), and *Fraxinus nigra* (black ash).

4. **Mountain laurel variant**: This variant is indicated by a dominant layer of mountain laurel in some swamps of southwest NH.



CLASSIFICATION CONFIDENCE: 1

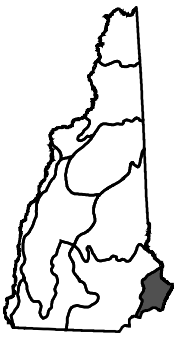
DISTRIBUTION: Black gum swamps are concentrated in southern NH and extend into the Lakes Region of the Sebago-Ossipee subsection. Good examples occur at Fox State Forest (Hillsboro) and Pawtuckaway State Park (Nottingham).

SOURCES: NHB field surveys; Andrus 1980; Zebryk 1990; Sperduto 1997; Sperduto et al. 2000b.

• Swamp white oak basin swamp (S1)

GENERAL DESCRIPTION: Swamp white oak basin swamps are similar to both red maple basin swamps and swamp white oak floodplain forests in several respects. The primary difference with floodplain forests is the isolation from riverine flooding, presence of low to moderate hummocks, moderate to abundant amounts of *Sphagnum* moss, the lack of several floodplain plant associates, and the presence of typical basin swamp species. They differ from red maple swamps primarily by the abundance of swamp white oak and association with silt loam or silt mineral soils, and in the restriction of their distribution to the coastal plain lowlands of southeastern New Hampshire.

CHARACTERISTIC VEGETATION: Species absent or less abundant in swamp white oak basin swamps compared to floodplains include *Carpinus caroliniana* (musclewood), *Cornus amomum* (silky dogwood), *Ulmus americana* (American elm), *Cinna arundinacea* (common woodreed), *Athyrium filix-femina* (lady fern), and *Onoclea sensibilis* (sensitive fern). Species that are more abundant or frequent in swamp white oak basin swamps include *Osmunda cinnamomea* (cinnamon fern), *Vaccinium corymbosum* (highbush blueberry), and *Kalmia angustifolia* (sheep laurel). Compared to red maple basin swamps, swamp white oak swamps appear to have poorly drained mineral histic soils that are seasonally saturated or seasonally flooded with very little or only a shallow organic horizon (up to 5 cm), modest amounts of *Sphagnum* (1-65%), a relatively sparse herb layer (less than 10-15% cover), and a moderate to dense shrub layer. The species composition is similar to red maple basins (see this description), with some indicators of more enriched soil conditions imparted by the silty mineral soils (e.g., occasional musclewood, elm, arrowwood, and poison ivy).



CLASSIFICATION CONFIDENCE: 2

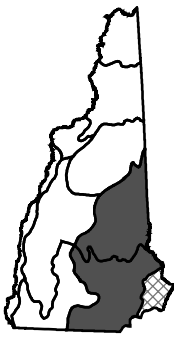
DISTRIBUTION: Restricted to the Coastal Lowland subsection of southeastern New Hampshire. Good examples occur in the Pickpocket vicinity (Exeter) and Stratham Hill vicinity (Stratham).

SOURCES: Nichols and Sperduto 1997; Sperduto et al. 2000b.

• Pitch pine - heath swamp (S1S2)

General description: This is a woodland swamp community characterized by a broken canopy of *Pinus rigida* (pitch pine) and *Acer rubrum* (red maple) with an understory of tall and medium heath shrubs and peat mosses. It is reminiscent of pitch pine swamps found on Cape Cod, in New Jersey, and southward on the coastal plain. Soils are saturated or seasonally saturated and probably have a shallow organic horizon over sand deposits. Although pitch pine trees are found as scattered individuals in open peatlands in southern NH, this community is distinct in its abundance of pitch pine in the canopy.

Characteristic vegetation: A woodland canopy of pitch pine is characteristic, sometimes joined by variable amounts of other species, including red maple, *Betula populifolia* (gray birch), and *Pinus strobus* (white pine). A tall and/or short shrub layer consists of *Chamaedaphne calyculata* (leather-leaf) (often dense), *Rhododendron canadense* (rhodora), *Lyonia ligustrina* (male-berry), *Kalmia angustifolia* (sheep laurel), *Aronia melanocarpa* (black chokeberry), *Gaylussacia baccata* (black huckleberry), *Vaccinium corymbosum* (highbush blueberry), *Vaccinium angustifolium* (lowbush blueberry), *Ilex verticillata* (winterberry), *Rubus pubescens* (dwarf raspberry), and *Spiraea alba* var. *latifolia* (eastern meadowsweet). Herbs are scattered and may include *Dulichium arundinaceum* (three-way sedge), *Carex canescens* (silvery sedge), *Scirpus cyperinus* (woolly bulrush), *Carex stricta* var. *strictior* (small-tussock sedge), and *Osmunda regalis* (royal fern).



Classification confidence: 2

Distribution: Restricted to the Coastal Plain and Sebago-Ossipee subsections. Good examples occur in Merrimack and Ossipee (on private land), at White Lake State Park (Tamworth), and at Grassy Pond (Litchfield).

Sources: NHB field surveys.

Conifer swamps primarily of central or northern NH

• Black spruce - larch swamp (S3)

General description: This is a forest or woodland swamp found on nutrient-poor, moderately deep to deep peat soils in stagnant basins or in stagnant areas within other wetland complexes. It is dominated by *Picea mariana* (black spruce) and sometimes *Larix laricina* (eastern larch) depending on the nutrient status and degree of saturation. This classic "bog forest" community often surrounds open bogs or fens or can dominate forested basins without open peatlands. This type differs from red spruce swamps by a shift to black spruce and/or larch in the tree canopy, usually a greater abundance or dominance of dwarf heath shrubs, lower abundance and frequency of *Osmunda cinnamomea* (cinnamon fern), and generally deeper, wetter, and more nutrient-poor peat soils.

Black spruce and larch are both relatively intolerant of shade and tolerant of saturated conditions. Both can adjust to changing water conditions by producing adventitious roots from the stem, layering from branches, and to some extent by root sprouting (Fowells 1965; Montague and Givnish 1996). Overall, black spruce is a bit more shade tolerant than larch and usually dominates on more oligotrophic peatlands of low pH (3.0-4.0), where it grows taller and faster than larch (Montague and Givnish 1996). Larch is more prominent on sites with higher pH (>4.5) and mineral availability (Bares and Wali 1979), where it grows taller and faster than black spruce (Montague and Givnish 1996). This relates well to the general ecological principal that coniferous evergreen species have a competitive advantage on low nutrient sites because of the higher nutrient use efficiency afforded by evergreen foliage. Black spruce can exceed 250 years of age in New Hampshire swamps.

Soils are typically moderate to deep (>0.5 m), nutrient poor (oligotrophic) peat soils. Some black spruce sites have shallower peat soils and mix with red spruce and balsam fir in lowland spruce - fir complexes. Most sites

are saturated, with the water table at or near the surface most of the year.

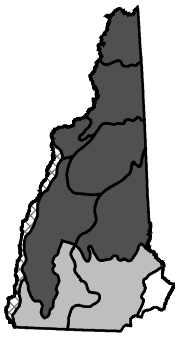
CHARACTERISTIC VEGETATION: Black spruce and/or larch form a discontinuous canopy cover of 25% to >80%, usually with a moderate to dense dwarf heath shrub layer, a variable tall shrub layer, an abundance of *Carex trisperma* var. *trisperma* (three-seeded sedge), and a low to modest cover of other herbs. Tall shrubs include *Nemopanthus mucronatus* (mountain holly), *Viburnum nudum* (witherod), *Lyonia ligustrina* (male-berry), and *Aronia melanocarpa* (black chokeberry). Dwarf heath shrubs include *Ledum groenlandicum* (Labrador-tea), *Kalmia angustifolia* (sheep laurel), *Rhododendron canadense* (rhodora), *Vaccinium myrtilloides* (velvet-leaf blueberry), *Chamaedaphne calyculata* (leather-leaf), *Kalmia polifolia* (bog laurel), *Vaccinium oxycoccos* (small cranberry), and *Gaultheria hispidula* (creeping snowberry). Herbaceous plants include peatland-restricted species such as *Smilacina trifolia* (three-leaved false Solomon's seal) and *Sarracenia purpurea* (pitcher-plant), as well as other northern plants including *Coptis trifolia* (goldthread) and *Cornus canadensis* (bunchberry). *Osmunda cinnamomea* (cinnamon fern) is occasional. A diversity of *Sphagnum* moss species forms a ubiquitous understory.

VARIANTS: The following variation is recognizable among New Hampshire examples and deserves further study:

1. **Typic woodland variant**: This includes most examples north of and including the White Mountain region, as described above.
2. **Forest variant**: This corresponds to examples with a more closed canopy, a less well developed heath layer, a sparse to moderate tall shrub layer, and a well developed moss layer.
3. **Larch woodland variant**: Larch becomes more prominent on more minerotrophic sites.
4. **Southern highbush blueberry - huckleberry variant**: Examples in southern and central New Hampshire may have species that reach their northern limit in central New England, including *Gaylussacia baccata* (black huckleberry) and *Vaccinium corymbosum* (highbush blueberry).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Moderately large examples are found only in the six northernmost subsections of the state. Small disjunct examples are associated with open peatlands or stagnant basins in the Coastal Plain and Coastal Lowland subsections. Elevations mostly range from 1000-3500 ft., with small examples in the southern part of the state occurring as low as ca. 200 ft. Good examples can be found at Cypress Brook (Beans Purchase), several sites in the Connecticut Lakes vicinity (Pittsburg), Norton Pool (Pittsburg), Stearns Branch vicinity (Success), and in the Trudeau Road vicinity (Bethlehem), with a disjunct southern variant at Camp Carpenter (Londonderry).



SOURCES: NHB field surveys; Montague and Givnish 1996.

MINEROTROPHIC SWAMPS

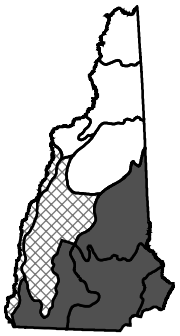
This group of communities includes very poorly to poorly drained saturated, seasonally saturated and seasonally flooded swamps, including seepage and mixed-hydrology swamps. Mixed-hydrology swamps have some combination of water inputs from groundwater, upland runoff, precipitation, and overbank flow, but are not dominated by a single source. Numerous species indicative of relatively minerotrophic conditions [e.g. *Onoclea sensibilis* (sensitive fern), *Fraxinus* spp. (ashes), *Cornus* spp. (dogwoods)], absent in boggy nutrient-poor swamps, are present in minerotrophic swamps.

RED MAPLE AND COASTAL CONIFER SWAMPS OF CENTRAL AND SOUTHERN NH

• Red maple - black ash - swamp saxifrage swamp (S2)

GENERAL DESCRIPTION: This is a classic type of seepage swamp with plants indicative of seepage and/or enriched conditions readily evident. These swamps are typically found along borders of larger swamp systems, in very slightly sloped wetlands where groundwater discharge and/or subsurface upland runoff influence the rooting zone of the swamp, or where groundwater discharge in flat basins is pronounced or influenced by intermediate/basic bedrock or soils. Soils are typically poorly to very poorly drained mineral histic or histic epipedons (shallow muck or peat over grayish or gleyed subsoil). Silt loam and silt soils of marine origin typically underlie these swamps in the seacoast region (e.g., Buxton or Scitico silt loams), or other soils with higher base-cation status.

CHARACTERISTIC VEGETATION: The tree canopy is dominated by red maple with lesser quantities of *Fraxinus nigra* (black ash), *Fraxinus americana* (white ash), *Betula alleghaniensis* (yellow birch), and occasionally *Tilia americana* (basswood). A diverse assemblage of herbaceous and moss species may be present (e.g., *Mnium* spp.) although *Sphagnum* is typically sparse or absent. Seepage indicators such as *Saxifraga pensylvanica* (swamp saxifrage), *Geum rivale* (purple avens), *Caltha palustris* (marsh marigold), *Hydrocotyle americana* (water pennywort), *Lindera benzoin* (northern spicebush), and *Senecio robbinsii* (Robbins' ragwort) are often present. Other typically abundant herbs and shrubs include *Onoclea sensibilis* (sensitive fern), *Toxicodendron radicans* (climbing poison ivy), *Viola* spp. (violets), *Impatiens capensis* (spotted touch-me-not), *Alnus incana* (speckled alder), and *Cornus sericea* (red osier dogwood).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is restricted to central and southern parts of the state. Good examples occur at College Woods (Durham) and Shaws Pond (New Durham).

SOURCES: NHB field surveys.

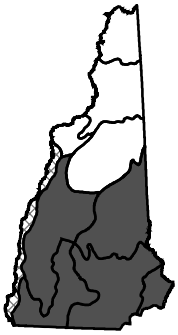
• Red maple - lake sedge swamp (S3)

GENERAL DESCRIPTION: This community is dominated by *Acer rubrum* (red maple) with a dense herbaceous understory dominated by *Carex lacustris* (lake sedge). It is associated with perennial seepage and other minerotrophic areas between uplands and open marshes, particularly on heavy mineral soils (silts and clays). These swamps are level to slightly sloping. The density of lake sedge is high (25-70%+). This species reaches its best development in this community and in minerotrophic marshes, including seepage marshes. Some examples are probably marshes succeeding to swamps.

Soils are poorly to very poorly drained and have a shallow fibric organic horizon (<20 cm) over gleyed silt, silt loam, or clay (mineral histic soils, some of marine origin). Soil water pHs are circumneutral.

CHARACTERISTIC VEGETATION: A woodland canopy of red maple (25-60 %) and a dense, tall layer of lake sedge is characteristic of this community. Other occasional trees include *Ulmus americana* (American elm) and *Quercus bicolor* (swamp white oak). A diverse assemblage of shrubs and herbs is typical, but lake sedge usually exceeds all other herbaceous species combined. A modest shrub layer commonly contains *Ilex verticillata* (winterberry), *Cornus amomum* (southeastern silky dogwood), *Viburnum dentatum* (northern arrowwood), *Viburnum lentago* (nannyberry), *Toxicodendron radicans* (climbing poison ivy), and *Spiraea alba* var. *latifolia* (eastern meadowsweet). The diverse herb layer has few species that exceed 1% cover, other than *Onoclea sensibilis* (sensitive fern), *Carex stricta* (tussock sedge), *Calamagrostis canadensis* (blue-joint), and *Osmunda regalis* (royal fern). Other characteristic species found in low abundance include *Impatiens capensis* (spotted

touch-me-not), *Chelone glabra* (white turtlehead), *Cicuta maculata* (common water-hemlock), *Cicuta bulbifera* (bulbiferous water-hemlock), *Rubus pubescens* (dwarf raspberry), and *Equisetum sylvaticum* (wood horsetail). *Sphagnum* spp. (peat mosses) are typically absent or not abundant in these swamps (<5% cover). Seepage species may be expected, such as *Sphagnum squarrosum* (peat moss). The rare species *Mikania scandens* (climbing hempweed)* occurs in this community.



CLASSIFICATION CONFIDENCE: 2

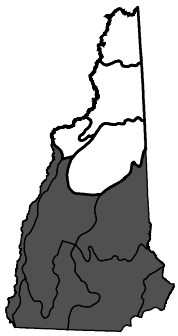
DISTRIBUTION: This community is probably broadly distributed south of the White Mountains, but is more abundant in the Coastal Lowland and Coastal Plain subsections where silt soils are common. Good examples occur in the Pickpocket vicinity and Great Meadows (Exeter), near Moulton Ridge (Kensington), and along the Contoocook River (Peterborough).

SOURCES: NHB field surveys.

• Red maple - sensitive fern swamp (S3S4)

GENERAL DESCRIPTION: This is a common type of red maple swamp characterized by a diverse assemblage of herbaceous species, relatively little *Sphagnum* moss, and saturated or seasonally saturated to seasonally flooded soils. The swamps may be small or very large (10-100 acres) and typically occupy headwater basins that give rise to drainages or along drainages where seepage or non-channelized upland runoff contributes to the water budget. It lacks seasonal flooding from over-bank flooding (typical of seasonally flooded red maple swamps) and is more minerotrophic than red maple - Sphagnum basin swamps. *Onoclea sensibilis* (sensitive fern) is a good indicator of minerotrophic conditions in this type. Subsurface groundwater discharge is likely in at least some of these swamps. These swamps are often found with other swamp communities in a larger mosaic.

CHARACTERISTIC VEGETATION: Tree cover ranges from 25% to more than 65% and consists of *Acer rubrum* (red maple), with lesser quantities of *Ulmus americana* (American elm) and other hardwoods, and no or few conifers. A diverse shrub layer is typical; *Ilex verticillata* (swamp winterberry) is abundant and *Vaccinium corymbosum* (highbush blueberry) is usually present but less abundant than in nutrient poor swamps. *Viburnum dentatum* (northern arrowwood), *Alnus incana* (speckled alder) and *Spiraea alba* (eastern meadowsweet) are occasional. *Toxicodendron vernix* (poison sumac), *Toxicodendron radicans* (climbing poison ivy), *Sambucus canadensis* (common elderberry), *Lindera benzoin* (northern spicebush), *Viburnum lentago* (nannyberry), and *Cornus amomum* (silky dogwood) may be present. *Carex stricta* (tussock sedge) and *Onoclea sensibilis* (sensitive fern) are usually abundant or co-dominant herbs. Other species include *Impatiens capensis* (spotted touch-me-not), *Iris versicolor* (northern blue flag), *Lysimachia terrestris* (swamp candles), *Carex crinita* (drooping sedge), *Osmunda regalis* (royal fern), and *Calamagrostis canadensis* (blue-joint). *Osmunda cinnamomea* (cinnamon fern) is often present but not dominant throughout. *Carex bromoides* (brome sedge) is abundant in some examples. Mosses are often abundant and diverse, but *Sphagnum* moss is absent or typically comprises less than 5% cover. Hummock-hollow topography may be absent to moderately well developed. Upland species found on large hummocks of acidic basin swamps appear to be less abundant in these swamps [e.g., *Aralia nudicaulis* (wild sarsaparilla), *Mitchella repens* (partridge-berry), and *Quercus rubra* (red oak)].



CLASSIFICATION CONFIDENCE: 1

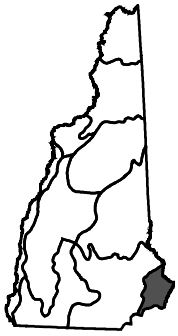
DISTRIBUTION: This community is broadly distributed in the state south of the White Mountains. Good examples occur at Great Bog and along Berry's Brook (Portsmouth) and in the Heath Brook valley (Rochester).

SOURCES: NHB field surveys.

• Circumneutral seepage swamp (S1)

General description: This is a minerotrophic swamp type significantly influenced by base-rich groundwater. It is rare and poorly documented in NH, but occurs elsewhere in southern New England.

Characteristic vegetation: Many of the species of the red maple - black ash - swamp saxifrage and other seepage swamps communities may be present in this type, as well as species indicative of more base-rich conditions such as *Cardamine bulbosa* (bulbous bitter-cress)*, *Liparis loeselii* (Loesel's twayblade)*, *Rhamnus alnifolia* (American alder-buckthorn), *Carex bebbii* (Bebb's sedge)*, and *Lysimachia thyrsiflora* (tufted loosestrife)*.



Classification confidence: 3

Distribution: Known from the Coastal Lowland subsection, although it may occur elsewhere in southern NH where base-rich bedrock or till and groundwater seepage occurs. Good examples occur at Pease International Tradeport (Newington) and in the vicinity of Wheelwright Pond (Lee).

Sources: NHB field surveys.

• Seasonally flooded Atlantic white cedar swamp (S2)

General description: This community is found along open or moving water such as along lake, pond, and stream borders and in basins with impounded drainage. This type is characterized by the presence of numerous herbaceous species typical of marsh or open wetland habitats that are not found in the other *Chamaecyparis thyoides* (Atlantic white cedar)* swamps. Species richness in this type is higher than other types of cedar swamps, although composition varies widely.

Some examples classified to this type naturally occur in seasonally flooded settings while others may be undergoing a shift in composition towards this type as a result of raised water levels from beavers or human impoundments. Atlantic white cedar in seasonally flooded settings may be more vulnerable to flood-extirpation than those with more isolated hydrologic conditions. Situations that are more susceptible to hydrologic or other alterations may not have a similar long-term viability.

Measurements of pH were generally among the highest recorded for cedar swamps in New Hampshire with a range of 4.4 to 6.5. Elevations range from 30 ft. to 250 ft. for the coastal examples.

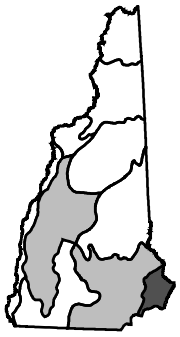
Characteristic vegetation: Characteristic species include *Triadenum virginicum* (marsh St. John's-wort), *Iris versicolor* (northern blue flag), *Carex stricta* (tussock sedge), *Spiraea alba* (eastern meadowsweet), *Sagittaria latifolia* (common arrowhead), *Sparganium americanum* (lesser bur-reed), *Carex intumescens* (inflated sedge), *Lycopus uniflorus* (common water horehound), *Bidens* spp. (beggar ticks), *Cicuta bulbifera* (bulbiferous water-hemlock), *Calamagrostis canadensis* (blue-joint) and *Rhamnus frangula* (European alder-buckthorn). Fifty other species are almost entirely restricted to this type but occur less frequently. Herbaceous cover can be quite high. The largely hummock-restricted upland species *Aralia nudicaulis* (wild sarsaparilla) and *Trientalis borealis* (starflower) are generally less constant than in the other types described, and boreal indicators are absent. Species much less frequent than in other Atlantic white cedar types include *Tsuga canadensis* (hemlock), *Nemopanthus mucronatus* (mountain holly), *Carex trisperma* (three-seeded sedge) and *Kalmia angustifolia* (sheep laurel).

As with other Atlantic white cedar swamp types *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (swamp winterberry), *Osmunda cinnamomea* (cinnamon fern), *Clethra alnifolia* (sweet pepperbush), and *Sphagnum* spp. (peat mosses) are frequent and often abundant. Other frequent species include *Carex folliculata* (follicled sedge), *Thelypteris palustris* (marsh fern), *Osmunda regalis* (royal fern), and *Symplocarpus foetidus* (skunk cabbage).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Occurs in the Coastal Lowlands, Coastal Plain, and Sunapee Uplands subsections. Good examples include Ring Brook Swamp (Sutton), Newton Cedar Swamp (Newton), and Fairhill Swamp (Rye).

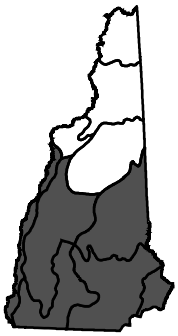
SOURCES: Belling 1977; Motzkin 1991; Sperduto and Ritter 1994; Sperduto and Crowley 2002a.



• Seasonally flooded red maple swamp (S4S5)

GENERAL DESCRIPTION: This is a common type of red maple swamp associated with stream drainages that are seasonally flooded, particularly along low gradient sections of first, second, or third order streams (less commonly 4th). Soils are typically alluvial or are shallow muck or peat over alluvial mineral soils. These differ from floodplain forests by a seasonally rather than temporarily flooded water regime, and lower energy environments that allow the development of organic or organic-rich soils as opposed to mineral soils with no organic horizon. They are commonly successional from wet meadows or shallow emergent marshes and have either a woodland or forest canopy structure.

CHARACTERISTIC VEGETATION: *Acer rubrum* (red maple) is the primary or sole tree species, and the shrub layer may be absent to moderately dense depending on the successional sequence. Clonal graminoids such as *Carex stricta* (tussock sedge) and *Calamagrostis canadensis* (blue-joint) are the most frequent dominants. Numerous other wetland herbs of marshes and swamps may be present. Although this is a common swamp type it has not been well sampled.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This swamp community occurs throughout southern and central NH up to the White Mountains. Good examples occur in Northwood Meadows State Park (Northwood).

SOURCES: NHB field surveys.

NORTHERN CONIFER AND HARDWOOD SWAMPS OF CENTRAL AND NORTHERN NH

• Northern hardwood - black ash - conifer swamp (S2)

GENERAL DESCRIPTION: This is a northern seepage swamp community characterized by a diverse overstory and lush understory composition on shallow peat or mineral soils. A hardwood - conifer mix is typical, although some examples have a prominence of either hardwoods or conifers. Although it shares numerous species with the red spruce - hardwood - violet variant of the red spruce swamp community, several species differentiate this more nutrient rich type. It occupies seepage or upland runoff-influenced areas including gently sloping hillsides, drainage headwater areas, minerotrophic upland margins of streamside or basin swamps, and local discharge areas within other swamp types. It is concentrated in northern regions of the state where surficial deposits of intermediate to base-rich composition are more prevalent. Most examples are fairly small (1-10 acres), although some examples in peatland basins probably exceed 40-50 acres.

Fraxinus nigra (black ash) is characteristic and may occur in nearly pure stands, although it is not always abundant or dominant. Although black ash does not grow as fast as red maple or American elm, its ability to

stump sprout may be an important reproductive strategy in response to disturbance. Black ash is fairly long-lived (>250 years).

This is a moderately rich swamp type influenced to some degree by groundwater seepage or near-surface upland runoff. Hummocks tend to be either modest in size (ca. 0.3 m tall) or are occasionally absent, particularly in sloped examples. There is often a gentle but discernable slope to these wetlands. Soil water pHs are subacid to circumneutral (range from 5.2-6.3, average=5.8, standard deviation=0.37, n=7) and conductivity measures range from 20-70 uS (average=36). Perennially saturated soils are typical and surface rivulets and springs are occasional. Peat or muck horizons generally consist of well decomposed organic matter and are very shallow to absent in some examples, particularly on slopes with gray (gleyed) silty or sandy mineral soil often mottled near the surface (mineral histic, histic epipedons, and shallow Histosols). Examples in flat peatland basins have moderately deep peats, averaging 127 cm (n=7 sites; range=70-265 cm).

Characteristic vegetation: The most abundant and constant species in the tree canopy consist of various combinations of black ash, *Betula alleghaniensis* (yellow birch), *Abies balsamea* (balsam fir), and *Picea rubens* (red spruce). Other frequent species include *Thuja occidentalis* (northern white cedar), *Acer rubrum* (red maple), *Picea glauca* (white spruce), *Populus balsamifera* (balsam poplar), *Fraxinus americana* (white ash), *Larix laricina* (eastern larch), *Picea mariana* (black spruce), and mostly south of the White Mountains, *Tsuga canadensis* (hemlock). Tree cover ranges from 25-80%.

The shrub layer is typically sparse to moderately well developed and may include *Alnus incana* (speckled alder), *Ilex verticillata* (swamp winterberry), *Nemopanthus mucronatus* (mountain holly), *Toxicodendron radicans* (climbing poison ivy), *Viburnum nudum* (witherod), *Lonicera canadensis* (Canadian honeysuckle), *Spiraea alba* (eastern meadowsweet), and *Cornus sericea* (red osier dogwood). *Vaccinium corymbosum* (highbush blueberry) is absent.

A broad diversity of herbaceous species indicative of minerotrophic conditions is characteristic, including *Geum rivale* (purple avens), *Senecio robbinsii* (Robbins' ragwort), *Onoclea sensibilis* (sensitive fern), *Tiarella cordifolia* (foamflower), *Hydrocotyle americana* (water pennywort), *Chrysosplenium americanum* (golden saxifrage), *Circaea alpina* (small enchanter's nightshade), *Impatiens capensis* (spotted touch-me-not), *Carex stricta* (tussock sedge)(particularly var. *strictior*), *Cinna latifolia* (drooping woodreed), *Carex gynandra* (perfect-awned sedge), *Glyceria striata* (small manna-grass), *Glyceria melicaria* (northeastern manna-grass), *Solidago flexicaulis* (zigzag goldenrod), *Thelypteris palustris* (marsh fern), *Chelone glabra* (white turtlehead), *Viola* spp. (violets), *Platanthera* spp. (rein-orchids), and *Sphagnum squarrosum* (peat moss). Other occasional species include *Cornus canadensis* (bunchberry), and *Coptis trifolia* (goldthread). Species absent or in lower abundance and constancy in this type compared to red spruce swamps include *Carex trisperma* (three-seeded sedge), *Osmunda cinnamomea* (cinnamon fern), and *Sphagnum* mosses.

Mosses are usually abundant and may form a continuous carpet. The so-called "Brown mosses" (species primarily of the Amblystegiaceae family) are typically present along with *Mnium* spp., and various liverworts.

Potential rare species include *Malaxis unifolia* (green adder's-mouth)*, *Solidago purshii* (Pursh's goldenrod)*, *Galium kamtschaticum* (northern wild licorice)*, *Listera cordata* (heart-leaved twayblade)*, and *Listera convallarioides* (lily-leaved twayblade)*.

This swamp type is essentially a more northern version of red maple - black ash - swamp saxifrage and red maple - sensitive fern swamps found in central and southern NH. It differs from these more southern swamps by the reduced importance of red maple, increased importance of more northern or boreal hardwoods, conifers, shrubs, and herbs, and usually by the absence of *Saxifraga pensylvanica* (swamp saxifrage), *Symplocarpus foetidus* (skunk cabbage), *Lindera benzoin* (northern spicebush), and other southern species. Examples transitional to red maple - black ash - swamp saxifrage swamps appear to occur at somewhat lower elevations (ca. 500 ft.).

Variants: Three variants have been described.

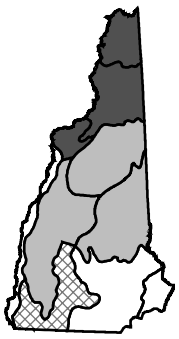
1. **Typic variant**: Moderately to weakly acidic (mediacid to subacid) conditions prevail in this variant,

and species restricted to basic conditions are absent. It generally occurs in small to large, flat or very slightly sloped open-basins that are more seasonally flooded than sloped variants described below. This is the northern analogue to the red maple - sensitive fern swamp.

2. **Circumneutral variant**: This type is similar to the first variant but contains a more significant presence of calcicoles. Conditions appropriate for these species may only occur as localized areas where base-rich groundwater discharge occurs within an otherwise more extensive and acidic swamp. Many of these species are found primarily in association with rich fens or northern white cedar swamps, but have the potential to occur in this swamp type as well, particularly in small canopy opening areas. These species include *Rhamnus alnifolia* (American alder-buckthorn), *Cypripedium reginae* (showy lady's-slipper)*, *Carex castanea* (chestnut sedge)*, *Carex baileyi* (Bailey's sedge)*, *Carex bebbii* (Bebb's sedge)*, *Cypripedium pubescens* (large yellow lady's-slipper)*, and *Liparis loeselii* (Loesel's twayblade)*.
3. **Sloped black ash variant**: This variant includes black ash dominated swamps formed on gentle, but definitively sloped terrain, often with visible evidence of surface seepage and non-entrenched drainage channels. Soils are grayish or gleyed silty loams with or without a shallow muck layer (histic epipedon). The shallow organic layer, sloped terrain and dominance of black ash may justify designating this type a distinct community type. This variant has a distinctly northern distribution north of and including Lancaster.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Primarily found north of the White Mountains in the Connecticut Lakes, Mahoosuc-Rangeley Lakes, and Vermont Piedmont subsections, and is occasional in the White Mountain, Sebago-Ossipee, and probably NH Upland subsections. Elevations range from approximately 800-2000 ft. Good examples occur at Coleman State Park (Stewartstown), Moore Reservoir vicinity (Littleton), part of Brown Ash Swamp (Thornton), Umbagog State Park (Errol), and South of Cleveland Mtn. (Bethlehem).



SOURCES: NHB field surveys; Fowells 1965; Sperduto and Engstrom 1998.

• Northern white cedar - balsam fir swamp (S2)

GENERAL DESCRIPTION: Swamps dominated by *Thuja occidentalis* (northern white cedar) are moderately acidic to circumneutral forested peatlands restricted to northern New Hampshire. Northern white cedar is a boreal species that approaches its southeastern limit in New Hampshire where it occurs only sparingly south of the 44th parallel. It is essentially absent from the interior core of the White Mountains, but becomes increasingly abundant northward in the state. It is more abundant in adjacent Maine and Vermont. In New Hampshire, it is particularly abundant in the Frontenec Formation area (formerly Waits River Formation) in the Stewartstown and Colebrook vicinity.

Although it occurs in nearly pure stands, northern white cedar is often associated with other conifers and to some extent northern hardwoods (see the northern hardwood - black ash - conifer seepage swamp description for examples with relatively minor amounts of cedar). Nearly closed-canopy stands (50-100% cover) create a deeply shaded understory. In mature examples, the typical structure consists of overstory canopy heights of 12-18 m (40-60 ft.) with occasional to frequent leaning trees and blowdowns, a moderately well developed tree subcanopy, a sparse shrub understory, well developed hummock-hollow topography, a dense carpet of bryophytes, and sparse to moderate herb cover. Trees can readily exceed 150 years of age (some examples in New Hampshire exceed 240 years; maximum ages for cedar rangewide approach 1300 years, although on cliff habitats only). Most swamps range from 1-50 acres, with at least a few examples in New Hampshire exceeding 100 acres.

Soils are moderately deep, well-decomposed (sapric), very poorly drained peats, usually over silt soils or occasionally bedrock, sand, or gravel. Peat depths average 135 cm (n=30 sites) with a range of 20-240 cm (only 4 of 30 sampled sites were less than 70 cm). Shallower soils are often found toward the swamp margins. Seasonal water fluctuations are apparent and result from variation in upland runoff and/or seasonal groundwater flow. Most swamps are not directly flooded by regular over-bank flow from adjacent streams. Circumneutral to basic groundwater seepage or near-surface flow is apparent in many examples, although some sites are weakly acidic. Average pH was 6.14 (n=32) with a range of 4.9-7.5. Average conductivity is 57 uS (n=29) with a range of 10-140 uS.

CHARACTERISTIC VEGETATION: Over 200 species of vascular plants and over 61 species of bryophytes have been documented from northern white cedar swamps in New Hampshire; 182 of these species were documented within 25 plots. Of the 182 species, 101 species (55%) occurred more commonly (in 4 or more plots), while 56 (31%) occurred in only one site, an additional 25 (14%) occurred in 3 or fewer sites; correspondingly.

Northern white cedar is dominant or co-dominant, with *Abies balsamea* (balsam fir) almost always present and next in abundance. *Fraxinus nigra* (black ash) is usually present though not necessarily abundant. Other frequent to occasional species, usually in lower abundance, include *Betula alleghaniensis* (yellow birch), *Acer rubrum* (red maple), *Picea glauca* (white spruce), *Larix laricina* (eastern larch), *Picea rubens* (red spruce), and *Picea mariana* (black spruce).

There is a sparse to moderate cover of tall shrubs, although composition is often diverse. *Lonicera canadensis* (Canadian honeysuckle) and *Viburnum nudum* (witherod) are the most frequent, *Nemopanthus mucronatus* (mountain holly), *Cornus sericea* (red osier dogwood), and *Acer spicatum* (mountain maple) are frequent, *Alnus incana* (speckled alder) is occasional, and *Ilex verticillata* (swamp winterberry), *Amelanchier bartramiana* (Bartram's serviceberry), *Sorbus americana* (American mountain ash), and *Corylus cornuta* (beaked hazelnut) are infrequent to rare. Trailing shrubs, dwarf shrubs, and herb-like dwarfed creeping shrubs are always present in some abundance and include *Cornus canadensis* (bunchberry), *Gaultheria hispidula* (creeping snowberry), *Linnaea borealis* (twinflower), *Ribes lacustre* (spiny swamp currant), and *Taxus canadensis* (Canada yew). *Rhamnus alnifolia* (American alder-buckthorn) and *Vaccinium myrtilloides* (velvet-leaf blueberry) are occasional.

Characteristic herbs that help differentiate this type from other northern white cedar swamps include *Mitella nuda* (naked miterwort), *Carex pedunculata* (long-stalked sedge), *Pyrola secunda* (one-sided shinleaf), *Platanthera obtusata* (blunt-leaved orchid), and *Rhamnus alnifolia* (American alder-buckthorn). Characteristic and frequent herbs (in approximately descending order of frequency) include *Carex trisperma* var. *trisperma* (three-seeded sedge), *Osmunda cinnamomea* (cinnamon fern), *Coptis trifolia* (goldthread), *Rubus pubescens* (dwarf raspberry), long-stalked sedge, naked miterwort, *Oxalis acetosella* (northern wood sorrel), *Dalibarda repens* (false violet), *Trientalis borealis* (starflower), *Carex intumescens* (inflated sedge), *Phegopteris connectilis* (long beech fern), *Carex leptalea* (delicate sedge), *Dryopteris cristata* (crested wood fern), *Tiarella cordifolia* (foamflower), and *Athyrium filix-femina* (lady fern). Foamflower appears to be a good indicator of somewhat enriched swamps [average pH when foamflower is present=6.5 (n=6 sites)].

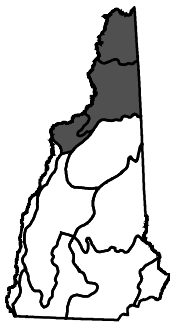
Bryophytes are diverse and form a nearly ubiquitous groundcover including *Hylocomnium splendens*, *Amblystegium riparium, Rhytidiadelphis triquetrus*, *R. subpinnatus*, *Thuidium delicatulum*, *Bazzania trilobata*, *Rhizomnium punctatum*, *Rhizomnium appalachianum*, *Fissidens adiantoides*, *Calliergon cordifolium, Sphagnum girgensohnii*, *S. subtile*, *S. russowii*, *Plagiochila asplenioides,* and *Trichocolea tomentella*.

Potential rare species of cedar swamps (often in fen-like openings within the swamps) include *Petasites frigidus* var. *palmatus* (sweet coltsfoot)*, *Carex castanea* (chestnut sedge)*, *C. baileyi* (Bailey's sedge)*, *C. bebbii* (Bebb's sedge)*, *Calypso bulbosa* (fairy slipper)*, *Cypripedium reginae* (showy lady's-slipper)*, *C. parviflorum* var. *makasin* (small yellow lady's-slipper)*, *C. pubescens* (large yellow lady's-slipper)*, *C. arietinum* (ram's-head lady's-slipper)*, and *Liparis loeselii* (Loesel's twayblade)*. These rare species are not present in most cedar swamps.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: These swamps occur north of the 44th parallel (VT Piedmont, Mahoosuc-Rangeley, and Connecticut Lakes subsections), excluding the interior White Mountains. Elevations range from 500-1920 ft. Good examples occur at Hurlbert Swamp (Colebrook) and the Umbagog Lake vicinity (Errol).

SOURCES: NHB field surveys; Sperduto and Engstrom 1998.



• Acidic northern white cedar swamp (S1)

GENERAL DESCRIPTION: This natural community is associated with large, very poorly drained peatland basins in northern NH. It lacks many of the herbaceous minerotrophic indicators found in northern white cedar - balsam fir swamps.

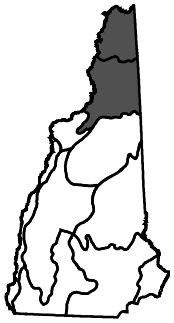
The soil conditions are acidic, with pH ranging from 4.1-5.9 (mediacid to subacid). Peat/muck depths range from 125-230 cm (n=3).

CHARACTERISTIC VEGETATION: The composition of this type is similar to that of northern white cedar - balsam fir seepage swamps. It differs by having abundant *Sphagnum* moss, typically a more well developed shrub layer, lower average cover and diversity in the herb layer, and a greater abundance or frequency of *Picea mariana* (black spruce), *Kalmia angustifolia* (sheep laurel), *Gaultheria hispidula* (creeping snowberry), *Nemopanthus mucronatus* (mountain holly), and sometimes *Alnus incana* (speckled alder).

CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: Known from the Mahoosuc-Rangeley Lakes and CT Lakes subsections (ca. 1200-1300 ft.). Good examples occur in and near Umbagog National Wildlife Refuge (Errol).

SOURCES: NHB field surveys; Sperduto and Engstrom 1998.



• Northern white cedar seepage forest (S2)

GENERAL DESCRIPTION: This community is often located along a seasonally saturated, sloping transition zone between uplands and flat swamps or along drainages. It has less well developed micro-topography than swamp communities and moderately to poorly drained soils. It is characterized by moderately low moss cover, a sparse shrub layer and a greater abundance of upland herbs, including rich-site species.

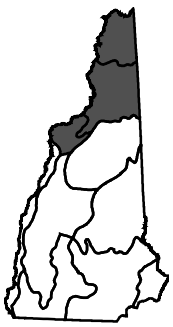
Shallow, well decomposed muck (generally <50 cm) often overlays gleyed silty loam. Two pH measurements taken in associated "seepage runs" were 7.0 and 7.8.

CHARACTERISTIC VEGETATION: The composition of this type is similar to that of northern white cedar - balsam fir swamps. Diagnostic upland and rich-site species infrequent or absent in other northern white cedar swamps include *Solidago flexicaulis* (zigzag goldenrod), *Tiarella cordifolia* (foamflower), *Arisaema triphyllum* (Jack-in-the-pulpit), *Clintonia borealis* (blue-bead lily), *Carex arctata* (contracted drooping wood sedge), *Medeola virginiana* (Indian cucumber-root), *Huperzia lucidula* (shining clubmoss), and *Acer saccharum* (sugar maple).

CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: Known from the VT Upland, Mahoosuc-Rangeley Lakes and CT Lakes subsections. Good examples can be found near Lime Pond (Columbia) and in the vicinity of Mud Pond (Pittsburg).

SOURCES: NHB field surveys; Sperduto and Engstrom 1998.

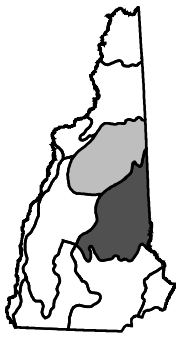


• Northern white cedar - hemlock swamp (S2)

GENERAL DESCRIPTION: This swamp community is only found south of the White Mountains in the Saco River watershed. It is characterized by abundant *Tsuga canadensis* (hemlock), *Acer rubrum* (red maple), numerous seepage indicators, and other plants absent or sparse in swamps north of the White Mountains.

These swamps occur on poorly to very poorly drained soils in moderately small, headwater basins influenced by groundwater seepage.

CHARACTERISTIC VEGETATION: *Thuja occidentalis* (northern white cedar) is dominant and hemlock and red maple are abundant. Species essentially absent from other cedar communities include *Mitchella repens* (partridge-berry), *Fraxinus americana* (white ash), *Epigaea repens* (trailing arbutus), and *Hamamelis virginiana* (witch hazel). Other common species include *Abies balsamea* (balsam fir), *Cornus canadensis* (bunchberry), *Linnaea borealis* (twinflower), *Dalibarda repens* (false violet), *Phegopteris connectilis* (narrow beach fern), *Osmunda cinnamomea* (cinnamon fern), *Platanthera lacera* (ragged-fringed orchid), and *Chelone glabra* (white turtlehead). One example has the rare *Petasites frigidus* var. *palmatus* (sweet coltsfoot)*.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Known from the Conway-Madison area in the Sebago-Ossipee subsection and nearby in the White Mountain subsection. Good examples include Whitton Ledge (Madison) and White Horse Ledge swamp (Albany).

SOURCES: NHB field surveys; Sperduto and Engstrom 1998.

• Red spruce swamp (S3)

GENERAL DESCRIPTION: This community is dominated by *Picea rubens* (red spruce) (25-50+% cover) and occurs on poorly drained mineral soils with a shallow organic cap. Carpets of *Sphagnum* moss, *Carex trisperma* var. *trisperma* (three-seeded sedge), and *Osmunda cinnamomea* (cinnamon fern) form a lush understory with a light to moderate tall shrub layer, a sparse dwarf heath layer, and slightly to moderately well developed hummock-hollow topography. Red spruce dominance, the poorly developed dwarf heath shrub layer, and mineral soils with a relatively shallow organic horizon are all indicative of more minerotrophic and less saturated conditions compared to *Picea mariana* (black spruce) swamps. Red spruce swamps are found in large swamp complexes or lake basins, in small stagnant drainages, and in pockets or benches on mountain sideslopes. These swamps appear to be more abundant in the White Mountain region than black spruce - larch swamps due to the prevalence of topogenically-influenced basins in mountainous terrain.

Soils are acidic, nutrient poor, and poorly to very poorly drained with a mineral histic horizon or histic epipedon usually 10-40 cm deep. Underlying mineral soils range from coarse sand and gravel to finer sand or silts, often derived from ice-contact deposits along drainages, glacial slackwater deposits in broader valley basins, or till sediments.

CHARACTERISTIC VEGETATION: Red spruce is typically the most abundant tree species, with lesser amounts of *Abies balsamea* (balsam fir), and occasionally some black spruce, *Acer rubrum* (red maple), and *Betula* spp. (birches). Among tall shrubs *Nemopanthus mucronatus* (mountain holly) is common, and *Viburnum nudum* (witherod), *Ilex verticillata* (swamp winterberry), and *Alnus incana* (speckled alder) are occasional. Speckled alder may be quite abundant near stream margins or areas influenced by upland runoff (see variants below). *Vaccinium corymbosum* (highbush blueberry) is absent from northern examples, although it may be present in disjunct examples in central and southern New Hampshire. Dwarf heath shrubs are absent or in low abundance, although *Kalmia angustifolia* (sheep laurel) and *Gaultheria hispidula* (creeping snowberry) are occasional.

Herbaceous species are moderately abundant with three-seeded sedge (ca. 5-90% cover) and cinnamon fern (<1-40+% cover) most abundant and fairly constant. Other common species found in moderately low abundance

(generally <5% cover) include *Coptis trifolia* (goldthread), *Clintonia borealis* (blue-bead lily), *Cornus canadensis* (bunchberry), *Dalibarda repens* (false violet), *Oxalis acetosella* (northern wood sorrel), and *Dryopteris cristata* (crested wood fern). *Rubus pubescens* (dwarf raspberry) is an occasional trailing herb. *Sphagnum* moss forms a more or less ubiquitous carpet in hollows and on the sides of hummocks. Species commonly encountered include *Sphagnum papillosum*, *S. magellanicum*, and *S. fallax*. Other mosses are occasional, particularly on hummocks and tree bases.

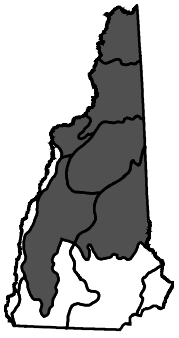
Potential rare species include *Malaxis unifolia* (green adder's-mouth)*, *Galium kamtschaticum* (northern wild licorice)*, *Listera cordata* (heart-leaved twayblade)*, and *Listera convallarioides* (lily-leaved twayblade)*.

Variants: Two variants have been described.

1. **Typic variant**: As described above, this variant is apparently more acidic and nutrient poor. In general it has a tendency towards greater spruce and fir cover, greater abundance and frequency of cinnamon fern and three-seeded sedge, lower diversity of species, and an absence of minerotrophic herbaceous species indicators (e.g., violets, turtlehead, rein-orchids, and "brown mosses").
2. **Red spruce - hardwood - violet variant**: This variant usually has the same species as the typic variant but with a greater prominence of hardwood trees, a greater diversity of herbs, and often greater influence of upland runoff or seepage influence. Tree species usually include *Betula alleghaniensis* (yellow birch) and/or *Acer rubrum* (red maple) and occasionally *Betula papyrifera* var. *papyrifera* (paper birch) and *B. populifolia* (gray birch). Cinnamon fern and three-seeded sedge are usually present, but often in lower abundance. Species richness appears to be greater than in the typic variant, perhaps indicative of more minerotrophic conditions or greater light availability. Differential species include *Viola macloskeyi* (wild white violet) and other violets, *Chelone glabra* (white turtlehead), *Platanthera clavellata* (small green woodland orchid), *P. dilatata* (white bog orchis) and other rein-orchids, and *Veratrum viride* (false hellebore), among other herbs. *Sphagnum* is usually abundant or dominant in the moss layer. Peat depth is generally shallow, although some examples appear to have depths exceeding one meter. This variant is similar to northern hardwood - conifer - black ash swamps, but generally lacks *Fraxinus nigra* (black ash) and numerous other species indicative of more minerotrophic conditions.

Classification confidence: 1

Distribution: Occurs in the White Mountain, Sebago-Ossipee, Mahoosuc-Rangeley Lakes, Connecticut Lakes, Vermont Piedmont, and NH Upland subsections. Elevations of range from ca. 700 ft. to over 2000 ft. Good examples of the typic variant include Elbow Pond (Woodstock), parts of Trudeau Road vicinity (Bethlehem), parts of Spruce Brook (Berlin), Big River vicinity (Barnstead). Good examples of the red spruce - hardwood - violet variant include Petty Brook vicinity (Langdon), Rickers Knoll and Langdon Brook vicinity (Chatham), Zealand River vicinity (Bethlehem), and part of Brown Ash Swamp (Thornton).



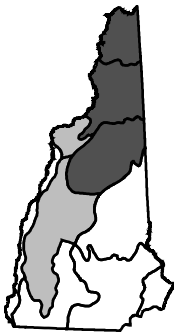
Sources: NHB field surveys.

• Seasonally flooded boreal swamp (SU)

General description: This is a broadly defined and very poorly sampled group of swamps. It is questionably distinct from red spruce swamps described elsewhere, but deserves field survey to determine its distinctiveness. Boreal conifers, tall shrubs, and herbs of alluvial wetlands dominate in stream or lakeside positions that are subject to seasonal over-bank flooding. They are presumably successional from marshes in abandoned beaver meadows of northern regions. These swamps have seasonally flooded water regime with mineral or shallow organic soils, although some examples have a seepage influence.

This swamp is more minerotrophic and wetter than red spruce swamps and montane black spruce - red spruce forests, and probably more seasonal water fluctuations than northern hardwood - black ash - conifer and other conifer swamps described elsewhere, but the differences in species composition needs to be substantiated with additional field observations. Some examples are conifer woodlands that appear to be a later-successional expression of speckled alder wooded fens (this shrub thicket is similar floristically but has a less dense tree canopy component).

CHARACTERISTIC VEGETATION: Potential trees include *Picea rubens* (red spruce), *Picea mariana* (black spruce), *Abies balsamea* (balsam fir), *Acer rubrum* (red maple), and *Populus balsamifera* (balsam poplar). *Alnus incana* (speckled alder) is the most likely dominant shrub, although others may be present in some abundance including *Spiraea alba* (eastern meadowsweet), *Cornus sericea* (red osier dogwood), and *Lonicera villosa* (mountain fly honeysuckle). Herbs are likely to include *Rubus pubescens* (dwarf raspberry), *Calamagrostis canadensis* (blue-joint), *Carex stricta* (tussock sedge), *Carex lacustris* (lake sedge), *Carex trisperma* (three-seeded sedge), and *Osmunda regalis* (royal fern). *Sphagnum* moss is probably in moderate to low abundance due to the broadly fluctuating water levels.



CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: North of and including the White Mountains. Good examples occur at the margins of the Androscoggin River (Errol) and south of First Connecticut Lake (Pittsburg).

SOURCES: NHB field surveys.

• Northern hardwood seepage forest (S3)

GENERAL DESCRIPTION: This is a swampy, semi-rich northern hardwood forest found on sloping lower mountain slopes with frequent seep openings and seepage runs. Because of the frequency of wet areas, a mosaic of both upland and wetland plant species characterize this forest. In some examples, the seepage zones are more extensive, occupying several acres. Seepy glade openings densely dominated by tall herbs are common and reach 1/2 acre or more in size in the North Country. This forest is typically dominated by a canopy of northern hardwoods or sometimes by a hardwood - conifer mix. It differs from red maple - black ash/swamp saxifrage seepage swamps by more prominent slopes and the codominance of *Acer saccharum* (sugar maple), *Betula alleghaniensis* (yellow birch), and occasionally *Abies balsamea* (balsam fir) or *Picea rubens* (red spruce). *Fraxinus nigra* (black ash) generally restricted to wetter portions of the forest (e.g., drainages). This community is most frequent in the Connecticut Lakes subsection where the combination of a cold northern climate and the abundance of sloping silt soils with a densipan and impeded drainage is more common than further south in New Hampshire.

Soils are usually poorly to very poorly drained silt loams with 3-10 (-20) degree slopes. In drier portions of seepage forests, soils consist of shallow mucky silt loams over silt loam with some mottling apparent near the surface (ca. 15-20 cm down). In wetter portions, soils have a deeper mucky silt loam at the surface. This community is found on Monarda (Cabot) and Peacham soil series in Coos County.

CHARACTERISTIC VEGETATION: Component tree species include sugar maple, yellow birch, balsam fir, and occasionally black ash. Other trees include *Picea glauca* (white spruce), and *Betula papyrifera* var. *cordifolia* (heartleaf birch). A well developed herb layer is dominated by *Glyceria melicaria* (northeastern manna-grass), *Impatiens capensis* (spotted touch-me-not), *Tiarella cordifolia* (foamflower), *Aster puniceus* (purple-stemmed aster), *Epilobium angustifolium* (great willow-herb), *Rubus pubescens* (dwarf raspberry), and *Athyrium filix-femina* (northern lady fern). Other herbs include *Carex gynandra* (perfect-awned sedge), *Epilobium ciliatum* (ciliated willow-herb)*, *Dryopteris campyloptera* (mountain wood fern), *Polystichum braunii* (Braun's holly fern), *Onoclea sensibilis* (sensitive fern), *Eupatorium rugosum* (white snakeroot), *Galium triflorum* (sweet-scented bedstraw), *Thalictrum pubescens* (tall meadow-rue), *Clintonia borealis* (blue-bead lily), *Solidago flexicaulis* (zigzag goldenrod), *Actaea rubra* (red baneberry), *Actaea pachypoda* (white baneberry), *Phegopteris*

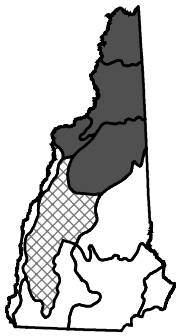
connectilis (long beech fern), *Dryopteris intermedia* (intermediate wood fern), *Eupatorium maculatum* var. *foliosum* (northeastern spotted Joe-pye-weed), *Euthamia graminifolia* (grass-leaved goldenrod), *Calamagrostis canadensis* (blue-joint), and *Chelone glabra* (white turtlehead). Shrubs include *Rubus idaeus* (red raspberry), *Sambucus racemosa* (red elderberry), *Viburnum alnifolium* (hobblebush), *Acer pensylvanicum* (striped maple), and *Alnus incana* (speckled alder). Rare or uncommon plants found in this community include *Galium kamtschaticum* (northern wild licorice)* and *Milium effusum* (millet-grass).

Circumneutral examples with such species as *Cypripedium pubescens* (large yellow lady's-slipper)* may deserve recognition as their own community type.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is largely restricted to the White Mountains and the North Country. Good examples occur in the Connecticut Lakes Headwaters Natural Area (Pittsburg) and along the lower portion of the Falling Waters Trail in Franconia Notch (Lincoln).

SOURCES: NHB field surveys.



OTHER FORESTS WITH A SEASONALLY HIGH WATER TABLE

Forests that are influenced by a seasonally high water table are transitional between hydric forested wetlands and uplands. Typically they have somewhat poorly drained soils, but can range from poorly drained to moderately well drained. These are "low" or wet forests that are either temporarily flooded (e.g., along drainages), seasonally saturated (e.g., along the upland transition of various wetlands), or otherwise maintain a seasonally high water table (such as on silt soils in coastal or northern New Hampshire).

• Hemlock - cinnamon fern forest (S4)

GENERAL DESCRIPTION: This community occurs in imperfectly to somewhat poorly drained areas along stream drainages, high floodplains, inactive river terraces, and other upland-wetland ecotones. It is characterized by *Tsuga canadensis* (hemlock), *Acer rubrum* (red maple), and a mixture of other wetland and upland plant species. Examples may occur along a narrow transition zone between uplands and wetlands or may be broader in extent and cover several acres.

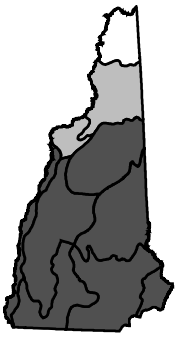
Hemlock is an important component in many other types of forest communities, but only reaches overstory dominance or codominance in hemlock forests on upland sites and in this community along upland-wetland ecotones. Sites where hemlock is abundant are characterized by open, dark understories. Although hemlock may be present in the understory in low density, it appears to maintain itself by out-competing other suppressed tree species for light and nutrients (Rogers 1978). Hemlock saplings may persist for decades or even centuries in the understory and still respond well to canopy openings. Maximum hemlock ages in the region exceed 500 years. The centers of most older trees are rotten, preventing accurate aging of individual trees. Deer often winter in these areas where snow cover is light and movement is therefore easier.

Soils vary from loamy sands to sandy loam till and river/kame terrace soils with a shallow water table (within 0.3 m (1 ft.) of soil surface for portion of growing season), and are nutrient poor. Mottles are evident within 30 cm (12 in.) of the soil surface in some examples, while others have deep A horizons (tending to obscure mottles) over moist to wet sediments. Although some sub-surface seepage may influence certain examples, this community appears distinct from seepage forest and forest seep communities, which tend to have relatively constant surface or near-surface seepage influence and more seepage or minerotrophic plant indicators. Soils include series Au Gres, among other types.

CHARACTERISTIC VEGETATION: *Tsuga canadensis* (hemlock) and *Acer rubrum* (red maple) dominate in the overstory. Canopy associates may include *Pinus strobus* (white pine), *Betula alleghaniensis* (yellow birch), and less

frequently *Quercus bicolor* (swamp white oak), *Quercus rubra* (red oak), *Betula lenta* (black birch), *Ulmus americana* (American elm), and *Prunus serotina* (black cherry). At upland-wetland ecotones in other landscape positions, *Fraxinus americana* (white ash) may also be prominent in the tree canopy. Other woody species can include *Kalmia angustifolia* (sheep laurel), *Vaccinium corymbosum* (highbush blueberry), *Viburnum nudum* (witherod), *Fagus grandifolia* (American beech), *Rosa palustris* (swamp rose), *Rubus occidentalis* (western black raspberry), *Sambucus canadensis* (common elderberry), *Acer pensylvanicum* (striped maple), *Viburnum alnifolium* (hobblebush), *Picea rubens* (red spruce), and *Abies balsamea* (balsam fir).

Although the overstory association can approximate certain upland forests, more mesic to wet conditions are indicated by the presence of *Osmunda cinnamomea* (cinnamon fern), *Osmunda claytoniana* (interrupted fern), *Arisaema triphyllum* (Jack-in-the-pulpit), *Thelypteris palustris* (marsh fern), *Lonicera canadensis* (Canadian honeysuckle), *Lindera benzoin* (northern spicebush), and various mosses. Other herbs may include *Thelypteris noveboracensis* (New York fern), *Aralia nudicaulis* (wild sarsaparilla), *Aster acuminatus* (whorled aster), *Dryopteris intermedia* (intermediate wood fern), *Mitchella repens* (partridge-berry), *Oxalis acetosella* (northern wood sorrel), and *Clintonia borealis* (blue-bead lily).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Occurs throughout most of New Hampshire primarily south of and including the White Mountains on valley bottoms and drainages of upland till and river/kame terrace soils. Good examples can be found east of swamp north of Birch Hill (Albany), along Allard Brook (Albany), east of White Ledge (Albany), and along Johnson Creek (Durham).

SOURCES: NHB field surveys; Nichols and Sperduto 1997.

• Red maple - elm - ladyfern silt forest (S1S2)

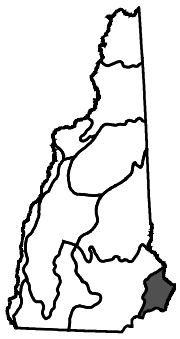
GENERAL DESCRIPTION: This forest type is intermediate between upland and wetland communities. It has a seasonally high water table and silt soils with a high water holding capacity and intermediate nutrient status. The vegetation consists of a moderately diverse combination of upland, moist-site forest species and facultative wetland species. The woody and herbaceous understories are sparse to moderately well developed. Unlike most swamps, there is very little or no organic soil horizon or hummock-hollow microtopography development.

Soils are somewhat poorly drained silt loams with a seasonally high water table, high moisture holding capacity due to the silt content, and moderate base-cation status judging from species composition and silty soils. Soil types include some Buxton and Scitico silt loams (of marine origin), among other soils. There is typically no or a very shallow O horizon (<2 cm), very dark gray-black silt loam A horizon, and olive gray silt loam B horizon with redoxymorphic features (mottles) found near the transition to the B horizon. One example has a distinct plow layer, although others have a more distinct horizon development and have not been plowed.

This community is similar in some respects to somewhat poorly drained floodplains forests and seepage forests, but are not flooded and do not have mucky organic horizons. It is also similar to hemlock - cinnamon fern and red maple - red oak - cinnamon fern forests in terms of drainage class.

CHARACTERISTIC VEGETATION: The characteristic dominant tree species is *Acer rubrum* (red maple), accompanied by a diverse but variable assemblage of other trees. *Ulmus americana* (American elm) is usually present in low abundance (probably contributed higher cover prior to Dutch elm disease), along with *Fraxinus americana* (white ash), *Carya ovata* (shagbark hickory), *Tilia americana* (basswood), *Pinus strobus* (white pine), *Prunus serotina* (black cherry), and *Tsuga canadensis* (hemlock), in decreasing order of constancy. *Carpinus caroliniana* (musclewood) can be abundant as an understory tree. Shrubs present in moderately low abundance include *Toxicodendron radicans* (climbing poison ivy), *Ilex verticillata* (swamp winterberry), *Parthenocissus quinquefolia* (Virginia creeper), *Viburnum dentatum* (northern arrowwood), *Lindera benzoin* (northern spicebush), and *Clethra alnifolia* (sweet pepperbush). The herb layer is moderately well developed, with *Athyrium*

filix-femina (lady fern) usually among the most abundant species. *Onoclea sensibilis* (sensitive fern) and *Viola* spp. (violets) are nearly constant, although in low abundance. Species indicative of semi-rich moist or wet sites found in at least half the known examples include *Saxifraga pensylvanica* (swamp saxifrage), *Carex radiata* (stellate sedge), *C. rosea* (star sedge), *C. laxiculmis* (loose-stemmed sedge), *C. blanda* (charming sedge), *Impatiens capensis* (spotted touch-me-not), and *Polystichum acrostichoides* (Christmas fern); those of generally acidic moist or wet sites include *Carex trisperma* (three-seeded sedge), *Equisetum arvense* (field horsetail), *Glyceria striata* (small manna-grass), *Maianthemum canadense* (Canada mayflower), and *Geum canadense* (white avens).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Currently described only from the Great Bay area. May also occur in other parts of the state with silty, somewhat poorly drained soils (e.g., the Connecticut River valley and northern Coos County). Good examples include Pickpocket Flats (Exeter), the south side of Great Bay (Greenland), Bellamy River Wildlife Sanctuary (Dover), and College Woods (Durham).

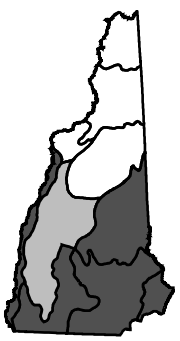
SOURCES: NHB field surveys; Nichols and Sperduto 1997.

• Red maple - red oak - cinnamon fern forest (S3S4)

GENERAL DESCRIPTION: This community occurs in somewhat poorly drained mineral soil settings in transition zones between wetland and upland communities. It is dominated by hardwood trees, particularly red maple, oaks, and birches, with a relatively minor component of pine and hemlock. *Osmunda cinnamomea* (cinnamon fern) and tall wetland shrubs such as *Vaccinium corymbosum* (highbush blueberry) are present in moderate abundance (~1-15%). Other wetland plants are sparse. More coastal or southern examples contain Appalachian oaks, hickories, and possibly black huckleberry, which are absent from central NH examples.

Soils consist of sand, sandy loams and silt loams, typically with a dark brown or black A horizon over B horizon materials with mottling within ~30 cm of the surface. This community is typically somewhat poorly drained, and therefore intermediate and transitional to more well drained upland forests and poorly or very poorly drained swamps. Soils series include Pipestone sand, Boxford silt loam, and possibly Raynham silt loam and Eldridge fine sandy loam.

CHARACTERISTIC VEGETATION: This community is similar to but differentiated from various mesic upland forests (e.g., mesic Appalachian oak - hickory and hemlock - beech - oak - pine forests) of central and southern NH by the presence of a few wetland species in low to moderate abundance, including cinnamon fern and highbush blueberry. *Acer rubrum* (red maple) and *Quercus rubra* (red oak) are usually present and often dominant, mixing with various combinations of *Betula alleghaniensis* (yellow birch), *B. lenta* (black birch), *Fraxinus americana* (white ash), *Quercus alba* (white oak), *Q. velutina* (black oak), *Carya ovata* (shagbark hickory), *Fagus grandifolia* (American beech), *Pinus strobus* (white pine), and *Tsuga canadensis* (hemlock). *Gaylussacia baccata* (black huckleberry) can be abundant. Ferns such as *Thelypteris noveboracensis* (New York fern) are more abundant than in mesic Appalachian oak - hickory forests. This community is similar in drainage class to the hemlock - cinnamon fern forest but lacks the prominence of hemlock, and similar to the red maple - elm - ladyfern silt forest, but lacks or has a low abundance of *Athyrium filix-femina* (northern lady fern), *Onoclea sensibilis* (sensitive fern), and *Ulmus americana* (American elm).



CLASSIFICATION CONFIDENCE: 1-2

DISTRIBUTION: This community occurs in southern and central New Hampshire with good examples in the Great Bay National Wildlife Refuge (Newington) and on Sandy Point (Stratham).

SOURCES: NHB field surveys.

FOREST SEEPS

Forest seeps form where groundwater is discharged at or near the soil surface, either continuously or for substantial portions of the year. They are found in headwater positions of streams, along "seepage runs" of small drainages, on benches and sloping terrain of upland till hillsides, along upland margins of swamps, and on steep faces of river terraces. Groundwater usually emerges where the surface of an impervious or slowly pervious soil layer (hardpan or densipan, silt, or clay material) forces water to the surface, or other situations where the ground surface intersects with the water table on sloped terrain. Most seeps occur on slopes ranging from 1-25 or more degrees and have mineral soil or a shallow muck horizon at the surface (less than 15-30 cm deep) and weakly acidic (subacid) to circumneutral pHs.

In many ways seeps are miniature swamps or marshes, but they differ from their larger counterparts in several important respects. They occur as small inclusions within upland forests and are therefore considerably shaded. Most are no larger than one to several tree canopies in breadth (less than 0.1 acres). They are often isolated from larger wetlands, have mineral soils with or without a shallow muck layer (usually not peat), and are usually more permanently saturated with a localized and pronounced seepage area compared to larger swamps. Seeps are important habitats for wetland plants, amphibians (e.g., northern dusky salamander, two-lined salamander, and various frogs), and other organisms within upland dominated landscapes, and reportedly contribute oxygenated water to streams and wetlands. Perennial seepage may keep seeps cool in the summer, and sometimes snow-free in the winter. Their local and collective significance is greater than implied by the area they cover, and as such, seeps warrant protection wherever they occur as sensitive wetland "hot-spots" within upland forest dominated landscapes.

Floristically, many of the wetland plants found in seeps may also be found in seepage swamps, although seeps tend to have a higher concentration or abundance of plants diagnostic of pronounced seepage. Within larger swamps, focused points of discharge and corresponding diagnostic species are usually confined to very small areas or are obscured as subsurface flow on a flatter swamp surface.

Seeps are variable in composition from one example to the next, and collectively are quite diverse. In a study of 17 seeps from around the state (3 different community types), 138 vascular plants were catalogued, with an average of 17 species per seep (NHB field surveys). About half of these species are found at only one seep, and more than two-thirds are found in only two or fewer seeps. Because of this variability, we classify seeps broadly, relying on broad acidity ranges indicated by certain species assemblages.

Species usually diagnostic of pronounced seepage include *Chrysosplenium americanum* (golden saxifrage), *Carex scabrata* (rough sedge), *Hydrocotyle americana* (water pennywort), *Circaea alpina* (small enchanter's nightshade), *Glyceria melicaria* (northeastern manna-grass), *Impatiens capensis* (spotted touch-me-not), *Platanthera dilatata* (tall white bog orchid), *Cardamine pensylvanica* (Pennsylvania bitter-cress), *Rubus pubescens* (dwarf raspberry), *Galium kamtschaticum* (northern wild licorice)*, *Listera convallarioides* (lily-leaved twayblade)*, *Scirpus microcarpus* (red bulrush), *Mnium* sp. (a moss), and certain *Sphagnum* species, such as *Sphagnum squarrosum*.

• Acidic Sphagnum forest seep (S3S4)

GENERAL DESCRIPTION: Acidic Sphagnum forest seeps occur on benches, along headwater drainages, on moderate to steep slopes adjacent to upper perennial streams, and on seepy, ledgy slopes. This community is probably most frequent in spruce - fir forests at higher elevations in the White Mountains, but may occur at a broad range of elevations in nutrient poor, coniferous and streamside settings. The typic variant is equivalent in some respects to miniature spruce - fir swamps but is characterized by active seepage that limits peat accumulation and contain more plants restricted to seepage conditions. The typic variant is also transitional to acidic fen communities in more open examples but are typically smaller in size and lack the abundance of sedges, heath shrubs, and deeper peat soils found in fens.

This community differs from the subacidic *Sphagnum* variant of the subacid forest seep by the absence of *Tiarella cordifolia* (foamflower), *Carex scabrata* (rough sedge), and *Glyceria melicaria* (northeastern manna-grass). These plants are indicative of more minerotrophic conditions.

Acidic groundwater is implied by the lack of species diagnostic of enriched conditions, although few pH measurements have been taken (pHs probably do not exceed ca. 5.5). Shallow peat or muck layers (<30 cm) are typical over seepy bedrock or in headwater and streamside positions over sandy loams, particularly in spruce - fir or other nutrient-poor coniferous settings.

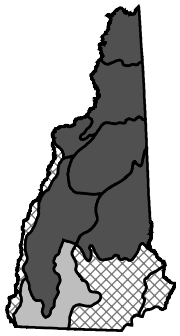
Characteristic vegetation: Trees that can form a dense tall shrub or subcanopy layer include *Picea rubens* (red spruce), *P. mariana* (black spruce), and *Abies balsamea* (balsam fir). The shrub layer is otherwise scant and herbs form a sparse to moderate cover over a dense *Sphagnum* layer. Common *Sphagnum* mosses include *S. girgensohnii*, *S. russowii*, *S. centrale*, *S. fallax*, *S. magellanicum*, and *S. squarrosum*. Characteristic herbs include *Veratrum viride* (false hellebore), *Aster acuminatus* (whorled aster), *Oxalis acetosella* (northern wood sorrel), *Thelypteris noveboracensis* (New York fern), *Carex disperma* (two-seeded sedge), *C. leptalea* (delicate sedge), *C. intumescens* (inflated sedge), *Thalictrum pubescens* (tall meadow-rue), *Osmunda cinnamomea* (cinnamon fern), *Coptis trifolia* (goldthread), *Gaultheria hispidula* (creeping snowberry), *Equisetum arvense* (field horsetail), and *Aster radula* (rough-leaved aster). *Galium kamtschaticum* (northern wild licorice)*, *Listera cordata* (heart-leaved twayblade)* and *L. convallarioides* (lily-leaved twayblade)* are rare species that may occur in this community. In examples transitional to acidic fens, the rare *Calamagrostis pickeringii* (Pickering's reed bent-grass)* might be expected. Heath shrubs and fen sedges may be present in some examples, but do not reach nearly the prominence found in acidic fens.

Variants: Two variants are described below.

1. **Typic variant**: This variant is characterized by a variable mix of species mentioned above and by its occurrence in headwater settings and on seepy, ledgy slopes.
2. **Streambank variant**: In contrast to the typic variant, examples along streamsides are influenced by flood- and ice-scour. Additional vegetation documented from streamside examples include *Chamaedaphne calyculata* (leather-leaf), *Nemopanthus mucronatus* (mountain holly), *Rhododendron canadense* (rhodora), *Amelanchier bartramiana* (Bartram's serviceberry), *Rubus idaeus* (red raspberry), *Viburnum dentatum* (northern arrowwood), *Eriophorum virginicum* (tawny cotton-grass), *Carex interior* (inland sedge), *C. trisperma* (three-seeded sedge), *C. pauciflora* (few-flowered sedge), *C. arctata* (contracted drooping wood sedge), *Drosera rotundifolia* (round-leaved sundew), and *Clintonia borealis* (blue-bead lily).

Classification confidence: 2

Distribution: This community occurs in high and low elevation coniferous forests, along upper perennial streams in cool entrenchments, or in other nutrient poor settings. The typic variant is most common above 2500 ft. elevation. Good examples of the typic variant can be found at Nancy Brook RNA (Livermore), on Imp Mtn. (Beans Purchase), and above Crystal Cascade (Pinkhams Grant). Good examples of the streamside variant occur along entrenched streams draining into Indian Stream (Pittsburg).



Sources: NHB field surveys; Royte et al. 1996.

• Subacid forest seep (S3S4)

General description: This is a broadly defined community with subacid (weakly acidic) conditions, intermediate between the nutrient poor conditions of acidic seeps and the enriched conditions of circumneutral seeps. Five fairly distinct variants are described based on differences in dominant life forms and species composition.

The foamflower - graminoid and subacidic *Sphagnum* variants have a shallow muck layer (typically 10-30 cm) over sand or silt loams on slopes ranging from 1 to 24 degrees. Most are headwater seeps associated with ephemeral or permanent streams. pH's are subacid and probably range from ca. mid-5s to mid 6s. Nutrient levels are probably moderate to moderately high (mesotrophic) as indicated by the plant composition. The bryophyte - violet variant has subacid to somewhat circumneutral pHs and has shallow sandy muck over sand and gravel soils. They occur on till soils and along terrace slope faces. One example of the herbaceous - fern glade variant had 20-25 cm of muck over fine sand along a steep river terrace slope. The streamside variant typically has a shallow organic surface layer over mineral soil.

Characteristic vegetation: A variable mix of characteristic seep species include *Tiarella cordifolia* (foamflower), *Carex scabrata* (rough sedge), *Glyceria melicaria* (northeastern manna-grass), *Cinna latifolia* (drooping woodreed), *Rubus pubescens* (dwarf raspberry), *Impatiens capensis* (spotted touch-me-not), *Circaea alpina* (small enchanter's nightshade), *Aster puniceus* (purple-stemmed aster), *Chrysosplenium americanum* (golden saxifrage), *Platanthera dilatata* (tall white bog orchid), *Geum rivale* (purple avens), *Mitella diphylla* (two-leaved miterwort), *Sphagnum* mosses, and other bryophytes. *Galium kamtschaticum* (northern wild licorice)* is an uncommon to rare seep species present in some mountain examples. *Listera cordata* (heart-leaved twayblade)* and *Listera convallarioides* (lily-leaved twayblade)* are other rare species that may occur in this community. Several other plants diagnostic of seeps may occur but are less frequent, including *Cardamine pensylvanica* (Pennsylvania bitter-cress), *Chelone glabra* (white turtlehead), *Hydrocotyle americana* (water pennywort), *Epilobium coloratum* (eastern willow-herb), *Veratrum viride* (false hellebore), *Carex leptalea* (delicate sedge), *Carex disperma* (two-seeded sedge), and *Equisetum sylvaticum* (wood horsetail).

Other frequent plants (with broader habitat ranges) include *Aster acuminatus* (whorled aster), *Oxalis acetosella* (northern wood sorrel), *Viola* spp. (violets), *Galium* spp. (bedstraws; including *G. tinctorium* and *triflorum*), *Arisaema triphyllum* (Jack-in-the-pulpit), *Carex stipata* (awl sedge), *C. intumescens* (inflated sedge), *C. gynandra* (perfect-awned sedge), and several ferns and fern allies. These include *Athyrium filix-femina* (lady fern), *Dryopteris campyloptera* (mountain wood fern), *D. intermedia* (intermediate wood fern), *Phegopteris connectilis* (long beech fern), *Onoclea sensibilis* (sensitive fern), *Osmunda cinnamomea* (cinnamon fern), *Gymnocarpium dryopteris* (oak fern), and *Huperzia lucidula* (shining clubmoss). Shrubs include *Acer spicatum* (mountain maple), *Alnus incana* (speckled alder), *Rubus* spp. (blackberries), and *Viburnum alnifolium* (hobblebush), among others. Trees largely reflect the surrounding forest type.

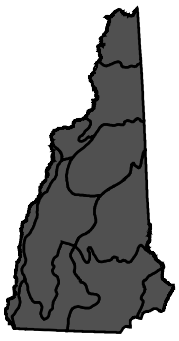
Variants: Key characteristics of the five variants are described below.

1. **Foamflower - graminoid variant**: These seeps are typical of mid-elevation northern hardwood and semi-rich mesic forests in the White Mountain region, and probably other parts of the state. They are densely herb-dominated with a high graminoid (grass and sedge) component and a low to moderate moss cover. Herbs diagnostic of this variant include *Tiarella cordifolia* (foamflower), which is usually present and abundant, and either or both *Carex scabrata* (rough sedge) and *Glyceria melicaria* (northeastern manna-grass), which are typically among the dominant species. *Cinna latifolia* (drooping woodreed) is also usually present, though usually not dominant. Total graminoid cover usually exceeds 35%, fern cover typically ranges from 5-20%, and total herbaceous cover exceeds 75% (sometimes >100% due to dense, overlapping herbs). Most examples are less than 1/10th acre and have 13-18 herb species present (some larger examples have more species).
2. **Subacidic *Sphagnum* variant**: This variant differs from the foamflower - graminoid variant by the presence of a moderate to dense carpet of *Sphagnum* moss and a less dense herb layer. It differs from acidic *Sphagnum* seeps by the presence of species indicative of more minerotrophic conditions including *Tiarella cordifolia* (foamflower), *Carex scabrata* (rough sedge), *Glyceria melicaria* (northeastern manna-grass), *Gymnocarpium dryopteris* (oak fern), *Mitella diphylla* (two-leaved miterwort), and *Onoclea sensibilis* (sensitive fern), among others. Frequent mosses include *Sphagnum squarrosum*, *S. girgensohnii*, and *S. fallax*.

3. **Bryophyte - violet variant**: Bryophytes (mosses and liverworts) dominate with an apparent paucity of *Sphagnum* moss. The herb layer is variable; some seeps have a dense herb layer over the bryophyte layer while others are dominated solely by bryophytes. Violets may be abundant. These seeps may be associated with a strong coniferous overstory component (e.g., >50%). The primary diagnostic plants of the foamflower - graminoid variant are sparse or absent. Seepage plants may include *Viola* spp. (violets; including *Viola cucullata*), *Chrysosplenium americanum* (golden saxifrage), *Carex gynandra* (perfect-awned sedge), *Circaea alpina* (small enchanter's nightshade), and *Rubus pubescens* (dwarf raspberry), among others. *Arisaema triphyllum* (Jack-in-the-pulpit) and *Onoclea sensibilis* (sensitive fern) may also be present.
4. **Herbaceous - fern glade variant**: A dense herb layer with a prominent fern and horsetail component is typical of this variant. The moss layer is variable. Herbs include *Onoclea sensibilis* (sensitive fern), *Osmunda cinnamomea* (cinnamon fern), *Osmunda claytoniana* (interrupted fern), *Athyrium filix-femina* (lady fern), *Equisetum sylvaticum* (wood horsetail), *Impatiens capensis* (spotted touch-me-not), and *Carex stipata* (awl sedge), among other seep plants. Graminoids are present but usually not a dominant life form as in the foamflower - graminoid variant.
5. **Streamside variant**: This variant occurs on low seepy benches or moderate to steep slopes immediately adjacent to upper perennial streams. Streambed gradients are moderate to high. Flood- and ice-scour and seasonal high water likely influence the vegetative structure and composition. Frequent herbs can include *Rubus pubescens* (dwarf raspberry), *Tiarella cordifolia* (foamflower), *Oxalis acetosella* (northern wood sorrel), *Galium kamtschaticum* (northern wild licorice)*, *Hydrocotyle americana* (water pennywort), *Chrysosplenium americanum* (golden saxifrage), *Circaea alpina* (small enchanter's nightshade), *Thalictrum pubescens* (tall meadow-rue), *Eupatorium rugosum* (white snakeroot), *Viola* spp. (violets), *Athyrium filix-femina* (northern lady fern), *Dryopteris intermedia* (intermediate wood fern), *Matteuccia struthiopteris* (ostrich fern), *Osmunda claytoniana* (interrupted fern), *Carex scabrata* (rough sedge), *C. leptalea* (delicate sedge), *Glyceria melicaria* (northeastern manna-grass), and *Cinna latifolia* (drooping woodreed). Shrubs include *Alnus incana* (speckled alder) and *Sambucus racemosa* (red elderberry), among others. Bryophyte cover is often high and includes *Conocephalum conicum*, *Brachythecium rivulare*, *Plagiomnium ciliare*, and *Mnium* sp.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Documented examples of the foamflower - graminoid and subacid *Sphagnum* variants occur from 1300-3100 ft. elevation in the northern hardwood and northern hardwood - spruce - fir zone north of and including the White Mountains. They probably also occur further south in the Sebago-Ossipee and NH Uplands subsections in appropriate forest settings. The bryophyte - violet variant is documented from the White Mountain region (700-1700 ft. elevation), but is probably of wider distribution (e.g., NH Uplands and Sebago-Ossipee region). The herbaceous - fern glade variant is documented from the Coastal Plain subsection (ca. 700 ft.), but is probably of broader distribution. The streamside variant likely occurs across most of the state. Good examples for each variant are listed below. Foam flower - graminoid variant: Jeffers Mtn. & Black Mtn. (Benton), Kelsey Mtn. (Millsfield), Spruce Brook (Berlin), Falling Waters Trail (Lincoln), and Lincoln Brook (Lincoln). Subacidic *Sphagnum* variant: Elbow Pond (Woodstock), Trudeau Rd. vicinity (Bethlehem), Moriah Brook headwaters (Beans Purchase), Fairy Spring at Ice Gulch (Randolph), and Ammonoosuc Lake (Bethlehem). Bryophyte - violet variant: Allard Brook (Albany) and Shingle Pond vicinity (Chatham). Herbaceous - fern glade variant: Merrimack River terrace slope (Sanbornton). Streamside variant: Jobber's Brook and Boundary Pond (Pittsburg).



SOURCES: NHB field surveys.

• Circumneutral hardwood forest seep (S3)

General description: Circumneutral forest seeps are those with pHs near neutral (ca. 6.5-7.4) and with a higher nutrient availability compared to subacid or acidic seeps (below ca. 6.4 and 5.3, respectively), as indicated by plants. They occur as small orbicular seeps, as linear "seepage runs" within a forest, or zones along river terrace slopes. A mixture of classic seepage and other wetland plants along with rich mesic hardwood plants is characteristic. They are treated here as one broadly defined group with three variants. Larger examples are preferably classified as seepage swamps or seepage forests.

Soils are either shallow mucks or silty, gravelly mucks (10-25 cm) over silt loams, silt, or clay soils. Soils are derived from circumneutral bedrock, till, or marine silt and clay sediments. pHs probably range from 6.5-7.4 in most examples; pHs higher than 7.4 may indicate a presently undocumented calcareous forest seep.

Characteristic vegetation: The presence of rich-site plants along with other seepage plants differentiates this type from subacid seeps. Diagnostic rich-site plants include the trees *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), *Fraxinus nigra* (black ash), and *Tilia americana* (basswood), and herbs and shrubs including *Laportea canadensis* (wood nettle), *Matteuccia struthiopteris* (ostrich fern), *Solidago flexicaulis* (zigzag goldenrod), *Carex plantaginea* (plantain-leaved sedge), *Caulophyllum thalictroides* (blue cohosh), *Diplazium pycnocarpon* (narrow-leaved spleenwort)*, *Polystichum acrostichoides* (Christmas fern), *Dryopteris goldiana* (Goldie's fern)*, *Actaea pachypoda* (white baneberry), *Cypripedium pubescens* (large yellow lady's-slipper)*, *Botrychium virginianum* (rattlesnake-fern), *Adiantum pedatum* (northern maidenhair fern), *Rubus odoratus* (purple-flowering raspberry), and *Viola pubescens* (downy yellow violet). Other documented species include *Viola* spp. (violets), *Athyrium filix-femina* (lady fern), *Gymnocarpium dryopteris* (oak fern), *Thalictrum pubescens* (tall meadow-rue), *Thelypteris palustris* (marsh fern), *Glyceria striata* (small manna-grass), and *Galium* spp. (bedstraws). *Equisetum scirpoides* (dwarf scouring-rush) is an uncommon plant that may be expected in northern seeps in coniferous or some deciduous forests.

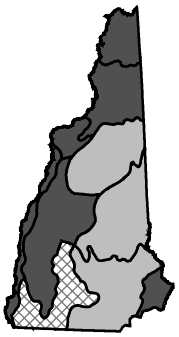
Variants: Three variants are described below.

1. **Typic northern hardwood variant**: As described above, one recognizable expression of circumneutral hardwood forest seeps are seepy fern and nettle glades that have a high cover contributed by ferns, particularly lady fern and/or ostrich fern, and wood nettle. Other expressions may contain species also found in calcareous fens such as large yellow lady's slippers*, *Cystopteris bulbifera* (bulblet bladder fern), *Liparis loeselii* (Loesel's twayblade)*, and *Carex bebbii* (Bebb's sedge)*, particularly in more northern calcareous regions. *Carex gynandra* (perfect-awned sedge) is much more likely in northern seeps than in coastal seeps, where it is replaced by its similar counterpart *C. crinita* (drooping sedge).
2. **Coastal/Appalachian variant**: Examples in coastal and southern New Hampshire contain many of the rich site species listed above in addition to several species apparently absent from the typic northern hardwood examples. These include *Carex cristatella* (small crested sedge)*, *C. crinita* (drooping sedge), *Lindera benzoin* (northern spicebush), *Carex radiata* (stellate sedge), *C. rosea* (star sedge), *Amphicarpaea bracteata* (hog peanut), *Acer nigrum* (black maple)*, *Carpinus caroliniana* (musclewood), and *Betula lenta* (black birch). Appalachian oaks and hickories are often prominent in the surrounding forest. Boreal conifers are absent while red maple may be frequent. Some examples are almost fen-like with a strong graminoid component, including the sedges listed here.
3. **River terrace slope variant**: Seeps along enriched river terrace slopes often contain *Equisetum hyemale* (scouring Rush) and *Matteuccia struthiopteris* (ostrich fern), along with other seep or wetland plants such as *Carex scabrata* (rough sedge), *Impatiens capensis* (spotted touch-me-not), *Chelone glabra* (white turtlehead), and *Alnus incana* (speckled alder).

Classification confidence: 2

Distribution: The typic northern hardwood variant occurs in subsections north of and including the White Mountains (Connecticut Lakes, Mahoosuc-Rangeley Lakes, White Mountain, Vermont Piedmont), NH Upland,

and Sebago-Ossipee subsections, probably mostly between 1000-2500 ft. elevation. The coastal/Appalachian variant occurs in the Coastal Lowland and probably the Coastal Plain and Northern Connecticut River subsections. Known example are ca. 100 ft. elevation or less, although the type may be expected up to ca. 1000 ft. elevation. The river terrace slope variant is known from the Coastal Plain, Northern Connecticut River, and Vermont Piedmont subsections (all <1000 ft. elevation), with other occurrences likely (but not presently documented) along major rivers north of the White Mountains. Good examples for each variant are described below. Typic northern hardwood variant: Black Mtn. (Benton), Smith Mtn. (Lyme), and Mt. Prospect (Lancaster). Coastal/Appalachian variant: Crommet Creek vicinity (Durham). River terrace slope variant: Society for the Protection of NH Forests Conservation Center riverbluff (Concord), Moore Dam site (Littleton), and Vernon Dam site (Hinsdale).



SOURCES: NHB field surveys.

VERNAL POOLS

These communities occur as small, isolated depressions that are generally flooded only seasonally and often dry out completely during the course of the growing season. Water levels are controlled by precipitation and groundwater fluctuations. The cycle of wet and dry phases prevents the establishment of fish populations. With these predators excluded, vernal pools are safe harbors for numerous animal species. Vernal pools are important feeding and breeding grounds for reptiles, amphibians, and invertebrates. Several of these species are good indicators of vernal pools as their life cycle is adapted to and completely dependent upon the cyclic and ephemeral nature of these wetlands.

Typically, vernal pools are small (<0.1 acres) and often not large enough to break the forest canopy above. They range from unvegetated to sparsely (or sometimes moderately) vegetated. They are defined biologically by characteristic animal species, not vegetation. Larger isolated vernal basins with perennial or annual vegetation are alternatively referred to as basin marshes, although they are also functionally "vernal pools." Many examples of sand plain marshes in closed basins (see open wetland section) are essentially large vernal pools because they have dramatically fluctuating water levels over the course of the year and do not support fish and certain other aquatic fauna associated with open-drainage wetlands.

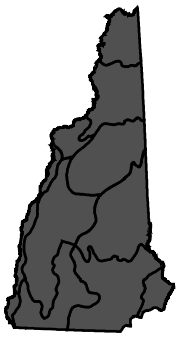
Vernal pools occur in a variety of settings, most often in forests. Plant species richness and cover are highly variable and typically low. Vegetation is often restricted to elevated mounds or areas near the pool margins.

• Vernal woodland pool (S3)

GENERAL DESCRIPTION: This community occurs as small, isolated depressions within upland forests. The depressions are vernally flooded and draw down completely or nearly completely each year or every few years during the summer months. They range from unvegetated to sparsely (or sometimes moderately) vegetated. Vernal pools are important feeding and breeding grounds for reptiles, amphibians, and invertebrates. Soils of vernal pools often have a densipan layer that impedes drainage.

CHARACTERISTIC VEGETATION: Plant species richness and cover are typically low and often restricted to elevated mounds or areas near the pool margins. Herbaceous species that may be present include *Lysimachia terrestris* (swamp candles) and other forbs, *Scirpus* spp. (bulrushes) and other graminoids, *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Athyrium filix-femina* (northern lady fern), and *Thelypteris palustris* (marsh fern). The presence of *Sphagnum* mosses varies from pool to pool from completely absent to having moderate cover. One or more shrub species may be present including, but not limited to, *Vaccinium corymbosum* (highbush blueberry), *Nemopanthus mucronatus* (mountain holly), *Ilex verticillata* (winterberry),

Cephalanthus occidentalis (buttonbush), *Kalmia angustifolia* (sheep laurel), *Viburnum nudum* (witherod), *Viburnum dentatum* (northern arrowwood), and *Chamaedaphne calyculata* (leather-leaf). On the highest areas of a pool and just beyond a pool's outer margin, wet to moist site tree species may be present including *Acer rubrum* (red maple), *Betula alleghaniensis* (yellow birch), *Nyssa sylvatica* (black gum), *Tsuga canadensis* (hemlock), and *Abies balsamea* (balsam fir), among others. Tree canopy cover forms a woodland or forested environment, shading much of the pool floor below.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Statewide. Good examples can be found at Pawtuckaway State Park (Nottingham).

SOURCES: NHB field surveys; Tappan 1997.

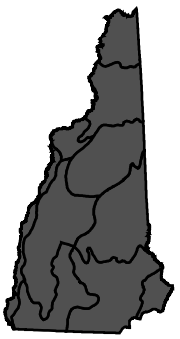
• Vernal floodplain pool (S2)

GENERAL DESCRIPTION: Many of the low swales occupied by oxbow marshes are technically "vernal pools" in that the water level draws down completely over the course of the season and the pools are used by numerous amphibians and reptiles for feeding, hibernation, and/or as temporary flood refugia (Carroll 1994). When these swales are larger than can be shaded by the tree canopy, the vegetation becomes strongly influenced by open light conditions and are consequently distinguished from their smaller counterparts discussed here (see also emergent marsh and oxbow marsh discussion). Smaller vernal pools (generally smaller than a tree canopy) occur throughout the floodplain forests along many New Hampshire rivers. These forested vernal pools exhibit different, albeit variable, vegetation characteristics. They often lack the robust marsh vegetation found in larger oxbow marshes and are mostly shaded. There may also be flood-length differences.

These small isolated basins are presumably formed by local eddy swirls or some other flow and deposition phenomena of the dynamic floodplain. The age of these vernal pools is uncertain. Regardless, they are hydrologically and ecologically different than most vernal pools on till or outwash due to flooding by moving water and the possible temporary exposure to predation by fish during high water.

Forested floodplain vernal pools observed on the Lamprey River exhibited a wide range of morphologies ranging from shallow to deep, small to large, and in different positions and distances relative to the river channel and water table (Sperduto and Crow 1994). These ecological and vegetative differences and seasonal changes may influence seasonal faunal use patterns.

CHARACTERISTIC VEGETATION: Vegetation is often sparse, quite variable from one basin to the next, and generally low in species richness. Tree canopy cover of the floodplain forest shades much of the pool floor below. Floodplain trees that may be in and around the pools include *Acer rubrum* (red maple), *Acer saccharinum* (silver maple), *Acer saccharum* (sugar maple), *Ulmus americana* (American elm), *Abies balsamea* (balsam fir), *Carpinus caroliniana* (musclewood), and less frequently *Platanus occidentalis* (sycamore), *Quercus bicolor* (swamp white oak), *Tsuga canadensis* (hemlock), *Betula alleghaniensis* (yellow birch), *Betula lenta* (black birch), *Prunus serotina* (black cherry), and others. Herbaceous species can include *Carex crinita* (drooping sedge), *Glyceria* spp. (manna-grasses), and *Pontederia cordata* (pickerel-weed) among many others.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Statewide. Good examples can be found along the Lamprey River corridor (Epping, Lee, Durham, and Newmarket) and along the Merrimack River (Concord).

SOURCES: NHB field surveys.

OPEN WETLANDS AND RIPARIAN COMMUNITIES

This section contains descriptions of four groups of open wetland communities, each with less than 25% cover of trees. These groups are 1) open river channels, riverbanks, and floodplains; 2) open emergent marshes, shrub thickets, and aquatic beds; 3) cliff seeps; and 4) open peatlands. Open river channels, riverbanks, and floodplains support riparian communities, mostly on mineral or rock substrate. Open emergent marshes, shrub thickets, and aquatic beds occur in limnogenous stream, river, and lake shore settings and topogenous or topogenous/limnogenous open- or closed-basin settings. Cliff seeps are near vertical rock outcrops characterized by perennial or near-perennial seepage. Open peatlands include a wide variety of bog and fen communities whose development is controlled in part by topogenous, limnogenous, or soligenous sources of water. Open alpine and subalpine wetlands are described along with other alpine/subalpine communities in the open uplands section.

OPEN RIVER CHANNELS, RIVERBANKS, AND FLOODPLAINS

The following communities 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 on river channels, riverbanks, floodplains, and riverbank outcrops or seeps. Emergent marshes on muck substrate, aquatic beds, and other communities associated with low energy settings along rivers and large streams are similar to those in streamside and open-basin settings, and are treated in that section of the classification.

River channels and low riverbanks

River channels are areas between riverbanks, 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 sparse or low percent cover of plants. Moderate-energy environments are indicated by sand or silt substrate and may range from sparse to moderate plant cover.

• Riverweed river rapid (S2S3)

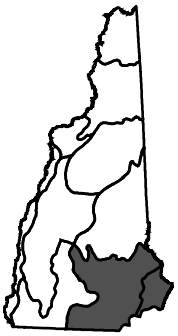
General description: River rapids occur where the slope of a river or stream is steep enough to support fast water velocity and white water. Water flows all year in at least the deeper portions (thalweg) of the channel. River channels exposed during a portion of the year are considered elsewhere in this section. A series of riffles and pools often characterize river rapids. Although river rapids most often occur in upper perennial streams and rivers, they can also be found on steeper gradient portions of lower perennial rivers. This community type is presently described only from the Lamprey River. Other examples probably occur in other rivers that contain *Podostemum ceratophyllum* (riverweed) sampled by Philbrick and Crow (1992).

Characteristic vegetation: *Podostemum ceratophyllum* (riverweed) is the characteristic species of this community. This clonal plant is restricted to river rapids, where it forms a low mat on submerged rocks. Other plants growing directly in the fast flowing waters include *Ranunculus trichophyllus* (white water crowfoot) and *Potamogeton nodosus* (knotty pondweed)*.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is presently described only from the Lamprey River. The most notable areas along the Lamprey River are at Packers Falls, Wadley (Wadleigh) Falls, the rapids at Lee Hook Road, several small sets of rapids between Wadley Falls and Lee Hook Road, and just downstream from the Main Street bridge in Epping.

SOURCES: Sperduto and Crow 1994; Nichols et al. 2001.



• Hudsonia - silverling river channel (S1)

GENERAL DESCRIPTION: This river channel barren natural community is currently known only from the Saco River in New Hampshire and Maine. The community occupies the uppermost zone of the river channel, corresponding to the two-year floodplain, approximately 1.5–2.5 m above the river at low water. The community is generally only 5–15 m wide, and up to 100–200 m long. This river channel barren can also occupy pointbar cutoff channels or "flood chutes" where the barren is separated from the lower, intensely scoured pointbar by a wooded vegetation strip. The community is wider – often 20–40 m – in pointbar cutoff positions. Most examples are roughly 0.2 ha, and larger examples range from 0.5 ha to approximately 1 ha.

The substrate of these river channel barrens consists of a variety of water-sorted sediments. Variation occurs within and between sites. The substrate on the surface varies from a matrix of pure sand to a mixture of gravel, small cobble, and sand. A thin surface layer of sand usually covers coarser material. Sand deposits form low, tear-shaped mounds whose long axes are aligned with stream-flow direction, and are the result of eddy deposition behind vegetation clumps. Downstream sites, mostly in Maine, have much larger sand mounds that may be streambed dunes. Wind may be responsible for reworking sand deposits at some sites.

Between sites, the variation corresponds to a larger fluvial-system pattern driven by changes in gradient, discharge, and sediment re-sorting. Coarser sediments, especially gravels, predominate upstream, which change to nearly pure sand downstream in Fryeburg, Maine.

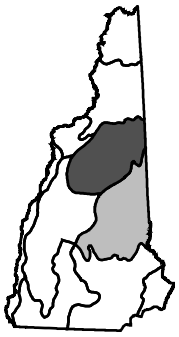
The restricted distribution of these river channel barrens likely corresponds to a combination of disturbance and edaphic conditions along the river profile controlled by flood dynamics. The lower half of the pointbar is too heavily washed and unstable, and perhaps too wet during the growing season, for most plants to survive. Above the open cobble shore the river channel barren zone is scoured enough to prevent most woody plant growth but stable enough for some perennial species, notably *Hudsonia tomentosa* var. *intermedia* (hairy hudsonia) and *Paronychia argyrocoma* (silverling), to survive and sometimes thrive in the sunny environment. Still higher is a sandy, depositional environment, often heavily vegetated by shrubs, saplings, and a variety of grasses and forbs. Presumably at this height in the channel, floodwater velocities have slackened to the point where depositional processes dominate, rather than riverwash erosion. The forested floodplain occurs above this zone. When the river exceeds bankfull capacity, it spills onto the floodplain, vertically aggrading fine sediments, especially silts and fine sand.

CHARACTERISTIC VEGETATION: Vegetation is typically sparse and occupies a zone above the river channel and below the shrub or forest edge. Grasses, forbs, mosses, and lichens are the dominant life forms, with widely scattered shrubs and saplings. Characteristic plant species include *Hudsonia tomentosa* var. *intermedia* (hairy hudsonia)*, *Paronychia argyrocoma* (silverling)*, *Schizachyrium scoparium* (little bluestem), *Solidago simplex* ssp. *randii* (Rand's goldenrod), *Oenothera biennis* (biennial evening primrose), *Polygonella articulata* (jointweed), *Panicum lanuginosum* (panic grass), *Lechea intermedia* (intermediate pinweed), and the moss *Polytrichum piliferum*. In the pointbar cutoff barrens, many of the same species are particularly important, but the abundance of ground cover is often greater, particularly non-vascular species such as *Polytrichum piliferum* and *Cladonia cristatella* (British soldiers).

The distribution of plants reflects substrate variability within and between sites. Perhaps the most telling plant distributions are those of the community signature species. Within sites, hairy hudsonia is most frequently associated with the sandier zones found near the highest areas of the channel, which are often farthest from the river itself. Among sites, the greatest concentration of hairy hudsonia occurs in the sandy river channel barrens in Maine. Farther upstream, hairy hudsonia becomes increasingly scarce in the barrens as sand becomes correspondingly less abundant. The distribution of silverling is just the reverse. Within sites, it occurs in the gravelly areas lower in the river channel, and among sites its largest concentrations in the state are in the upstream barrens. In New Hampshire, silverling is otherwise known only from mid- to high-elevation outcrops and cliffs, and hairy hudsonia from sandy beach-strand shores and coastal sand formations.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This natural community is apparently unique to a limited stretch of the upper Saco River in New Hampshire and Maine, where it occupies open river channel and channel bar areas. A good example in New Hampshire is the Townline Gravel Barrens site (North Conway). The rare association of silverling and hairy hudsonia is otherwise known only from ridge-top barrens of Panther Knob, West Virginia.

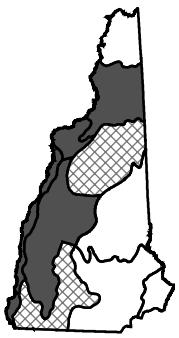


SOURCES: Rawinski 1985; Rawinski et al. 1988; Nichols et al. 2001.

• Dwarf cherry river channel (S2)

GENERAL DESCRIPTION: This river channel community typically occurs on high-energy channel bars scoured by floodwater and ice along the Connecticut and Pemigewasset Rivers. The coarse substrate consists of sand, gravel, and cobble. These river channel communities are typically dry or merely moist for most of the growing season and are characterized by the low-growing shrub *Prunus pumila* (dwarf cherry). This community supports the highest cover of low shrubs (average cover=12%) of any open riparian community sampled. Bryophytes and medium and tall shrubs are generally scattered or absent except in successional settings where severe scouring by ice and flood has not occurred in recent years. Associates vary from site to site, ranging from few species with low cover to moderate species richness with low to moderate cover. This variation in species composition and cover likely relates to the variable environmental conditions, propagule availability, and disturbance dynamics of stream channels. Some examples have native "prairie species" as well as exotics.

CHARACTERISTIC VEGETATION: *Prunus pumila* (dwarf cherry) is always present and often dominant. Both varieties of dwarf cherry (var. *susquehanae* and var. *depressa*) have been documented at one site. Native "prairie species" are frequently present in low cover, including *Andropogon gerardii* (big bluestem) and *Schizachyrium scoparium* (little bluestem). *Panicum* spp. (panic grasses), *Agrostis perennans* (upland bent-grass), and *Carex torta* (twisted sedge) may also be present. Forbs can include *Apocynum sibiricum* (prairie dogbane), *Solidago* spp. (goldenrods), *Aster* spp. (asters), *Galium* spp. (bedstraws), and several other less frequent herbs. Scattered, generally short shrubs and trees may include *Populus deltoides* (eastern cottonwood), *Acer saccharinum* (silver maple), *Acer rubrum* (red maple), *Rubus hispidus* (bristly dewberry), *Toxicodendron radicans* (climbing poison ivy), *Cornus* spp. (dogwoods), *Salix* spp. (willows), and *Alnus* spp. (alders).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is presently known from the Connecticut and Pemigewasset Rivers. A good example is at Livermore Falls (Holderness).

SOURCES: Nichols et al. 2001.

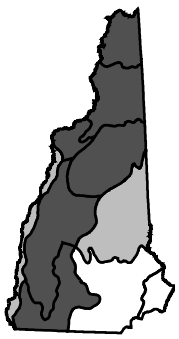
• Boulder - cobble river channel (S3)

General description: This river channel community typically occurs along small to medium-sized, high-energy rivers in montane settings. The high gradient riverbed and flashy nature of flooding from snow melt and significant rain events create a high-energy, erosional environment that leaves only the coarsest substrate particles behind. Frequent scouring by floods and ice minimizes deposition of fine soil particles, keeps vegetation cover low, and prevents establishment of lichens. Boulders and cobbles are the dominant substrate. Gravel and sand also occur among the boulders or cobble at some sites. Very little organic litter accumulates. This community is currently defined primarily by physical conditions (high-energy cobble and boulders) and the presence of species tolerant of flood scouring disturbance.

Characteristic vegetation: The coarse substrate is sparsely vegetated with tall shrubs, tree seedlings, and herbs, particularly grasses and composites. While many examples have only a few isolated plants emerging among the rocks, some examples grade into areas with greater than 25% cover in transition to other communities. Species composition can be variable between examples, probably due to local variation in propagule availability of stress- and disturbance-tolerant species. Woody seedlings often reflect the composition of the surrounding forest and include *Acer rubrum* (red maple), *Pinus strobus* (white pine), *Betula papyrifera* var. *papyrifera* (paper birch), and *Quercus rubra* (red oak). Tall shrubs are usually present in low abundance. *Salix* spp. (willows) and *Alnus incana* (speckled alder) or *Alnus serrulata* (smooth alder) are found in most examples. Other characteristic shrubs may include *Rubus occidentalis* (western black raspberry), *Sorbus decora* (showy mountain ash), *Prunus pensylvanica* (pin cherry), *Corylus cornuta* (beaked hazel-nut), *Myrica gale* (sweet gale), *Salix sericea* (silky willow), and *Rubus* spp. (brambles). *Vaccinium cespitosum* (dwarf bilberry), characteristic of alpine areas and northern riverbanks, may occur here or in adjacent riverbank habitat. Grasses are common and may include *Agrostis* spp. (bent grasses), *Phalaris arundinacea* (reed canary-grass), *Schizachyrium scoparium* (little bluestem), *Deschampsia flexuosa* (common hair-grass), *Calamagrostis canadensis* (blue-joint), *Calamagrostis pickeringii* (Pickering's reed bent-grass)*, *Calamagrostis lacustris* (pond reed bent-grass)*, *Danthonia spicata* (poverty oat-grass), and *Panicum* spp. (panic grasses). Other herbs include *Aster umbellatus* (tall flat-topped white aster), *Solidago bicolor* (silverrod), and other composites, *Eupatorium maculatum* (spotted Joe-pye-weed), *Houstonia caerulea* (bluets), *Carex torta* (twisted sedge), and *Fragaria virginiana* (wild strawberry).

Classification confidence: 2

Distribution: This community is found in mountainous areas of the state. Good examples are East Branch of Pemigewasset River (Lincoln), Pemigewasset River (North Woodstock), Wild River (Beans Purchase), Swift River (Albany), Peabody River (Martin Location and Gorham), and Wild Ammonoosuc River (Bath, Landaff, and Easton).



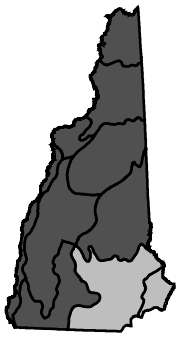
Sources: Nichols et al. 2001.

• Cobble - sand river channel (S3S4)

General description: This high energy community consists of sparse vegetation on a mix of sand, gravel, and cobble. It is subjected to flood and ice scour and is dry to moist for most of the growing season. It is common on pointbars. Species richness varies from low to high, with some examples supporting a rich variety of scattered graminoids and forbs. Shrub and tree seedlings are often present but generally less frequent than herbs. Variation in species composition and cover likely relates to the variable environmental conditions, propagule availability, and disturbance dynamics of stream channels.

The rare cobblestone tiger beetle (*Cicindela marginipennis*) occurs in this community along the Connecticut River. The use of these open shores by invertebrates, especially tiger beetles, deserves further investigation. The spotted sandpiper (*Actitis macularia*) may nest in this habitat.

CHARACTERISTIC VEGETATION: Plant species richness and cover are variable in this community. Species richness may be high even when overall vegetation cover is sparse. Herbs include *Poa* spp. (blue-grasses), *Agrostis* spp. (bent grasses), *Calamagrostis canadensis* (blue-joint), *Panicum* spp. (panic grasses), *Schizachyrium scoparium* (little bluestem), *Andropogon gerardii* (big bluestem), *Carex torta* (twisted sedge), *Apocynum sibiricum* (prairie dogbane), *Aster* spp. (asters), *Solidago* spp. (goldenrods), *Polygonum* spp. (smartweeds), *Eupatorium* spp. (Joe-pye-weeds), *Hieracium* spp. (hawkweeds), *Viola* spp. (violets) and several weedy native and non-native plants. *Equisetum arvense* (field horsetail) is a common fern-ally. Shrubs and trees are sparse and include *Salix sericea* (silky willow), *S. eriocephala* (stiff willow), *S. lucida* (shining willow), *Toxicodendron radicans* (climbing poison ivy), *Rubus* spp. (brambles), and seedling-sized *Acer saccharinum* (silver maple), *Acer rubrum* (red maple), *Alnus incana* (speckled alder), and *Salix* spp. (willows). Southern and central New Hampshire examples may support *Lespedeza capitata* (round headed bush-clover), *Potentilla anserina* (silver-weed), *Physostegia virginiana* (lion's-head)*, and seedlings of *Platanus occidentalis* (sycamore) and *Populus deltoides* (eastern cottonwood).



CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: This community is likely found statewide. Good examples are documented from the Ashuelot, Saco, Connecticut, Lamprey, and Merrimack Rivers.

SOURCES: Sperduto and Crow 1994; Engstrom 1997; Nichols et al. 2001.

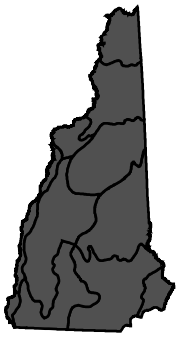
• Herbaceous sandy river channel (S4)

GENERAL DESCRIPTION: This moderate-energy community is subjected to flood and ice scour early in the year and occurs on low-lying bars and channel shores of small to large rivers. Sandy soils are flooded early in the growing season and may retain standing water or remain permanently saturated through much or all of the growing season in lower areas, ranging to more mesic to seasonally dry conditions on slightly higher ground. A sparse to moderate cover of emergent marsh herbs is characteristic. Species richness is variable, but high in some examples. Shrub and tree seedlings are absent or provide sparse cover in hydric areas, but may be more apparent in drier examples. This community is one of the lowest channel features supporting emergent species and may be adjacent to aquatic beds in deeper water. Variation in species composition and cover likely relates to the variable environmental conditions, propagule availability, and disturbance dynamics of stream channels.

Several examples along the upper Saco and Swift Rivers are less than 0.1 ha in size, occupy exposed bars or river shores at the downstream end of pointbars near the mouth of a back channel, and are characterized by rushes and non-*Carex* sedges. Some of these areas are associated with eddy environments where fine sediments accumulate in slack water. As with other communities associated with the river channel, this community probably migrates with channel shifts. In more hydric areas the substrate is saturated muddy sand, with mottling up to the surface. More hydric portions are often within 0.5 m above average summer low water level and are inundated with any modest rise in river level.

This community is similar to the herbaceous low riverbank community but occurs in exposed sandy river channels as opposed to riverbank settings and has a more variable mix of plant species. The species composition is also similar to some sand plain basin marsh and pondshore communities that have several low- to moderate-height wetland herbs in common.

CHARACTERISTIC VEGETATION: A variable mix of herbaceous plants can be found in this river channel community. Graminoids include *Poa* spp. (blue-grasses), *Panicum clandestinum* (deertongue), *Glyceria* spp. (manna-grasses), *Leersia* spp. (cut-grasses), *Puccinellia* spp. (manna-grasses), *Calamagrostis canadensis* (blue-joint), *Juncus* spp. (rushes), *Eleocharis* spp. (spike-rushes), *Carex lupulina* (hop sedge), *Carex crinita* (drooping sedge), *Scirpus torreyi* (Torrey's threesquare), *Scirpus smithii* (Smith's bulrush), *Scirpus cyperinus* (woolly bulrush), *Bulbostylis capillaris* (hair sedge), *Juncus canadensis* (Canada rush), *Juncus brachycephalus* (short-fruited rush)*, and other *Carex* spp. Forbs may include *Galium* spp. (bedstraws), *Cicuta maculata* (common water-hemlock), *Cicuta bulbifera* (bulbiferous water-hemlock), *Sium suave* (water parsnip), *Impatiens capensis* (spotted touch-me-not), *Thelypteris palustris* (marsh fern), *Onoclea sensibilis* (sensitive fern), *Osmunda cinnamomea* (cinnamon fern), *Viola* spp. (violets), *Polygonum* spp. (smartweeds), *Hypericum* spp. (St. John's-worts), *Triadenum virginicum* (marsh St. John's-wort), *Bidens* spp. (sticktights), *Lycopus uniflorus* (common water horehound), *Iris versicolor* (northern blue flag), *Apocynum sibiricum* (prairie dogbane), *Eupatorium* spp. (Joe-pye-weeds), *Lysimachia terrestris* (swamp candles), *Equisetum* spp. (horsetails), and several others. Mesic to seasonally dry examples or those not scoured recently may contain woody species in low abundance including *Spiraea alba* (eastern meadowsweet), *Salix* spp. (willows), *Cornus amomum* (southeastern silky dogwood), *Ilex verticillata* (winterberry), *Toxicodendron radicans* (climbing poison ivy), *Vitis* spp. (grapes), *Cephalanthus occidentalis* (buttonbush), and seedling-sized *Acer saccharinum* (silver maple) and *Acer rubrum* (red maple).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is found statewide. Good examples occur at Blackwater River (Salisbury), Livermore Falls (Holderness), Swift River (Albany), and Saco River (Conway).

SOURCES: NHB field surveys.

• Willow low riverbank (S3)

GENERAL DESCRIPTION: This community occurs on moderate- to high-energy low riverbanks along streams and rivers. Willow cover can range from sparse to moderate in this dynamic environment. It is transitional to twisted sedge low riverbank communities at some sites. It typically differs by occurring farther from and a bit higher above the channel, having a lower graminoid cover (average 5% vs. 19%), and more shrubs (ca. 25% vs. <5%) than the twisted sedge low riverbank.

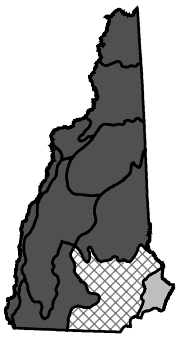
Soils are typically a mix of sand, gravel, and cobble, flooded at high water, and apparently remain mesic as river water levels fall later in the growing season.

CHARACTERISTIC VEGETATION: One or more species of willow, including *Salix eriocephala* (stiff willow), *S. nigra* (black willow), and *S. sericea* (silky willow), may characterize this community. Less frequent shrubs, seedling- (to sapling-) sized trees, and woody vines include *Cornus* spp. (dogwoods), *Alnus* spp. (alders), *Acer* spp. (maples), *Spiraea alba* (eastern meadowsweet), *Spiraea tomentosa* (steeple-bush), *Rubus* spp. (brambles), *Ulmus americana* (American elm), *Populus deltoides* (eastern cottonwood), and *Vitis* spp. (grapes). Some of the southwestern examples support *Platanus occidentalis* (sycamore) and *Populus deltoides* (eastern cottonwood) seedlings while a more northern example has scattered *Populus balsamifera* (balsam poplar) seedlings. The most frequent herbs are *Carex torta* (twisted sedge), *Calamagrostis canadensis* (blue-joint), *Apocynum sibiricum* (prairie dogbane), and *Euthamia graminifolia* (grass-leaved goldenrod). Occasional species include *Agrostis* spp. (bent grasses), *Solidago* spp. (goldenrods), *Eupatorium maculatum* (spotted Joe-pye-weed), *Lysimachia terrestris* (swamp candles), *Viola* spp. (violets), *Polygonum* spp. (smartweeds), and *Panicum* spp. (panic grasses). The weedy *Polygonum cuspidatum* (Japanese knotweed) occurs in most examples. Several other native and non-native weeds may also occur, but generally in very low cover.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: The willow low riverbank community likely occurs throughout the state in suitable riparian habitat. A good example is at Surry Mountain Lakes Flood Control Area (Surry).

SOURCES: Nichols et al. 2001.

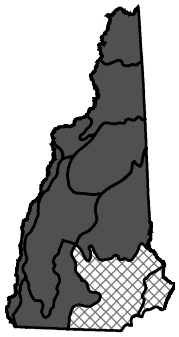


• Twisted sedge low riverbank (S3S4)

GENERAL DESCRIPTION: This community appears at the base of riverbanks just above summer water level. The patchy herbaceous layer is often just a narrow strip stretching along high-energy, rocky to gravelly rivers. Where a river broadens to include a cobble-gravel bar, this community may be more extensive. *Carex torta* (twisted sedge) may occur in other natural communities but reaches its peak abundance in this type. Similar riparian communities characterized by *Carex torta* (twisted sedge) have been described throughout the eastern United States.

The substrate is a variable mixture of rocks, gravel, and sand. The community sometimes reaches a meter above the summer river level, but averages 26 cm.

CHARACTERISTIC VEGETATION: This community consists of a patchy herbaceous layer and scattered woody seedlings able to withstand frequent scouring by ice and floods. *Carex torta* (twisted sedge) is always present and forms large tussocks averaging 15% cover. Species present in low abundance include *Salix* spp. (willows), *Calamagrostis canadensis* (blue-joint), *Apocynum sibiricum* (prairie dogbane), *Rubus* spp. (brambles), *Viola* spp. (violets), *Euthamia graminifolia* (grass-leaved goldenrod), *Lysimachia terrestris* (swamp candles), *Eupatorium maculatum* (spotted Joe-pye-weed), *Spiraea alba* (eastern meadowsweet), *Onoclea sensibilis* (sensitive fern), *Phalaris arundinacea* (reed canary-grass), *Panicum* spp. (panic grasses), and *Acer rubrum* (red maple) seedlings.



CLASSIFICATION CONFIDENCE: 1-2

DISTRIBUTION: This community likely occurs throughout the state in suitable habitat. Good examples are at Livermore Falls (Holderness) and Dead Diamond River (Second College Grant).

SOURCES: Nichols et al. 2001.

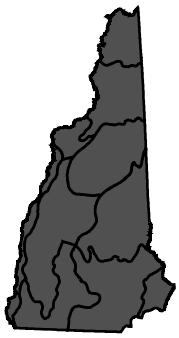
• Herbaceous low riverbank (S3S4)

GENERAL DESCRIPTION: This community occurs on moist to wet, coarse substrates of high- to moderate-energy low riverbanks subject to flood and ice scour early in the year and ranging from the river shore to a meter above the river at mid-summer water levels. It is most common along medium to large streams and small rivers with cobbly to stony bottoms. The community ranges from flooded to hydric or mesic conditions as water levels fall during the growing season. The community forms a generally narrow and continuous zone along low riverbanks that lack well-developed marshy margins. These habitats support a variety of wetland species, including amphibious plants (able to grow under submersed or emergent conditions), emergent plants, and moist-site species.

CHARACTERISTIC VEGETATION: This is a broadly defined and variable community characterized by herbaceous species. Shrubs and trees are absent. Species composition likely varies with substrate and slope gradient. See variant descriptions below for characteristic vegetation documented in high- and moderate-energy settings in New Hampshire.

VARIANTS: High- and moderate-energy variants are described. Higher energy examples occur on mid- to large-size streams with cobble to stone dominated bottoms and sparse to moderate plant cover. Moderate-energy examples have fine sand with some silt, coarse sand, or organic materials. Species composition in the high-energy variant is similar to the herbaceous sandy river channel community. The latter community has a more variable mix of plant species and occurs in moderate-energy sandy channels typically in small to larger rivers (not on the low banks of mid- to large-size streams with cobbly to stony bottoms). The moderate-energy variant differs from the herbaceous sandy river channel community by its riverbank position, species composition, and a typically higher cover of herbaceous plants.

1. **High-energy variant**: Higher-energy examples are characterized by *Lobelia cardinalis* (cardinal-flower), *Ludwigia palustris* (water purslane), *Boehmeria cylindrica* (false nettle), *Sium suave* (water parsnip), *Cicuta* spp. (water-hemlocks), and *Onoclea sensibilis* (sensitive fern). Less frequent plants include *Mimulus ringens* (monkey flower), *Hypericum boreale* (northern St. John's-wort), *Verbena hastata* (blue vervain), *Lysimachia terrestris* (swamp candles), *Polygonum* spp. (smartweeds), *Sparganium americanum* (lesser bur-reed), *Cardamine pensylvanica* (Pennsylvania bitter-cress), *Viola* spp. (violets), *Lycopus uniflorus* (common water horehound), *Pilea pumila* (clearweed), *Carex torta* (twisted sedge), *Glyceria* spp. (manna-grasses), *Agrostis* spp. (bent grasses), *Calamagrostis canadensis* (blue-joint), *Isoetes engelmannii* (Engelmann's quillwort)*, *Osmunda regalis* (royal fern), and *Thelypteris palustris* (marsh fern). Shrubs and tree seedlings are absent or sparse.
2. **Moderate-energy variant**: Moderate-energy examples on finer materials have a moderate to high cover of several grasses including *Panicum dichotomiflorum* (fall panic-grass), *Echinochloa* spp. (barnyard-grasses), *Leersia* spp. (cut-grasses), and *Phalaris arundinacea* (reed canary-grass), and the annual herb *Bidens cernua* (nodding bur-marigold). Less frequent species include *Eragrostis pectinacea* (Carolina love-grass), *Eragrostis pilosa* (India love-grass), *Polygonum* spp. (smartweeds), *Cyperus strigosus* (straw-colored umbrella-sedge), *Panicum capillare* (witch grass), and *Bidens comosa* (leafy-bracted beggar-ticks). Several other species occur with a cover of less than 1%.



CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: This community is found statewide. Good examples occur along Berry's Brook (Rye), Lamprey River (Epping), and by outcrops along the Merrimack River (Manchester).

SOURCES: NHB field surveys; Sperduto and Crow 1994; Nichols et al. 2001.

MEDIUM TO HIGH RIVERBANKS AND FLOODPLAINS

Medium to high riverbanks and floodplains form a transition zone between river channel and low riverbank communities toward the river and floodplain or upland forests at higher elevations. Substrates are variable, with composition dependent on both the slope gradient of the river and position relative to the main channel. Soils are most often dominated by sand but may have either a coarser component (gravel to bedrock) in higher energy environments or a silt component in lower energy environments. Vegetative cover is typically moderate to high and consists of variable mixes of herbs and woody plants (<25% trees).

Herbaceous and mixed herbaceous - woody

• Herbaceous riverbank/floodplain (S2S4)

General description: This temporarily flooded meadow community occurs on banks and adjacent floodplains of rivers and large streams. Silt and fine sandy soils support a variable mix of graminoids and forbs. Shrubs are generally absent or infrequent. Average height above midseason water level is ca. 0.75 m. This is a broadly described community with several variants linked by a common physiognomy. This community is similar in appearance to shallow emergent marshes but occurs on larger streams or rivers with little or no organic matter accumulation.

Characteristic vegetation: The vegetation of this broadly described community is dominated most often by graminoids or by goldenrods. See variants described below.

Variants: Five variants are described here.

1. **Reed canary-grass variant**: This variant is dominated by *Phalaris arundinacea* (reed canary-grass). Several other species occur with a cover of less than 1%. Soil is characterized by fine sand with some silt. This variant ranges from 1.0-1.8 m above midseason water levels. This community is certainly more widespread, but its full distribution and abundance is not well documented.
2. **Blue-joint variant**: The description for this variant is based on one site along the Exeter River where several acres of open floodplain are dominated by *Calamagrostis canadensis* (blue-joint). A thin organic fibric layer (1 cm) covers a mesic to saturated silt layer. A layer of marine clay exists below the silt (>20 cm). This variant may be limited to coastal New Hampshire. A site along the Cocheco River is transitional between this variant and the reed canary-grass riverbank/floodplain variant.

   A dense cover (60%) of *Calamagrostis canadensis* (blue-joint) characterizes this variant. Associates include *Carex stricta* (tussock sedge), *C. lacustris* (lake sedge), *Phalaris arundinacea* (reed canary-grass), *Spiraea alba* (eastern meadowsweet), *Cornus amomum* (southeastern silky dogwood), *Viburnum dentatum* (northern arrowwood), *Viburnum lentago* (nannyberry), and scattered *Acer rubrum* (red maple), *Quercus bicolor* (swamp white oak), and *Ulmus americana* (American elm) saplings.
3. **Goldenrod variant:** A dense cover of *Solidago canadensis* (Canada goldenrod) dominates this variant. Common associates include *Solidago rugosa* (rough goldenrod), *Vitis aestivalis* (silverleaf grape), *Acer negundo* (box elder), *Toxicodendron radicans* (climbing poison ivy), *Lonicera morrowii* (Morrow's honeysuckle), *Parthenocissus quinquefolia* (Virginia creeper), *Rubus allegheniensis* (common blackberry), and *Polygonum cuspidatum* (Japanese knotweed). Soils are fine sand and loam over 50 cm deep.
4. **Northern herbaceous variant:** This variant occurs along several major streams and minor rivers north of the White Mountains. It is characterized by graminoids or a mix of graminoids and forbs on intermittently flooded silt or fine, sandy alluvial soils of moderate-energy environments. It occurs at slightly higher elevations than adjacent sand and gravel barrens but lower than adjacent dense shrub thickets. Species composition includes both wetland and moist-meadow species generally <1–1.5 m tall. Non-*Sphagnum* mosses may be abundant. Microtopography may undulate slightly due to the presence of abandoned, intertwining stream channels.

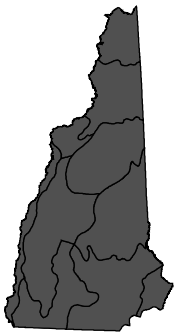
   Characteristic species include *Bromus ciliatus* (fringed brome-grass), *Euthamia graminifolia* (grass-leaved goldenrod), *Carex scoparia* (broom sedge), *C. debilis* (Rudge's sedge), *C. stricta* (tussock sedge), *C. folliculata* (follicled sedge), *Potentilla norvegica* (cinquefoil), *Muhlenbergia mexicana* (Mexican muhly), *Juncus effusus* (soft rush), *Calamagrostis stricta* var. *inexpansa* (neglected reed bent-grass)*, *Calamagrostis* spp. (bent grasses), *Ribes* spp. (currants), and moss spp. Medium-height shrubs such as *Spiraea alba* (eastern meadowsweet) and *Spiraea tomentosa* (steeple-bush) are occasional or locally abundant.

5. **Inflated sedge variant:** Moderate-sized swales supporting this meadow are intermixed in a mosaic dominated by *Cornus amomum* (southeastern silky dogwood). The soil is silt and fine sand. This sedge-dominated meadow also supports a low shrub cover.

   This variant is dominated by *Carex vesicaria* (inflated sedge) with lesser amounts of *Scirpus cyperinus* (woolly bulrush), *Glyceria canadensis* (rattlesnake manna-grass), *Phalaris arundinacea* (reed canary-grass), *Carex stricta* (tussock sedge), *Spiraea alba* (eastern meadowsweet), and *Cornus amomum* (southeastern silky dogwood). Infrequent plants are *Cicuta bulbifera* (bulbiferous water-hemlock), *Polygonum sagittatum* (arrow-leaved tearthumb), *Boehmeria cylindrica* (false nettle), *Convolvulus arvensis* (field bindweed), and other species.

Classification confidence: 2

Distribution: This community is found statewide. Good examples of the reed canary-grass variant are found along the Merrimack and Cocheco Rivers and Little Cohas Brook. A good example of the blue-joint variant is found along the Exeter River. Good examples of the goldenrod variant are found on Hart Island (Connecticut River) and Sumner Island (Pemigewasset River). Good examples of the northern herbaceous variant occur along the upper Ammonoosuc River (Milan). A good example of the inflated sedge variant occurs along the Winnicut River.



Sources: Nichols et al. 2001.

• Herbaceous - wooded riverbank/floodplain (S4)

General description: This community occurs on temporarily flooded moderate-energy riverbanks and open floodplains. Substrates are most often dominated by sand but may have a coarser component (gravel to bedrock). Scour by ice and water is intense enough to erode soil and expose bedrock in some areas but short-lived enough to permit scattered 25–35 foot-tall trees to persist on slightly higher soil mounds. Average height above summer water levels was 1.35 m (n=7 sites). Herb and shrub cover is often moderately developed and varies in composition due to variability in flood intensity and frequency, moisture, soil stability, and propagule availability. Both upland and wetland species are characteristic, and most are common in other habitats as well.

Characteristic vegetation: Characteristic graminoids include *Calamagrostis canadensis* (blue-joint), *Bromus ciliatus* (fringed brome-grass), *Panicum clandestinum* (deertongue), *Schizachyrium scoparium* (little bluestem), *Andropogon gerardii* (big bluestem), *Glyceria* spp. (manna-grasses), *Leersia* spp. (cut-grasses), *Agrostis* spp. (bent grasses), and *Carex* spp. (sedges). Characteristic forbs include *Onoclea sensibilis* (sensitive fern), *Eupatorium* spp. (Joe-pye-weeds), *Lysimachia terrestris* (swamp candles), *Euthamia graminifolia* (grass-leaved goldenrod), *Solidago* spp. (goldenrods), *Viola* spp. (violets), and several others. Woody species form low to moderate cover and include *Spiraea alba* (eastern meadowsweet), *Salix* spp. (willows), *Cornus* spp. (dogwoods), *Ilex verticillata* (winterberry), *Toxicodendron radicans* (climbing poison ivy), *Vitis* spp. (grapes), *Comptonia peregrina* (sweet fern), *Alnus incana* (speckled alder), *Rubus* spp. (brambles), and seedling- to sapling-sized *Acer saccharinum* (silver maple), *Acer rubrum* (red maple), *Betula populifolia* (gray birch), *Ulmus americana* (American elm), and *Quercus* spp. (oaks).

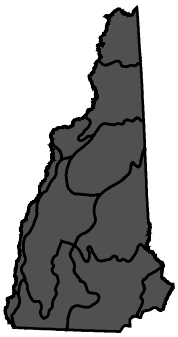
Variants: Two variants are described.

1. **Typic variant**: This variant is characterized by a variable mix of species mentioned above and by the absence or low cover of big bluestem.
2. **Big bluestem variant**: Big bluestem is diagnostic and is usually the most common herb. Woody plant richness is moderate, while cover is low to moderate. Scattered mature trees typically average around 5% cover.

CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: This community is found throughout the state. A good example of the typic variant occurs along the Dead Diamond River (Second College Grant). The big bluestem variant is found at Manchester River Outcrops (Manchester), Garvins Falls (Concord), and Bellows Falls (Walpole).

SOURCES: Nichols et al. 2001.



• Blue-joint - goldenrod - virgin's bower riverbank/floodplain (S3S4)

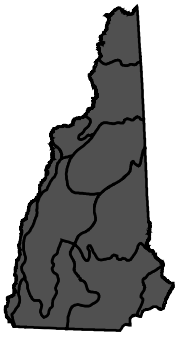
GENERAL DESCRIPTION: This temporarily flooded meadow community occurs on banks and adjacent floodplains of small "flashy" rivers and major streams. It is characterized by tall graminoids, goldenrods and other tall forbs, herbaceous vines, and less frequently, shrubs, ferns, trees, and woody vines. This community averages 1.1 m above midseason river water levels (n=11 sites). It is usually positioned between a narrow band of shrub or forested floodplain at higher elevations and low riverbank and channel communities at lower elevations. Flood frequency, duration, intensity, and seasonal timing are likely important factors affecting this community's successional state and range in species richness. Soils are typically mesic, deep, medium-grained sands flooded and scoured during spring high water.

CHARACTERISTIC VEGETATION: Dominant species in most expressions include *Calamagrostis canadensis* (blue-joint), *Solidago rugosa* (rough goldenrod), *Solidago gigantea* (smooth goldenrod), and *Clematis virginiana* (virgin's bower). Some examples have few other species, all with low cover. In examples with higher species richness, occasional species include *Onoclea sensibilis* (sensitive fern), *Aster umbellatus* (tall flat-topped white aster), *Eupatorium* spp. (Joe-pye-weeds), *Euthamia graminifolia* (grass-leaved goldenrod), *Apios americana* (groundnut), *Thalictrum pubescens* (tall meadow-rue), *Galium* spp. (bedstraws), *Aster* spp. (asters), *Viola* spp. (violets), *Osmunda* spp. (ferns), *Carex* spp. (sedges), *Juncus* spp. (rushes), *Scirpus* spp. (bulrushes), *Polygonum* spp. (smartweeds), *Panicum* spp. (panic grasses), *Glyceria* spp. (manna-grasses), *Agrostis* spp. (bent grasses), *Lycopus uniflorus* (common water horehound), *Thelypteris palustris* (marsh fern), *Athyrium filix-femina* (northern lady fern), *Lysimachia terrestris* (swamp candles), *Lythrum salicaria* (purple loosestrife), *Impatiens capensis* (spotted touch-me-not), *Solidago canadensis* (Canada goldenrod), *Bromus ciliatus* (fringed brome-grass), *Elymus* spp. (wild ryes), *Iris versicolor* (northern blue flag), and other species. In examples that are succeeding to increased woody dominance (e.g., some oxbows and older pointbars), a low cover of the following woody species may be present: *Alnus incana* (speckled alder), *Salix* spp. (willows), *Spiraea* spp. (meadowsweets), *Rubus* spp. (brambles), *Vitis* spp. (grapes), *Acer saccharinum* (silver maple), *Acer rubrum* (red maple), *Cornus* spp. (dogwoods), *Ulmus americana* (American elm), *Toxicodendron radicans* (climbing poison ivy), *Sambucus canadensis* (common elderberry), and a few other species.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is found statewide. Good examples are along the Dead Diamond River (Second College Grant) and the Pemigewasset River (New Hampton).

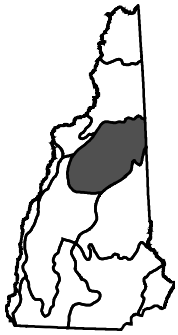
SOURCES: Nichols et al. 2001.



• Riverbank/floodplain fern glade (SU)

General description: The description of this natural community is based on a single site in New Hampshire, although other occurrences have been documented in Maine and New York. This community is dominated by *Osmunda claytoniana* (interrupted fern), with very little other vegetation. It forms a narrow band along a medium-sized, moderate-energy river that is scoured by ice and floods. It occurs between a narrow zone of twisted sedge low riverbank along the river and a hemlock-northern hardwood forest above. The soil is moist sand with no mottling and very little organic material. Some litter collects under the ferns.

Characteristic vegetation: The moderately dense vegetation is dominated by *Osmunda claytoniana* (interrupted fern), with 75% cover in the single sample. *Alnus incana* (speckled alder) is sparse (3%). Also present are seedlings of other woody species and a moderately diverse scattering of herbs. *Sphagnum* and other mosses cover about 10% of the sandy substrate.



Classification confidence: 3

Distribution: The only known example in New Hampshire is along the Moose River (Gorham). Similar sites appear to exist in Maine and New York.

Sources: Maine Natural Areas Database; Platt et al. 1982; Nichols et al. 2001.

Shrub

• Alder alluvial shrubland (S3)

General description: This natural community is a patchy shrubland dominated by *Alnus incana* (speckled alder) or *Alnus serrulata* (smooth alder). Other woody species and herbs are usually sparse in moderate-energy settings, but moderately dense to dense in lower-energy floodplain and silt soils settings. Alders may out-compete other shrubs and trees along riverbanks because they bend in strong currents, rather than uprooting or breaking, and tolerate long periods of flooding. High-energy water leaves its mark on the shrubs; they may lean in the direction of river flow, and their bark is often scraped by ice on the upstream side. Alders have an additional advantage over competitors with their nitrogen-fixing root nodules that provide nitrogen to the shrubs in nutrient-poor, coarse substrate. This community often forms a band (<1–10 m wide) along rivers for hundreds of meters, or forms wider expanses on silt plains in broader valley bottoms.

Mineral soils range from cobble, gravel, and sand-silt mixes (typic and bryophyte variants) to silt (silt variant). This community is seasonally to infrequently flooded. Water levels are near the surface for substantial portions of the year.

The alder - dogwood - arrowwood alluvial thicket differs in having a more even and diverse mix of shrub species, including numerous shrubs found only in central and southern New Hampshire. Adjacent areas with more frequent overbank flow or recent beaver drawn-down areas can support blue-joint – goldenrod – virgin's bower riverbank/floodplain or the blue-joint variant of the tall graminoid emergent marsh.

Characteristic vegetation: Thickets of moderately dense alder dominate all variants (15 to >60% cover).

Variants: Three variants are described.

1. **Typic variant**: This moderate-energy variant has 1% or less bryophyte cover and 25–40% alder cover. The substrate is variable, from sand and silt to mixtures of sand, gravel, cobbles, and boulders. The pH of the sandy patches was invariably 5.1 (n=7). This variant is often flanked by herbaceous riverbank communities and upland forests. Examples of this variant are likely to be found on many moderate-energy stretches of rivers and streams in New Hampshire.

   Alnus incana (speckled alder) or, less frequently, *A. serrulata* (smooth alder) dominates this variant. Bryophytes are almost entirely absent. Though not abundant, common associates are *Cornus sericea* (red osier dogwood), *Salix sericea* (silky willow), *Calamagrostis canadensis* (blue-joint), *Solidago*

spp. (goldenrods), *Aster umbellatus* (tall flat-topped white aster), *Euthamia graminifolia* (grass-leaved goldenrod), *Lysimachia terrestris* (swamp candles), *Spiraea alba* (eastern meadowsweet), and *Panicum* spp. (panic grasses). In some examples, herbs and shrubs contribute greater cover (5–15%) including *Ilex verticillata* (winterberry), *Rubus occidentalis* (western black raspberry), *Clematis virginiana* (virgin's bower), *Onoclea sensibilis* (sensitive fern), and *Acer rubrum* (red maple). The state-threatened *Calamagrostis pickeringii* (Pickering's reed bent-grass)* occurs in one of the sampled sites.

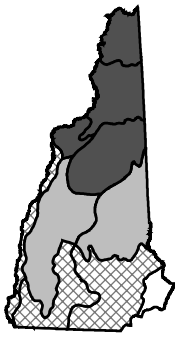
2. **Bryophyte variant**: This variant is based on two samples in northern New Hampshire, but qualitative observations indicate it is more widespread. It has a notable bryophyte component (up to 80% cover) and occurs on riverbanks and level terraces of alluvial sand. This variant may be flanked by a sparse herbaceous zone on the river side and spruce - fir forest on the upland side. Spring high water left a thick, patchy layer of litter and woody debris at one site. *Alnus incana* (speckled alder) and bryophytes dominate this variant. Other species that make a significant showing (5-10% cover) are *Viola* spp. (violets), *Eupatorium maculatum* (spotted Joe-pye-weed), and *Houstonia caerulea* (bluets). The rare *Listera auriculata* (auricled twayblade)* occurs in this community.

3. **Silt variant**: This variant occurs on silty soils found in generally lower-energy settings compared to the other variants. These settings can occur along streams, minor rivers, and silt plains formed from glacial lakebed deposits or stream deltas adjacent to lakes. It is characterized by a moderate to dense herbaceous layer in contrast to sparser herbaceous cover found in the other two variants. There is also an increase in the number and abundance of species indicative of richer and/or wetter soil conditions. *Abies balsamea* (balsam fir) and/or *Picea glauca* (white spruce) form a sparse woodland canopy (<25% cover) in many examples. This variant can transition into balsam fir floodplain/silt plain forest on relatively higher terrace positions. Cutover examples of balsam fir floodplain/silt plain forests can approximate the composition of this variant. This variant is described from northern New Hampshire and lacks some of the shrub species found in the alder - dogwood - arrowwood alluvial thicket community more typical of central and southern parts of the state.

   Frequent species include *Cornus sericea* (red osier dogwood), *Calamagrostis canadensis* (blue-joint), *Thalictrum pubescens* (tall meadow-rue), *Onoclea sensibilis* (sensitive fern), *Rubus pubescens* (dwarf raspberry), *Glyceria melicaria* (northeastern manna-grass), *Aster umbellatus* (tall flat-topped white aster), *Impatiens capensis* (spotted touch-me-not), *Dryopteris intermedia* (intermediate wood fern), *Solidago rugosa* (rough goldenrod), *Eupatorium maculatum* (northeastern spotted Joe-pye-weed), and *Aster puniceus* (purple-stemmed aster). Occasional species include *Betula papyrifera* var. *papyrifera* (paper birch), *Viburnum edule* (squashberry), *Tiarella cordifolia* (foamflower), *Athyrium filix-femina* (lady fern), *Sambucus racemosa* ssp. *pubens* (red elderberry), *Osmunda regalis* (royal fern), *Brachyelytrum erectum* (northern short husk grass), *Geum rivale* (purple avens), *Ranunculus recurvatus* (hooked buttercup), *Arisaema triphyllum* (Jack-in-the-pulpit), *Dryopteris cristata* (crested wood fern), *Chelone glabra* (white turtlehead), *Carex intumescens* (inflated sedge), and *Solidago flexicaulis* (zigzag goldenrod).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is widely distributed but most frequent in northern New Hampshire. A good example of the typic variant occurs along the Dead Diamond River (Atkinson and Gilmanton Academy Grant) and East Branch of the Pemigewasset River (Lincoln). A good example of the bryophyte variant is found along the Dead Diamond River (Atkinson and Gilmanton Academy Grant). Good examples of the silt variant occur along the Dead Diamond River (Atkinson and Gilmanton Academy Grant), Indian Stream and Scott Brook (Pittsburg), and the delta area of Moose Brook on Second Connecticut Lake (Pittsburg).



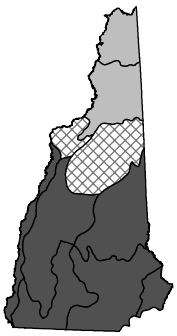
SOURCES: NHB field surveys; Nichols et al. 2001; Sperduto et al. 2001.

• Alder - dogwood - arrowwood alluvial thicket (S4)

GENERAL DESCRIPTION: This broadly defined community is characterized by shrub thickets on loam and fine- to medium-grained sands subjected to flooding early in the year. Moderate-energy examples on coarser sand (e.g., alder alluvial shrubland) are distinct from this low- to moderate-energy riparian thicket on finer sediments. As river water levels fall during the growing season, sandy soils become less wet. Shrub cover is typically moderate to high and is often a mix of several shrub species. Variation in species composition and cover likely relates to the variable environmental conditions, propagule availability, and disturbance dynamics of stream channels. This community may occur as broad floodplain thickets along major rivers or as narrow zones along large streams and rivers. Some examples are dominated by one species [e.g., *Cornus sericea* (red osier dogwood)] and warrant consideration as their own community.

CHARACTERISTIC VEGETATION: Common shrubs that may be locally dominant include *Cornus amomum* (southeastern silky dogwood), *Alnus incana* (speckled alder), *Alnus serrulata* (smooth alder), *Cornus sericea* (red osier dogwood), *Salix* spp. (willows), *Viburnum dentatum* (northern arrowwood), *Ilex verticillata* (winterberry), and *Spiraea alba* (eastern meadowsweet). Trees, woody vines, and other shrubs include *Vitis* spp. (grapes), *Rubus* spp. (brambles), *Clethra alnifolia* (sweet pepperbush; along the coast), *Viburnum lentago* (nannyberry), *Viburnum nudum* (witherod), *Rosa palustris* (swamp rose), *Rhamnus frangula* (European alder-buckthorn), *Acer rubrum* (red maple), *Acer saccharinum* (silver maple), *Spiraea tomentosa* (steeple-bush), *Sambucus canadensis* (common elderberry), *Ulmus americana* (American elm), and *Toxicodendron radicans* (climbing poison ivy).

A moderate diversity of herbs may also be present, including *Lysimachia terrestris* (swamp candles), *Calamagrostis canadensis* (blue-joint), *Poa* spp. (blue-grasses), *Euthamia graminifolia* (grass-leaved goldenrod), *Solidago* spp. (goldenrods), *Aster* spp. (asters), *Galium* spp. (bedstraws), *Eupatorium* spp. (Joe-pye-weeds), *Onoclea sensibilis* (sensitive fern), *Clematis virginiana* (virgin's bower), *Carex* spp. (sedges), *Agrostis* spp. (bent grasses), *Glyceria* spp. (manna-grasses), *Lysimachia ciliata* (fringed loosestrife), *Thelypteris palustris* (marsh fern), *Osmunda* spp. (ferns), *Boehmeria cylindrica* (false nettle), *Lycopus uniflorus* (common water horehound), *Cinna arundinacea* (common woodreed), *Impatiens capensis* (spotted touch-me-not), *Cicuta maculata* (common water-hemlock), *Viola* spp. (violets), and *Thalictrum pubescens* (tall meadow-rue).



CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: This community is widely distributed but most frequent in central and southern New Hampshire. A good example occurs along the South Branch of the Piscataquog River (New Boston).

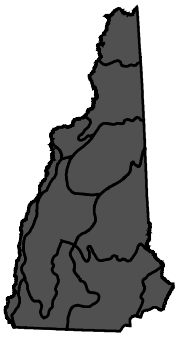
SOURCES: Nichols et al. 2001.

• Meadowsweet alluvial thicket (S3?)

GENERAL DESCRIPTION: Thickets dominated by *Spiraea alba* (eastern meadowsweet) have been documented along major streams and minor rivers throughout the state, including the Ammonoosuc, Suncook, Soucook, Big, Swift, and Blackwater rivers. A shallow organic horizon often lies above a wet to mesic silt and fine sandy soil.

CHARACTERISTIC VEGETATION: *Spiraea alba* (eastern meadowsweet) dominates this community. Several other woody species may be present, including *Viburnum nudum* (witherod), *Rhododendron canadense* (rhodora), *Rubus* spp. (brambles), *Aronia arbutifolia* (red chokeberry), *Lyonia ligustrina* (male-berry), *Chamaedaphne calyculata* (leather-leaf), and seedling- and sapling-sized *Acer rubrum* (red maple), *Prunus serotina* (black cherry), *Abies balsamea* (balsam fir), and *Prunus virginiana* (choke cherry). Common herbs include

Calamagrostis canadensis (blue-joint), *Carex lurida* (sallow sedge), *C. stricta* (tussock sedge), *Lysimachia terrestris* (swamp candles), *Lycopus* spp. (water horehounds), *Solidago* spp. (goldenrods), *Iris versicolor* (northern blue flag), *Bromus* cf. *ciliatus* (fringed brome-grass), *Carex debilis* (Rudge's sedge), *C. intumescens* (inflated sedge), and *Scirpus* spp. (bulrushes). An expression of this community along the Swift River supports the rare *Calamagrostis pickeringii* (Pickering's reed bent-grass)*.



CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: This community is found statewide. Documented along the Ammonoosuc, Suncook, Soucook, Big, Swift, and Blackwater rivers. A good example is at the Annis Field Recreation Area (Intervale in Albany).

SOURCES: Nichols et al. 2001.

• Alluvial mixed shrub thicket (S4)

GENERAL DESCRIPTION: This broadly defined community forms a woody transition zone between more open riparian communities closer to the river channel and floodplain forests at higher elevations. Thickets of tree saplings and tall shrubs, often interspersed with sizable patches of bare, coarse substrate, is the most characteristic structure, although low shrub, grass, and other herb species can also be common. Most examples are less than 0.5 ha, and occur as narrow bands and as broader patches. The community occupies unstable, depositional areas characterized by sand and leaf-litter accumulation. The sand frequently forms low, linear mounds (with long axis parallel to stream flow) around the bases of the shrub thickets. Leaf-litter accumulates as pockets of mulch in hollows adjacent to these mounds along with woody debris. High-energy water leaves its mark on the shrubs; they may lean in the direction of river flow, and their bark is often scraped by ice on the upstream side. Given the dynamic nature of the fluvial environment, it is likely that these communities are successional and/or migrate laterally with pointbar progression.

The variety of dominant shrubs may indicate different communities, transitional processes, disturbance frequency, or other factors. Similar riparian shrub communities include two alder-dominated communities: 1) alder alluvial shrubland; and 2) alder - dogwood - arrowwood alluvial thicket communities. Willow low riverbank communities sit lower on the bank, are dominated by willows, and have coarser substrates, indicating higher-energy river flow.

This community has a variable mixture of medium to coarse sand, gravel, cobbles, and boulders, and is typically very well drained at low water.

CHARACTERISTIC VEGETATION: Variable patches of shrubs and tree saplings are interspersed with open, sandy–cobbly areas, ranging from 10% to 50% cover. *Spiraea alba* (eastern meadowsweet), *Salix* spp. [willows, especially *Salix sericea* (silky willow) and *S. eriocephala* (stiff willow)], and *Betula* spp. (birches) and other tree saplings are most characteristic. Some examples have *Cornus amomum* (southeastern silky dogwood), *Salix nigra* (black willow), *Betula papyrifera* var. *papyrifera* (paper birch), *Betula populifolia* (gray birch), *Quercus rubra* (red oak), *Acer saccharinum* (silver maple), *Fraxinus americana* (white ash), *Alnus serrulata* (smooth alder), *Pinus strobus* (white pine), *Prunus pumila* (dwarf cherry), *Parthenocissus quinquefolia* (Virginia creeper), *Rhus typhina* (staghorn sumac), *Populus* spp. (aspens), and *Acer rubrum* (red maple). These species may appear as scattered individuals where they are not dominant. Herbs and low shrubs are also common and can include *Solidago* spp. (goldenrods), *Schizachyrium scoparium* (little bluestem), *Panicum clandestinum* (deertongue), *Sorghastrum nutans* (wood-grass), *Phalaris arundinacea* (reed canary-grass), *Calamagrostis canadensis* (blue-joint), and *Comptonia peregrina* (sweet fern), The state-rare *Pycnanthemum virginianum* (Virginia mountain mint)* occurs in some examples.

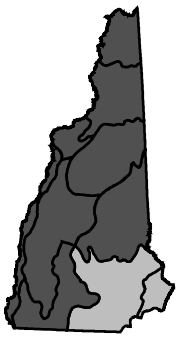
Invasive species are common and occasionally abundant in this natural community including *Rhamnus frangula* (European alder-buckthorn), *Polygonum cuspidatum* (Japanese knotweed), *Lonicera morrowii* (Morrow's

honeysuckle), *Vincetoxicum nigrum* (black swallowwort), *Lythrum salicaria* (purple loosestrife), *Robinia pseudoacacia* (black locust) and *Physocarpus opulifolius* (ninebark).

CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: This community is found statewide. Good examples occur at Livermore Falls (Holderness) and along the Pemigewasset River (Woodstock).

SOURCES: Nichols et al. 2001.



RIVERBANK OUTCROPS, RIVERSIDE SEEPS, AND RIVER BLUFFS

Riverbank outcrops typically occur in river narrows where ice and water scour are intense enough to expose considerable amounts of bedrock. Vegetative cover of these outcrops is low and includes both flood- and drought-tolerant species. Riverbank outcrops occur on both acidic and circumneutral bedrock. Riverside seeps occur on open bedrock, cobble, sand or silt substrates of flood scoured shores of larger rivers. Both acidic and calcareous riverside seeps occur in New Hampshire. Dry and mesic river bluff communities are characterized by sloughing riverbanks with sandy soils along outside bends of meanders of major or minor rivers in sand plain settings. Bluffs range from sparsely vegetated open sands to a woodland structure, depending on past disturbance.

• Acidic riverbank outcrop (S3)

GENERAL DESCRIPTION: This natural community includes open, flood-scoured bedrock exposures along medium-sized and large rivers, typically along river narrows. Height above the river channel appears to influence species composition and plant size. Emergent seepage is absent, although the community may occur in conjunction with seep communities. In contrast to seeps, sedges are often absent. This community differs from rocky ridge communities by the paucity of lichens and woody plants intolerant of flooding, and by the presence of flood-tolerant species. Exotics may be common. Plants may be stressed or killed during periods of drought. Sand, silt, and turf can accumulate in rock crevices and pockets.

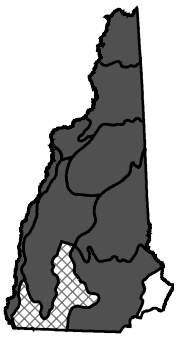
CHARACTERISTIC VEGETATION: Vegetation is usually extremely sparse, but characterized by a diverse array of forbs and grasses. Mosses may be abundant and help stabilize the soil. Characteristic vascular species include *Juncus tenuis* (path rush), *Hieracium* spp. (hawkweeds), *Athyrium filix-femina* (northern lady fern), *Schizachyrium scoparium* (little bluestem), *Andropogon gerardii* (big bluestem), *Agrostis perennans* (upland bent-grass), *Deschampsia caespitosa* (blue-green hair-grass), *Aster novi-belgii* (New York aster), *Euthamia graminifolia* (grass-leaved goldenrod), and a variety of other composites and graminoids. *Carex torta* (twisted sedge) and seedling-sized *Salix* spp. (willows), *Sorbus* spp. (mountain ashes), and *Alnus incana* (speckled alder) may survive here, but remain scattered.

Northern New Hampshire examples are likely to have *Danthonia compressa* (tufted oat-grass), *Vaccinium cespitosum* (dwarf bilberry), *Potentilla tridentata* (three-toothed cinquefoil), *Trisetum spicatum* (spiked false oats)*, and less frequently, seedling-sized *Populus balsamifera* (balsam poplar) and *Thuja occidentalis* (northern white cedar). Dwarf bilberry and three-toothed cinquefoil are otherwise restricted to alpine areas and high-elevation outcrops. The rare *Hieracium robinsonii* (Robinson's hawkweed)* may occur in this community (known only from one site in New Hampshire).

CLASSIFICATION CONFIDENCE: 1-2

DISTRIBUTION: This community is likely found statewide. Large examples are located on medium-sized to large rivers, including the Connecticut, Merrimack, Pemigewasset, and Dead Diamond rivers. Good examples are at No-Mans Island (Bath), Garvins Falls (Concord), and Livermore Falls (Holderness).

SOURCES: NHB field surveys; Nichols et al. 2001.



• Circumneutral riverbank outcrop (S1)

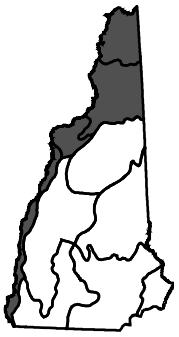
GENERAL DESCRIPTION: This natural community includes open, flood-scoured bedrock exposures along medium-sized and large rivers, typically along river narrows. Height above the river channel appears to influence species composition and plant size. In one example, the outcrop ranged from 0-7 m above the channel and supported few wetland species above 2-3 m. Emergent seepage is absent, although the community may occur in conjunction with seep communities. In contrast with seeps, sedges are often absent. This community differs from rocky ridge communities by the paucity of lichens and woody plants intolerant of flooding, and by the presence of flood-tolerant species. Exotics may be common. Plants may be stressed or killed during periods of drought. Sand, silt, and turf can accumulate in rock crevices and pockets.

CHARACTERISTIC VEGETATION: Plants present that are probably indicative of circumneutral or more enriched conditions may include *Campanula rotundifolia* (harebell), *Senecio pauperculus* (dwarf ragwort)*, *Astragalus robbinsii* var. *jesupii* (Jesup's milk-vetch)*, *Allium schoenoprasum* (Siberian chives)*, *Woodsia ilvensis* (rusty woodsia), and *Polystichum acrostichoides* (Christmas fern). Species found on acidic outcrops may also be found in this community, including *Aster* spp. (asters), *Solidago* spp. (goldenrods), *Viola* spp. (violets), *Schizachyrium scoparium* (little bluestem), *Andropogon gerardii* (big bluestem), *Onoclea sensibilis* (sensitive fern), and scattered woody shrubs and tree seedlings.

CLASSIFICATION CONFIDENCE: 1-2

DISTRIBUTION: This community is apparently limited to the Connecticut River (mostly in the Northern Connecticut River Valley and Vermont Piedmont subsections). A good example is at Bellows Falls (Walpole).

SOURCES: NHB field surveys; Nichols et al. 2001.

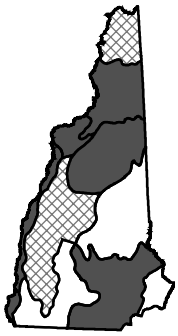


• Acidic riverside seep (S1)

GENERAL DESCRIPTION: This community occurs on seepy, open bedrock or cobble, sand or silt substrate of flood scoured shores of larger rivers where cold groundwater emerging from bedrock generates fen-like conditions. It is distinguished from calcareous seeps by the absence of calcareous indicators and from riverside outcrops by the presence of acidic, wet-site indicators.

CHARACTERISTIC VEGETATION: Species include *Chamaedaphne calyculata* (leather-leaf), *Vaccinium macrocarpon* (large cranberry), *Agalinis purpurea* (purple gerardia), *Viola lanceolata* (lance-leaved violet), *Rhododendron canadense* (rhodora), *Lyonia ligustrina* (male-berry), *Drosera rotundifolia* (round-leaved sundew), *Carex canescens*, *Matteuccia struthiopteris* (ostrich fern), *Lysimachia terrestris* (swamp candles), *Scirpus cyperinus* (woolly bulrush), *Houstonia caerulea* (bluets), *Spiraea alba* (eastern meadowsweet), *Alnus* spp., *Hypericum*

spp. (St. Johnsworts), mosses, and liverworts. Northern occurrences may have such species as *Picea mariana* (black spruce), *Gaultheria hispidula* (creeping snowberry), and *Ledum groenlandicum* (Labrador-tea). Drier outcrop areas present often have such species as *Schizachyrium scoparium* (little bluestem), *A. gerardii* (big bluestem), *Panicum* spp., *Aster* spp., *Euthamia graminifolia* (grass-leaved goldenrod), and numerous other graminoids and composites.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is apparently rare in New England. A good example occurs along the Merrimack River at Garvins Falls (Concord).

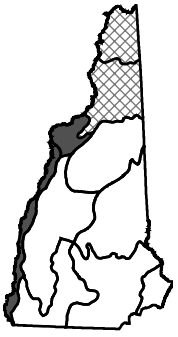
SOURCES: NHB field surveys; Nichols et al. 2001.

• Calcareous riverside seep (S1)

GENERAL DESCRIPTION: Calcareous riverside seeps occur at river narrows of major rivers and below dams (usually at river narrows where riverside seeps were likely natural), on outcrops and occasionally on sediments of steep terraces or cobble bars where there is year-round influence of groundwater seepage. Emergent and subsurface seepage through silty cracks in bedrock, or in cobble, gravel, sand, or silt substrates is evident by the presence of species indicative of cold, fen-like, calcareous conditions. Annual flood and ice scour is intense and removes competing woody vegetation. Drier, non-seepy or ledge outcrop areas may be interspersed with seepy spots. Most seeps of smaller rivers appear to be acidic and/or harbor acid-loving plants.

Soils tend to be turfy sands (i.e., sand impregnated with a tightly woven fine root mass) wedged in cracks of outcrop, boulders, cobble and bare outcrop. Little to no organic horizon accumulates or is at least stripped away each year. Less often seep vegetation can be found in unconsolidated sediments of steep river terraces or silty banks. Partial shading from trees and shrubs is typical. Calcareous riverside seeps appear to be restricted to areas with considerable calcareous bedrock influence or at least mineral enriched groundwater, and pH of seepage water ranges from 6.8 to 8.2.

CHARACTERISTIC VEGETATION: Dominant plant species tend to vary between examples, but many characteristic and rare forbs, grasses, and sedges are typically present, including a variety of midwestern prairie species. Characteristic species include *Lobelia kalmii* (Kalm's lobelia)*, *Tofieldia glutinosa* (sticky false asphodel)*, *Parnassia glauca* (grass-of-Parnassus)*, *Carex garberi* (Garber's sedge)*, *Rhynchospora capillacea* (hair-like beak-rush)*, *Equisetum variegatum* (variegated horsetail)*, *Senecio pauperculus* (dwarf ragwort)*, *Mimulus moschatus* (muskflower)*, *Spiranthes lucida* (shining ladies'-tresses)*, *Scirpus* spp., and *Houstonia caerulea* (bluets). On drier areas *Andropogon gerardii* (big bluestem), *Schizachyrium scoparium* (little bluestem), *Deschampsia caespitosa* (blue-green hair-grass), *Campanula rotundifolia* (harebell), *Toxicodendron radicans* (climbing poison ivy), and *Prunus pumila* var. *depressa* (dwarf cherry) may occur. Shrub border areas may include *Cornus sericea* (red osier dogwood), *Alnus crispa* (mountain alder), *Spiraea alba* (eastern meadowsweet), and *Salix* spp. (willows).



CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is limited to the banks of the Connecticut River. A good example is at Bellows Falls (Walpole).

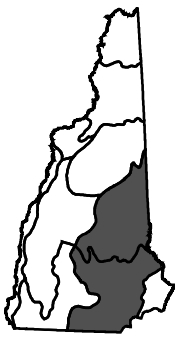
SOURCES: Rawinski 1983a; Sperduto and Gilman 1995.

• Dry river bluff (S2?)

General description: This community is characterized by sloughing riverbanks with dry sandy soils along outside bends of meanders of major or minor rivers in sand plain settings. River bluffs form where a river cuts into a terrace whose brow sits above the active floodplain. The slopes are steep, presumably to the angle of repose, and highly unstable. As the river erodes sand at the base, the areas higher on the slope slide downward, constantly exposing fresh sand, interspersed with tree trunks and chunks of turf eroded from the terrace directly above. Portions of otherwise dry sand bluffs are mesic or slightly enriched from laterally surfacing groundwater. Bluffs range from sparsely vegetated open sands to a woodland structure, depending on past disturbance.

The bluffs form as their rivers cut through thick outwash and old glacial lakebed deposits and, in some examples, are several hundred feet high. Along the upper Saco River, the river cuts into the sand plain that filled the Saco River valley at the end of the Wisconsin glaciation. The Saco River expressions of this community are approximately 60 ft. high and extend up to ¼ mile along the outside edge of river bends. Along the Merrimack and Soucook Rivers the nutrient-poor, sandy soils support a rare plant association on slopes and bluff edges of southern and western exposures, characterized by *Lupinus perennis* (wild lupine)* and *Hudsonia ericoides* (golden-heather)*. These plants grow in open areas, balancing among the forces of river undercutting and erosion, destabilization from groundwater seepage from the thick sandy deposits, and stabilization by vegetation. Some stretches of bluff rivers are too unstable to support wild lupine or golden-heather; other bluff areas are stable enough to support trees and other vegetation that shade out the two rare plants. Rivers are dynamic systems, however, and the long-term perturbation of this community depends on the preservation of large areas of riverine corridor to allow for the migration of the community as the river's channel meanders.

Characteristic vegetation: Plants typical of dry, sandy disturbed sites characterize this community including *Schizachyrium scoparium* (little bluestem), *Andropogon gerardii* (big bluestem), *Danthonia spicata* (poverty oat-grass), *Bromus inermis* (awnless brome-grass), *Elytrigia repens* (quack-grass), *Agrostis gigantea* (redtop), *Carex* cf. *brevior* (shorter sedge) and other *Carex* in section Ovales, *Carex rugosperma* (sand sedge), *Lespedeza capitata* (round headed bush-clover), *Polygonella articulata* (jointweed), *Lechea intermedia* (intermediate pinweed), *Aralia hispida* (bristly sarsaparilla), *Eupatorium rugosum* (white snakeroot), *Viola sagittata* (arrow-leaved violet), *Oenothera biennis* (biennial evening primrose), *Erechtites hieracifolia* (fireweed), *Veronica officinalis* (common speedwell), *Lupinus perennis* (wild lupine)*, *Hudsonia ericoides* (golden-heather)*, *Comptonia peregrina* (sweet fern), *Betula populifolia* (gray birch), *Betula papyrifera* var. *papyrifera* (paper birch), and mosses.



Classification confidence: 2

Distribution: This community is found in limited areas within New Hampshire. Good examples are along the Lower Saco (Conway) and Soucook (Concord) Rivers, and the Merrimack River (Concord).

Sources: NHB field surveys; Engstrom 1997.

OPEN EMERGENT MARSHES, SHRUB THICKETS, AND AQUATIC BEDS

The following communities occur in low-energy settings along streams, rivers and open-basins (those with outlets), in closed-basins (no outlets) with broadly fluctuating water levels, and on shady, wave-exposed lake and pond shores. These settings contrast with higher-energy riparian environments and stagnant basins that accumulate peat (covered elsewhere in open wetlands and riparian communities section).

OPEN-BASINS AND STREAMSIDES

These communities occur 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 typically found in lower energy sections of the riparian corridor and are similar to those in streamside and open-basin settings. As such, they are treated in this section of the classification.

Shallow emergent marshes

This is a broad category of communities characterized by permanently saturated to seasonally flooded mineral, muck, or shallow fibrous peat soils, dominated by grasses and sedges (graminoids) or mixes of graminoids, herbs, and medium-height shrubs between 0.5-1.5 m tall. These marshes are usually flooded by one to several feet during spring high-water but have considerably lower water levels by mid to late summer. Dominance by rhizomatous, clonal species is common in shallow, medium, and deep emergent marshes, and what species prevail at a site is strongly influenced by hydrologic regime and seed or other propagule availability. A very high diversity of species has been documented from marshes in general. Species richness for a 400 square meter area typically exceeds 30 (-40+) species, even when one or a few species accounts for over 50% of the cover (NHB field surveys).

Typical shallow emergent marsh plants include *Calamagrostis canadensis* (blue-joint), *Glyceria canadensis* (rattlesnake manna-grass), *Leersia virginica* and *L. oryzoides* (cutgrasses), *Phalaris arundinacea* (reed canary-grass), *Dulichium arundinaceum* (three-way sedge), *Carex stricta* (tussock sedge), *C. lacustris* (lake sedge), *Scirpus cyperinus* (woolly bulrush), *Eupatorium dubium* (three-nerved Joe-pye-weed), *E. maculatum* (spotted Joe-pye-weed), *Iris versicolor* (northern blue flag), *Juncus canadensis* (Canada rush), and *Thalictrum pubescens* (tall meadow-rue). Shallow emergent marshes may be successional to scrub-shrub swamps and ultimately forested swamps over the coarse of decades. Alternatively, they may revert to either deeper water marshes or aquatic beds following submergence caused by damming of the drainage.

The rare *Scirpus ancistrochaetus* (northeastern bulrush)* (federally endangered) occurs in shallow to medium-depth emergent marshes. This species does not appear in the common botanical manuals, but is closest to *Scirpus atrovirens* in character. The primary gross difference is that the peduncles (fruiting-head stalks) are mostly drooping rather than ascending (bristle barbs are also different). Other potential rare species include *Mikania scandens* (climbing hempweed)*, *Campanula uliginosa* (greater marsh bellflower)*, *Lysimachia thyrsiflora* (tufted loosestrife)*, *Iris prismatica* (slender blue flag)*, *Carex trichocarpa* (hairy-fruited sedge)*, *Bidens laevis* (smooth bidens)*, and *B. discoidea* (small beggars tick)*.

In many cases, shallow emergent marshes are rather mixed in composition and may not fit a particular dominance type, or are transitional to shrub thickets. In other circumstances, one or two species clearly dominate. Numerous associations or dominance types can be observed, which may deserve distinction as natural community types with an expanded sampling and understanding of hydrologic-vegetation dynamics. Presently, we recognize several broad groups of communities based on dominant life forms.

• Tall graminoid emergent marsh (S4)

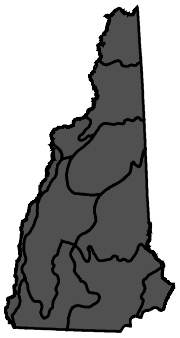
General description: This shallow emergent marsh community is dominated by tall "matrix" forming graminoids. Dominant species are maintained vegetatively through the development of dense tussocks or by lateral spread (clonal or spreading from loose tussocks).

Characteristic vegetation: Typical marsh plants here include *Calamagrostis canadensis* (blue-joint), *Glyceria canadensis* (rattlesnake manna-grass), *Leersia virginica* and *L. oryzoides* (cutgrasses), *Phalaris arundinacea* (reed canary-grass), *Dulichium arundinaceum* (three-way sedge), *Carex stricta* (tussock sedge), *C. lacustris* (lake sedge), *Scirpus cyperinus* (woolly bulrush), *Eupatorium dubium* (three-nerved Joe-pye-weed), *E. maculatum* (spotted Joe-pye-weed), *Iris versicolor* (northern blue flag), *Juncus canadensis* (Canada rush), and *Thalictrum pubescens* (tall meadow-rue).

A broad diversity of other herbs is often present, but much of the cover and biomass is contributed by only a few species.

Variants: Four variants are described here.

1. **Blue-joint variant**: This common variant is dominated by *Calamagrostis canadensis* (blue-joint). These "meadows" are often inundated for shorter periods or do not sustain water as close to the surface for as long compared to other shallow emergent marshes.
2. **Tussock sedge variant**: This variant is dominated by the ubiquitous *Carex stricta* (tussock sedge).
3. **Bulrush variant**: These marshes are dominated by bulrushes, most commonly *Scirpus cyperinus* (woolly bulrush).
4. **Reed canary grass variant**: *Phalaris arundinacea* (reed canary-grass) is dominant in this variant.



Classification confidence: 2

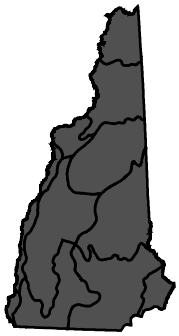
Distribution: This community is found throughout the state. Good examples can be found at Pawtuckaway State Park (Nottingham).

Sources: NHB field surveys.

• Mixed tall graminoid - scrub-shrub marsh (S4S5)

General description: This community is a very common "scrub-shrub"/emergent marsh type. It is similar to tall graminoid emergent marshes but has a substantial component of medium-height (0.5-1.5 m) shrubs less that 60% cover overall. Many examples are successional between marsh and shrub thicket or swamp.

Characteristic vegetation: Species include a mixture of tall graminoids such as *Calamagrostis canadensis* (blue-joint), *Carex stricta* (tussock sedge), other tall grasses and sedges, *Osmunda cinnamomea* (cinnamon fern), *O. regalis* (royal fern), *Spiraea alba* (eastern meadowsweet), and *Myrica gale* (sweet gale). Tall shrubs include *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (winterberry), *Alnus incana* (speckled alder), *Viburnum nudum* (witherod), and *Salix* spp. (willows). This community is transitional to streamside poor fens that have a greater abundance of *Sphagnum* moss, *Chamaedaphne calyculata* (leather-leaf), sweet gale, and "peatland" sedges such as *Carex utriculata* (bottle-shaped sedge) and *C. lasiocarpa* (hairy-fruited sedge).



Classification confidence: 2

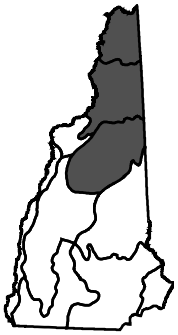
Distribution: Occurs throughout the state. Good examples can be found at Pawtuckaway State Park (Nottingham).

Sources: NHB field surveys.

• Northern medium sedge meadow marsh (S3)

General description: This community is dominated by medium sized sedges [0.3-0.6 m (1-2 ft.) high] and other herbs and occurs in old, abandoned, "filled-in" beaver marshes in montane settings. It probably represents a successionally intermediate community between emergent marsh and graminoid fens on peat soils. It may succeed into a fen as the wetland paludifies, or shift to a wetter marsh or aquatic bed with renewed impoundment by beavers.

Characteristic vegetation: This community is dominated by medium sized sedges such as *Carex echinata* (prickly sedge), *C. utriculata* (bottle-shaped sedge), and a diverse assemblage of marsh forbs. Other marsh plants may include *Calamagrostis canadensis* (blue-joint), *Glyceria canadensis* (rattlesnake manna-grass), *Leersia* spp. (cutgrasses), *Dulichium arundinaceum* (three-way sedge), *Carex stricta* (tussock sedge), *C. lacustris* (lake sedge), *Scirpus cyperinus* (woolly bulrush), *Eupatorium maculatum* var. *foliosum* (northeastern spotted Joe-pye-weed), *Iris versicolor* (northern blue flag), *Juncus canadensis* (Canada rush), *Thalictrum pubescens* (tall meadow-rue), *Aster puniceus* (purple-stemmed aster), *Agrostis* spp. (bent-grasses), *Galium* spp. (bedstraws), *Hypericum* spp. (St. John's-worts), and *Lycopus uniflorus* (common water horehound).



Classification confidence: 2

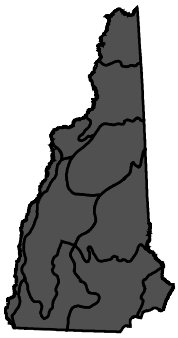
Distribution: This community is found in montane settings of the northern part of the state (including the White Mountains). Good examples occur at Norton Pool Preserve (Pittsburg) and Elbow Pond (Woodstock).

Sources: NHB field surveys.

• Short graminoid - forb emergent marsh/mud flat (S4)

General description: This community consists of short [<0.65 m (0.25-2.0 ft.)] herbaceous vegetation (sedges, rushes, grasses and forbs) under seasonally flooded to semi-permanently flooded or intermittently exposed situations, such as mud-flats of recently drawn-down beaver ponds or exposed mineral soil along wet river shores. Annuals, seedling perennials, modest-sized perennial herbs, and graminoids are common. It is similar to some closed-basin sand plain marshes described elsewhere.

Characteristic vegetation: Vegetation of these areas might include *Lindernia dubia* (common false pimpernel), *Gratiola aurea* (golden-pert), *Bidens* spp. (beggar ticks), *Hypericum boreale* (northern St. John's-wort), *Eleocharis smallii* (Small's spike-rush), *Sium suave* (water parsnip), and *Glyceria borealis* (northern floating manna-grass).



Classification confidence: 2-3

Distribution: This community is found throughout the state. Good examples occur along the Merrimack River (Concord) and in the Dame Rd. vicinity (Durham).

Sources: NHB field surveys.

• Oxbow marsh (S3)

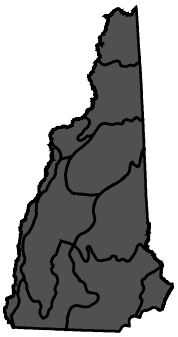
GENERAL DESCRIPTION: Marshes associated with oxbow formations on floodplain terraces are influenced by the flood regime of the river and modified both by the length of inundation and saturation, and by the amount of time since the last flood. Oxbow marshes contain many of the same common wetland plants that grow in shallow and deep emergent marshes in basins not associated with riparian settings. However, they have a different and distinct hydrologic signature and occur in a complex mosaic of plant communities associated with the varying flood regimes of terraces and oxbow channels. In this respect, they are significant and distinct ecological expressions of emergent marsh vegetation.

Oxbow marshes are isolated in varying degrees from the river channel for most of the year, but are flooded during spring and other high runoff events. Species composition in oxbows can be quite variable from one oxbow to another, even when two oxbows occur near one another.

CHARACTERISTIC VEGETATION: Graminoids that may be present include *Carex vesicaria* (inflated sedge), *C. lupulina* (hop sedge), *C. crinita* (drooping sedge), *C. stricta* (tussock sedge), *C. folliculata* (follicled sedge), *C. lurida* (sallow sedge), *C. cristatella* (small crested sedge)*, *Scirpus cyperinus* (woolly bulrush), *Dulichium arundinaceum* (three-way sedge), *Eleocharis* spp. (spike-rushes), *Glyceria* spp. (manna-grasses), *Leersia* spp. (cut-grasses), *Puccinellia* spp. (manna-grasses), *Calamagrostis canadensis* (blue-joint), *Juncus canadensis* (Canada rush), and *J. effusus* (soft rush). The first three sedges are more abundant in riparian marshes than in other wetlands, particularly in oxbow swales. Forbs may include *Pontederia cordata* (pickerel-weed), *Sparganium americanum* (lesser bur-reed), *Cicuta maculata* (common water-hemlock), *Cicuta bulbifera* (bulbiferous water-hemlock), *Sium suave* (water parsnip), *Impatiens capensis* (spotted touch-me-not), *Osmunda regalis* (royal fern), *O. cinnamomea* (cinnamon fern), *Thelypteris palustris* (marsh fern), *Onoclea sensibilis* (sensitive fern), *Polygonum sagittatum* (arrow-leaved tearthumb), *Triadenum virginicum* (marsh St. John's-wort), *Bidens* spp. (sticktights), *Sagittaria latifolia* (common arrowhead), *Iris versicolor* (northern blue flag), *Lysimachia terrestris* (swamp candles), *Eupatorium* spp. (Joe-pye-weeds), and *Typha latifolia* (common cattail). Woody species that may be present in low cover include *Spiraea alba* (eastern meadowsweet), *Salix* spp. (willows), *Cornus amomum* (southeastern silky dogwood), *Ilex verticillata* (winterberry), *Toxicodendron radicans* (climbing poison ivy), *Vitis* spp. (grapes), *Cephalanthus occidentalis* (buttonbush), and seedlings of *Acer saccharinum* (silver maple) and *Acer rubrum* (red maple).

VARIANTS: Oxbow marshes occur as either deep emergent or shallow emergent variants. They deserve further study and consideration as distinct communities:

1. **Shallow emergent marsh variant (S3)**: The hydrologic regime may range from seasonally or temporarily flooded to permanently saturated or mesic when the water table drops during the growing season. Soils are alluvially deposited sand and/or silt or muck over sand and/or silt. Vegetation is characterized by graminoids, forbs, and shrubs (absent to low cover) typical of shallow emergent marshes in other settings.
2. **Deep emergent marsh variant (S3)**: Sand and/or silt or muck over sand and/or silt soils are flooded early in the growing season and may retain standing water through much or all of the growing season. Vegetation is characterized by graminoids, forbs, and aquatic species typical of deep emergent marshes in other settings.



CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: This community is found statewide. Good examples occur along the Lamprey River (Epping) and the Blackwater River (Salisbury).

SOURCES: NHB field surveys; Nichols et al. 2001.

Medium-depth and deep emergent marshes

Medium-depth emergent marshes are intermediate between shallow and deep emergent marshes. They contain at least some vegetation characteristic of deep emergent marshes (e.g., aquatic or spongy tissued perennial emergent species), but may contain some species indicative of the wet end of shallow emergent marshes. These marshes may occur on muck, peat, or mineral soil. They are flooded early in the growing season, and may retain shallow standing water through much or all of the growing season. Characteristic plants include *Typha latifolia* (common cattail), *Scirpus tabernaemontanii* (softstem bulrush), *Scirpus pungens* (three-square rush), *Sparganium americanum* (lesser bur-reed), *Peltandra virginica* (arrow-arum), *Pontederia cordata* (pickerel-weed), and *Sagittaria* spp. (arrowheads).

Deep emergent marshes may remain flooded throughout the year or draw down late in the growing season. They often have some medium-depth emergent marsh and aquatic bed vegetation. Characteristic plants include *Sparganium americanum* (lesser bur-reed), *Pontederia cordata* (pickerel-weed), *Peltandra virginica* (arrow-arum), *Sagittaria latifolia* (common arrowhead), *Potamogeton* spp. (pondweeds), *Nuphar variegata* (variegated yellow pond-lily), *Nymphaea odorata* (white water-lily), *Utricularia* spp. (bladderworts), *Elodea* spp. (waterweeds), *Vallisneria americana* (tape-grass), *Eleocharis* spp. (spike-rushes), *Lemna* spp. (duckweeds), *Brasenia schreberi* (water shield), and *Myriophyllum humile* (low water-milfoil).

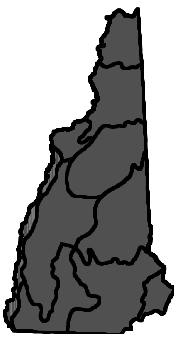
Some rare species that may be found in medium-depth and deep emergent marshes include *Sparganium eurycarpum* (giant bur-reed)*, *S. androcladum* (branching bur-reed)*, *Lysimachia thyrsiflora* (tufted loosestrife)*, and *Megalodonta beckii* (water marigold)*.

A variety of wetland birds frequent these marshes including red-winged blackbird (*Agelaius phoeniceus*), pied-billed grebe (*Podilymbus podiceps*)*, Virginia rail (*Rallus limicola*)*, marsh wren (*Cistothorus palustris*), and various waterfowl.

• Medium-depth emergent marsh (S4)

General description: This community occurs on silt and fine to medium-grained sand or muck along streams, rivers, lakes, and ponds. Scattered patches of fibric organic material is common. The substrate is often partially exposed by mid-growing season and is inundated by shallow water for most of the rest of the season. On low- to moderate-energy shores, plant height is relatively low and the soil is typically fine to medium-grained sand. On lower-energy shores, taller plants may occur with the low-growing species. Low-energy shorelines that are exposed for longer periods are classified as shallow emergent marshes. Infrequently exposed zones with deeper water are classified as deep emergent marsh - aquatic bed community.

Characteristic vegetation: This emergent marsh is dominated by a mix of emergent graminoid and other herbaceous aerenchymatous (spongy tissue) species, such as *Sparganium americanum* (lesser bur-reed), *Sagittaria latifolia* (common arrowhead), *Pontederia cordata* (pickerel-weed), *Eleocharis* spp. (spike-rush), *Polygonum hydropiperoides* (mild water pepper), *Scirpus tabernaemontanii* (softstem bulrush), *S. pungens* (three-square rush), *S. subterminalis* (water bulrush), *Juncus militaris* (bayonet rush), *Dulichium arundinaceum* (three-way sedge), and *Typha latifolia* (common cattail). Less frequent species include *Lysimachia terrestris* (swamp candles), *Lindernia dubia* (common false pimpernel), *Ludwigia palustris* (water purslane), and *Glyceria* spp. (manna-grasses), among others.



Classification confidence: 3

Distribution: This community is found statewide. Good examples can be found along the Blackwater River (Salisbury) and the Merrimack River (Concord).

Sources: NHB field surveys.

• Cattail marsh (S4)

General description: This community is dominated by cattails and found in open-basins along small stream drainageways, and in protected depressions or backwater areas of lakes, ponds, and rivers. Soils may be mucky organic or mineral with a high organic content. This community is seasonally to semi-permanently flooded, with saturated soils and water levels remaining at or above the ground surface year round. Dead thatch from the previous year's growth can form a thick ground cover in well-developed clonal stands.

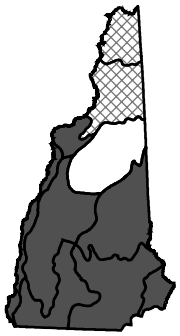
Typha angustifolia (narrow-leaved cattail) also occurs in communities associated with brackish basins along tidal rivers (see robust forb brackish marsh variant); in small depressions along the upper edge of low graminoid brackish marshes (see *Typha angustifolia* panne); and within the zone between mean sea level and mean high tide along brackish tidal river- and stream-banks (see low brackish tidal riverbank marsh).

Birds that breed in cattail marshes include American bittern, least bittern, sora, Virginia rail, marsh wren, swamp sparrow, red-winged blackbird, common moorhen, and several species of waterfowl.

Characteristic vegetation: *Typha latifolia* (common cattail) and/or *Typha angustifolia* (narrow-leaved cattail) may dominate and exclude nearly all other species or may codominate with other herbs and shrubs. *Typha x glauca* (glaucous cattail; *Typha angustifolia x Typha latifolia*) can locally dominate as well. Associates may include *Carex stricta* (tussock sedge), *Scirpus cyperinus* (woolly bulrush), *Sparganium americanum* (lesser bur-reed), *Glyceria* spp. (manna-grass), *Calamagrostis canadensis* (blue-joint), *Phragmites australis* (common reed), *Lythrum salicaria* (purple loosestrife), *Lemna minor* (lesser duckweed), *Lycopus uniflorus* (common water horehound), *Lysimachia terrestris* (swamp candles), *Acer rubrum* (red maple) seedlings and saplings, and several species of shrubs including *Spiraea alba* (eastern meadowsweet), *Ilex verticillata* (winterberry), *Vaccinium corymbosum* (highbush blueberry), *Viburnum dentatum* (northern arrowwood), and *Lyonia ligustrina* (male-berry).

Variants: Two variants are described here.

1. **Typic variant**: As described above.
2. **River channel variant**: Cattail marshes immediately adjacent to rivers are influenced by river flooding and alluvial soils and may support a different array of species. More sampling is required to determine whether river channel cattail marshes are distinct from others. *Typha angustifolia* (narrow-leaved cattail) and/or *Typha glauca* (hybrid cattail) dominate two Connecticut River sites. Infrequent species include *Lythrum salicaria* (purple loosestrife), *Ludwigia palustris* (water purslane), *Pontederia cordata* (pickerel-weed), *Nymphaea odorata* (white water-lily), *Sagittaria latifolia* (common arrowhead), *Myriophyllum* sp. (water-milfoil), *Elodea canadensis* (common waterweed), *Onoclea sensibilis* (sensitive fern), *Mimulus ringens* (monkey flower), *Scutellaria lateriflora* (mad-dog skullcap), *Cardamine pensylvanica* (Pennsylvania bitter-cress), *Boehmeria cylindrica* (false nettle), *Glyceria striata* (fowl manna-grass), and *Eleocharis acicularis* (least spike-rush).



Classification confidence: 1

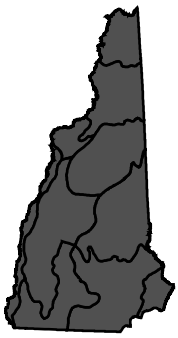
Distribution: Cattail marshes occur throughout the state at low to moderate elevations. A good example of the typic variant occurs along Crommet Creek (Durham). A good example of the river channel variant can be found along the Connecticut River (Hinsdale).

Sources: NHB field surveys; Nichols et al. 2001.

• Deep emergent marsh - aquatic bed (S4S5)

General description: This broadly defined, widespread community occurs in quiet, shallow-water areas of ponds, lakes, and slow-moving streams dominated by a mix of floating-leaved, submersed, and emergent herbaceous species. The substrate may be flooded throughout the year or exposed later in the growing season. Perennial aquatic beds are treated separately and include semi-permanently to permanently flooded, relatively deeper water zones characterized by submersed and floating-leaved aquatic species, but with emergent plants absent or in low cover. Water depths are typically 2-3 ft. (0.6-0.9 m).

Characteristic vegetation: Characteristic species include *Sparganium americanum* (lesser bur-reed), *Pontederia cordata* (pickerel-weed), *Peltandra virginica* (arrow-arum), *Sagittaria latifolia* (common arrowhead), *Potamogeton* spp. (pondweeds), *Nuphar variegata* (variegated yellow pond-lily), *Nymphaea odorata* (white water-lily), *Utricularia* spp. (bladderworts), *Elodea* spp. (waterweeds), *Vallisneria americana* (tape-grass), *Eleocharis* spp. (spike-rushes), *Lemna* spp. (duckweeds), *Brasenia schreberi* (water shield), and *Myriophyllum humile* (low water-milfoil). Less frequent species include *Glyceria borealis* (northern floating manna-grass), *Puccinellia pallida* (pale manna-grass), *Polygonum hydropiperoides* (mild water pepper), and several other emergent and aquatic species.



Classification confidence: 2

Distribution: This community is found throughout the state. A good example is along the Powwow River (Kingston).

Sources: NHB field surveys.

Aquatic beds

Additional information is needed to better describe aquatic beds at the community level in New Hampshire. Differentiation of types will likely relate to water depth and periodicity, flood-energy and organic matter accumulation, and water body nutrient status. Aquatic bed communities have been more thoroughly sampled along sandy pond shores and closed-basin sand plain marshes. (See those sections for other descriptions.)

• Aquatic bed (S4S5)

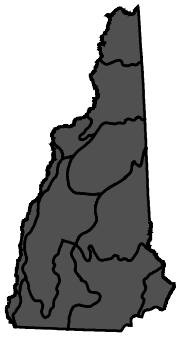
General description: This is a broadly defined community dominated by floating leaved, submersed, and emergent herbaceous species in quick water streams and shallow quiet water areas of ponds, lakes, oxbows, streams and rivers. Water depths typically are at least 0.6-0.9 m (2-3 ft.) in mid-late summer or shallower but semi-permanently to permanently flooded. Deep emergent marshes are treated separately and include vegetation of littoral zones consisting primarily of emergent rather than floating or submersed species and have water depths generally less than 0.6-0.9 m (2-3 ft.).

Characteristic vegetation: Common species include *Nuphar variegata* (variegated yellow pond-lily), *Brasenia schreberi* (water shield), *Nymphoides cordata* (floating heart), *Utricularia vulgaris* (common bladderwort), *Lemna minor* (lesser duckweed), *Spirodela polyrhiza* (water-flaxseed), *Wolffia columbiana* (Columbian water-meal), *Pontederia cordata* (pickerel-weed), *Vallisneria americana* (tape-grass), *Potamogeton* spp. (pondweeds), and *Myriophyllum* spp. (milfoils). Less frequent are *Scirpus subterminalis* (water bulrush), *Ceratophyllum demersum* (submerged hornwort), *Megalodonta beckii* (water marigold)*, *Utricularia* spp. (bladderworts), *Polygonum hydropiperoides* (mild water pepper), *Sparganium americanum* (lesser bur-reed), *Dulichium arundinaceum* (three-way sedge), and *Eleocharis acicularis* (least spike-rush). Some rare floating-leaved or submersed aquatic species found in quiet, relatively deep water or along shallow shores of rivers or ponds include several *Potamogeton* spp. (pondweeds; see NH Heritage rare plant tracking list), *Hippuris vulgaris*

(common mare's-tail)*, *Megalodonta beckii* (water marigold)*, *Sagittaria cuneata* (wapato)*, *Lemna valdiviana* (duckweed)*, *Lemna trisulca* (star-duckweed)*, *Isoetes engelmannii* (Engelmann's quillwort)*, *Isoetes macrospora* (large-spored quillwort)*, and *Ranunculus subrigidus* (stiff water crowfoot)*.

VARIANTS: Two variants are described below.

1. **Quiet water variant**: This variant includes shallow quiet water areas of ponds, lakes, oxbows, streams and rivers. See description above for characteristic species.
2. **Quick water variant**: A lower cover of free floating and emergent species occurs in this variant. It is characterized by submersed and free floating rooted vegetation such as *Potamogeton nodosus* (knotty pondweed)*, other pondweeds (possibly *P. foliosus*, *P. gramineus*, and *P. richardsonii*), *Ranunculus trichophyllus* (white water crowfoot), and *Isoetes* spp. (quillworts), and other species.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is found statewide. Good examples occur in Pawtuckaway State Park (Nottingham), along the Lamprey River (Epping), and in oxbows along the Blackwater River (Salisbury).

SOURCES: NHB field surveys; Sperduto and Crow 1994.

Open seepage marshes

Seepage marshes are soligenous wetlands (e.g., they have a reliable source of groundwater seepage) that also appear to be influenced to some extent by water from stream overflow (limnogenous) and upland runoff (topogenous) sources. They typically have shallow organic material over mineral substrates. Some have moderately deep organic matter and are transitional to open peatland communities but differ from them by having a robust herbaceous layer including minerotrophic forbs.

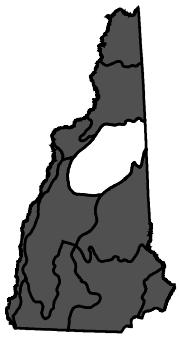
• Herbaceous seepage marsh (S3)

GENERAL DESCRIPTION: Seepage marshes occur in association with groundwater discharge zones near upland borders of various wetland types, in headwater positions, along stream drainages (including the interface of a drainage with a larger marsh), or in other areas where groundwater discharge is prominent. They tend to be larger than forest seeps and do not have a significant tree canopy influence, except along the borders. Seepage marshes are intermediate between fens and marshes both floristically and environmentally. All contain a mixture of graminoids, forbs, and ferns including indicators of seepage and minerotrophic conditions. Some examples have a moderate cover of alder and may be successional to speckled alder wooded fen.

Soils consist of shallow peat or fibric muck organic layers over silt or silty muck. Mosses may be abundant but *Sphagnum* is generally absent. Examples dominated by *Carex lacustris* (lake sedge) are the most frequently observed and may be described as a distinct community in the future. Soils tend to be shallow fibric peats or mucks over silty muck, silt, or silty sands. In four examples, pHs range from 5.5 to 6.3, indicating subacid to circumneutral conditions.

CHARACTERISTIC VEGETATION: Dominant species indicative of seepage or minerotrophic conditions include *Onoclea sensibilis* (sensitive fern) (high frequency among known examples), *Carex lacustris* (lake sedge), *Eupatorium maculatum* (spotted Joe-pye-weed), *Osmunda regalis* (royal fern), *Thelypteris palustris* (marsh fern), *Symplocarpus foetidus* (skunk cabbage), *Saxifraga pensylvanica* (swamp saxifrage), and *Carex scabrata* (rough sedge). Other minerotrophic indicators are usually present in lower abundance and may include *Senecio robbinsii* (Robbins' ragwort), *Hydrocotyle americana* (water pennywort), *Chrysosplenium americanum* (golden saxifrage), *Carex stipata* (awl sedge), *Carex leptalea* (delicate sedge), *Carex prasina* (leek-green drooping

sedge), *Impatiens capensis* (spotted touch-me-not), *Mentha arvensis* (field mint), *Toxicodendron vernix* (poison sumac), *Chelone glabra* (white turtlehead), *Lysimachia terrestris* (swamp candles), and *Equisetum fluviatile* (water horsetail). Other occasionally abundant species indicative of at least weakly minerotrophic conditions may include *Calamagrostis canadensis* (blue-joint), *Equisetum arvense* (field horsetail), *Aster puniceus* (purple-stemmed aster), *Potentilla palustris* (marsh cinquefoil), *Spiraea alba* (eastern meadowsweet), and *Carex lasiocarpa* (hairy-fruited sedge). Mosses include *Mnium* spp. and *Philonotis fontana*, among many others. Other common marsh plants may be present as well, including *Carex lurida* (sallow sedge).



CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: This community is broadly distributed but intermittently documented in the state. Good examples occur in College Woods (Durham), Weeks State Park (Lancaster), and south of Ossipee Lake (Ossipee).

SOURCES: NHB field surveys.

Shrub thickets (non-peatland types)

These shrub thickets occur on mineral soils or well-decomposed organic soils, in open- and closed-basin settings including oxbows. Shrub thickets in peatlands typically differ by their deep peat soil, abundant peat mosses, prominent medium-height heath shrub layer, and other peatland indicators species. See also sweet gale - speckled alder shrub thicket described under the sandy pond shore section.

• Highbush blueberry - winterberry shrub thicket (S4)

GENERAL DESCRIPTION: This is a common and widespread seasonally flooded tall shrub thicket community found in small open basins, closed sand plain basins, and seasonally flooded zones within larger wetlands. *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (winterberry) are the dominant shrubs. It is found around the upland margin of nearly all closed-basin marshes on sand plains.

This community is found on seasonally flooded mineral soils that vary in organic content. In some settings, leaf litter covers the basin floor and bryophytes and herbs are in low abundance. In other settings it can grade into tall shrub fens with organic soils.

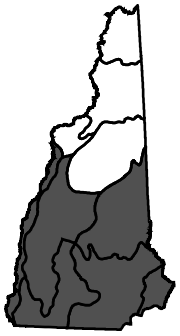
Highbush blueberry - winterberry shrub thickets are distinguished from tall shrub peatland types by the absence of deep peat soils, abundant peat mosses, prominent medium-height heath shrub layer, and other peatland indicators of this community such as *Picea mariana* (black spruce) and *Sarracenia purpurea* (pitcher-plant).

CHARACTERISTIC VEGETATION: Dominant shrubs include *Ilex verticillata* (winterberry) and/or *Vaccinium corymbosum* (highbush blueberry). Seedling and sapling sized *Acer rubrum* (red maple) are often present. Herbs are typically scarce and may include *Osmunda cinnamomea* (cinnamon fern), *Osmunda regalis* (royal fern), *Thelypteris palustris* (marsh fern), *Lycopus uniflorus* (common water horehound), and few others. Somewhat more minerotrophic examples may contain *Salix* spp. (willows), *Alnus* spp. (alders), *Viburnum nudum* (witherod), and *Cephalanthus occidentalis* (buttonbush) in low to moderate abundance (never dominant). Dominance by buttonbush indicates one of the buttonbush communities (seasonally to semi-permanently flooded).

VARIANTS: Two variants are presently recognized:

1. **Typic variant**: As described above.
2. **Dense sand plain basin marsh variant:** This variant occurs in more nutrient-poor settings such as around the margins of sand plain marshes in closed-basins. *Lyonia ligustrina* (male-berry),

Chamaedaphne calyculata (leather-leaf), *Nemopanthus mucronatus* (mountain holly), *Aronia arbutifolia* (red chokeberry), *A. melanocarpa* (black chokeberry), and *Rhododendron canadense* (rhodora) are characteristic of this variant.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is found throughout southern and central NH. Good examples of the typic variant occur on the Army Corps of Engineers' Hopkinton-Everett Lakes property (Weare) and Grassy Pond (Litchfield).

SOURCES: NHB field surveys.

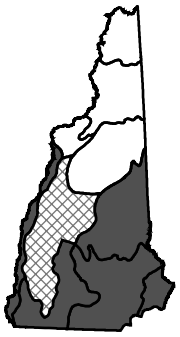
• Oxbow buttonbush swamp (S3)

GENERAL DESCRIPTION: This community is dominated by a thicket of *Cephalanthus occidentalis* (buttonbush). Oxbow buttonbush swamps can be a matrix for small ephemeral oxbow ponds or form a fringe thicket around larger, semi-permanently to permanently flooded oxbow ponds. The oxbow may be flanked by a forested floodplain or terrace. Oxbow marshes differ in being dominated by forbs and graminoids. Buttonbush basin swamp thickets, a related natural community type (see below), have well-decomposed organic soils, perched water tables, and seasonally to semi-permanently flooded hydrology.

Oxbows are periodically flooded backwaters of a meandering river. They are remnants of once-active channels, and now, because they fill and drain slowly, they accumulate sediment. The oxbow buttonbush swamp has alluvial soil consisting of silt and sand, dark with organic material, which may be saturated or flooded for much of the year.

Buttonbush is a good source of food for bees (superfamily Apoidea) and provides cover for wood ducks (*Aix sponsa*) rearing their young. It outcompetes other plants apparently because of its high tolerance for flooding and fluctuating water levels.

CHARACTERISTIC VEGETATION: A moderate to dense thicket of *Cephalanthus occidentalis* (buttonbush) lines all but the lowest, ponded parts of the oxbow. *Thelypteris palustris* (marsh fern), *Sium suave* (water parsnip), and a few other herbs may be scattered or locally common along the borders of the buttonbush swamps. The community may include scattered, mature canopy trees such as *Acer saccharinum* (silver maple) and *A. rubrum* (red maple).



CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: This community is widespread in the state but apparently most abundant in central and southern New Hampshire. A good example is found along the Blackwater River (Salisbury).

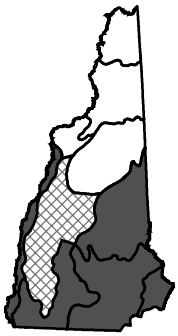
SOURCES: NHB field surveys; Faber-Langendoen and Maycock 1989.

• Buttonbush basin swamp (S4)

GENERAL DESCRIPTION: This community occurs in small basins dominated by *Cephalanthus occidentalis* (buttonbush) with standing water present for most or all of the growing season. Exposed soil is periodically required for buttonbush regeneration. Buttonbush can also be found with other shrubs and herbs along lake and pond margins and slow-moving streams. Buttonbush basins are characterized by well-decomposed organic soils, perched water tables, and seasonally to semi-permanently flooded hydrology. Oxbow buttonbush swamp

thickets, a related natural community type (see above), occurs on alluvial soils in oxbow depressions that are periodically inundated by riverbank overflow. These wetlands provide brood cover for wood ducks (*Aix sponsa*).

CHARACTERISTIC VEGETATION: *Cephalanthus occidentalis* (buttonbush) typically dominates with a moderate to dense cover. Other characteristic species include *Acer rubrum* (red maple), *Ulmus americana* (American elm), *Vaccinium corymbosum* (highbush blueberry), *Alnus incana* (speckled alder), *Ilex verticillata* (winterberry), *Rosa palustris* (swamp rose), *Chamaedaphne calyculata* (leather-leaf), *Kalmia angustifolia* (sheep laurel), *Viburnum dentatum* (northern arrowwood), *Thelypteris palustris* (marsh fern), *Osmunda regalis* (royal fern), *O. cinnamomea* (cinnamon fern), *Lycopus uniflorus* (common water horehound), and *Lysimachia terrestris* (swamp candles). The persistence of standing water throughout much of the growing season limits shrub and herb diversity. Many of the shrubs mentioned above may occur with greater cover on drier basin margins or other relatively higher ground in the wetland.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community type is widespread in the state but apparently most abundant in central and southern New Hampshire. A good example is found at Stratham Hill Park (Stratham).

SOURCES: NHB field surveys.

SANDY POND SHORE, CLOSED - BASIN, AND SAND DUNE SETTINGS

The following communities occur in sand plain settings (pond shores, closed-basins, and interdunal swales). They are distinguished from typical limnogenous wetlands on the basis of their unique geomorphic settings, floristic composition, and more broadly fluctuating water levels. Vertical water fluctuations (precipitation, evapotranspiration, groundwater fluctuations, and limited topographic runoff inputs) dominate the hydrology in closed-basin marshes and interdunal swales (e.g., no limnogenous influence). Soils are seasonally to permanently flooded fine mineral to organic materials over sand or silt. Many of these communities harbor plants restricted to or concentrated in the Atlantic coastal plain region.

Sandy pond shore settings

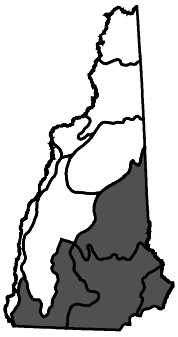
• Sweet gale - speckled alder shrub thicket (S3)

GENERAL DESCRIPTION: This temporarily flooded shrub community usually forms a narrow zone at the upland edge of pond shores or along the side and top of sandy ice-berms formed on large lakes. It is characterized by a mixture of tall and medium shrubs, with lesser amounts of dwarf shrubs and herbs. The composition is more diverse than highbush blueberry - winterberry shrub thickets.

Variable soils of sand or sand and gravel, inter-bedded sand and peat turf, or sandy muck form on open pond shore beach ridge or upland edge. Soils consist of shallow hemic O horizons (0-13 cm), variable A horizons (0-55 cm), with sand and gravel deposits to over 1 m. A single location included in this type has over 125 cm of peat at the surface.

CHARACTERISTIC VEGETATION: Diagnostic species occurring with higher frequency and/or greater abundance that are absent or infrequent in dense highbush blueberry - winterberry tall shrub thickets include *Myrica gale* (sweet gale), *Alnus incana* (speckled alder), *A. serrulata* (smooth alder), *Spiraea tomentosa* (steeplebush), *Osmunda regalis* (royal fern), *Viburnum nudum* (witherod), *V. dentatum* (northern arrowwood), and *Vaccinium macrocarpon* (large cranberry). Other less frequent species that are largely limited to this community include *Panicum virgatum* (switch-grass), *Solidago rugosa* (rough goldenrod), *Onoclea sensibilis* (sensitive fern),

Aster racemosus (small headed white aster), *Carex stricta* var. *strictior* (small-tussock sedge), *Euthamia graminifolia* (grass-leaved goldenrod), and *Carex scoparia* (broom sedge). Some of these less frequent species are also found in adjacent (lower) zones occupied by *Cladium mariscoides* sandy turf pond shore.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is found in central and southern NH. A good example occurs along the south shore of Ossipee Lake (Ossipee).

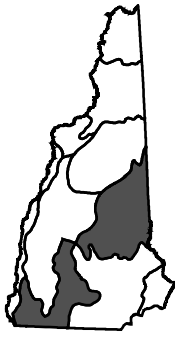
SOURCES: Sperduto 1994b; Sperduto 2000c.

• Twig-rush sandy turf pond shore (S1)

GENERAL DESCRIPTION: This community occurs on sandy organic turf mats between open water or sand beach and shrub communities on sandy shores of large lakes (e.g., Ossipee Lake and Lake Massasecum). Wave and ice action are prominent disturbance forces, but less severe than in bulblet umbrella-sedge open sandy pond shore and water lobelia aquatic sandy pond shore communities, which are lower on the shoreline and have much lower percent cover of vegetation. Soil cores of inter-bedded sand, muck, and peat >1.2 m in depth attest to the dynamic nature of these pond shore communities on a time scale of decades to centuries. This community is similar to meadow beauty sand plain marsh, but contains more robust, rhizomatous, stress tolerant graminoids, a sparse *Sphagnum* presence, and is much more diverse compositionally and structurally. Numerous species of coastal plain distribution are found in this community.

Soils are shallow sandy peat mats alternating with sand layers. Sand dominates below 50 cm, or, in several cores, interbedded with organic layers to over 1 m depth.

CHARACTERISTIC VEGETATION: *Cladium mariscoides* (twig-rush) is the dominant stress tolerant matrix species. Other characteristic species include *Euthamia graminifolia* (grass-leaved goldenrod), the state-rare *E. tenuifolia* (fine grass-leaved goldenrod)*, *Carex stricta* var. *strictior* (small-tussock sedge) (rhizomatous form), *C. lasiocarpa* (hairy-fruited sedge), *Calamagrostis canadensis* (blue-joint), and *Vaccinium macrocarpon* (large cranberry). Frequent or constant species found in low abundance include *Eleocharis tenuis* (slender spike-rush), *Viola lanceolata* (lance-leaved violet), *Cyperus dentatus* (bulblet umbrella-sedge), *Sagittaria latifolia* (common arrowhead), *Spiraea tomentosa* (steeple-bush), *Myrica gale* (sweet gale), *Scirpus pungens* (three-square rush), *Panicum virgatum* (switch-grass), *Galium tinctorium* (Clayton's bedstraw), *Bidens frondosa* (common beggar-ticks), *Muhlenbergia uniflora* (one-flowered muhly), *Glyceria canadensis* (rattlesnake manna-grass), *Dulichium arundinaceum* (three-way sedge), and *Lycopus uniflorus* (common water horehound). *Lycopodiella appressa* (slender bog clubmoss)* and *Proserpinaca pectinata* (mermaid-weed)* are two rare species known from this community, but not observed recently, along the shores of Ossipee Lake. The globally rare *Sclerolepis uniflora* (sclerolepis)* spills over into this community from deeper water habitats along Lake Massasecum.



CLASSIFICATION CONFIDENCE: 2

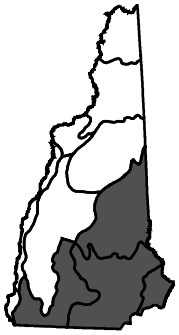
DISTRIBUTION: Occurs on sandy organic turf mats between open water or sand beach and shrub communities on sandy shores of large lakes. Good examples occur along Ossipee Lake (Ossipee) and Lake Massasecum (Bradford).

SOURCES: Sperduto 1994b; Sperduto 2000c.

• Bulblet umbrella-sedge open sandy pond shore (S2)

General description: This natural community consists of sparsely vegetated lower sandy shores of medium to large lakes and ponds subjected to regular wave and ice disturbance and with little to no organic matter accumulation. This community is often interspersed discontinuously along unvegetated sand beach. With several species of coastal plain distribution, it is similar to meadow beauty sand plain marsh and twig rush sandy turf pond shore, but has a much lower total percent cover than either, a greater prominence of ruderals, and lacks the robust graminoids of twig rush sandy turf pond shore. Short clumped graminoids, and rhizomatous forbs and graminoids dominate along with numerous native ruderals.

Characteristic vegetation: *Cyperus dentatus* (bulblet umbrella-sedge), *Viola lanceolata* (lance-leaved violet), *Juncus pelocarpus* (mud rush) (rhizomatous), and *Bidens frondosa* (common beggar-ticks) are nearly constant and vary from low to moderate abundance. Other frequent species include *Panicum* spp. (seven species; annuals and perennials), *Agrostis scabra* (rough ticklegrass), *Gratiola aurea* (golden-pert), *Aster racemosus* (small headed white aster), *Carex scoparia* (broom sedge), *Eleocharis tenuis* (slender spike-rush), *Euthamia tenuifolia* (fine grass-leaved goldenrod)*, *E. graminifolia* (grass-leaved goldenrod), *Triadenum virginicum* (marsh St. John's-wort), and *Eriocaulon aquaticum* (pipewort). Frequent annuals include *Agalinis purpurea* var. *parviflora* (small-flowered gerardia), *Bidens discoidea* (small bidens)*, *Erechtites hieracifolia* (fireweed), and on wetter or less exposed sections, sometimes *Eleocharis acicularis* (least spike-rush).



Classification confidence: 1

Distribution: Occurs on both unimpounded lakes and those with artificially elevated water levels (e.g., Lake Massabesic, Manchester) in central and southern New Hampshire. Some impounded lakes may once have supported *Cladium mariscoides* sandy turf pond shores prior to impoundment.

Sources: Sperduto 1994b; Sperduto 2000c.

• Water lobelia aquatic sandy pond shore (S1S2)

General description: This natural community occurs in shallow water environments of sandy pond shores characterized by a permanently inundated to intermittently exposed flood regime and regular wave and ice disturbance. Most examples are characterized by a very low percent cover of aquatic rosette-stress tolerant species (including "Isoetids") and various floating and submersed species and submersed forms of normally emergent vegetation. Several examples occur in protected coves or interior pools on twig rush sandy turf pond shore mats and have a much higher percent cover of vegetation, particularly of floating leaved aquatics more sensitive to wave disturbance along exposed shores.

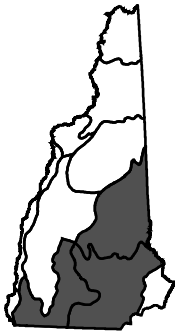
Characteristic vegetation: Component species are described in the two variants below.

Variants: Two discernable variants are recognized, although some overlap is evident:

1. **Pondweed - pickerel-weed variant**: This subtype is characterized primarily by floating leaved and aerenchymatous aquatics, including *Potamogeton epihydrus* (surface pondweed), *P. natans* (floating pondweed), *Pontederia cordata* (pickerel-weed), and *Sparganium americanum* (lesser bur-reed). Cover varies from very low to moderately high in coves. One of these pond shores supports New Hampshire's only population of *Sclerolepis uniflora* (sclerolepis)*.
2. **Rosette stress-tolerant Isoetid variant**: This type has a lower frequency and abundance of floating-leaved aquatics and much higher frequency and abundance of rosette stress tolerant "Isoetid" species. The community is only intermittently exposed, typically as a narrow band at or near the water level line, with all or a portion of the vegetated zone staying inundated during moderately high water years.

Characteristic species include *Eriocaulon aquaticum* (pipewort) (sparse to abundant), *Lobelia dortmanna* (water lobelia), *Isoetes tuckermanii* (Tuckerman's quillwort) and other *Isoetes*, *Scirpus pungens* (three-square rush), *Utricularia gibba* (humped bladderwort), and submersed aquatic forms of *Sagittaria graminea* (grass-leaved arrowhead), *Gratiola aurea* (golden-pert), *Juncus pelocarpus* (mud rush), *Eleocharis acicularis* (least spike-rush), and *Sparganium americanum* (lesser bur-reed).

Dense to intermittent, permanently flooded rhizomatous stands of *Scirpus pungens* (three-square rush) or *Juncus militaris* (bayonet rush) have been observed in New Hampshire along shallow sandy shores, but have not been quantitatively sampled. These occur in other New England states (Sorrie 1994) and may deserve recognition as distinct types.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Found in shallow water environments of sandy pond shores characterized by a permanently inundated to intermittently exposed flood regime and regular wave and ice disturbance. Good examples are found at White Lake State Park (Tamworth) and Lake Massabesic (Manchester and Auburn).

SOURCES: Sperduto 1994b; Sperduto 2000c.

Sand plain closed-basin marsh settings

• Meadowsweet - robust graminoid sand plain marsh (S3S4)

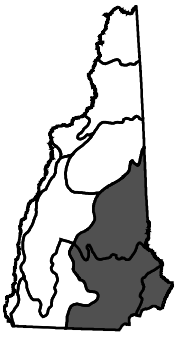
GENERAL DESCRIPTION: This is a broadly defined, seasonally flooded community found in closed-basins on sand plains and dominated by various robust perennial graminoids, medium shrubs, and *Sphagnum* mosses. Dominants vary among examples but consist almost entirely of common, widespread wetland species with affinities to seasonally flooded poor fens and alluvial emergent marshes. However, this community has shallower peat and muck horizons (over sand) compared to fens, more broadly fluctuating water levels than both fens and alluvial marshes, and no over-bank or surface water flow-through typical of alluvial marshes. It is typically positioned between drier tall shrub thickets and various wetter, short graminoid and forb communities.

Soils are mostly shallow peat (5 cm) and shallow sandy muck A horizons (5-20 cm) over sand. *Dulichium*-dominated examples have peat up to 50 cm over 5-30 cm of mucky sand over sand.

CHARACTERISTIC VEGETATION: *Spiraea alba* (eastern meadowsweet) is frequent and often a dominant but an abundance of *Sphagnum* moss (mostly *Sphagnum cuspidatum*) and <1% cover of *Scirpus cyperinus* (woolly bulrush) are the only near constants. Robust tussock-forming (cespitose) and rhizomatous perennial graminoids are constant as groups. Rhizomatous species include frequent *Dulichium arundinaceum* (three-way sedge) (aerenchymatous) and *Carex stricta* var. *strictior* (small-tussock sedge) (the rhizomatous form of the otherwise tussock-forming species), and occasional *C. lasiocarpa* (hairy-fruited sedge) and *C. utriculata* (bottle-shaped sedge). Cespitose species include *Glyceria canadensis* (rattlesnake manna-grass), *Calamagrostis canadensis* (blue-joint), and *Scirpus cyperinus* (woolly bulrush). *Vaccinium macrocarpon* (large cranberry) and *Chamaedaphne calyculata* (leather-leaf) are the only other occasional shrubs. *Lysimachia terrestris* (swamp candles) is a near constant in the type in low abundance, but other forbs are sparse and mostly represent spill-over from adjacent zones. Three-way sedge - manna-grass mud flat marsh shares some species with this community, but has much less *Sphagnum* and *Spiraea alba*, very few tussock-forming graminoids, and more short graminoids and forbs.

VARIANTS: One occurrence of this community forms a unique association for the state. It consists of a dense two-acre stand of solid *Dulichium arundinaceum* and *Sphagnum cuspidatum* to the near exclusion of all other

vegetation, with a patch of *Glyceria acutiflora* shallow peat marsh in one small pool area.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is limited to sand plain settings in central and southern NH, particularly the southern Merrimack River valley, seacoast, and Ossipee areas. A good example is at Grassy Pond (Litchfield).

SOURCES: Sperduto 1994b; Sperduto 2000c.

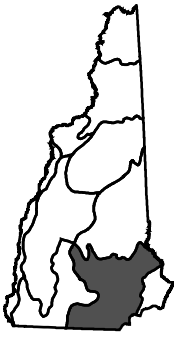
• Meadow beauty sand plain marsh (S1)

GENERAL DESCRIPTION: This is a seasonally to semi-permanently flooded community formed on shallow sand-bottomed basins. It is dominated by short rhizomatous sedges, forbs, short clumped graminoids, and an abundance of *Sphagnum cuspidatum*. Many of the species characteristic of this type have coastal plain affinities.

Ninety-five percent of water input at New Hampshire's only site for this community comes in the form of precipitation, with the remainder from ground water in-flow. Draw-downs usually occur by late summer (earlier in dry years), stranding the aquatic *Sphagnum cuspidatum* as thin dry mats on mucky sand. From 1996-1999, water fluctuations averaged 1.76 m/year, with a maximum range of 2.2 m recorded during the four-year period.

This community is similar to twig-rush sandy turf pond shore and bulblet umbrella-sedge open sandy pond shore. It differs by a greater abundance of short rhizomatous and clumped sedges, and fewer ruderals and tall graminoids than twig rush sandy turf pond shore and bulblet umbrella sedge open sandy pond shore. All three are rare and declining communities in New Hampshire. Three-way sedge - manna-grass mud flat marsh occupies approximately the same topographic position as this community (both begin ca. 0.75 m on average below the upland transition), but tends to have more organic matter accumulation, perhaps driven by less dramatically fluctuating water levels that lead to more organic matter production and accumulation. One basin that was classified to bulblet umbrella sedge open sandy pond shore is transitional to this type and contains the rare coastal plain species *Scleria reticularis* (stone nut-rush)* (disjunct from southeastern Massachusetts), and other rare species including *Euthamia tenuifolia* (fine grass-leaved goldenrod)* and *Lindernia anagallidea* (false pimpernel)*. Soils are shallow sandy muck (10-20 cm) over sand.

CHARACTERISTIC VEGETATION: Dominant species include *Eleocharis tenuis* (slender spike-rush), *Rhexia virginica* (Virginia meadow beauty), *Glyceria canadensis* (rattlesnake manna-grass), and *Sphagnum cuspidatum*. Frequent and locally abundant species include *Panicum spretum* (spurned panic-grass), *Muhlenbergia uniflora* (one-flowered muhly), *Gratiola aurea* (golden-pert), *Viola lanceolata* (lance-leaved violet), *Juncus pelocarpus* (mud rush), *Hypericum boreale* (northern St. John's-wort), *Xyris difformis* (robust yellow-eyed grass), *Cyperus dentatus* (bulblet umbrella-sedge), and *Eriocaulon aquaticum* (pipewort).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Known from only one site in the lower Merrimack River valley (Litchfield).

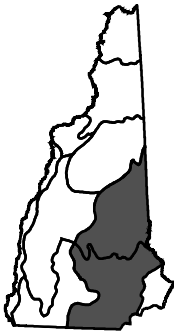
SOURCES: Sperduto 1994b; Owen 1999; Sperduto 2000c.

• Three-way sedge - manna-grass mud flat marsh (S2S3)

General description: This is a densely vegetated, semi-permanently flooded "mud flat" community found in mucky sand plain basins dominated by short forbs and graminoids (<0.65 m). Prominent life forms include short aerenchymatous (spongy-tissued), floating-stemmed, and other rhizomatous species, short clumped graminoids, and ruderals. This type is wetter than and has a lower abundance of tall graminoids compared to meadowsweet - robust graminoid sand plain marshes and twig rush sandy turf pond shores, and a lower abundance of ruderals and floating-leaved aquatics than spike-rush - floating-leaved aquatic mud flat. A higher proportion of the species in this community have a more general or northern distribution than the coastal plain species found in meadow beauty sand plain marsh, *Cladium mariscoides* sandy turf pond shore, and bulblet umbrella-sedge open sandy pond shore communities. Moderate to deep muck soils are typical, forming mud flat conditions during draw-down periods. The community is commonly found just above the wetter spike-rush - floating-leaved aquatic mud flat community.

Soils have 20-110 cm (average = 57 cm) of O horizon with a muck A horizon over sand, gravel, or slightly silty-gravelly sand.

Characteristic vegetation: Frequent characteristic species include the aerenchymatous *Dulichium arundinaceum* (three-way sedge) (usually a dominant); floating-stemmed species *Glyceria borealis* (northern floating manna-grass) and *Puccinellia pallida* (pale manna-grass); short rhizomatous graminoids including *Eleocharis smallii* (Small's spike-rush), *E. flavescens* (olive-brown spike-rush), and *Juncus pelocarpus* (mud rush); and rhizomatous forbs including *Hypericum boreale* (northern St. John's-wort), *Triadenum virginicum* (marsh St. John's-wort), *Viola lanceolata* (lance-leaved violet), and *Lysimachia terrestris* (swamp candles). Tall graminoids are occasional and in moderately low abundance, including *Carex vesicaria* (inflated sedge) and *C. utriculata* (bottle-shaped sedge). *Sphagnum* is occasional and in low abundance. Mud flat annuals are frequent as a group and occasionally abundant, but inconsistent as to species. These include *Eleocharis obtusa* (blunt spike-rush), *Lindernia dubia* (common false pimpernel), *Scirpus smithii* (Smith's bulrush), *Bidens connata* (swamp beggar-ticks), *B. frondosa* (common beggar-ticks), and *Erechtites hieracifolia* (fireweed).



Classification confidence: 2

Distribution: Found on low elevation sand plains in closed-basins, particularly in the lower Merrimack River valley, and sparingly on the seacoast and Ossipee regions. Commonly found just above spike-rush - floating-leaved aquatic mud flat.

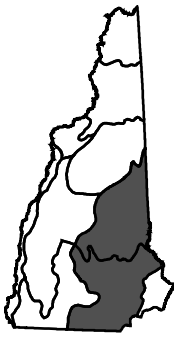
Sources: Sperduto 1994b; Sperduto 2000c.

• Spike-rush - floating-leaved aquatic mud flat (S1)

General description: This is an intermittently exposed, moderately to densely vegetated community found on deep muck soils of closed basins, typically below three-way sedge - manna-grass mud flat marshes. During draw-down periods, short rhizomatous graminoids and forbs and mud flat annuals emerge along with aerenchymatous species and "stranded" floating-leaved and submerged aquatic species. This community occurs in wetter settings than three-way sedge - manna-grass mud flat marshes and differs from it by the absence of tall graminoids and a greater abundance of floating and/or submersed aquatics. Soils consist of 50-100 cm of muck (up to 73% organic matter) over sand and/or gravel.

Characteristic vegetation: Perennial, short rhizomatous species include *Eleocharis flavescens* (olive-brown spike-rush), *E. smallii* (Small's spike-rush), *E. acicularis* (least spike-rush), *Juncus pelocarpus* (mud rush), *Scirpus torreyi* (Torrey's threesquare), *Hypericum boreale* (northern St. John's-wort), *Gratiola aurea* (golden-pert), and *Polygonum hydropiperoides* (mild water pepper). The floating stemmed graminoid *Glyceria borealis*

(northern floating manna-grass) is occasional. Characteristic mud flat annuals include frequent *Eleocharis obtusa* (blunt spike-rush) and *Scirpus smithii* (Smith's bulrush)*, and occasional *Panicum tuckermanii* (Tuckerman's panic-grass), *Bidens connata* (swamp beggar-ticks) *Panicum rigidulum* (stiff panic-grass), *Eleocharis ovata* (ovoid spike-rush), *Bidens discoidea* (small bidens)*, and *Erechtites hieracifolia* (fireweed). Floating-leaved aquatics include *Nuphar variegata* (variegated yellow pond-lily), *Potamogeton oakesianus* (Oakes' pondweed), and *P. diversifolius* (common snailseed pondweed). Submersed aquatics are also occasional, including *Myriophyllum humile* (low water-milfoil) and *Utricularia radiata* (inflated bladderwort). Aerenchymatous species include *Sparganium americanum* (lesser bur-reed). *Eriocaulon aquaticum* (pipewort) is occasional.



CLASSIFICATION CONFIDENCE: 2

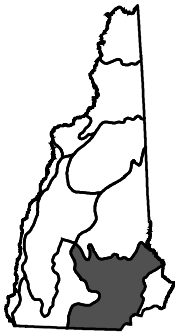
DISTRIBUTION: This community has only been documented from closed-basins on the lower Merrimack River sand plain region. Good examples occur in Hollis and Litchfield.

SOURCES: Sperduto 1994b; Sperduto 2000c.

• Sharp-flowered manna-grass shallow peat marsh (S1)

GENERAL DESCRIPTION: This wetland community is characterized by semi-permanently flooded to intermittently exposed shallow peat swales dominated by the floating-stemmed *Glyceria acutiflora* (sharp-flowered manna-grass)*, which is at the northern edge of its range. Soils are 10-35 cm of well-decomposed peat over a shallow sandy muck layer over sand to >1.2 m (histic and mineral histic epipedons).

CHARACTERISTIC VEGETATION: *Sphagnum* spp. (including *S. cuspidatum*) vary from being present in low abundance to being codominant with *Glyceria acutiflora* (sharp-flowered manna grass)*. Drawdown periods produce habitat for mud flat ruderals such as *Scirpus smithii* (Smith's bulrush), *Polygonum pensylvanicum* (Pennsylvania smartweed), *Bidens cernua* (nodding bur-marigold), *B. frondosa* (common beggar-ticks), *B. connata* (swamp beggar-ticks), *Erechtites hieracifolia* (fireweed), and *Panicum dichotomiflorum* (fall panic-grass), and for seedling establishment of *Glyceria acutiflora*. At the time of sampling, the lower central zones were dominated by seedlings of *Glyceria acutiflora* surrounded by mature fruiting plants in the outer zone, rooting at the nodes. Other vegetation is sparse but includes *Glyceria canadensis* (rattlesnake manna-grass), *Callitriche heterophylla* (diverse-leaved water starwort), *Potamogeton oakesianus* (Oakes' pondweed), *Panicum tuckermanii* (Tuckerman's panic-grass), and *Nuphar variegata* (variegated yellow pond-lily).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Presently known from a single complex of basins in southern New Hampshire.

SOURCES: Sperduto 1994b; Sperduto 2000c.

• Montane sandy basin marsh (S1)

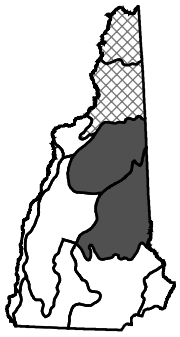
GENERAL DESCRIPTION: Only a few basin marshes have been located in the White Mountain region and north country. The basins in the White Mountains tend to have larger watersheds than their more southern counterparts and have very broad fluctuations in water levels of up to two meters or more between spring and late summer. They are primarily found at the interface of mountain slopes and mixed outwash deposits of the Saco River valley. They have outlets that are breached only during high water periods, after which the basins are effectively closed (vertical fluctuations only). Variation from one basin to another is substantial in the five documented examples.

However, this is a broadly defined community distinguished by the association with topographically nearly-closed basins with broadly fluctuating water levels and the absence of coastal plain species that are found in examples further south. Two basins have steep side slopes with unusual mixtures of upland and wetland species.

CHARACTERISTIC VEGETATION: Coastal plain species are absent and more common broadly-distributed marsh plants are characteristic. Some of these include *Osmunda regalis* (royal fern), *Juncus canadensis* (Canada rush), *Glyceria borealis* (northern floating manna-grass), *Scirpus subterminalis* (water bulrush), *Spiraea alba* (eastern meadowsweet), *Alnus incana* (speckled alder), *Iris versicolor* (northern blue flag), *Puccinellia pallida* (pale manna-grass), *Juncus pelocarpus* (mud rush), and *Bidens frondosa* (common beggar-ticks).

VARIANTS: Two of the sites have a unique distinction among basin broadly-distributed marshes in the state: they have steep side slopes several meters in width that are characterized by a mixture of upland and wetland species, apparently indicative of widely fluctuating water levels that produce a broad transition zone between wet basin-bottom vegetation and upland forest. This zone has a sparse cover of shrubs and herbs including *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (winterberry), *Maianthemum canadense* (Canada mayflower), *Pteridium aquilinum* (bracken), *Danthonia spicata* (poverty oat-grass), *Osmunda regalis* (royal fern), *Rubus pubescens* (dwarf raspberry), and mosses. No mature trees grew in this zone. These basins received considerable upland runoff inputs, but only maintain surface drainage at very high water events. Water fluctuations during the remainder of the year appeared to be entirely due to the balance of groundwater inputs and evapotranspiration losses. Soil at one site consists of a thin (2 cm) fibric organic layer over a black, very sandy A horizon grading to very mucky coarse sand (to 50 cm). B horizon consists of coarse, very stony sandy gravel.

Among the wetter zones of these basin marshes, there was considerable variation within and between basins, precluding definition of variants. However, some dominance-combinations observed include the following: royal fern - blue flag marsh; *Thelypteris palustris* (marsh fern) - *Carex lurida* (sallow sedge) marsh; *Onoclea sensibilis* (sensitive fern) - *Glyceria striata* (manna-grass) - moss marsh; and *Callitriche heterophylla* (diverse-leaved water starwort) - moss mudflat.



CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: Primarily found at the interface of mountain slopes and mixed outwash deposits of the Saco River valley. One example is located in Stewartstown. Good examples occur at Bragdon Ledge (Albany) and Sugarloaf Basins (Albany).

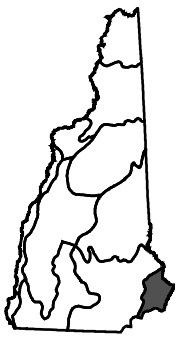
SOURCES: NHB field surveys; Sperduto 1994b; Sperduto 2000c.

Coastal sand dune settings

• Coastal interdunal marsh/swale (S1)

GENERAL DESCRIPTION: A freshwater wetland community found in sandy depressions between sand dunes.

CHARACTERISTIC VEGETATION: Dominants vary from swale to swale and include *Vaccinium macrocarpon* (large cranberry) swales and *Juncus arcticus* (shore rush) swales. Marginal associates include *Aronia prunifolia* (purple chokeberry), *Ilex verticillata* (winterberry), *Toxicodendron radicans* (climbing poison ivy), and *Triadenum virginicum* (marsh St. John's-wort).



CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: Restricted to the coastal zone. Occurs within the one small, fragmented dune system remaining in New Hampshire (Seabrook).

SOURCES: Dunlop and Crow 1985.

CLIFF SEEPS

Cliffs exhibit a substantial amount of small-scale variation in rock composition, pH, and base-cation status. Cliff seeps are either cliffs or portions of cliffs characterized by perennial or near-perennial seepage from bedrock groundwater fractures or terrestrial runoff. They are distinguished from dry to mesic cliffs (see open uplands section) based on the prevalence of hydric conditions and characteristic wetland plants.

• Cliff seep (S3S4)

General description: Cliff seeps are differentiated from other seeps by their occurrence on steep rock outcrops or cliffs. As such, soil accumulation is largely limited to bedrock cracks, small ledges, or thin layers on the rock surface. Cliff seeps have been poorly studied, but there is apparent variation in species composition that relates to major pH, base-cation status, and climate differences.

Variation in mineral composition of bedrock is frequent and can occur at a small-scale, often resulting in localized zones of higher base-cation content (for instance, from weathering and deposition of material from calcium-bearing dikes or sills transported through fractures). Thus, the pH, nutrient status, and species composition of cliffs may vary considerably even within a single ledge.

Characteristic vegetation: Moss and liverworts are often dominant. Some *Sphagnum* seeps on the brow of cliff faces in the White Mountains should be more thoroughly sampled and compared to sliding fens, acidic *Sphagnum* seeps on mineral soil, and acidic fens.

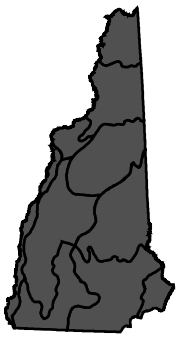
Variants: Three broad variants are described here. Future research may substantiate these differences and justify elevating these variants to community status, parallel to how dry to mesic cliffs are classified.

1. **Acidic variant**: This variant is characterized by *Aster acuminatus* (whorled aster), *Drosera rotundifolia* (round-leaved sundew), *Viola macloskeyi* (northern white violet), *Viola cucullata* (blue marsh violet), *Viola* spp. (violets), *Phegopteris connectilis* (long beech fern), *Chrysosplenium americanum* (golden saxifrage), *Rubus hispidus* (bristly dewberry), *Solidago rugosa* (rough goldenrod), *Cinna latifolia* (drooping woodreed), *Rubus pubescens* (dwarf raspberry), *Circaea alpina* (small enchanter's nightshade), *Platanthera dilatata* (tall white bog orchid), *Cardamine pensylvanica* (Pennsylvanian sedge), *Epilobium* spp. (willow-herbs), *Carex scabrata* (rough sedge), and *Prenanthes altissima* (tall white lettuce). Common tree saplings may include *Tsuga canadensis* (hemlock) and *Betula alleghaniensis* (yellow birch). Bryophytes are typically abundant, and include such species as *Blindia acuta*, *Hygrohypnum ochraceum* and *Sphagnum girgenshonii*.
2. **Circumneutral variant**: This variant contains species listed for the acidic seep variant but is differentiated by the presence of circumneutral-indicators. These include *Saxifraga virginiensis* (early saxifrage) and *Eupatorium rugosum* (white snakeroot), and in northern or subalpine examples *Scirpus hudsonianus* (northern cotton club rush), *Scirpus cespitosus* (tussock bulrush), *Cystopteris bulbifera* (bulblet bladder fern), *Woodsia glabella* (smooth woodsia)*, *Potentilla floribunda* (shrubby cinquefoil), *Calamagrostis lacustris* (pond reed bent-grass)*, *Pinguicula vulgaris* (common butterwort)*, *Muhlenbergia glomerata* (clustered marsh muhly), and *Senecio robbinsii* (Robbins' ragwort). Bryophytes are common to abundant and may include *Distichium capillaceum*, *Gymnostomum aeruginosum*, *Preissia quadrata*, *Conocephalum conicum*, *Mnium thomsonii*, *Crytomnium hymenophylloides*, *Timmia megapolitana*, and *Thamnobryum alleghaniense*.
3. **Alpine cliff seeps**: Species found in this variant include *Salix herbacea* (dwarf willow)*, *Geum peckii* (mountain avens)*, *Arnica lanceolata* (arnica)*, *Saxifraga rivularis* (alpine brook saxifrage)*, and *S. cernua* (nodding saxifrage)*.

Classification confidence: 2-3

DISTRIBUTION: Good examples occur at the Flume (Lincoln), Smarts Brook (Thornton; acidic variant), Ice Gulch (Randolph; circumneutral variant), Connecticut River State Forest (Pittsburg; circumneutral variant), west ridge of Mt. Lincoln (Franconia), and Tuckerman and Huntington Ravines (alpine cliff seep variant).

SOURCES: NHB field surveys.



OPEN PEATLANDS

Open peatland communities are grouped into five categories based on vegetation structure: (1) mud-bottoms, 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. Many community types are widespread, some are geographically restricted, and a few are state and regionally rare. Rare types include calcareous patterned fen, acidic patterned fen, calcareous sedge/moss fen, all sloping and level alpine/subalpine peatlands, montane peatlands dominated by *Calamagrostis pickeringii* (Pickering's reed bent-grass)*, and some intermediate fens and seepage marshes. Alpine and subalpine peatland communities are described along with upland alpine/subalpine communities in the open uplands section.

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, limnogenous, or soligenous 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. Using these terms in reference to whole-peatland sites can be misleading because many peatland basins contain both fen and bog communities.

It is also important to recognize that the vegetation of bogs and fens change at different rates depending on conditions. They may be quite stable over long periods, change slowly over long time frames as peat accumulates, or undergo rapid change and succession over much shorter time frames in response to natural or human disturbances. For example, peatlands in lake basins or those associated with streams 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).

MUD-BOTTOMS, OPEN MOSS LAWNS, AND FLARKS

The following natural communities are saturated open *Sphagnum* moss, liverwort, or other non-vascular plant dominated lawns, carpets or pools with a sparse, dwarf heath shrub layer. Heath shrubs average less than 15% cover and are less than 0.5 m in height in all communities, although there is some variation among individual plots. Peat is usually poorly decomposed near the surface and hummocks are weakly developed (average

height is less than 0.15 m in all communities). *Rhynchospora alba* (white beak-rush) is occasional to frequent in all communities, and peat mosses are usually dominant.

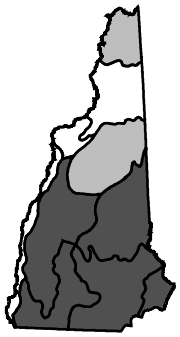
Mud-bottom and open moss lawn communities can be divided into oligotrophic (very acidic), weakly minerotrophic, and minerotrophic communities. The more oligotrophic communities are indicated by *Vaccinium oxycoccos* (small cranberry), *Sphagnum rubellum*, and low pHs (<4.0). The weakly minerotrophic communities are indicated by some combination of *Myrica gale* (sweet gale), *Vaccinium macrocarpon* (large cranberry), *Carex canescens* (silvery sedge), *Triadenum virginicum* (marsh St. John's-wort), *Dulichium arundinaceum* (three-way sedge), and pHs between 4.0 and 5.0. Minerotrophic communities are indicated by calciphytic plants, such as *Scirpus hudsonianus* (northern cotton club rush), *Carex livida* (livid sedge)*, *C. tenuiflora* (thin-flowered sedge), *Muhlenbergia glomerata* (clustered marsh muhly), and *Sphagnum contortum*, and pHs above 5.5. These indicators are sometimes present in low abundance.

• Liverwort - horned bladderwort mud-bottom (S3)

General description: Mud-bottoms are wet, oligotrophic lawns dominated by low, turfy mats of the leafy liverwort *Cladopodiella fluitans*, which turns black and looks like mud from a distance. This community is most common in kettle holes or portions of other peatland basins that are isolated from the minerotrophic influence of upland runoff or lake water.

In this community, peat is typically poorly decomposed near the surface and has a relatively flat surface profile (hummocks are generally <0.20 m; average hummock height is 0.10 m). The average height of dwarf heath shrubs is 0.15 m, and pH is very acidic, averaging 3.9. Mud-bottoms generally occur in association with floating or grounded peat mats of pond-border or lake-fill kettle holes, frequently in association with shallow peat mats near interior pools.

Characteristic vegetation: *Cladopodiella fluitans, Sphagnum cuspidatum*, *Utricularia cornuta* (horned bladderwort), *Rhynchospora alba* (white beak-rush), and *Drosera intermedia* (spatulate-leaved sundew) are all diagnostic and usually abundant. Dwarf shrubs are stunted (usually <0.2 m) and often contribute less than 8% cover. The most frequent shrubs are *Vaccinium oxycoccos* (small cranberry), *Andromeda glaucophylla* (bog rosemary), and *Chamaedaphne calyculata* (leather-leaf). Species characteristic of this community, but that also occur on other oligotrophic dwarf shrub peatlands, include *Sphagnum rubellum*, *S. magellanicum*, *Sarracenia purpurea* (pitcher-plant), and *Drosera rotundifolia* (round-leaved sundew). North of the White Mountains, *Carex exilis* (coastal sedge)* may be abundant in this community. Mud-bottoms with *Carex exilis* can be the dominant community in the wet "flarks" of patterned fens between linear "strings" characterized by *Picea mariana* (black spruce) and heath shrubs. Trees and tall shrubs are always absent in this community.



Classification confidence: 1

Distribution: This community is broadly distributed in New Hampshire, but concentrated in the central and southern portions of the state where kettle holes are more abundant. Good examples can be found at South Bay Bog (Clarksville), Little Church Pond (Livermore/Albany), White Lake Kettles (Tamworth), Lost Ponds (Ossipee), and Cedar Swamp Pond (Kingston).

Sources: Sperduto et al. 2000a.

• Sphagnum rubellum - small cranberry moss carpet (S3)

General description: This community includes floating and grounded peat mats dominated by carpets of *Sphagnum rubellum* and a relatively sparse and dwarfed heath shrub layer (average shrub height is 0.29 m and

cover is generally 5-20%). Found in oligotrophic kettle holes and other peatland basins that are isolated from the minerotrophic influence of upland runoff or lake water. Average pH is 3.9. The peat is poorly decomposed in the upper 0.5 m and hummock-hollow topography is poorly developed (average hummock height 0.13 m).

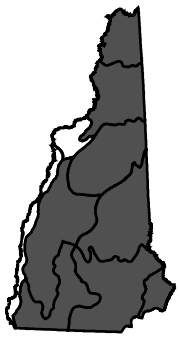
CHARACTERISTIC VEGETATION: *Vaccinium oxycoccos* (small cranberry) is diagnostic and prominent despite its diminutive stature. *Chamaedaphne calyculata* (leather-leaf) is also always present. *Kalmia polifolia* (bog laurel), *K. angustifolia* (sheep laurel), *Andromeda glaucophylla* (bog rosemary), *Sarracenia purpurea* (pitcher-plant), *Rhynchospora alba* (white beak-rush), and *Eriophorum virginicum* (tawny cotton-grass) are often present. *Eriophorum vaginatum* (hare's-tail) is occasional. Trees are absent or sparse and stunted. The rare *Gaylussacia dumosa* var. *bigeloviana* (huckleberry)* occurs in examples within ca. 30 miles of the coast.

VARIANTS: A fairly distinct variant of this community is evident, characterized by an abundance of *Sphagnum magellanicum* and less frequent *Drosera rotundifolia* (round-leaved sundew).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Widespread throughout the state. Good examples can be found at South Bay Bog (Clarksville), Lost Ponds (Ossipee), Cedar Swamp Pond (Kingston), Trask Swamp (Alton), and Little Church Pond (Livermore/ Albany).

SOURCES: Sperduto et al. 2000a.



• Large cranberry - short sedge moss lawn (S3)

GENERAL DESCRIPTION: This natural community forms small to extensive floating peat mats in lake margin peatlands, in wet lagg areas along upland borders, and in pools within other peatlands. It is characterized by lawns, carpets, or pools of *Sphagnum cuspidatum* or *S. torreyanum* with *Vaccinium macrocarpon* (large cranberry), a sparse dwarf shrub layer (<0.5m), and various short sedges indicative of weakly minerotrophic conditions.

The pH ranges from high 3s to mid 4s and averages 4.3. Hummocks are moderately small and peat is moderately well decomposed in the upper 0.5 m.

This community differs from intermediate fens (e.g., those with *Myrica gale* (sweet gale) or dominated by robust sedges) by the abundance of aquatic peat mosses; a relatively sparse, dwarfed shrub layer; a higher frequency of "bog" plants such as *Eriophorum virginicum* (tawny cotton-grass) and *Sarracenia purpurea* (pitcher-plant); a lower frequency of robust *Carex* species; a higher frequency of short sedges (*Carex*, *Dulichium*, and *Rhynchospora*); and the absence of *Sphagnum lescurii*.

CHARACTERISTIC VEGETATION: Some combination of *Sphagnum torreyanum*, *S. cuspidatum,* and *S. pulchrum* dominate the moss layer. *Vaccinium macrocarpon* (large cranberry), *Dulichium arundinaceum* (three-way sedge), *Carex canescens* (silvery sedge), and *Myrica gale* (sweet gale) are common in low to moderate abundance. *Rhynchospora alba* (white beak-rush), *Sarracenia purpurea* (pitcher-plant), *Eriophorum virginicum* (tawny cotton-grass), *Carex limosa* (quagmire sedge), *Lysimachia terrestris* (swamp candles), *Triadenum virginicum* (marsh St. John's-wort), and *Juncus pelocarpus* (mud rush) are occasional to frequent. *Chamaedaphne calyculata* (leather-leaf) is frequent and sometimes abundant, but dwarfed. Robust *Carex* species [*Carex lasiocarpa* (hairy-fruited sedge), *C. utriculata* (bottle-shaped sedge), and *C. oligosperma* (few seeded sedge)] are infrequent.

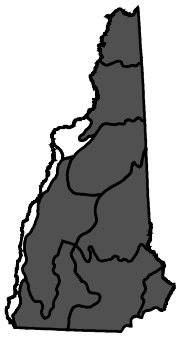
VARIANTS: Three variants are described based largely on the dominant peat moss and minor shifts in species composition.

1. **Sphagnum cuspidatum variant**: *Sphagnum cuspidatum* is dominant and *Drosera intermedia* (spatulate-leaved sundew) and white beak rush are frequent. Robust sedges and sweet gale are rare

(more frequent in the other variants). *Sphagnum angustifolium*, *S. fimbriatum*, and *S. fallax* are infrequent. The average pH is 4.2 and hummocks are moderately small (average hummock height 0.11 m; average maximum hummock height 0.20 m). Peat is moderately well decomposed in the upper 0.5 m. Dwarf shrub height averages 0.29 m. One example is dominated by the coastal plain sedge *Carex bullata* (inflated sedge)* and *Sphagnum cuspidatum*; although this association is known from only one peatland site in the state, it is probably more widespread farther south on the coastal plain. Overall, the floristic composition is indicative of slightly more oligotrophic conditions than in the *S. torreyanum* variant.

2. **Sphagnum torreyanum variant**: *Sphagnum torreyanum* is abundant to dominant, *S. papillosum* is occasional, and *S. affine, S. pulchrum,* and *S. cuspidatum* are infrequent. *Juncus pelocarpus* (mud rush), *Drosera intermedia* (spatulate-leaved sundew), *Sarracenia purpurea* (pitcher-plant), and *Eriophorum virginicum* (tawny cotton-grass) are occasional. *Scheuchzeria palustris* (pod-grass), *Carex lasiocarpa* (hairy-fruited sedge), *C. utriculata* (bottle-shaped sedge), *C. oligosperma* (few seeded sedge), and *C. limosa* (quagmire sedge) are infrequent. Average pH is 4.3. Hummocks are moderately small (average 0.14 m) and range to an average maximum height of 0.29 m. Peat is moderately well decomposed within the upper 0.5 m. Dwarf shrub height averages 0.42 m.

3. **Sphagnum pulchrum - quagmire sedge variant**: This variant corresponds to open moss lawns or pools dominated by *Sphagnum pulchrum* and sparse cover of vascular plants. It occurs as small pools with loose *Sphagnum*, or occasionally as extensive carpets or lawns associated with large lake border peatlands (e.g., peatlands around Lake Umbagog). These moss lawns or pools have an oligotrophic to weakly minerotrophic nutrient status (average pH is 4.0); more minerotrophic examples along lake borders contain species such as *Myrica gale* (sweet gale), *Sphagnum affine*, and *S. papillosum. Vaccinium oxycoccos* (small cranberry), *Carex limosa* (quagmire sedge), *Andromeda glaucophylla* (bog rosemary), and *Scheuchzeria palustris* (pod-grass) are occasional. *Sphagnum torreyanum* and *S. angustifolium* are present in some examples. Trees and tall shrubs are always absent. Heath shrubs are typically dwarfed (average height 0.30 m). Hummocks are poorly developed and peat is poorly decomposed. Overall, the floristic composition is indicative of slightly more oligotrophic conditions than in the two other variants.



Classification confidence: 1

Distribution: This community is widespread in New Hampshire. Good examples occur along Lake Umbagog (Errol), Cedar Swamp Pond (Kingston), and Little Church Pond (Livermore/Albany).

Sources: Sperduto et al. 2000a.

• Water willow - Sphagnum lagg (S3)

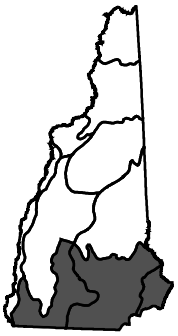
General description: This community occurs in wet minerotrophic settings along pond borders, laggs, and other upland border situations. Average pH is 4.4 and hummocks are usually moderately well developed (average height 0.25 m). Peat is relatively well decomposed near the surface. Average medium shrub height is 0.95 m. *Sphagnum recurvum* and *Decodon verticillatus* (water willow) have southern or coastal affinities.

Characteristic vegetation: Dominated by minerotrophic *Sphagnum* species including *S. recurvum*, *S. flexuosum*, *S. fimbriatum*, and occasionally *S. papillosum*. *Decodon verticillatus* (water willow) is usually but not always present, and it can occur in other communities. Other frequent species include *Carex canescens* (silvery sedge), *Chamaedaphne calyculata* (leather-leaf), *Myrica gale* (sweet gale), *Lysimachia terrestris* (swamp candles), and *Triadenum virginicum* (marsh St. John's-wort). *Vaccinium corymbosum* (highbush blueberry) is infrequent and in low abundance.

CLASSIFICATION CONFIDENCE: 2-3

DISTRIBUTION: This community occurs in southern and central New Hampshire. Good examples can be found at Lynxfield Pond (Chichester), Cedar Swamp Pond (Kingston), Hubbard Pond (Rindge), and Binney Pond (New Ipswich).

SOURCES: Sperduto et al. 2000a.



• Circumneutral - calcareous flark (S1)

GENERAL DESCRIPTION: Of the two occurrences of patterned fens in New Hampshire, one site supports an acidic fen and the other has circumneutral-calcareous conditions. Slow groundwater movement through the gently sloping wetland causes the patterned or "ribbed" fen topography. Circumneutral - calcareous flarks and flark borders at the single, northern New Hampshire site are characterized by saturated to flooded hollows (flarks) lying approximately parallel to low peat ridges (strings or ribs) in the patterned fen.

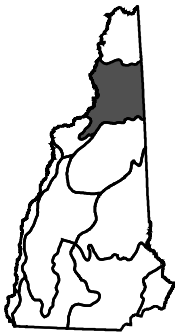
The flarks range from a few meters to more than 25 m wide with pH ranging from 6.3 – 8.4 (-9.0). The sparse shrub cover (<1%) averages less than 20 cm in height. Peat is more than 4.8 m deep and is poorly decomposed in the upper meter.

CHARACTERISTIC VEGETATION: Vegetation is characterized by an abundant brown algal mat, low vascular plant cover (ca. 12%), and sparse cover of *Sphagnum contortum* (ca. 5%). Herbaceous plants include *Carex exilis* (coastal sedge)*, *Menyanthes trifoliata* (buckbean), *Scirpus hudsonianus* (northern cotton club rush), *Utricularia minor* (small bladderwort), *Sarracenia purpurea* (pitcher-plant), *Rhynchospora alba* (white beak-rush), *Drosera intermedia* (spatulate-leaved sundew), *Eriophorum viridicarinatum* (green keeled cotton-grass), *Andromeda glaucophylla* (bog rosemary), *Solidago cf. purshii* (Pursh's goldenrod)*, *Carex livida* (livid sedge)*, *Juncus stygius* (styx rush)*, *Carex tenuiflora* (thin-flowered sedge)*, and *Muhlenbergia glomerata* (clustered marsh muhly).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: In New Hampshire, patterned fens are known to occur at only two sites (one in South Bay Bog and one in the Umbagog Lake vicinity) and are otherwise restricted in New England to the more boreal climate of northern Maine.

SOURCES: Sperduto et al. 2000a.



DWARF- AND MEDIUM-SHRUB BOGS AND POOR FENS

The following communities are oligotrophic to minerotrophic and are dominated by moderately dense to dense, dwarf or occasionally medium-height shrubs. If present, tall shrubs have very low cover. Average percent cover for dwarf and medium shrubs for all communities ranges from ca. 30% to 45%, in contrast to open moss lawn or mud-bottom communities, in which shrub cover averages less than 15%. Average shrub heights range from 0.16 m to 0.52 m. Trees may be present, but generally are in low abundance compared to communities that have greater cover by tall shrubs. Hummocks are better developed in these communities than in mud-bottom and moss lawn communities, and average hummock heights are greater than 0.15 m. Peat is poorly to moderately well decomposed in the upper meter, and average pH ranges from 3.8 to 4.1. These

communities are divided into two distinct groups based on their occurrence in alpine/subalpine (above ca. 2900 ft.) or mid-low elevation settings (below ca. 2900 ft.). Most mid-low elevation communities are oligotrophic. One minerotrophic community type is described from a single site.

• Leather-leaf - sheep laurel dwarf shrub bog (S1S3)

General description: This community is characterized by oligotrophic to weakly minerotrophic bogs and poor fens dominated by a low diversity but dense cover of dwarf- to medium-height heath shrubs, and an absence or very low abundance of tall shrubs and trees. Hummock and hollow topography is well developed with average and average-maximum hummock heights of 0.24 m and 0.40 m, respectively. Average pH is 3.8. Shrubs average 0.52 m in height and form a relatively dense cover (35-50%) compared to other peatland communities.

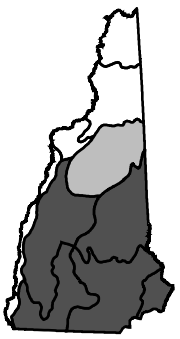
Characteristic vegetation: *Chamaedaphne calyculata* (leather-leaf) is the dominant shrub, with lesser quantities of *Kalmia angustifolia* (sheep laurel) and sometimes *Rhododendron canadense* (rhodora). *Sphagnum capillifolium* is diagnostic and typically occupies hummocks. Other abundant Sphagna include *Sphagnum magellanicum* and *S. rubellum*, while *S. angustifolium* is occasional. *Polytrichum strictum* is common on hummocks and *Carex trisperma* var. *billingsii* (Billing's sedge) is occasional. This community has a higher constancy of *S. capillifolium* and apparent lower frequency of *Picea mariana* (black spruce) than the leather-leaf - black spruce bog. Scattered individuals of black spruce may occur, however, across the larger matrix of vegetation at some sites.

Variants: Two variants are described:

1. **Dwarf-medium shrub variant (S3)**: *Kalmia angustifolia* (sheep laurel), *Sphagnum magellanicum*, and *S. capillifolium* are more prominent than in the other variant. Shrub height averages 0.60 m, but occasionally ranges to nearly 1 m in a few samples. Average pH is 3.8.
2. **Dwarf shrub variant (S1)**: This variant is floristically similar to the first variant but has a very short dwarf heath layer (shrub heights range from 0.30-0.35 m) and very oligotrophic to possibly ombrogenous conditions. This variant has very low vascular species richness compared to most other peatland communities and occupies hydrologically isolated portions of oligotrophic basin peatlands. In this variant pH is superacid, with an average of 3.5 (range 3.3-3.7). These are the lowest pHs recorded among lowland peatlands in the state (below 1000 ft.), and they are comparable to or more acidic than those of many alpine bogs.

Classification confidence: 1

Distribution: This community is documented from central and southern New Hampshire, but it is probably widespread in the state. Good examples occur in the large peatlands east of the Pine River (Ossipee) and Bradford Bog (Bradford). The dwarf heath shrub bog variant is rare and only occurs at a few sites in the state, including Rochester Heath Bog (Rochester).



Sources: Sperduto et al. 2000a.

• Leather-leaf - black spruce bog (S3)

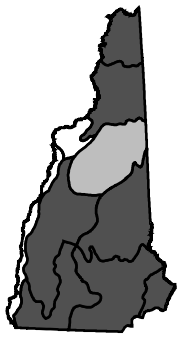
General description: This community corresponds to oligotrophic dwarf heath bogs or very poor fens with essentially no tall shrubs and a sparse, stunted tree canopy of *Picea mariana* (black spruce) and/or *Larix laricina* (eastern larch) (generally 1-10% cover and less than 1-6 m in height). It is structurally similar to "muskegs" in the boreal forest region.

Shrub height averages ca. 0.48 m, pH averages 3.8, and peat is poorly decomposed in the upper 0.5 m. Hummocks are moderately to very well developed. Canopy trees (above the tall shrub layer) average ca. 6 m in height.

CHARACTERISTIC VEGETATION: Some combination of *Sphagnum angustifolium*, *S. rubellum*, and/or *S. magellanicum* dominates the moss layer. *Sphagnum capillifolium* is occasional but not as frequent as in *Chamaedaphne calyculata - Kalmia angustifolia*/*Sphagnum capillifolium* dwarf heath shrub bogs. *Eriophorum vaginatum* (hare's-tail), *E. virginicum* (tawny cotton-grass), *Smilacina trifolia* (three-leaved false Solomon's seal), and *Carex trisperma* var. *billingsii* (Billing's sedge) are frequent. *Chamaedaphne calyculata* (leather-leaf), *Kalmia angustifolia* (sheep laurel), *Vaccinium oxycoccos* (small cranberry), and *Kalmia polifolia* (bog laurel) are characteristic of the dwarf heath layer.

VARIANTS: Two reasonably distinct variants are described:

1. ***Sphagnum rubellum - S. angustifolium* dwarf heath variant**: This variant is most common in central and southern New Hampshire and is distinguished from the next variant by a generally stronger dominance of *Sphagnum rubellum* and *S. angustifolium*, the lack of *Ledum groenlandicum* (Labrador-tea) and *Sphagnum fuscum*, a less developed hummock-hollow topography, and a lower abundance of trees. Average pH is 3.7, heath shrubs are less than 0.5 m in height, and peat is poorly decomposed in the upper 0.75 m. Hummocks average about 0.16 m, with a maximum height of less than 0.30 m.
2. **Labrador tea - *Sphagnum fuscum* dwarf heath variant**: This variant is most common in northern New Hampshire and is distinguished by the presence of *Ledum groenlandicum* (Labrador-tea) and *Sphagnum fuscum*; a better developed hummock-hollow topography; and a higher abundance and structural complexity of the tree layer. *Carex pauciflora* (few-flowered sedge) is occasional. Hummock height averages 0.25 m, with maximum heights averaging 0.4 m. The average pH is 3.95.



CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community occurs throughout the state. Good examples occur NW of Umbagog Lake (Errol), in South Bay Bog (Clarksville), near Duncan Lake (Ossipee), at Trask Swamp (Alton), at Hubbard Pond (Rindge), and at Loverens Mill (Antrim).

SOURCES: Sperduto et al. 2000a.

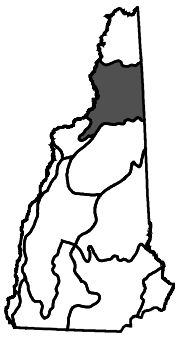
• Northern white cedar circumneutral string (S1)

GENERAL DESCRIPTION: Circumneutral strings or "ribs" at the single, northern New Hampshire patterned calcareous fen site are characterized by saturated, low peat ridges lying approximately parallel to saturated or flooded circumneutral/calcareous flarks. Slow groundwater movement through the gently sloping wetland causes the patterned or "ribbed" fen micro-topography.

The strings average 0.30 m in height and range from a few meters to more than 10 m wide. The pH ranges from 6.3-6.7. Peat extends to more than 4.8 m in depth and is poorly to moderately decomposed in the upper meter.

CHARACTERISTIC VEGETATION: The strings are dominated by stunted (and heavily browsed) *Thuja occidentalis* (northern white cedar), averaging 1 m tall (ranging from <1-7 m tall). The most common medium to short shrub associates include *Chamaedaphne calyculata* (leather-leaf), *Ledum groenlandicum* (Labrador-tea), *Andromeda glaucophylla* (bog rosemary), and *Salix pedicellaris* (bog willow). Scattered *Thuja occidentalis*, *Picea mariana* (black spruce), *Larix laricina* (eastern larch), and *Acer rubrum* (red maple) reach heights of 5-7 m in the tall shrub layer. *Carex exilis* (coastal sedge)* and less frequently *Drosera rotundifolia* (round-

leaved sundew), *Osmunda regalis* (royal fern), *Sarracenia purpurea* (pitcher-plant), *Aster radula* (rough-leaved aster), *Solidago cf. purshii* (Pursh's goldenrod)*, *Menyanthes trifoliata* (buckbean), *Muhlenbergia glomerata* (clustered marsh muhly), *Carex trisperma* var. *billingsii* (Billing's sedge), *Scirpus hudsonianus* (northern cotton club rush), and few others characterize the poorly developed herb layer. Mosses include *Sphagnum angustifolium*, *S. warnstorfii*, *S. magellanicum, S. rubellum*, *S. fuscum*, *Tomenthypnum nitens*, *Hylocomium splendens*, *Pleurozium schreberi*, *Aulocomnium palustre*, and *Dicranum undulatum.*



CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: In New Hampshire, patterned fens are known to occur at only two sites (one in South Bay Bog and one in the Umbagog Lake vicinity) and are otherwise restricted in New England to the more boreal climate of northern Maine.

SOURCES: Sperduto et al. 2000a.

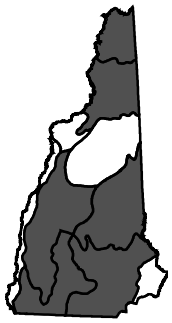
SEDGE AND SHRUB/GRAMINOID FENS

The following communities are a conglomeration of types that includes three weakly minerotrophic to minerotrophic fens dominated by a mix of graminoids and dwarf to medium height shrubs, a unique grass-dominated fen from montane areas, a minerotrophic shrub fen dominated by robust graminoids and tall shrubs, and strongly minerotrophic calcareous fens dominated by short sedges. They are relatively wet, trees are generally sparse, and peat decomposition is variable.

• Bog rosemary - sweet gale - sedge fen (S3)

GENERAL DESCRIPTION: This is a weakly minerotrophic fen community dominated by a mixture of dwarf shrubs, *Carex* species, and several peat mosses. Trees and tall shrubs are sparse or absent. Shrub stature is dwarfed with an average height of 0.49 m. Average pH is 4.12. Hummocks are weakly developed (average height 0.16 m and usually <0.20 m) and peat is poorly decomposed in the upper 0.5 m.

CHARACTERISTIC VEGETATION: *Chamaedaphne calyculata* (leather-leaf) is usually a dominant, and *Carex utriculata* and/or *C. oligosperma* (few seeded sedge) are frequently present. These fens differ from other fens that contain *Myrica gale* (sweet gale) and *Carex utriculata* (bottle-shaped sedge) in the abundance of *Sphagnum fallax*, *S. angustifolium*, and *S. magellanicum*, and some combination of *Andromeda glaucophylla* (bog rosemary), *Kalmia polifolia* (bog laurel), *Vaccinium oxycoccos* (small cranberry), and *Smilacina trifolia* (three-leaved false Solomon's seal).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community occurs primarily in central and southern New Hampshire. A good example is found between Ossipee Lake and Rte. 25 (Ossipee). Other examples occur at the delta of the Bearcamp River (Ossipee) and in the Broad/Leavitt bay kettles (Ossipee).

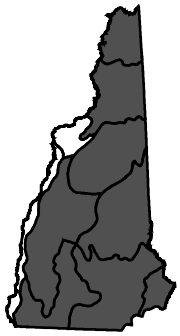
SOURCES: Sperduto et al. 2000a.

• Sweet gale - meadowsweet - tussock sedge fen (S4)

GENERAL DESCRIPTION: This community is typically limnogenous and occurs along stream or pond borders and other moderately minerotrophic settings at low-mid elevations throughout the state. Average pH is 4.5. Peat is

moderately well decomposed near the surface and hummocks are well developed (average height 0.25 m; average maximum height 0.43 m).

CHARACTERISTIC VEGETATION: *Myrica gale* (sweet gale), *Spiraea alba* (eastern meadowsweet), and *Carex stricta* (tussock sedge) are diagnostic and usually present in some combination, and tall shrubs are sparse (<5%) or absent. *Myrica gale* and *Chamaedaphne calyculata* (leather-leaf) are robust (average height 0.90 m), nearly constant, and abundant. The herb layer is moderately well developed and typically contributes 5-25% cover (average is 18%). Several herbaceous species are present in low abundance, including *Calamagrostis canadensis* (blue-joint), *Carex lasiocarpa* (hairy-fruited sedge), *C. utriculata* (bottle-shaped sedge), *Typha latifolia* (common cattail), *Lysimachia terrestris* (swamp candles), *Triadenum virginicum* (marsh St. John's-wort), and *Carex canescens* (silvery sedge). *Sphagnum fimbriatum* and *S. henryense* are frequent, and *S. cuspidatum* is occasional.



CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Occurs at low-mid elevations throughout the state. Good examples can be found at Betty Meadows (Northwood), NW of Lake Umbagog (Errol), Little and Big Church Ponds (Livermore/Albany), Bradford Bog (Bradford), and Berry Pond (Moultonborough/Sandwich).

SOURCES: Sperduto et al. 2000a.

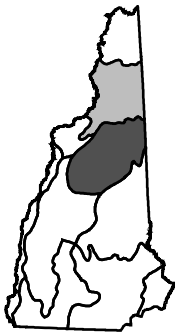
• Montane sloping fen (S1)

GENERAL DESCRIPTION: This community 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 2400 ft.). Slopes are frequently up to 10 degrees, with a maximum of about 20 degrees. This community is dominated by graminoids or graminoids and shrubs, and is the only known fen dominated by a grass in the state or region. It is characterized by a prominence of *Calamagrostis pickeringii* (Pickering's reed bent-grass)* and frequent *Carex wiegandii* (Wiegand's sedge)*, numerous other northern fen plants, and the absence of southern or lowland fen plants such as *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (winterberry), and *Gaylussacia baccata* (black huckleberry). This community occurs in mosaics with montane alder - heath shrub thickets and montane heath woodlands.

Soils are characterized by shallow organics over hydric, cryic, silty gravels. pH ranges from 4.2 to 6.2, and average 5.3. Hummock and hollow topography is moderately to poorly developed. Climate, hydrologic conditions, and soil features are probably the primary factors contributing to the development of this unique soligenous peatland community.

CHARACTERISTIC VEGETATION: Pickering's reed-bent grass is one of the dominant herbs, typically contributing 5% cover or more (up to 25%). A Sphagnum layer is ubiquitous under a dense herb layer (20-60+% cover) and moderate dwarf shrub layer (<5-20% cover). The herbaceous layer is characterized by a mix of fen plants and those typical of more minerotrophic marsh or swamp habitats. Herbs include *Carex echinata* (prickly sedge), *C. pauciflora* (few-flowered sedge), *C. michauxiana* (Michaux's sedge), *C. wiegandii* (Wiegand's sedge)*, *C. oligosperma* (few seeded sedge), *C. brunnescens* (brownish sedge), *Solidago purshii* (Pursh's goldenrod)*, *Veratrum viride* (false hellebore), *Thalictrum pubescens* (tall meadow-rue), *Sarracenia purpurea* (pitcher-plant), *Platanthera dilatata* (tall white bog orchid), *P. clavellata* (small green woodland orchid), *Houstonia caerulea* (bluets), *Drosera rotundifolia* (round-leaved sundew), *Smilacina trifolia* (three-leaved false Solomon's seal), *Aster radula* (rough-leaved aster), and *Eriophorum virginicum* (tawny cotton-grass). Common shrubs include *Chamaedaphne calyculata* (leather-leaf), *Kalmia polifolia* (bog laurel), *Ledum groenlandicum* (Labrador-tea), *Vaccinium oxycoccos* (small cranberry), *Rhododendron canadense* (rhodora), *Nemopanthus mucronatus* (mountain holly), *Viburnum nudum* (witherod), *Vaccinium myrtilloides* (velvet-leaf blueberry),

Aronia melanocarpa (black chokeberry), *Coptis trifolia* (goldthread), and *Cornus canadensis* (bunchberry). *Sphagnum* mosses are abundant, and include *S. subtile, S. angustifolium*, and *S. girgensohnii* (detailed surveys not undertaken). Other occasional species include *Carex trisperma* var. *trisperma* (three-seeded sedge), *Dalibarda repens* (false violet), *Juncus brevicaudatus* (short-tailed rush), *Alnus incana* (speckled alder), *Kalmia angustifolia* (sheep laurel), and *Amelanchier bartramiana* (Bartram's serviceberry). Scattered trees include *Larix laricina* (eastern larch), *Picea mariana* (black spruce), and *P. rubens* (red spruce). One fen was co-dominated by *Carex exilis* (coastal sedge)*, a rare plant in NH and otherwise not known from the White Mountains.



CLASSIFICATION CONFIDENCE: 1-2

DISTRIBUTION: Restricted to a few scattered localities in the White Mountains above 2400 ft. elevation. Good examples include the extensive fens of the upper East Branch of the Pemigewasset River watershed near Shoal and Ethan Ponds (Lincoln), Whitewall Mtn. (Bethlehem), and North Bald Cap Mtn. in the Mahoosuc Range (Success).

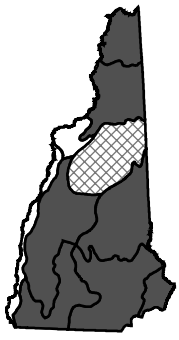
SOURCES: NHB field surveys; Sperduto et al. 2000a; Sperduto and Neid 2003.

• Hairy-fruited sedge - sweet gale fen (S3)

GENERAL DESCRIPTION: This is a widespread, intermediate (minerotrophic) fen community often associated with lake and pond margins. It is also occasional along upland borders of some kettle holes or along floating mats of lake-fill peatlands.

Average pH is 4.9. Hummocks are low to moderately sized (average height 0.19 m), and peat is moderately to well decomposed within the upper 0.5 m. Many examples along lakes consist of moderately shallow peat layers underlain by lake silts.

CHARACTERISTIC VEGETATION: *Carex lasiocarpa* (hairy-fruited sedge) and *Myrica gale* (sweet gale) are usually present. *Carex utriculata* (bottle-shaped sedge) is frequent and *C. oligosperma* (few seeded sedge) is occasional. At least one of these three sedge species is always present. Forbs indicative of intermediate nutrient status are usually present in low abundance, including *Lysimachia terrestris* (swamp candles), *Triadenum virginicum* (marsh St. John's-wort), and *Sagittaria latifolia* (common arrowhead). *Vaccinium macrocarpon* (large cranberry) can be common but is not always present. *Spiraea alba* (eastern meadowsweet), *Calamagrostis canadensis* (blue-joint), and *Typha latifolia* (common cattail) are occasional, particularly when *Vaccinium macrocarpon* (large cranberry) is absent. *Peltandra virginica* (arrow-arum) is occasional. *Sphagnum* may be absent but usually forms a sparse to moderate cover that may include *S. lescurii* (frequent) and *S. torreyanum* (occasional). *Sphagnum cuspidatum*, *S. fimbriatum*, and *S. affine* are uncommon. *Chamaedaphne calyculata* (leatherleaf) is occasional, but medium and tall shrubs and trees are sparse or absent.



CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is widespread in NH and often associated with lake and pond margins. Good examples can be found south of Ossipee Lake, north of Rte. 25 (Ossipee), the Bearcamp River delta (Ossipee), Berry Pond (Moultonborough/Sandwich), along the Powwow River (Kingston), and World End Pond (Salem).

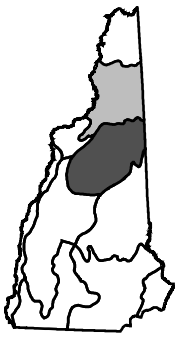
SOURCES: Sperduto et al. 2000a.

• Speckled alder - lake sedge intermediate fen (S2S3)

General description: This is a minerotrophic fen community dominated by medium and tall shrubs and robust herbaceous species. The prominence of shrubs, deeper organic soil, and greater abundance of peat moss differentiates this community from herbaceous fern seepage marshes; the abundance of herbs (25-90% cover) differentiates it from other fen communities; and the absence or low cover of trees in the overstory (<25%) differentiates it structurally from seepage swamps.

This community presumably occurs where there is some seepage influence. In three examples, peat soils were one meter thick over sand or loam materials. Poorly decomposed surface peat transitioned to well decomposed peat within 20-30 cm of the surface. Hummock and hollow topography is well developed. pH ranges from 4.4 to 5.7.

Characteristic vegetation: The tall shrub layer varies from 5-40% cover, with *Alnus incana* (speckled alder) usually being the most abundant tall shrub. Others include *Ilex verticillata* (winterberry), *Lyonia ligustrina* (male-berry), *Viburnum nudum* (witherod), and *Vaccinium corymbosum* (highbush blueberry). Medium shrubs are usually abundant (5-50% cover). Frequent species include *Chamaedaphne calyculata* (leather-leaf), *Myrica gale* (sweet gale), *Rhododendron canadense* (rhodora), *Spiraea alba* (eastern meadowsweet), *Kalmia angustifolia* (sheep laurel), *K. polifolia* (bog laurel), and *Andromeda glaucophylla* (bog rosemary). The rare *Betula pumila* (swamp birch)* occurs in one example in the state. Trees may include *Larix laricina* (eastern larch), *Picea mariana* (black spruce), *Acer rubrum* (red maple), and *Betula populifolia* (gray birch). Robust herbs are abundant (25-90%). Frequent and abundant species include *Carex lacustris* (lake sedge), *Symplocarpus foetidus* (skunk cabbage), *Osmunda regalis* (royal fern), and *O. cinnamomea* (cinnamon fern). Less frequent or abundant herbs include *Carex utriculata* (bottle-shaped sedge), *C. oligosperma* (few seeded sedge), *Calla palustris* (wild calla), *Lysimachia terrestris* (swamp candles), *Triadenum virginicum* (marsh St. John's-wort), *Calamagrostis canadensis* (blue-joint), and *Smilacina trifolia* (three-leaved false Solomon's seal). Peat mosses are abundant (20-80% cover) and include *Sphagnum fallax*, *S. magellanicum*, *S. angustifolium*, and *S. flexuosum*.



Classification confidence: 2-3

Distribution: This community may occur throughout the state, but is presently documented from central and northern New Hampshire. A good example can be found south of Ossipee Lake, north of Rte. 25 (Ossipee).

Sources: Sperduto et al. 2000a.

• Calcareous sedge - moss fen (S2)

General description: Calcareous sedge - moss fens occur in northern New Hampshire in a variety of groundwater influenced hydrological settings (disturbed and natural) where seepage often has a year-round influence and contributes a relatively high proportion of the water budget. These settings include (1) headwater positions, (2) marginal areas of lakes and stream drainages through marshes or swamps, (3) beaver meadows, (4) gaps in calcareous seepage swamps (e.g., cedar swamps), (5) other small basins, kettles, or catchments with seepage influence, (6) steep terraces of major rivers or minor stream drainages where seepage emerges and more moderately sloping side slopes of hills, and (7) grazed pastures. All of these settings have some or a considerable level of seepage influence and a tendency to stay open to one degree or another, depending on other factors. In addition, disturbance intensity varies and may be either natural or artificial in character. Examples affected by pasturing have a greater prominence of non-native pasture grasses and forbs, and of native ruderals.

Soils typically have shallow to moderate organic horizon depths (0.2-1.2+ m) of poorly to well decomposed peat (depending on depth). Muck or peaty muck layers are found at some sites, particularly in active pasture

fens where there has presumably been more mixing of shallow peat with underlying mineral horizons due to bovine traffic. Underlying till, or less often outwash soils, invariably have a significant gravelly or stony silt or silty muck soil that impedes downward movement of water.

Calcareous fens appear to have a strong correlation with bedrock and till source material containing a significant amount of calcium and other base-cations. Bedrock types in New Hampshire with these qualities include the Frontenac (Waits River), Fitch, and Ammonoosuc Volcanic Formations, and to a lesser extent syenites, diorites, Gile Mountain Formation, and others.

Average pH is 7.2 and ranges from 6.7 to 8.2, with one aberrant pH of 6.2. Conductivity ranges from 90-380 uS.

CHARACTERISTIC VEGETATION: Characteristic vegetation includes *Carex interior* (inland sedge), *C. flava* (yellow sedge), *C. hystericina* (porcupine sedge), *Drosera rotundifolia* (round-leaved sundew), *Eleocharis tenuis* (slender spike rush), *Equisetum fluviatile* (water horsetail), *Eriophorum virginicum* (tawny cotton-grass), *Geum rivale* (purple avens), *Platanthera hyperborea* (northern green orchis), *P. psycodes* (small purple-fringed orchid), *P. dilatata* (tall white bog orchid), *Scirpus hudsonianus* (northern cotton club rush), *S. microcarpus* (red bulrush), *Senecio robbinsii* (Robbins' ragwort), *Thuja occidentalis* (northern white cedar), and *Typha latifolia* (common cattail). Other species frequent in calcareous fens that may also occur in other habitats include *Equisetum arvense* (field horsetail), *Eupatorium maculatum* (spotted Joe-pye-weed), *Fragaria virginiana* (wild strawberry), *Glyceria striata* (manna-grass), *Hydrocotyle americana* (water pennywort), *Juncus tenuis* (= *dudleyi*) (path rush), *J. nodosus* (knotty rush), *Salix lucida* (shinning willow), *S. discolor* (large pussy willow), *S. bebbiana* (long-beaked willow), and *Thelypteris palustris* (marsh fern).

Rare plants occurring in calcareous fens include *Spiranthes romanzoffiana* (hooded lady's-tresses)*, *Equisetum variegatum* (variegated horsetail)*, *Cypripedium reginae* (showy lady's-slipper)*, *Lobelia kalmii* (Kalm's lobelia)*, *Petasites frigidus* var. *palmatus* (sweet coltsfoot)*, *Carex bebbii* (Bebb's sedge)*, *C. castanea* (chestnut sedge)*, *Equisetum palustre* (marsh horsetail)*, *E. pratense* (meadow horsetail)*, *Carex aurea* (golden-fruited sedge)*, and *Eleocharis pauciflora* (few-flowered spikerush)*.

Bryophytes often found in calcareous fens include *Aulocomnium palustre*, *Sphagnum warnstorfii*, *Tomenthypnum nitens*, *Mnium affine* var. *rugicum*, *M. cuspidatum, Bryum pseudo-triquetrum*, *Campylium stellatum*, *Climaceum dendroides*, *Fissidens adianthoides*, *Helodium blandowii*, *Hypnum pratense*, *Lophoclea* sp., *Philonotis fontana*, and *Pellia epiphylla*.

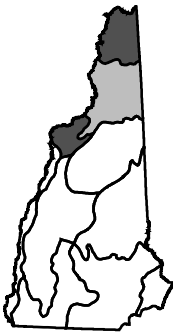
VARIANTS: Four variants are recognized.

1. **Typic sloping variant**: This variant occurs on shallow peat (less than 0.5 m) and occurs in slightly sloping headwater positions of drainages and former pastures.
2. **Level/shallow sloping deep peat variant**: This variant has deeper peats (0.5-1+ m) and is often found in more level positions or natural basins and drainage margins where basin morphology and hydrology has led to significant peat accumulations. It often occurs as temporary to semi-permanent natural openings in *Thuja occidentalis* (northern white cedar) swamps.
3. **Steep slope horsetail variant**: This variant occurs on seepy, steep river terraces or headwater drainage positions with shallow peat and a strong prominence of *Equisetum* species (horsetails).
4. **Beaver meadow variant**: This variant occurs in marsh drainages behind old beaver impoundments in calcareous regions. Few examples are known, but clearly these wetlands have a different long- and short-term disturbance regime. Orchids appear to be sparse, and certain graminoids may be more prominent in these situations than in the above variants (e.g., *Carex utriculata* (bottle-shaped sedge), *C. bebbii* (Bebb's sedge)*, *Calamagrostis canadensis* (blue-joint), and the rare *Eleocharis pauciflora* (few-flowered spikerush)*), but calciphiles are present, distinguishing this variant from typical beaver meadows. Presumably, a beaver meadow variant is also a temporary phase in a natural successional cycle, either toward woody plants (with drainage or sedimentation of the meadow) or toward aquatic vegetation (when flooded).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is restricted to the Vermont Piedmont, Mahoosuc Rangeley, and Connecticut Lakes subsections of northern New Hampshire. Good examples are associated with the Frontenac Formation in the Stewartstown area; all are on private property.

SOURCES: Sperduto and Gilman 1995; Sperduto et al. 2000a.



TALL – MEDIUM SHRUB THICKET/SPARSE WOODLANDS

Tall – medium shrub thicket peatlands usually occur as part of a mosaic with other peatland communities, but they can be the primary community in some peatland basins. Compared to peatlands dominated by shorter vascular plants, the presence of tall shrubs is usually associated with some combination of greater minerotrophic status, drier hydroperiod, or a seasonally variable water table resulting from topographic runoff. Hummocks are usually well developed. The medium-height shrub layer is usually well developed (greater than 0.5 m tall), and in some examples, it may be more abundant than the tall shrub layer.

• Highbush blueberry - mountain holly wooded fen (S3S4)

GENERAL DESCRIPTION: This is an oligotrophic to weakly minerotrophic community. It occurs most commonly as a border thicket around more open dwarf heath peatlands, including kettle hole bogs or additionally over large areas of perched basins. A mixture of northern and more southern or coastal species is characteristic.

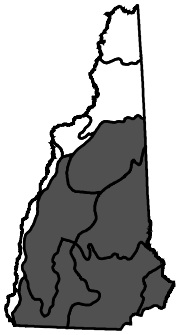
Average pH is 3.9. The medium shrub layer averages ca. 0.85 m in height and is therefore taller than that of dwarf heath communities. Peat is moderately well decomposed within the upper 0.5 m, and hummock-hollow topography is moderately well developed (average hummock height 0.26 m).

CHARACTERISTIC VEGETATION: Characterized by a mixture of tall and medium height heath shrubs, and usually a sparse canopy of *Picea mariana* (black spruce), *Larix laricina* (eastern larch), and sometimes *Pinus strobus* (white pine) or *Pinus rigida* (pitch pine). Tall shrubs average ca. 15% cover (range is 1-30%) and usually include *Vaccinium corymbosum* (highbush blueberry), *Nemopanthus mucronatus* (mountain holly), *Lyonia ligustrina* (male-berry), and *Aronia melanocarpa* (black chokeberry). *Ilex verticillata* (winterberry) and forbs indicative of more minerotrophic conditions are generally not present. Dwarf and medium-height shrubs are on average more abundant (34% cover) than tall shrubs and include *Chamaedaphne calyculata* (leather-leaf), *Kalmia angustifolia* (sheep laurel), *Gaylussacia baccata* (black huckleberry), and occasionally *K. polifolia* (bog laurel). *Woodwardia virginica* (Virginia chain-fern) and *Carex trisperma* var. *billingsii* (Billing's sedge) are occasional. *Sphagnum magellanicum* is dominant, while *S. rubellum* is characteristic but less frequent and abundant than in *Sphagnum rubellum* - small cranberry dwarf heath moss carpets that lack tall shrubs. *Sphagnum bartlettianum*, a species with coastal and southern distributional tendencies, is infrequent.

VARIANTS: Two variants are apparent:

1. **Rhodora - mountain holly - *Sphagnum russowii* variant**: This variant is characterized by a much higher frequency and abundance of *Rhododendron canadense* (rhodora) and *Sphagnum russowii* with little or no *Vaccinium corymbosum* (highbush blueberry). The most frequent tall shrub species are *Nemopanthus mucronatus* (mountain holly) and *Viburnum nudum* (witherod). Peat is moderately well decomposed within 0.25 m of the surface. Other hummock *Sphagnum* mosses include *S. capillifolium* and *S. fuscum*. *Sphagnum russowii* is occasional but more frequent than in the next variant, and *S. angustifolium* is occasional to sometimes abundant.

2. **Highbush blueberry - huckleberry - large cranberry variant**: This variant has a higher frequency and abundance of *Vaccinium corymbosum* (highbush blueberry) and *Gaylussacia baccata* (black huckleberry), and *Vaccinium macrocarpon* (large cranberry) occurs in low abundance. *Rhododendron canadense* (rhodora) and *Nemopanthus mucronatus* (mountain holly) are occasional but not as frequent as in the other variant. There is also a higher frequency of dwarfed black spruce (<1.5 m). Peat is poorly decomposed to a greater depth (0.7 m). Otherwise the two variants are quite similar environmentally and structurally.



CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Generally occurs in southern and central New Hampshire, and rarely farther north at low elevations (below 1300 ft.). Good examples occur south of Ossipee Lake, north of Rte. 25 (Ossipee), east of Pine River (Effingham), NW of Umbagog Lake (Errol), at Spruce Swamp (Fremont), and at Big Church Pond (Albany).

SOURCES: Sperduto et al. 2000a.

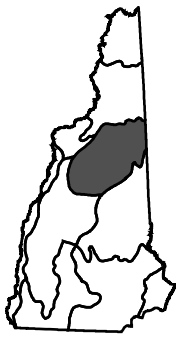
• Montane alder - heath shrub thicket (S1?)

GENERAL DESCRIPTION: This community is dominated by tall shrubs, has a sparse woodland to woodland structure, and is restricted to flat ridges and slopes near the transition to heath - krummholz and certain high elevation valleys in the White Mountains. It may be expected in other parts of northern NH, although the similar speckled alder wooded fen is more common.

Soils are characterized by shallow organics over hydric, cryic, silty gravels. Organic soil depths are generally shallower than those underlying the related montane sloping fen. Near-surface water pH is 5.0. Hummock and hollow topography is moderately developed.

This community differs from more lowland shrub thickets by the absence of more southern or coastal species such as *Vaccinium corymbosum* (highbush blueberry), *Gaylussacia baccata* (black huckleberry), and *Woodwardia virginica* (Virginia chain-fern). It differs from speckled alder wooded fens by having more abundant heaths and other northern shrubs. It has scattered trees and small openings that support herbaceous plants.

CHARACTERISTIC VEGETATION: Characteristic shrubs include *Alnus incana* (speckled alder), *Rhododendron canadense* (rhodora), *Nemopanthus mucronatus* (mountain holly), and *Viburnum nudum* (witherod). Other common plants include *Ledum groenlandicum* (Labrador-tea), *Vaccinium myrtilloides* (velvet-leaf blueberry), *Gaultheria hispidula* (creeping snowberry), *Larix laricina* (eastern larch), and *Picea mariana* (black spruce). Scattered herbaceous vascular plants found in small openings include *Eriophorum virginicum* (tawny cotton-grass), *Drosera rotundifolia* (round-leaved sundew), *Carex trisperma* (three-seeded sedge), *Calamagrostis pickeringii* (Pickering's reed bent-grass)*, *Thalictrum pubescens* (tall meadow-rue), *Aster umbellatus* (tall flat-topped white aster), *Chelone glabra* (white turtlehead), *Carex intumescens* (inflated sedge), and *Glyceria melicaria* (northeastern manna-grass). *Sphagnum* mosses are abundant.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Restricted to the upper East Branch of the Pemigewasset River watershed near Shoal and Ethan Pond in the White Mountains at elevations above 2400 ft. and, at a few sites, near the transition to heath - krummholz.

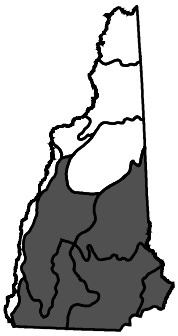
SOURCES: NHB field surveys; Sperduto et al. 2000a.

• Winterberry - cinnamon fern wooded fen (S4)

General description: This community commonly occurs in the lagg zone or as a broad to narrow zone around the border of small peatlands, along sluggish stream borders, and occasionally can dominate large areas of big peatland basins. It is essentially restricted to lowland areas south of the White Mountains. It is a weakly to moderately minerotrophic tall shrub thicket community with a sparse, low-tree canopy of *Acer rubrum* (red maple) and sometimes *Picea mariana* (black spruce), and variable mixtures of medium shrubs and herbaceous species. *Ilex verticillata* (winterberry) and *Osmunda cinnamomea* (cinnamon fern) are abundant. The tree layer is sparse (ca. 1-20% cover), and the tall shrub layer is moderate to dense (ca. 5-40% cover, but usually around 30-40% cover including tree species in the shrub layer). The medium shrub layer is sparse to moderately well developed (1-25% cover, average height 0.85 m).

Average pH is 4.4. Peat is well decomposed near the surface, and hummock-hollow topography is well developed (average hummock height is 0.22 m; average maximum height is 0.44 m). Medium shrub height averages 0.84 m. Peat depths are often less than 1 m.

Characteristic vegetation: Characteristic tall shrubs include *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (winterberry), *Lyonia ligustrina* (male-berry), *Nemopanthus mucronatus* (mountain holly), *Alnus incana* (speckled alder), and *Aronia melanocarpa* (black chokeberry). *Decodon verticillatus* (water willow) is occasionally abundant, and *Chamaedaphne calyculata* (leather-leaf), *Kalmia angustifolia* (sheep laurel), *Gaylussacia baccata* (black huckleberry) are common. *Acer rubrum* (red maple) is always present in low abundance in the sparse, low-tree canopy or tall shrub layer. Herbaceous species indicative of at least weakly minerotrophic conditions are in low abundance but are diagnostic. These include *Osmunda cinnamomea* (cinnamon fern), *Carex canescens* (silvery sedge), *Lysimachia terrestris* (swamp candles), *Triadenum virginicum* (marsh St. John's-wort), *Lycopus uniflorus* (common water horehound), and *Carex stricta* (tussock sedge; occasionally abundant). *Calla palustris* (wild calla), *Iris versicolor* (northern blue flag), and *Typha latifolia* (common cattail) are occasional in wet hollows. A few examples are dominated by herbs such as *Carex canescens* (silvery sedge) and have little shrub cover. *Sphagnum fallax* (*sensu latu*) is frequent and usually abundant (= *S. fallax* (*sensu stricta*) and *S. isoviitae*). *Sphagnum fimbriatum* and *S. cuspidatum* are frequent, while *S. henryense*, *S. recurvum*, *S. palustre, S. angustifolium,* and *S. affine*, and the moss *Aulocomnium palustre* are occasional. *Aster nemoralis* (bog aster) and *A. x blakei* (Blake's bog aster) are occasional.



Classification confidence: 1

Distribution: This community occurs below 1500 ft. in central and southern New Hampshire, and rarely north of the White Mountains. Numerous good examples occur in the Ossipee area (including east of Pine River) and another good example occurs at Bradford Bog (Bradford).

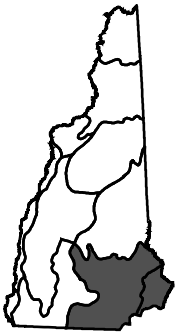
Sources: Sperduto et al. 2000a.

• Sweet pepperbush wooded fen (S2)

General description: This is a weakly to moderately minerotrophic, peatland community dominated by medium height shrubs (to 0.90 m) with a sparse to moderate cover of tall shrubs restricted to coastal New Hampshire. *Clethra alnifolia* (sweet pepperbush) is abundant. It is essentially a coastal version of the winterberry - cinnamon fern wooded fen. It is found as an upland border zone around acidic fens, and sometimes as the dominant fen community in large peatland basins.

Characteristic vegetation: The species composition of this community is similar to winterberry - cinnamon fern wooded fens, but with more coastal species. Sweet pepperbush is one of the dominant shrubs along with *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (winterberry). Other coastal or southern

species include *Woodwardia virginica* (Virginia chain-fern), *Rhododendron viscosum* (swamp azalea)*, *Carex seorsa* (separated sedge)*, *Toxicodendron vernix* (poison sumac), *Gaylussacia frondosa* (dangleberry), *Ilex laevigata* (smooth winterberry), *Decodon verticillatus* (water willow), and *Nyssa sylvatica* (black gum). Sphagnum moss may occur in microtopographic hollows.



CLASSIFICATION CONFIDENCE: 2

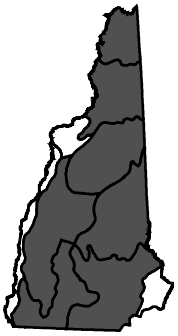
DISTRIBUTION: Restricted to the Coastal Lowland and Coastal Plain subsections. A good example occurs at Spruce Swamp (Fremont).

SOURCES: NHB field surveys.

• Speckled alder wooded fen (S3S4)

GENERAL DESCRIPTION: This "boggy alder swamp" is dominated by *Alnus incana* (speckled alder), various other shrub associates and sometimes scattered conifers. It occurs in open headwater basins, in somewhat seepy subacidic fens, and along small low-energy streams (e.g., first and second order streams), which are lower-energy settings relative to other alder-dominated communities. It has fewer heath shrubs [e.g., *Rhododendron canadense* (rhodora) and *Ledum groenlandicum* (Labrador-tea)] than montane alder - heath shrub thicket communities described from the White Mountains. Shallow to deep muck or peat soils are typical.

CHARACTERISTIC VEGETATION: Characteristic shrubs include dominance by speckled alder and lower abundance of such shrubs as *Cornus sericea* (red osier dogwood), *Nemopanthus mucronatus* (mountain holly), *Lonicera villosa* (mountain fly honeysuckle), *Spiraea alba* (eastern meadowsweet), *S. tomentosa* (steeple-bush), *Viburnum nudum* (witherod), *Ribes triste* (swamp red currant), and *R. glandulosum* (skunk currant). Herbs and dwarf shrubs are common including *Carex trisperma* var. *trisperma* (three-seeded sedge), *Dryopteris cristata* (crested wood fern), *D. carthusiana* (spinulose wood fern), *Smilacina trifolia* (three-leaved false Solomon's seal), *Rubus pubescens* (dwarf raspberry), *Carex canescens* (silvery sedge), *C. echinata* (prickly sedge), *Gymnocarpium dryopteris* (oak fern), and *Viola* spp. (violets). Trees generally contribute less than 25% cover and may include *Picea mariana* (black spruce), *Abies balsamea* (balsam fir), *Thuja occidentalis* (northern white cedar), and *Betula populifolia* (gray birch).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is broadly distributed in the state, but most abundant in the White Mountains region and the North Country. A good example can be found at South Bay Bog (Clarksville).

SOURCES: Sperduto et al. 2000a.

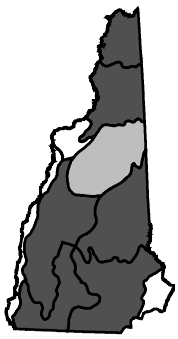
• Highbush blueberry - sweet gale - meadowsweet shrub thicket (S4)

GENERAL DESCRIPTION: This is a weakly to moderately minerotrophic, limnogenous community dominated by medium height shrubs (average height 0.90 m) with a sparse to moderate cover of tall shrubs. It is found along upland borders and laggs of acidic fens, along sluggish stream borders, and sometimes as the dominant fen community in basins that are influenced by upland runoff.

Average pH is 4.6. Hummock-hollow topography is well developed (average hummock height is 0.25 m; average maximum height is 0.47 m), and peat is moderately well decomposed near the surface. Peat depths are often less than 1 m.

CHARACTERISTIC VEGETATION: *Myrica gale* (sweet gale) and *Spiraea alba* (meadow-sweet) are diagnostic in

combination with tall shrubs, including various combinations of *Vaccinium corymbosum* (highbush blueberry), *Lyonia ligustrina* (male-berry), *Aronia melanocarpa* (black chokeberry), *Ilex verticillata* (winterberry), and *Alnus incana* (speckled alder). *Chamaedaphne calyculata* (leather-leaf) is always present in low to moderate abundance. *Acer rubrum* (red maple) is common in low abundance in the tall shrub and low tree layers. *Carex utriculata* (bottle-shaped sedge), *Kalmia angustifolia* (sheep laurel), and *Rhododendron canadense* (rhodora) are occasional. Bryophyte cover is moderate (average ca. 50% cover), with *Sphagnum fimbriatum*, *S. henryense*, *S. torreyanum*, *S. flexuosum*, and *S. fallax* usually present in some combination.



CLASSIFICATION CONFIDENCE: 1-2

DISTRIBUTION: This community occurs primarily at low to mid elevations (below1500 ft.) in central and southern New Hampshire, but it does occur occasionally in the northern part of the state.

SOURCES: Sperduto et al. 2000a.

MARSHY PEATLAND-MARGIN COMMUNITIES

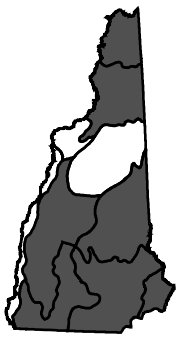
These peatland communities occur adjacent to quiet pond and lake borders, stagnant streams, or upland habitats where a minerotrophic influence from upland runoff or open water exists. They may be transitional to aquatic beds, emergent marshes, shrub thickets, or upland habitats. Some peatland types described elsewhere may occur along pond or upland borders but do not contain an abundance of emergent or aquatic marsh species indicative of the two types below.

• Floating marshy peat mat (S3S4)

GENERAL DESCRIPTION: This community occurs along quiet margins of ponds and lakes or stagnant, slow-moving streams on floating, loosely consolidated, thin, well-decomposed peat. It is transitional between a deep emergent marsh - aquatic bed community and an open peatland on thicker, more consolidated peat landward.

The depth of the floating peat mat ranges from a few to more than 50 cm, and pH ranges from 4.4-5.7 and are influenced by the proximity of the peat mat to open water. The mat surface is flat with occasional, very low micro-relief and ranges from less than a meter to several meters wide.

CHARACTERISTIC VEGETATION: Species composition is somewhat variable and may include *Nymphaea odorata* (white water-lily), *Nuphar variegata* (variegated yellow pond-lily), *Eriophorum viridicarinatum* (green keeled cotton-grass), *Eleocharis flavescens* (olive-brown spike-rush), *E. smallii* (Small's spike-rush), *Rhynchospora alba* (white beak-rush), *Drosera intermedia* (spatulate-leaved sundew), *Triadenum virginicum* (marsh St. John's-wort), *Dulichium arundinaceum* (three-way sedge), *Utricularia* spp. (bladderworts), *Pontederia cordata* (pickerel-weed), *Iris versicolor* (northern blue flag), *Juncus pelocarpus* (mud rush), *Hypericum boreale* (northern St. John's-wort), and other forbs and graminoids. Shrubs are sparse and stunted or absent.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community probably occurs throughout New Hampshire, at the edges of open waterbodies. Good examples of floating marshy peat mats can be found at Binney Pond (New Ipswich), World End Pond (Salem), and Pickerel Cove (Stoddard).

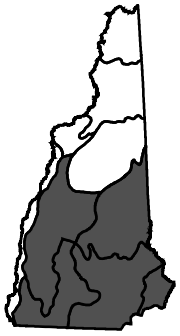
SOURCES: Sperduto et al. 2000a.

• Marshy moat (S4)

General description: Moats (also referred to as laggs) are wet zones generally found between other peatland communities and adjacent upland habitats, typically in southern and central New Hampshire. Moats may vary considerably, both within and between sites, in width (less than 1 m to more than 20 m) and in duration and frequency of flooding. They may be restricted to basins with significant yearly water fluctuations. Moat development likely is related to increased peat decomposition along the peatland edge as a result of decreased acidity and dry periods during seasonal water-level drawdown. Several other peatland communities occur in moat locations; marshy moats differ in the greater prominence of emergent marsh or aquatic species.

Soils are typically relatively shallow, well-decomposed peat. Because the moat is located where surface water runoff enters the peatland, nutrient availability and pH are generally higher in the moat than in areas closer to the peatland center.

Characteristic vegetation: Vegetation is typically poorly to moderately developed, variable in composition, and with a number of minerotrophic indicator species. Temporarily to seasonally flooded moat zones support most of the shrub and emergent marsh species present. Emergent or aquatic species generally absent from other peatland types include *Sparganium americanum* (lesser bur-reed), *Glyceria* spp. (manna-grass), *Scirpus cyperinus* (woolly bulrush), *Eleocharis smallii* (Small's spike-rush), *Calamagrostis canadensis* (blue-joint), *Juncus canadensis* (Canada rush), and *Juncus effusus* (soft rush). In semi-permanently flooded moat zones, several aquatic species may be present, including *Potamogeton* spp. (pondweeds), *Brasenia schreberi* (water shield), *Utricularia vulgaris* (common bladderwort), *Nuphar variegata* (variegated yellow pond-lily), and *Nymphaea odorata* (white water-lily). Other characteristic emergent and other species also occasional in other peatland communities include *Peltandra virginica* (arrow-arum), *Dulichium arundinaceum* (three-way sedge), *Triadenum virginicum* (marsh St. John's-wort), *Carex canescens* (silvery sedge), *C. lasiocarpa* (hairy-fruited sedge), *Lycopus uniflorus* (common water horehound), and *Lysimachia terrestris* (swamp candles). Shrubs may include *Cephalanthus occidentalis* (buttonbush), *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (winterberry), *Decodon verticillatus* (water willow), *Chamaedaphne calyculata* (leather-leaf), *Spiraea alba* (eastern meadowsweet), *Aronia melanocarpa* (black chokeberry), and *Myrica gale* (sweet gale). *Sphagnum* species may be absent or when present, unconsolidated and often characterized by *S. cuspidatum* and other Sphagna found in "soupy" conditions. Moss species that may be found on woody stem bases and elsewhere in the moat include *Callicladium haldanianum*, *Hypnum pallescens*, and *Aulocomnium palustre*.



Classification confidence: 2

Distribution: Typically occurs in southern and central New Hampshire. Examples of (rather small) marshy moats can be found at Trask Swamp (Alton), Town Hall Bog (Lee), and Nyemeadow (Stoddard).

Sources: Sperduto et al. 2000a.

ESTUARINE COMMUNITIES

Estuarine communities 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. Connectivity of these communities to the ocean is open, partly obstructed, or sporadic. 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). Ocean water within the estuarine system is at least occasionally diluted by freshwater runoff. The estuarine system extends 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 the system extends to where ocean-derived salts are less than or equal to 0.5 parts per thousand (ppt) during the period of average annual low freshwater flow (Cowardin et al. 1979).

Surface water salinity fluctuates widely according to seasonal variation in freshwater discharge. Greater seasonal variation occurs within the Great Bay complex than in estuaries closer to the coast (Short 1992). There is also a pattern of decreased surface water salinity from coastal marshes to those occurring in Great Bay and its tributaries. Salinity in the Great Bay complex is generally greater than 20 ppt (except during major spring runoff events), whereas coastal marshes remain closer to 30 ppt year-round (Short 1992). 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. Freshwater emergent marshes occur where salinity levels are 0.5 ppt or less during the period of annual low freshwater flow.

Salt marshes are arguably the most well-known natural communities in estuarine ecosystems. In New Hampshire, salt marshes grow atop fibrous marine peat. They have very little mineral content in the substrate due to the weather resistant bedrock found along the North Atlantic coast. Salt marshes in this region are referred to as the New England Type (Johnson 1925). New England Type salt marshes comprise less than 2% of the marsh along the east coast of the United States (Reimold 1977) and are estimated to be 4,000 years old. The rate of sea level rise slowed sufficiently during this period to allow for the establishment and growth of salt marshes (Redfield 1972). Salt marshes replaced brackish marshes and uplands landward and accreting intertidal flats seaward. At Hampton Harbor, the mean tidal range is 8.3 ft. with spring tides averaging 9.5 ft. Here, the high marsh rises from approximately 4 ft. above mean sea level at its lower end to 5 ft. above mean sea level at the landward limit of the salt marsh rush zone.

In addition to hydroperiod (duration and frequency of tidal flooding), factors that affect plant distribution in salt marshes and other estuarine communities include soil salinity, soil oxygen, nutrient availability, elevation of substrate, concentration of growth inhibitors in the sulfihemist soils, storms, ice-scouring, and land use history (Breeding et al. 1974; Howes et al. 1986). Competitive interaction and biological facilitation between and among species has also been documented (Bertness 1992). Many of these factors and processes are interrelated, but vary along gradients at different rates or in different quantities (Zoltai and Vitt 1995). The ability of individual plant species to tolerate the combination of stresses dictate which plant species grow where. For example, *Spartina alterniflora* (smooth cord-grass) dominates the physically stressful low marsh due to its ability to oxygenate its roots and rhizosphere. *Spartina patens* (salt-meadow cord-grass), sensitive to tidal flooding, competitively excludes smooth cord-grass from the high marsh. Along the upland edge of the marsh, salt-meadow cord-grass is itself competitively excluded by *Juncus gerardii* (salt marsh rush), the marsh perennial most susceptible to tidal flooding (Bertness 1990). Salt marsh vegetation is very dynamic and

traditional successional concepts have limited application in addressing patterns of vegetation change (Niering and Warren 1980), largely due to ongoing sea level rise.

From the time of European settlement until recently, salt marshes were routinely drained by farmers to increase the productivity of salt-meadow cord-grass and *Distichlis spicata* (spike-grass) for hay, pasture, and mulch. New Hampshire's salt marshes were also ditched in an effort to reduce salt marsh mosquito (*Aedes sollicitans*) populations. The ecological impacts of ditching include reduced flood duration and lowered water table; changes in species composition across the marsh; reductions of insect, mollusk, and crustacean populations (Bourn and Cottam 1950; Britton et al. 1915); decline in shorebirds and waterfowl (Bradbury 1938); and loss of submerged aquatics including *Ruppia maritima* (widgeon-grass), and the state-threatened *Potamogeton pectinatus* (sago pondweed)* and *Zannichellia palustris* (horned pondweed)*. However, spoil deposits from the ditches may support high marsh grasses and *Iva frutescens* (marsh elder)*, a state-threatened shrub (Miller and Egler 1950).

About twenty percent (1240 acres) of New Hampshire's salt marshes have been degraded by varying degrees of non-natural restrictions to tidal flow (Soil Conservation Service 1994). Where restrictions are severe, salt marshes are replaced by brackish or fresh water wetlands. Other causes of salt marsh deterioration from human activity include filling, draining, increased nutrient inputs, increased and, in some cases, decreased sediment inputs, introduction of invasive plant species, and excess freshwater runoff. Recent mitigation efforts have helped to begin the restoration process for these degraded salt marshes.

INTERTIDAL MARSHES, FLATS, AND SHORES

Intertidal communities 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. 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 wetlands beyond the upper reach of spring tides but periodically infused with salt water during storm events (supporting coastal salt pond marsh, high salt marsh, brackish marsh, high marsh pannes and pools, high brackish tidal riverbank marsh, and coastal shoreline strand/swale). 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 tidal riverbank marsh, saline/brackish 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 saline/brackish intertidal flat and intertidal rocky shore natural communities.

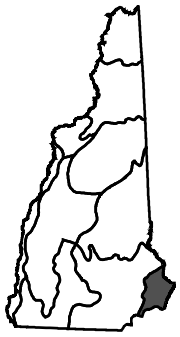
• Low salt marsh (S3)

GENERAL DESCRIPTION: Low salt marshes are dominated by *Spartina alterniflora* (smooth cord-grass) and occur between mean sea level and mean high tide in areas protected from high-energy wave action. Together with high salt marshes, they occur along the coast behind rocky spits, barrier beaches, and sand bars and along bays and rivers. Low salt marshes grade into intertidal flats and subtidal communities seaward and high salt marshes landward. Pannes and pools can be found in low salt marshes. A band of smooth cord-grass, reaching heights of ca. 1-2 m (ca. 3-6 ft.), is often restricted to a narrow fringe along ditches, creeks, rivers, and bays where poly- to euhaline conditions limit competition. Where slopes are gentler, smooth cord-grass may cover broader areas. This is a distinct, narrowly defined natural community, most similar to the low brackish tidal riverbank marsh described later in this section.

Low salt marsh soils are organic materials 16 to 50" thick overlying sandy materials (Terric Sulfihemists over sand). Most of the low salt marsh soils along stream and river mouths entering Great Bay and the narrow margins around the bay are organic materials 16 to 50" thick overlying silty materials (Terric Sulfihemists

over silt). Salt marsh soil water salinity roughly corresponds to polyhaline levels (18–30 ppt).

CHARACTERISTIC VEGETATION: *Spartina alterniflora* (smooth cord-grass) dominates the physically stressful low salt marsh. Associated vascular halophytes occur in low abundance and may include *Salicornia europaea* (common glasswort), *Atriplex hastata* (halberd-leaved orach), *Atriplex glabriuscula* (smooth orache), *Eleocharis parvula* (small spike-rush)*, *Suaeda* spp. (sea blites), *Spergularia marina* (seabeach sand-spurrey), and macroalgae (seaweed) such as *Ascophyllum nodosum* and *Fucus* spp. (rockweeds). As salinity decreases, *Scirpus robustus* (stout bulrush)* and *Typha angustifolia* (narrow-leaved cattail) become more prominent and may dominate the low marsh in brackish environments (see low brackish tidal riverbank marsh description).



CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Restricted to sheltered areas of the seacoast in the Coastal Lowland subsection. Good examples are found along the Blackwater and Hampton Rivers (Seabrook, Hampton Falls, Hampton).

SOURCES: NHB field surveys; Breeding et al. 1974; Nichols et al. 2001.

• High salt marsh (S3)

GENERAL DESCRIPTION: 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. High and low salt marshes occur along the coast behind rocky spits, barrier beaches, and sand bars and along bays and rivers where they are protected from high-energy wave action. High salt marsh grades into low salt marsh, intertidal flats, and subtidal communities seaward and depending on local conditions, brackish marsh, fresh water wetlands, or upland communities landward. Pannes and pools can be found within the high salt marsh.

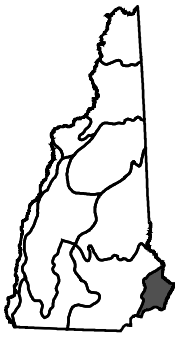
High marsh soils of the coastal marshes and those bordering the smaller streams flowing into Great and Little Bays are generally organic materials thicker than 50" over sand, silt, or bedrock (Typic Sulfihemists). Lesser amounts of Sulfaquents (<16" of organic material over sand) underlie high marsh at the extreme seaward edge of coastal margins, small areas on the Great Bay's western side, and along some streams flowing into the bay. 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 are organic materials 16 to 50" thick overlying silty materials (Terric Sulfihemists over silt). Salt marsh soil water salinity roughly corresponds to polyhaline levels (18–30 ppt).

CHARACTERISTIC VEGETATION: *Spartina patens* (salt-meadow cord-grass) is strongly dominant on the high salt marsh. Other common plants include *Spartina alterniflora* (smooth cord-grass; short form), *Distichlis spicata* (spike-grass), and *Juncus gerardii* (salt marsh rush). Spike-grass often forms pure stands in wetter, more poorly drained areas, or mixes with salt-meadow cord-grass, growing at similar elevations on the high marsh. Salt marsh rush often dominates landward of salt-meadow cord-grass in narrow vegetative zones with decreased tidal flooding and soil water salinity, beginning at about mean spring high water. Only spring tides and storm surges reach this area along the upper edge of the high salt marsh. This zone has the highest species richness within the high marsh and includes *Solidago sempervirens* (seaside goldenrod), *Panicum virgatum* (switch-grass), *Hierochloe odorata* (sweet grass), *Carex hormathodes* (necklace sedge), *Festuca rubra* (red fescue), *Aster novi-belgii* (New York aster), *Elymus virginicus* (Virginia wild rye), *Teucrium canadense* (germander), *Sanguisorba canadensis* (Canadian burnet), *Elytrigia repens* (quack-grass), *Spartina pectinata* (fresh-water cord-grass, slough-grass), *Ligusticum scothicum* (Scotch lovage), and *Juncus arcticus* (shore rush). Less frequent high marsh species are *Polygonum ramosissimum* (bushy knotweed), *P. exsertum* (exerted knotweed)*, *P. prolificum* (prolific knotweed)*, *Potentilla egedii* (silverweed), *Aster tenuifolius* (large salt marsh aster)*, and *A. subulatus* (small salt marsh aster).

The salt shrub community, common in southern New England, rarely occurs landward of the high salt marsh in New Hampshire. Small, poorly developed shrubland pockets are characterized by the state-threatened shrub

Iva frutescens (marsh elder)* and the high marsh herbs switch-grass, salt marsh rush, salt-meadow cord-grass, New York aster, and seaside goldenrod. Because this community is poorly developed in New Hampshire, it is not described as a distinct community.

Plants often found on low natural levees include *Suaeda* spp. (sea-blites), *Puccinellia maritima* (seaside alkali-grass), and *Atriplex hastata* (halberd-leaved orach). Along larger marsh creeks, levees several meters wide typically rise 5–15 cm (2–6") above the marsh. Areas along the upper edge of the high salt marsh influenced by freshwater streams, ephemeral channeled runoff, or groundwater discharge often support brackish marsh communities.



CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Restricted to sheltered areas of the seacoast in the Coastal Lowland subsection. Good examples are found along the Blackwater and Hampton Rivers (Seabrook, Hampton Falls, Hampton).

SOURCES: NHB field surveys; Breeding et al. 1974; Nixon 1982; Nichols et al. 2001.

• Brackish marsh (S2S3)

GENERAL DESCRIPTION: Brackish marshes occasionally occur along the upper margins of high salt marshes and high brackish tidal riverbank marshes where sufficient fresh water runoff or groundwater discharge flows onto the marsh surface. They are tidally flooded by salt water only during spring tides and storm surges. This hydrologic regime supports brackish marsh species and other species most often found in fresh or salt marshes but are also tolerant of brackish conditions and able to successfully compete in this environment. High and low brackish tidal riverbank marshes are two similar communities but are tidally flooded more frequently than by spring tides alone.

Sulfihemist soils with low surface salt content likely underlie most brackish marsh communities. However, Sulfihemist soils supporting brackish marshes are typically too small to be readily mapped at the scale used in the New Hampshire soil survey (Breeding et al. 1974). Soil water salinity generally ranges from greater than 0.5 parts per thousand (ppt) to less than 18 ppt (oligo- to mesohaline).

CHARACTERISTIC VEGETATION: Brackish marshes are characterized by various mixtures of *Carex paleacea* (chaffy salt sedge), *Scirpus robustus* (stout bulrush)*, *Typha angustifolia* (narrow-leaved cattail), *Agrostis stolonifera* (marsh creeping bent-grass), *Solidago sempervirens* (seaside goldenrod), *Spartina pectinata* (fresh-water cord-grass), *S. patens* (salt-meadow cord-grass), *Aster novi-belgii* (New York aster), and *Juncus gerardii* (salt marsh rush). *Eleocharis parvula* (small spike-rush)* and *E. halophila* (salt-loving spike-rush)*, state-threatened species, can be found in all variants described below.

VARIANTS: Four variants of brackish marsh with reasonably distinct plant associations distributed along a hydrology and salinity gradient are described.

1. **Short graminoid variant**: This variant supports a greater diversity of plants and is generally flooded less frequently than other brackish marsh variants. It is vertically higher, receives more freshwater input, and experiences less frequent tidal flooding than the high salt marsh. It is characterized by a mix of graminoids including *Agrostis stolonifera* (marsh creeping bent-grass), *Spartina patens* (salt-meadow cord-grass), and *Juncus gerardii* (salt marsh rush). One or more of these species may be locally dominant.

   Other common graminoids and forbs include *Aster novi-belgii* (New York aster), *Solidago sempervirens* (seaside goldenrod), *Spartina pectinata* (fresh-water cord-grass, slough-grass), and *Scirpus robustus* (stout bulrush)*. Less constant and frequent plants include *Juncus arcticus* (shore rush), *Polygonum ramosissimum* (bushy knotweed), *Scirpus pungens* (three-square rush), *Distichlis spicata* (spike-grass),

Triglochin maritimum (arrow-grass), *Potentilla anserina* (silver-weed), *Carex hormathodes* (necklace sedge), *Carex paleacea* (chaffy salt sedge), *Ranunculus sceleratus* (cursed crowfoot), *Panicum virgatum* (switch-grass), *Amaranthus cannabinus* (water hemp), *Hierochloe odorata* (sweet grass), *Elymus virginicus* (Virginia wild rye), *Acorus calamus* (sweetflag), *Typha angustifolia* (narrow-leaved cattail), and *Sanguisorba canadensis* (Canadian burnet). The state-threatened *Iris prismatica* (slender blue flag)* occurs in this brackish marsh variant.

Three types of pannes (small, temporary depressions isolated from tidal creeks) may occur within the relatively larger-sized short graminoid brackish marsh variant (see "pannes and pools" description).

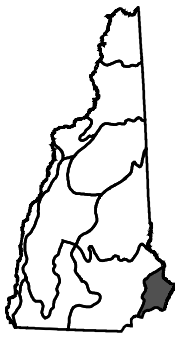
2. **Medium graminoid variant**: This variant is dominated by *Carex paleacea* (chaffy salt sedge), but is otherwise floristically most similar to the short graminoid brackish marsh variant. Common associates include *Scirpus robustus* (stout bulrush)*, *Agrostis stolonifera* (marsh creeping bent-grass), *Spartina patens* (salt-meadow cord-grass), *Juncus gerardii* (salt marsh rush), *Solidago sempervirens* (seaside goldenrod), and *Spartina pectinata* (fresh-water cord-grass, slough-grass). The hydroperiod appears to be slightly wetter compared to the low graminoid brackish marsh variant.
3. **Tall graminoid variant**: This variant occurs along the upland edge of salt marshes in shallow, less frequently flooded depressions compared to other brackish marsh variants. *Scirpus pungens* (three-square rush), *Typha angustifolia* (narrow-leaved cattail), *Carex paleacea* (chaffy salt sedge), *Phragmites australis* (common reed; a native "weedy" grass in brackish marshes), and *Spartina pectinata* (fresh-water cord-grass, slough-grass) are characteristic.
4. **Robust forb variant**: This variant occurs along the upper edge of high salt marshes, often in coves or other protected areas with restricted spring-tide "sheet flow" (bi-monthly or less frequent tidal flooding events) and with significant freshwater input. Soils are ponded for longer periods compared to other variants of brackish marsh. Dead stems from the previous year are often thick above the hydrated soil surface. The robust forb brackish marsh variant may grade into a *Typha angustifolia* (narrow-leaved cattail) dominated high brackish tidal riverbank marsh on tidal streams and rivers where salinity levels are lower upstream and tidal flooding occurs several times a week (see description for high brackish tidal riverbank marsh).

   Narrow-leaved cattail dominates this variant forming a near monoculture in some examples. Associated plants may include *Scirpus robustus* (stout bulrush)*, *Spartina patens* (salt-meadow cord-grass), *Lythrum salicaria* (purple loosestrife), *Phragmites australis* (common reed), and less frequently *Solidago sempervirens* (seaside goldenrod), *Aster novi-belgii* (New York aster), *Festuca rubra* (red fescue), *Scirpus pungens* (three-square rush), *S. tabernaemontanii* (softstem bulrush), *Thelypteris palustris* (marsh fern), *Eleocharis flavescens* (olive-brown spike-rush), *Amaranthus cannabinus* (water hemp), and several other brackish marsh species. In one example, *Typha x glauca* (glaucous cattail; *Typha angustifolia* x *Typha latifolia*) is the dominant cattail species in the brackish marsh.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Restricted to sheltered areas of the seacoast in the Coastal Lowland subsection. Good examples can be found along the Squamscott River (Stratham, Exeter, Newfields) and at the Blackwater and Hampton River Salt Marsh complex (Seabrook, Hampton Falls, Hampton).

SOURCES: NHB field surveys; Breeding et al. 1974; Nichols et al. 2001.



• Salt pannes and pools (S3)

GENERAL DESCRIPTION: Pannes and deeper pools are low wet areas isolated from tidal creeks that occur in both saline and brackish marshes where they form fine-scale natural communities (less than 1 m^2 to over 100 m^2). Species composition varies with salinity, hardness of substrate, elevation, soil oxygen, hydroperiod, and other factors. Low marsh pannes and pools are regularly flooded and often unvegetated with a soft, silty mud substrate. Irregularly flooded high marsh pannes and pools vary in composition, with the highest species richness and cover generally found in the shallow and relatively dry forb pannes. Salinity fluctuates in response to tidal flooding, evaporation, and rainfall. Salinity levels in pannes found in the high salt marsh are typically in the range of 40–50(-60) ppt. Under the most extreme conditions (e.g., high salinity or low oxygen) pannes may be devoid of vegetation.

Shallow pannes are created by damage to *Spartina patens* (salt-meadow cord-grass) and other high marsh vegetation from ice erosion or smothering by stranded mats of *Spartina alterniflora* (smooth cord-grass) (Bertness 1992) and other flood-deposited plant litter or trash. Other processes account for the formation of "pond holes" or deep pools (Redfield 1972).

Since the first European settlers arrived on the coast until recently, pannes were routinely drained to increase the productivity of salt-meadow cord-grass and *Distichlis spicata* (spike-grass) for hay, pasturage, and mulch. New Hampshire's salt marshes were also ditched and their pannes drained into tidal creeks in an effort to reduce salt marsh mosquito (*Aedes sollicitans*) populations.

VARIANTS: Several panne variants are described below, including four in salt marshes and three in brackish marshes.

Salt marsh panne variants:

1. **Arrow-grass (forb) panne**: Very shallow, briefly flooded, moderately vegetated high marsh forb pannes are typically dominated by *Triglochin maritimum* (arrow-grass). Other common species include *Distichlis spicata* (spike-grass), *Juncus gerardii* (salt marsh rush), *Spartina patens* (salt-meadow cord-grass), and *S. alterniflora* (smooth cord-grass; short form). Less frequent are *Plantago maritima* (salt marsh plantain), *Limonium carolinianum* (sea lavender), *Atriplex hastata* (halberd-leaved orach), *Glaux maritima* (sea milkwort), *Puccinellia maritima* (seaside alkali-grass), and *Potentilla egedii* (silverweed). Lower portions of the panne where evaporation and poor drainage create high salinity levels may remain unvegetated or support the succulent *Salicornia europaea* (common glasswort). Forb pannes also provide habitat for the state-threatened *Agalinis maritima* (salt-marsh gerardia)*, *Salicornia bigelovii* (Bigelow's glasswort)*, and the state-endangered *Puccinellia paupercula* (Alaskan goose-grass)*. *Pluchea odorata* (marsh-fleabane)*, a state-endangered species, may be found in this habitat and in brackish marsh communities.
2. **Smooth cord-grass (short form) panne**: Shallow anaerobic depressions with poor drainage, low nutrient availability, and high concentrations of sulfides and other plant growth inhibitors promote the growth of the short form (6–12" tall) of *Spartina alterniflora* (smooth cord-grass) (Howes et al. 1986). Smooth cord-grass pannes occur on less firm peat soils and appear to be somewhat deeper, often larger, and saturated or flooded for longer periods than forb pannes. However, as soil saturation and ponding increase, the abundance of smooth cord-grass usually decreases (Redfield 1972). Species occurring in low abundance include *Salicornia europaea* (common glasswort), *Atriplex hastata* (halberd-leaved orach), and few other vascular halophytes. This panne type is most often found on the high salt marsh but can occasionally occur on the upper margins of the low salt marsh. Wetter areas dominated by the short form of smooth cord-grass are occasionally formed from mini-levees trapping water along ditch margins (Shea et al. 1975).
3. **Salt marsh mosquito panne**: Sparsely-vegetated salt marsh mosquito pannes are most often found on the upper half of the high salt marsh. They are generally deeper than both forb and *Spartina alterniflora* pannes and are typically flooded by the higher of the two spring tides (new or full moon

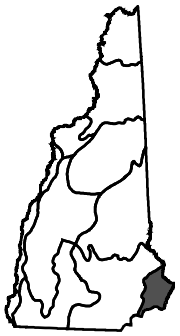
tide), drying-out two to three weeks later. Because they are not permanently flooded, "marsh minnows" [stickleback (*Pungitius pungitius*, *Gasterosteus aculeatus*, and *Apeltes quadracus*) and mummichog (*Fundulus heteroclitus*)], predators of salt marsh mosquitoes (*Aedes sollicitans*) and other invertebrates, are absent or in low numbers. The flooding duration generally restricts emergent halophytic graminoids and forbs to the shallower panne margin while preventing the growth of *Ruppia maritima* (widgeon-grass), a species typically found in semi-permanently to permanently flooded pools.

When the panne is dry, female salt marsh mosquitoes lay eggs on the exposed surface. After the panne is flooded by the new or full moon tide, the salt marsh mosquito larvae develop through several instars and emerge as adults (5-)7–10 days later. Other mosquito species may also successfully breed in these pannes during the warmer months, particularly when salinity levels are reduced during periods of significant rainfall.

4. **Widgeon grass - marsh minnow deepwater pool**: Semi-permanently and permanently flooded pools on the high salt marsh are important foraging areas for many species of shorebirds. These deepwater pools can provide habitat for the submerged aquatic *Ruppia maritima* (widgeon-grass) and for "marsh minnows" [stickleback (*Pungitius pungitius*, *Gasterosteus aculeatus*, and *Apeltes quadracus*) and mummichog (*Fundulus heteroclitus*)]. Emergent halophytic graminoids and forbs are generally restricted to shallow margins, the principal habitat for *Scirpus maritimus* (saltmarsh bulrush). The margin may also be steep and deep, without emergent marsh vegetation. Purple sulfur-bacteria is often common across the stagnant water surface. The state-threatened *Potamogeton pectinatus* (sago pondweed)* and *Zannichellia palustris* (horned pondweed)* are submerged aquatics that may be found in this habitat. Deepwater pools occasionally occur on the upper margins of the low salt marsh.

Brackish marsh panne variants: These variants occur in the brackish marshes (short graminoid variant).

1. **Mixed forb panne**: These shallow depressions are ponded only for short periods and are characterized by a variable mix of graminoids and forbs. Frequent herbs include *Scirpus pungens* (three-square rush), *S. robustus* (stout bulrush)*, *Triglochin maritimum* (arrow-grass), *Agrostis stolonifera* (marsh creeping bent-grass), *Eleocharis halophila* (salt-loving spike-rush)*, and *E. parvula* (small spike-rush)*. Less frequent are *Festuca rubra* (red fescue), *Aster novi-belgii* (New York aster), *Potentilla egedii* (silverweed), *Spartina patens* (salt-meadow cord-grass), and *Juncus gerardii* (salt marsh rush).
2. **Narrow-leaved cattail panne:** This association includes small to moderate sized, ponded or saturated depressions dominated by *Typha angustifolia* (narrow-leaved cattail). Large areas of narrow-leaved cattail are typically not pannes, and are better classified as brackish marsh or brackish tidal riverbank communities.
3. **Sparsely vegetated panne**: These saturated to occasionally ponded, mud dominated pannes can occur adjacent to forested uplands where they are shaded by overhanging canopy branches. This is the usual habitat for the uncommon *Ranunculus cymbalaria* (seaside crowfoot), where prostrate colonies may form small patches over the soil surface. Other graminoids and forbs scattered across the mud, or more often around the panne edge, include *Agrostis stolonifera* (marsh creeping bent-grass), *Elymus virginicus* (Virginia wild rye), *Aster novi-belgii* (New York aster), *Solidago sempervirens* (seaside goldenrod), *Spartina alterniflora* (smooth cord-grass), *Carex paleacea* (chaffy salt sedge), and *Plantago major* var. *scopulorum* (rock plantain).



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Restricted to sheltered areas of the seacoast in the Coastal Lowland subsection. Good examples occur in the Blackwater and Hampton River Salt Marsh (Seabrook, Hampton Falls, Hampton).

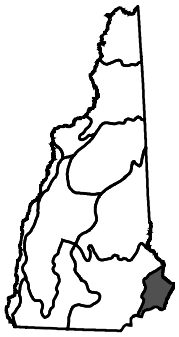
SOURCES: NHB field surveys; Redfield 1972; Shea et al. 1975; Howes et al. 1986; Bertness 1992; Nichols et al. 2001.

• Low brackish tidal riverbank marsh (S1S2)

General description: Brackish tidal riverbanks are flooded by seawater pushing in from tides that is diluted by freshwater flowing in from the watershed above. The low brackish tidal riverbank marshes typically occur in zones between mean sea level and mean high tide along moderate to steep brackish tidal river- and stream-banks. The hydroperiod (duration and frequency of tidal flooding) 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 seawater, causing salinity to fluctuate widely with the tides. This community may grade into intertidal flat and subtidal communities toward the channel and high brackish tidal riverbank marsh landward. Where slopes are gentler, the marsh may cover broader areas. As the sea level continues to rise (1–2 mm/year), brackish marsh may be submerged and replaced by salt marsh, while new areas suitable for brackish marsh may form landward. Several rare plants are restricted to brackish tidal riverbank marshes in New Hampshire. This is a narrowly defined community nearly always found in association with high brackish tidal riverbank marsh, and often as a fairly narrow zone.

Sulfihemist soils with low surface salt content likely underlie most brackish marsh communities. However, Sulfihemist soils supporting brackish marshes are typically too small to be readily mapped at the scale used in the New Hampshire soil survey (Breeding et al. 1974). Substrate of smaller brooks near the upper reaches of the tidal influence are often gravelly or cobbly. Soil water salinity generally ranges from greater than 0.5 parts per thousand (ppt) to less than 18 ppt (oligo- to mesohaline).

Characteristic vegetation: *Spartina alterniflora* (smooth cord-grass) typically dominates the physically stressful low marsh. As salinity decreases, *Scirpus robustus* (stout bulrush)* and *Typha angustifolia* (narrow-leaved cattail) become more prominent and may dominate the low marsh in some examples. Associated vascular plants in low abundance may include *Amaranthus cannabinus* (water hemp), *Atriplex hastata* (halberd-leaved orach), *Eleocharis parvula* (small spike-rush)*, *E. halophila* (salt-loving spike-rush)*, *Scirpus pungens* (three-square rush), *Scirpus maritimus* (saltmarsh bulrush), *Salicornia europaea* (common glasswort), and *Limonium carolinianum* (sea lavender). Rare plants that occur here and distinguish this community from low salt marshes include *Limosella australis* (Atlantic mudwort)*, *Lilaeopsis chinensis* (eastern lilaeopsis)*, *Tillaea aquatica* (pygmy weed)*, and *Samolus parviflorus* (false water pimpernel)*. These rare species can also occur in the high brackish tidal riverbank marsh. *Limosella australis* (Atlantic mudwort)* may also be found on brackish intertidal flats.



Classification confidence: 2

Distribution: Restricted to brackish tidal stream and river margins in the Coastal Lowland subsection. Good examples are found along the Lamprey River Narrows (Newmarket), Salmon Falls River (Rollinsford), Bellamy River (Dover), and Squamscott River (Exeter).

Sources: NHB field surveys; Breeding et al. 1974; Nichols et al. 2001.

• High brackish tidal riverbank marsh (S1S2)

General description: Brackish tidal riverbanks are flooded by seawater pushing in from the tides that is diluted by freshwater flowing in from the watershed above. High brackish tidal riverbank marshes typically occur as narrow zones along moderate to steep brackish tidal river- and stream-banks flooded less than daily between the mean high water mark and the upper reaches of spring tides. The transition between high and low brackish tidal riverbank marsh occurs approximately at the mean high water mark; from here high brackish riverbank marsh stretches landward to the upper reaches of spring tides. The hydroperiod corresponds to that found in the high salt marsh, whereas soil water salinity is more equivalent to brackish marshes (0.5-18 ppt).

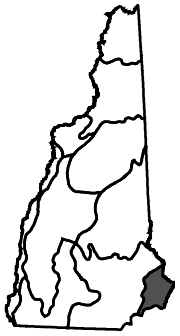
Fresh water can form a lens on top of the sea water, causing the salinity to fluctuate widely with the tides. Where slopes are gentler, the marsh may cover broader areas. This community may grade into low brackish tidal riverbank marsh, intertidal flats, and subtidal communities toward the channel. Fresh water wetlands or upland communities are found landward. As the sea level continues to rise (1–2 mm/year), brackish marsh may be submerged and replaced by salt marsh, while new areas suitable for brackish marsh may form landward. This community supports brackish marsh species and other species most often found in fresh or salt marshes but tolerant of brackish conditions and able to successfully compete in this environment. Several rare plants are restricted to brackish tidal riverbank marshes in New Hampshire. This is a narrowly defined community nearly always found in association with low brackish tidal riverbank marsh, and often as a fairly narrow zone.

Sulfihemist soils with low surface salt content likely underlie most brackish marsh communities. However, Sulfihemist soils supporting brackish marshes are typically too small to be readily mapped at the scale used in the New Hampshire soil survey (Breeding et al. 1974). Substrate of smaller brooks near the upper reaches of the tidal influence are often gravelly or cobbly material. Soil water salinity generally ranged from greater than 0.5 parts per thousand (ppt) to less than 18 ppt (oligo- to mesohaline).

Characteristic vegetation: A variable mix of graminoids and forbs characterize this community including *Scirpus robustus* (stout bulrush)*, *Aster novi-belgii* (New York aster), *Spartina patens* (salt-meadow cord-grass), *Juncus gerardii* (salt marsh rush), *Typha angustifolia* (narrow-leaved cattail), *Spartina pectinata* (fresh-water cord-grass, slough-grass), *Agrostis stolonifera* (marsh creeping bent-grass), *Carex paleacea* (chaffy salt sedge), *Solidago sempervirens* (seaside goldenrod), and *Scirpus pungens* (three-square rush). One or more of these species may be locally dominant. Less frequent species include *Atriplex hastata* (halberd-leaved orach), *Cyperus filicinus* (beach umbrella-sedge), *Potentilla anserina* (silver-weed), *Sium suave* (water parsnip), *Calystegia sepium* (hedge bindweed), *Juncus arcticus* (shore rush), *Rumex crispus* (curly dock), *Plantago major* var. *scopulorum* (rock plantain), *Distichlis spicata* (spike-grass), *Amaranthus cannabinus* (water hemp), *Spartina alterniflora* (smooth cord-grass), *Elymus virginicus* (Virginia wild rye), *Poa pratensis* (Kentucky bluegrass), *Toxicodendron radicans* (climbing poison ivy), *Panicum virgatum* (switch-grass), *Carex hormathodes* (necklace sedge), *Hierochloe odorata* (sweet grass), *Lythrum salicaria* (purple loosestrife), and *Spergularia marina* (seabeach sand-spurrey). Rare plants that occur here and distinguish this community from high salt marshes that have equivalent flood regime include *Limosella australis* (Atlantic mudwort)*, *Lilaeopsis chinensis* (eastern lilaeopsis)*, *Tillaea aquatica* (pygmy weed)*, and *Samolus parviflorus* (false water pimpernel)*. These rare species can also occur in the low brackish tidal riverbank marsh. *Limosella australis* (Atlantic mudwort)* may also be found on brackish intertidal flats.

Classification confidence: 2

Distribution: Restricted to brackish tidal stream and river margins in the Coastal Lowland subsection. Good examples are found along the Lamprey River Narrows (Newmarket), Salmon Falls River (Rollinsford), Bellamy River (Dover), and Squamscott River (Exeter).



Sources: NHB field surveys; Breeding et al. 1974; Nichols et al. 2001.

• Coastal salt pond marsh (S1)

General description: This community includes emergent marshes that are seasonally flooded with freshwater and periodically infused with salt water during storm events. It is presently known from a single site in New Hampshire. Water chemistry is characterized by a brackish to slightly brackish salinity and an average pH of 8.2. The marsh is separated from the coastal shoreline by a cobble ridge rising up to 12 ft. above mean sea level. The northern end of this ridge drops to approximately 7.5 ft. above mean sea level and shows recent evidence of wave action overtopping the barrier and depositing salt water and small amounts of sand into the

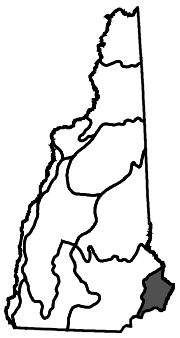
marsh. The southern end of the cobble ridge is slightly higher (9-10 ft. above mean sea level) and has several furrows on its backside formed by breaching storm waves.

The seasonally flooded soils consist of a 25 cm thick O horizon overlying a gravelly silt loam containing scattered coarse sand. Depth to bedrock (Rye Formation) in one soil pit was 35 cm. Scattered outcrops are exposed in the marsh.

Soil water salinity generally ranges from greater than 0.5 parts per thousand (ppt) to less than 18 ppt (oligo- to mesohaline). Salinity levels greater than or equal to 18 ppt (poly- to euhaline) typically support salt marsh. In contrast, freshwater emergent marshes occur where salinity levels are 0.5 ppt or less during the period of annual low freshwater flow. Salinity levels may fluctuate seasonally and over several years in response to freshwater input, evaporation, and periodic infusion with salt water during storm events.

CHARACTERISTIC VEGETATION: Vegetation appears to be zonally distributed along hydrologic gradients (flood and saturation duration and salinity). The marsh is dominated by clonal stands of *Typha angustifolia* (narrow-leaved cattail) and *Scirpus tabernaemontanii* (softstem bulrush). Lower areas exposed later in the growing season after draw-down are dominated by *Eleocharis parvula* (small spike-rush)*, in association with *E. halophila* (salt-loving spike-rush)*, *E. flavescens* (olive-brown spike-rush), *Scirpus maritimus* (saltmarsh bulrush), and *S. pungens* (three-square rush). *Spartina pectinata* (fresh-water cord-grass, slough-grass) is abundant on higher ground along the basin edge. Other rare plants occurring in this marsh include *Chenopodium rubrum* (coast-blite goosefoot)* and *Zannichellia palustris* (horned pondweed)*.

Other characteristic brackish marsh species include *Plantago maritima* (salt marsh plantain), *Solidago sempervirens* (seaside goldenrod), *Phragmites australis* (common reed), *Agrostis stolonifera* (marsh creeping bent-grass), and *Aster novi-belgii* (New York aster). Many of these species occur in either or both fresh water and brackish habitats, but when found together, they indicate brackish conditions. Several other species found only in freshwater habitats are restricted to higher ground along the basin edge where plant diversity is highest. The uncommon *Lythrum hyssopifolia* (hyssop-leaved loosestrife) and *Spartina caespitosa* (marsh cord-grass) also occur here.



CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Restricted to the coastal zone. The only known occurrence is at Odiorne Point State Park (Rye) (Gulf of Maine Coastal Lowland subsection).

SOURCES: NHB field surveys; Straus 1992.

• Coastal shoreline strand/swale (S2)

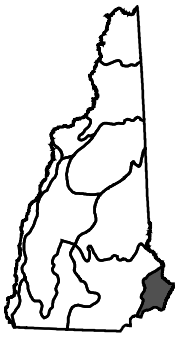
GENERAL DESCRIPTION: This is a sparsely vegetated upper intertidal community found on fine to coarse soils of protected estuarine shorelines or backdune sandy depressions and channels bordering salt marshes. The community is flooded less than daily and is often characterized by plant stems and other 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.

The substrate consists of fine to coarse soils or various types of bedrock including those of the Rye Formation.

CHARACTERISTIC VEGETATION: A sparse cover (typically <25%) of halophytic herbs consists of *Spergularia marina* (seabeach sand-spurrey), *Salicornia europaea* (common glasswort), *Suaeda linearis* (southern sea-blite), *Limonium carolinianum* (sea lavender), and *Puccinellia maritima* (seaside alkali-grass). Infrequent species include *Atriplex hastata* (halberd-leaved orach) and other *Suaeda* spp. (sea-blites). *Distichlis spicata* (spike-grass) and *Spartina patens* (salt-meadow cord-grass) may be present in sandy areas. Other vascular plants

often can be found along the upland border including *Cakile edentula* (sea-rocket), *Chenopodium rubrum* (coast-blite goosefoot)*, and *Polygonum* spp. (knotweeds). Rare species that may be found along the strand line are *Honckenya peploides* (sea-chickweed)* and *Salicornia bigelovii* (dwarf glasswort)*. Plant stems and other detritus often cover much of the substrate surface.

This upper intertidal community is distinguished from intertidal rocky shores and flats by the presence of vascular plants, absence or very sparse cover of rooted macroalgae, and less frequent tidal flooding. It is equivalent to the "drift-line community" found between the salt marsh and dunes at The Sands (Seabrook) as described by Dunlop et al. (1983).



CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: Restricted to immediate shoreline areas of the Coastal Lowland subsection. Good examples are at Odiorne Point State Park (Rye) and The Sands (Seabrook).

SOURCES: NHB field surveys; Dunlop et al. 1983; Short 1992.

• Intertidal rocky shore (S3)

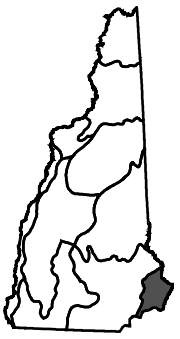
GENERAL DESCRIPTION: This is a sparsely vegetated intertidal community found on open stretches of estuarine rivers and streams or quiet, partially enclosed shores. It is flooded daily by tides. Macroalgae is characteristic on rubble or bedrock substrates. This community may form large patches or narrow strands below the upper intertidal shoreline and is important habitat for various arthropods, predatory fish, wading birds, mud snails, and other animals.

The substrate, exposed completely during particularly low spring tides, primarily consists of coarse soils and/or various types of bedrock including those of the Rye Formation.

Surface water salinity fluctuates widely according to seasonal variation in freshwater discharge. Greater seasonal variation occurs within the Great Bay complex and its tributaries than in estuaries closer to the coast (Short 1992). The upstream limit of this community occurs where salinity levels are 0.5 ppt or less during the period of annual low freshwater flow.

This community is distinguished from intertidal flat communities by a coarser soil particle size and firmer substrate and from high-energy marine intertidal rocky shores by limited exposure to strong currents and wave-action.

CHARACTERISTIC VEGETATION: Macroalgae are often common on bedrock and rubble including *Ascophyllum nodosum* on larger outcrops and *Fucus vesiculosus* on less stable strata.



CLASSIFICATION CONFIDENCE: 1-2

DISTRIBUTION: This community is restricted to immediate shoreline areas of the Coastal Lowland subsection. A good example is found at Odiorne Point State Park (Rye).

SOURCES: NHB field surveys; Short 1992.

• Saline/brackish intertidal flat (S3)

GENERAL DESCRIPTION: Intertidal sand and mud flats are gently sloping, sparsely vegetated areas that occur between low salt or brackish marshes landward and subtidal communities seaward. Tidal creek channels exposed at low tide are included in this community. Intertidal flats 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. These coastal landforms contribute sediments to intertidal flat formation. The substrate, exposed completely during particularly low spring tides, ranges in composition from sand to mud and silt.

Benthic diatoms and other microalgae occurring in this environment are important contributors to the primary productivity of the total estuarine system (Sickley 1989). Macroalgae is typically uncommon across the exposed substrate. Characteristic invertebrates found in New Hampshire's intertidal mud flats include polychaete worms (including *Nereis virens*, *Nephtys caeca*, *Clymenella tortquata*, and *Scoloplos* spp.) and mollusks [including soft-shelled clam (*Mya arenaria*), Baltic Macoma (*Macoma balthica*), gem shell (*Gemma gemma*), and swamp Hydrobia (*Hydrobia minuta*)] (Normandeau Associates 1973). Arthropods are also well represented and include green crabs (*Carcinus maenus*), rock crabs (*Cancer irroratus*), flat-clawed hermit crabs (*Pagurus pollicaris*), and horseshoe crabs (*Limulus polyphemis*). During the diurnal (twice daily) tidal flooding several species of fish and other aquatic species feed on the benthos and epibenthic algae. This community also provides important foraging habitat for shorebirds and other animals when the intertidal flat is exposed. The diverse variety of primary foods (microalgae, phytoplankton, and detritus) available to consumers supports the high productivity found on intertidal flats.

The substrate is composed of sand or silt and clay rich in organic matter. Muds contain a greater percentage of organic matter than sands. Coarser sediments are deposited in areas exposed to greater wave action and stronger currents while finer particles are deposited in lower-energy environments. Ice action during winter months can also influence sediment accretion, erosion, and transport.

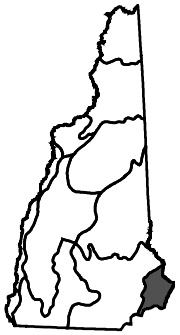
Surface water salinity fluctuates widely according to seasonal variation in freshwater discharge. Greater seasonal variation occurs within Great Bay and its tributaries than in estuaries closer to the coast (Short 1992). The upstream limit of this community occurs where salinity levels are 0.5 ppt or less during the period of annual low freshwater flow.

This community is distinguished from coastal shoreline strand/swales by the absence or very sparse cover of vascular plants and more frequent tidal flooding. Intertidal flats differ from intertidal rocky shores by a finer soil texture and less firm substrate.

CHARACTERISTIC VEGETATION: Vascular plants are sparse to more typically absent. Brackish flats may support populations of *Eleocharis parvula* (small spike-rush)* and *Limosella australis* (Atlantic mudwort)*. A total of 169 seaweed species have been documented in the Great Bay Estuary including the Piscataqua River (144 spp.), Little Bay (132 spp.), Great Bay proper (90 spp.), and ranging from four to 49 species in the seven tidal rivers entering Great Bay (Mathieson and Penniman 1991).

CLASSIFICATION CONFIDENCE: 1-2

DISTRIBUTION: This community is restricted to sheltered areas of the seacoast in the Coastal Lowland subsection. Good examples of this community can be found seaward of the Blackwater and Hampton River salt marshes (Seabrook, Hampton Falls, Hampton) and at Great Bay and its vicinity.



SOURCES: NHB field surveys; Normandeau Associates 1973; Whitlatch 1982; Sickley 1989; Mathieson and Penniman 1991; Short 1992.

SUBTIDAL COMMUNITIES

Subtidal communities occur almost exclusively below mean low tide, although upper reaches may be briefly exposed during the lowest spring tides. In New Hampshire, subtidal natural communities include the saline/brackish subtidal channel/bay bottom, tidal creek bottom, eelgrass bed, and oyster bed communities. These communities perform 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).

• Saline/brackish subtidal channel/bay bottom (S3)

General description: This community occurs in permanently flooded, saline or brackish tidal channels and bays. Intertidal flats or rocky shores found landward and exposed at low tide are described as saline/brackish intertidal flat or intertidal rocky shore communities.

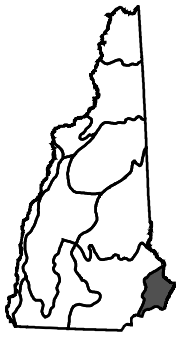
A lens of freshwater may flow over heavier brackish water. Salinity can fluctuate widely as the boundary between the two water layers rises and falls as it moves upstream or downstream with the tides. Water salinity generally ranges from greater than 0.5 parts per thousand (ppt) to less than 30 ppt (mixohaline). Salinity can also fluctuate with seasonal variation in freshwater discharge. Substrates vary at different locations and include mud, sand, gravel, cobble, or rock.

Where salinity levels are 0.5 ppt or less during the period of annual low freshwater flow, freshwater tidal rivers and streams may occur. The construction of dams across brackish sections of major tidal rivers probably eliminated examples of this community type that may once have occurred in New Hampshire.

Characteristic vegetation: Vascular plants are typically absent or sparse. Seaweeds are an important component of this community and the surrounding environment. A total of 169 seaweed species have been documented as occurring in the Great Bay Estuary including the Piscataqua River (144 species), Little Bay (132 species), Great Bay proper (90 species), and a range of four to 49 species in the seven tidal rivers entering Great Bay (Mathieson and Penniman 1991). Common species include *Gracilaria tikvahiae* (the most abundant algae), *Fucus vesiculosus* (rockweed), *Laminaria* spp. (kelps), *Ascophyllum nodosum* (rockweed), and *Chondrus crispus* (Irish moss). *Enteromorpha* spp. and *Ulva lactuca* (sea lettuce) are also present and considered to be indicators of eutrophication. Several species of seaweed within Great Bay are disjunct from populations south of Cape Cod (Short 1992). These include *Gracilaria tikvahiae, Bryopsis plumosa, Dasya baillouviana, Chondria tenuissima, Lomentaria clavellosa, L. orcadensis,* and *Polysiphonia subtilissima*. Several marine and estuarine invertebrates also have a similar disjunct distributional pattern (Turgeon 1976). These disjunct plants and animals are either relics of a time when coastal waters were warmer (Bousfield and Thomas 1975) or are introduced from the south.

Classification confidence: 2-3

Distribution: Restricted to subtidal channels and bays of the Coastal Lowland subsection. Good examples are found along the Lamprey River Narrows (Newmarket), Salmon Falls River (Rollinsford), Bellamy River (Dover), Squamscott River (Exeter), Berry's Brook (Rye), and Great Bay.

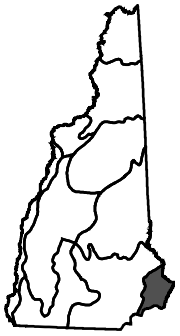


Sources: NHB field surveys; Bousfield and Thomas 1975; Turgeon 1976; Mathieson and Penniman 1991; Short 1992.

• Tidal creek bottom (S3)

General description: This community occurs in permanently flooded creek-bottoms draining water from the high and low salt marsh into a main channel or bay. The substrate is composed of mud rich in organic matter. Portions of tidal creeks exposed at low tide are described under saline/brackish intertidal flat. Tidal creeks provide habitat for stickleback (*Pungitius pungitius*, *Gasterosteus aculeatus*, and *Apeltes quadracus*), mummichog (*Fundulus heteroclitus*), and several other species of fish, and foraging ground for migratory and year-round bird species and other animals. As salt marshes replace accreting intertidal flats seaward, tidal creeks develop along former intertidal flat drainage channels. Landward, as the high salt marsh develops above mean high water, tidal flooding frequency decreases, reducing drainage flow in the creeks. This tends to cause the upstream end of the tidal creek to fill in as sediment deposition occurs at a greater rate than erosion.

Characteristic vegetation: Vascular plants are sparse but may include *Ruppia maritima* (widgeon-grass). The banks of tidal creeks are nearly vertical and often slump, supporting a narrow band of *Spartina alterniflora* (smooth cord-grass) (see low salt marsh description).



Classification confidence: 2-3

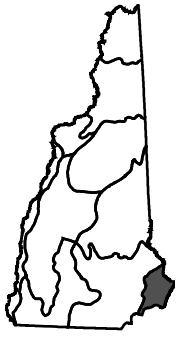
Distribution: Restricted to the coastal zone. Good examples of this community occur in the Blackwater and Hampton River Salt Marsh (Seabrook, Hampton Falls, Hampton).

Sources: NHB field surveys; Redfield 1972; Short 1992.

• Eelgrass bed (S1)

General description: Eelgrass beds 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 (2585 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. This community also provides foraging grounds for waterfowl and wading birds that feed on the eelgrass or the fish and invertebrates the beds harbor. The upper limits of eelgrass populations are determined in large part by ice scour in winter and desiccation in summer (Costa 1988). Daily period of light penetration above a physiological minimum threshold regulates the maximum depth (Dennison and Albert 1986). Light penetration is a function of depth and concentration of suspended particles. In the northeast, eelgrass can grow to a depth of 6 m (20 ft.) where water transparency is high.

Characteristic vegetation: Shallow subtidal populations of *Zostera marina* (common eel-grass) characterize this community.



Classification confidence: 2

Distribution: Restricted to the Great Bay estuarine complex in the coastal zone. Good examples of eelgrass beds occur in shallow subtidal areas of Great Bay.

Sources: Thayer et al. 1975; Short and Short 1984; Dennison and Albert 1986; Costa 1988; Short 1992.

• Oyster bed (S2?)

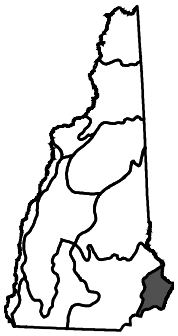
GENERAL DESCRIPTION: *Crassostrea virginica* (oyster) beds occur in shallow mixohaline estuarine waters of the Great Bay estuarine complex. The largest beds are found within the upper Piscataqua River and near Nannie Island while the southwest portion of Great Bay supports the highest oyster densities (Short 1992). Oysters are an important food source for many other animals including starfish, crabs, fishes, and waterfowl.

CHARACTERISTIC VEGETATION: Unlike other subtidal natural communities, oyster beds do not contain rooted vegetation, but are included here because they are an integral part of the broader estuarine ecosystem.

CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: Restricted to the Great Bay estuarine complex in the coastal zone. Good examples of oyster beds occur in shallow subtidal areas of Great Bay.

SOURCES: Short 1992.



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GLOSSARY

ablation till: Loose, permeable *glacial till* deposited from material in and on a glacier during its final downwasting (as opposed to compact *basal till* which forms under the ice). Ablation till often form more rolling, choppy landscapes compared to relatively smooth, even landscapes with frequent drainages.

acidic: Technically, water or soil with a *pH* of less than 7.0. In this document, the pH scale is broken into several ranges according to Wherry's (1919) definitions: *superacid* (pHs 3.0-3.9); *mediacid* (4.0-4.9); *subacid* (5.0-5.9); and *circumneutral* refers to pHs from 6.0-6.9 (*minimacid*) or 7.0-7.9 (*minialkaline*). Geology: also referring to bedrock with more than 65% total silica content, typically due to an abundance of quartz, feldspar (esp. Na and K plagioclase feldspars), and mica (biotite and muscovite). Acidic bedrock typically has low concentrations of *base-cations* and weathers to yield nutrient poor acidic soils with low pHs. *Granite, granodiorite, monzonite, rhyolite,* and some mica schists are examples of acidic rocks. Compare *intermediate*, *circumneutral*, *basic*, *calcareous*, and *mafic*.[13]

acidophile: A plant species that grows best in *acidic* soils (= *calcifuge*).

A horizon: The dark colored soil layer beneath the O horizon, where organic matter has been mixed or incorporated into the mineral soil. An E or B horizon is generally under the A horizon in some soils.

alkaline: Water or soils with a pH >7 (= *basic*).

Alleghanian: Applied to the forest distribution pattern that stretches from the glaciated northeastern United States and adjacent southern Canada to the Great Lakes region with an extension part way down the Appalachian Mountains. Representative species include red spruce, yellow birch, heartleaf paper birch, white pine, and hemlock.

alluvium: Sand, silt, and/or clay sediments deposited by moving water on land surfaces.

alpine: Refers to largely treeless zone (tundra) and its characteristic vegetation found at high elevations, characterized by low temperatures, short summers, and high winds relative to surrounding lowlands. Low-growing *graminoids*, shrubs and herbs with northern or arctic centers of distribution are characteristic. In New Hampshire, restricted to largely treeless high-elevation peaks and ravines of the White Mountains above 4900 ft. and occasionally on lower summits and ridges, a few scattered high elevation monadnocks in central and southern NH, and several lower elevation cold microhabitats. Many of these plants are disjunct from arctic centers of distribution in northern Canada. Grades into *subalpine* vegetation at lower elevations. Compare *subalpine*.

anions: Negatively charged *ions*.

back-dune: In a coastal sand dune system, the dune farthest from the sea and least influenced directly by wave action and salt water. Compare *fore-dune*.

bankfull discharge: The highest level of water a river channel can reach prior to spilling over its banks onto its *floodplain*; bankfull discharge is exceeded (e.g., river achieves flood stage) on average every 1-3 years.

barrens: A nutrient-poor area that is either sparsely vegetated (<25% total cover) or dominated by shrubs or herbs (<50% total cover) with or without sparse tree cover.

basal till (lodgement till): Base layer of compact *glacial till* deposited directly under the ice.[7] Basal till is the most common soil parent material in New Hampshire, and like *ablation till*, it consists of an unsorted, unstratified mix of rock fragments, sand, silt, and clay. Also referred to as a Cd horizon, or densipan. Basal till often forms relatively smooth landscapes with frequent drainages compared to more rolling or choppy landscapes formed by ablation till.

basalt: A fine-grained, *basic igneous rock*, consisting essentially of a plagioclase feldspar (calcium and sodium feldspar), a pyroxene, and with or without olivine. Yields *circumneutral* or *basic* soils with high nutrient availability.[2]

base cations: Positively charged *ions* including calcium, magnesium, sodium, and potassium that generally have a higher concentration under *basic* (*alkaline* or *calcareous*) conditions.

base saturation: Measurement of the percent of the *cation exchange capacity* occupied by *base cations*; in soils, a base saturation of 100% indicates a pH of about 7.0 or higher.[12]

basic: Precisely, any water or soil with a pH >7.0; practically, applied to any soil with a pH of 7.4 or greater. Applied to an *igneous rock* that contains a relatively low amount of silica (45-52%) and a relatively high amount of *base cations*. Compare *acidic*, *calcareous*, *circumneutral*, *intermediate*, and *mafic*.

B horizon: A mineral soil layer characterized by accumulation of nutrients, organic matter, and fine sediments leached from the A or E horizon above. Organic matter content is less pronounced than in the A horizon and is due to decomposition of roots or precipitation of organic coatings on mineral surfaces rather than by physical mixing.

biome: Large regional or continental-scale biotic ecosystems. Each has distinctive life forms and species that are adapted to the environment. Often correspond closely to the major climatic regions of the world, e.g., boreal forest biome; eastern deciduous forest biome; desert biome.

bog: Bogs are defined in a narrow sense and a broad sense: 1) The narrow hydrologic definition is an o*mbrotropic peatland* whose only source of water is precipitation; 2) The less restrictive definition used in this document is an oligotrophic peatland with superacid conditions (pHs<4.0). In this definition, bogs may receive minor inputs of minerotrophic water, but are floristically and trophically similar to ombrotrophic peatlands. Compare *fen*.

boreal: (1) Applied to a climate zone with short, warm summers and snowy winters. (2) Applied to northern coniferous forests growing in a boreal climate, or individual species that have a boreal distribution. Boreal forest species in New Hampshire include balsam fir and quaking aspen. Compare *transitional*, *central hardwood*, and *coastal plain*.[2]

calcareous: Soil or rock containing calcite (calcium carbonate $CaCO_3$). When applied to a rock, it implies that as much as 50% of the rock is calcium carbonate. When applied to a soil, it implies that there is sufficient calcium carbonate, or other carbonates such as dolomite, to effervesce visibly or audibly when treated with cold dilute (0.1M) HCl. Bedrock or soils rich in calcium derived from non-carbonate sources of calcium (*igneous* and most *metamorphic* rocks) are technically not "calcareous" in the sense used by soil scientists and geologists (see *basic*, *intermediate,* and *circumneutral* as alternative terms). Calcareous soils generally have circumneutral pHs (6s and 7s). Compare *acidic*, *basic*, *circumneutral*, *intermediate*, and *mafic*.

calcifuge: see *acidophile*.

calciphile (calcicole): A plant species that grows best or is adapted to compete successfully in calcium-rich soils.

cations: Positively charged *ions*. Compare *anions*.

cation-exchange capacity (CEC): The sum total of exchangeable *cations* that a soil can adsorb[7] including base-cations plus exchangeable aluminum and hydrogen ions. Cations are held on charged sites that consist mainly of organic humus and clay soil particles; therefore, CEC is directly proportional to humus and clay content. Compare *base saturation*.

central hardwood: Applied to forest regions that have oaks, hickories, flowering dogwood, sassafras, and numerous other plant species found in the Appalachian states but which reach their northern limit in or near southern New Hampshire. Compare *boreal, transitional,* and *coastal plain*.

cespitose: Growing in dense tufts (compact clusters with closely-spaced stems).

C horizon: Parent material or soil that has been minimally modified by soil forming processes.

circumneutral: Water or soil with pHs between 6.0 and 7.9. This includes Wherry's (1919) minimacid (6s) and minimalkaline (7s) categories. Compare *acidic*, *alkaline* or *basic*, *calcareous*, *intermediate*, and *mafic*.

coastal plain: A 10-100+ mile wide biophysical region along the Atlantic and Gulf coasts from Texas to New England, characterized by certain plants that are restricted to or concentrated in this area. Evolutionarily, many of these plants have tropical origins. Compare *boreal, transitional*, and *central hardwood*.

coevolution: Interdependent evolution of two or more species that have exerted selective forces on each other, resulting in an obvious ecological relationship or specialization between the species.

colluvium: Soil material and rock debris that has moved downslope by creep, slide, or local wash, and accumulated in lower landscape positions, (e.g., bases of steep slopes or cliffs).

cosmopolitan distribution: When a species grows over extensive areas of the earth, such as field horsetail, lady fern, and many of our "weedy" plants.

cryic: The coldest of the soil temperature classes for family groupings of soils in the USDA Soil Taxonomy system for soils in temperate regions. Mean annual soil temps are between 0-8˚C (32-46˚F).[1]

densipan: A hardened *soil horizon*, usually found in the middle to lower portions of a soil profile, which may impede *drainage* and restrict root penetration (except along cracks). Densipans develop from compaction of sediments by glaciers as found in *basal tills*.[1] Synonymous with duripan; colloquially referred to as *hardpans*.

dimictic: A body of fresh water that experiences vertical mixing twice during one year.

diorite: A coarse-grained, *intermediate, igneous rock* that consists of plagioclase (sodium and calcium) feldspar (~75% or more) which are more calcium-rich than the feldspar in *granite*, or *granodiorite*, together with one or more ferromagnesian minerals (~20%) including amphibole, biotite, hornblende, augite, and almost without quartz (~3%). Often yields less *acidic* intermediate or *circumneutral* soils.[2]

discharge: The movement of water from the groundwater table to the surface of the ground or atmosphere. Also, the volume of water flowing past a given point in a stream channel in a given period of time.[2]

disjunct: Plant distributions that are notably distant from the primary range edge. For example, *alpine* areas in New Hampshire are said to be disjunct from the widespread ring of arctic flora found in the polar region to the north of the *boreal* forests.

dolomite: A calcium magnesium carbonate mineral. Also, a sedimentary rock (preferably called dolostone) with a high content of magnesium-calcium carbonate. Produces calcium and magnesium rich soils with high pH and nutrient availability.

drainage: Refers to the depth, frequency, and duration of periods of water saturation in a soil. A series of drainage classes (ranging from excessively well-drained to very poorly drained) have been described by the USDA that reflect the average, long-term water budget for a soil as affected by landscape position, groundwater fluctuations, and soil texture.

drumlins: Elliptical hills formed from till by the movement of glaciers, typically with a steep face on the lee-side of the direction of glacial travel. They are most common in central and southern New Hampshire. The bases of drumlins are often characterized by compact *basal till*.

dune: see *back-dune* and *fore-dune*.

ecotone: A transition zone between two or more communities, sharply defined and often corresponding to an environmental gradient or discontinuity (e.g., differences in disturbance, *succession*, soils, or climate). from [1, 2, 9]

edaphic: Of, related to, or influenced by soil.

E horizon: A soil layer beneath an O horizon or (less commonly) an A horizon. Characterized by mineral soil that has had most soil nutrients, organic matter, iron, and aluminum leached away to the B horizon. Usually indicates cool, moist, *acidic* environments. Fairly common in New Hampshire's forested soils from the White Mountains northward. See also *Spodosols*.

endemic: Referring to species that are restricted to a particular geographic region. Dwarf cinquefoil, only found at a few sites in the White Mountains, is considered endemic to New Hampshire.

Entisols: Young mineral soils that have had no or very little horizon development. The O horizon can be thin or absent. Common floodplain soils that have either been recently formed or that continue to accumulate sediments, and on coarse *outwash* or stream terrace deposits.

ericaceous: Pertaining to plants of the heath family.

esker: A long, narrow, steep-sided, and usually sinuous ridge of sand and gravel (often crossbedded) that has been deposited by meltwater from a glacier or ice sheet, usually forming along the margins of a downwasting glacier or in torrents inside a glacier. Subsidence of turbulent waters and melting of the glacier dumps the former streambed material in place.

estuarine: A coastal waterbody with a free connection to the open sea, where fresh and salt water mix (brackish water); also refers to other ecosystems which are directly influenced the brackish tidal waters.

eutrophic: Freshwater or upland soils that have high nutrient levels, and are therefore very high *productivity* / high nutrient systems. Compare *mesotrophic* and *oligotrophic*.

evapotranspiration: A collective term for the sum of evaporation from soils and water bodies and transpiration through plants, usually expressed in comparison to rainfall amounts; an output from the water budget system.

felsenmeer: A German word meaning "sea of rocks," applied to extensive fields of large, angular, frost-cracked boulders found in alpine and arctic environments where precipitation soaks in without apparent runoff. Felsenmeer is one type of surface features that result from differential movement of coarse and fine material from freeze-thaw cycles in arctic-alpine environments. These boulder fields have been described as "fossil," meaning they are inactive, although some scientists have concluded that they still move by slow "felsenmeer creep" on top of a slurry of silty, stony soils. Boulders show signs of weathering and are covered with lichens on their upper surfaces.

fen: A peat-accumulating wetland that develops where the water source has at least some mineral enrichment. Compare *bog* and *minerotrophic*.

floodplain: Nearly level land, consisting of sediments deposited by a stream or river along its borders and subject to periodic flooding. On average, the lowest floodplains flood every 1-3 years; this occurs when the river exceeds its "bankfull discharge", the highest level of water the river channel can hold prior to spilling over its banks. River *terraces* with flood return intervals of more than 100 years are referred to in this document as *terraces* (ancient floodplains); those with less than 100 year return intervals are referred to as floodplains.

fluvial: Deposits of sediments transported and sorted by the action of moving water.

forb: Collective term for *herbaceous* plants, excluding *graminoids* (grasses and grass-like plants) and ferns.

forest: Applied in classification to communities with more than 65% cover by trees that are >2m in height.

fore-dune: In a coastal sand dune system, the dune nearest to the sea and more influenced by wave action and salt water.[1] Compare *back-dune*.

frigid: The second coldest of the soil temperature classes for family groupings of soils in the USDA Soil Taxonomy system for soils in temperate regions, corresponding to soils with average annual temperatures of <47°F (8°C) at 20" below the surface, but whose summer temperatures are at least 5F greater than those in winter. Compare *cryic* and *mesic*.[1]

gabbro: A coarsely crystalline *basic igneous rock*. Consists essentially of plagioclase feldspar and pyroxene, with or without olivine.[1] Yields *circumneutral* or *basic* soils with relatively high nutrient availability.

geomorphology: The study of the origin of landforms, especially their physical and surface features and processes that produced these features.

glacial drift: Clay, silt sand, gravel, stones, and boulders mixed in any proportion that has been transported and deposited by glacial ice or its meltwaters (collective term for all glacial deposits including *till*, *outwash*, and *ice-contact deposits*).

glacio-fluvial: Pertaining to processes or material moved by glacial meltwaters, including subsequent deposition by meltwater streams on land surfaces. The deposits are stratified and occur as *kames*, *eskers*, *deltas*, *ice-contact deposits*, and *outwash plains*.[8]

graminoid: Collective term for grasses and grass-like plants including sedges and rushes.

granite: A coarse crystalline *igneous rock* with quartz (at least 10%, and averaging 27%), potassium feldspar, and plagioclase feldspar (calcium and sodium) in roughly equal portions as the essential minerals. "Dark minerals" (mica, pyroxene, and amphibole) comprise 3-10%. Weathers slowly to produce *acidic*, nutrient poor soils.[2]

granodiorite: A coarse crystalline acid *igneous rock* with quartz, differing from *granite* by containing more plagioclase (sodium and calcium) than orthoclase (potassium) feldspar. Mica is commonly present.

Probably the most voluminous of the plutonic igneous rocks and predominates in most of the batholiths in the world. Weathers slowly to produce *acidic*, nutrient poor soils.[2]

groundwater: Water in the unblocked pores of soil sediments or fractures of bedrock below the *water table*.

halophyte: A terrestrial plant that is adapted morphologically and/or physiologically to grow in salt-rich conditions.[1]

hardpan: A colloquial term for a hardened or cemented *soil horizon*, usually found in the middle to lower portions of a soil profile, which may impede *drainage*. Partially synonymous with densipan and duripan. Hardpans develop from compaction of sediments by glaciers as found in *basal tills*.[1]

hardwater: Water rich in dissolved minerals, especially calcium.

herbaceous: Non-woody vascular plants having no parts that persist above the ground after the growing season. Includes forbs, ferns, and graminoids.

hibernaculum: A shelter occupied during the winter by a dormant animal (e.g., bats).[4]

Histosols: Organic soils (moderately well to very poorly drained) that form in cold, moist to wet, usually acid, nutrient-poor conditions that inhibit the decomposition of organic matter. Characterized by a thick organic horizon, and include *muck* and *peat* soils. Common in wetlands as well as some high-elevation areas (e.g., spruce - fir forests and *alpine* tundra) where thick organic horizons have formed on rock. Compare *Inceptisols*, *Spodosols*.

hollow: A generally small, variably sized topographic depression (generally <1 to several meters in width and up to several feet high), found in *peatlands* or uplands; may or may not support intermittent standing water. Hollows are separated from each other by *hummocks* and may form as a result of numerous causes, such as windthrow in swamps and upland forests and differential decomposition and ice-wedging in some peatlands. Hollows are also called "pits," as in "pit-and-mound topography," particularly as applied to uplands. Compare *hummock*.

horizon: see *soil horizon*.

hummock: A mound in a *peatland* or upland community, up to several feet in height, and separated from other hummocks by *hollows* or "pits." Compare *hollow*.

hydrogeomorphic: Land or soil structures formed by water activity; refers to the physical and hydrologic characteristics associated with a particular geomorphic or landscape setting.

hydric: Pertaining to a condition of being inundated by water, or soils formed in poorly drained conditions (under the influence of permanent or intermittent inundation). Compare *mesic, xeric*.

ice-contact deposits: Variously sorted and *stratified* deposits formed from meltwater deposits in or at the edge of a downwasting glacier (includes *kames*, *eskers*, and other undifferentiated deposits).

igneous rocks: Rocks formed by the cooling and solidification of molten material. Compare *metamorphic rocks* and *sedimentary rocks*.

Inceptisols: Soils formed where leaching and *weathering* of iron, aluminum oxides, and other materials are less intense than *Spodosols*, resulting in somewhat less distinct and more yellowish-brown Bw horizons. The O horizon tends to be thinner than in *Spodosols* in well drained situations, but can still be significant, particularly in wetlands. Many of New Hampshire's low to mid elevation and southern upland forests and some wetlands are formed on inceptisols. Compare *Histosols*, *Spodosols*.

intermediate: Applied to *igneous rocks* that contain intermediate amounts of silica (50-60%), but generally <10% quartz. Intermediate rocks, such as *syenite* and *diorite*, may produce *circumneutral* to *acidic* soils. Compare *acidic*, *basic*, *calcareous*, *circumneutral*, and *mafic*. Also used in this document to refer to wetlands of intermediate nutrient status, e.g., between *oligotrophic* and strongly *minerotrophic*.

ions: Charged particles including *cations* (positive charge) and *anions* (negative charge). Nutrients become available to plants as elements and minerals in ionic form.

kame: An irregular, short ridge or hill of *stratified glacial drift*.[6] Geologists have come to use this term more restrictively. *Ice-contact deposits* include various kame and kame-like deposits.

kettlehole: A depression formed from the melting of a remnant, stagnant ice block stranded in surrounding *glacial drift*.

krummholz: Gnarled, stunted, and shrub-like forest characteristic of timberline, generally less than 2m in height. Balsam fir and black spruce are the most common krummholz formers in NH at high elevations, replaced by or mixed with red spruce on *subalpine* summits around or below 4000 ft.

lacustrine: Referring to freshwater lakes and ponds.

lagg: A minerotrophic, often moat-like, shallow water zone around the margin of a peatland, characterized variously by sedges, forbs, or tall shrubs. Lagg zones are influenced by minerotrophic upland runoff, are stagnant or slowly drained, and may have seasonally fluctuating water levels. They contrast with more interior portions of a peatland that are less influenced by upland runoff.

lakebed deposits: Fine sediments (consisting primarily of clay and silt) that settled-out in the quiet-water environments at the bottom of lakes.

levee: An elevated ridge formed parallel to a river from sediments that settle out of the water overflowing the banks, usually consisting of coarser sediments which settle due to the decreased water velocity away from the main river channel (finer particles are carried further from the river).

liana: A vine or any wiry or woody, free-hanging, climbing plant that roots in the ground.

limestone: A *sedimentary calcareous* rock primarily composed of calcium carbonate. Produces calcium rich soils with high pH and nutrient availability.

limnogenous: Pertaining to lakes and other freshwater bodies. Refers to peatland hydrology; limnogenous peatlands form adjacent to surface water bodies. Compare *soligenous* and *topogenous*.

lodgement till: see *basal till*.

mafic: Applied to the ferromagnesian minerals or to *igneous rocks* relatively rich in such minerals (e.g., *gabbro*). The term *ultramafic* is applied to rocks primarily composed of ferromagnesian minerals (e.g., olivine or pyroxine). Compare *acidic*, *basic*, *calcareous*, *circumneutral*, *intermediate*, and *ultramafic*.

mesic: 1) Applied to moist, well drained soils, intermediate between *xeric* and *hydric* soils. 2) Also refers to the warmest of the soil temperature classes for family groupings of soils in the USDA Soil Taxonomy system for soils in temperate regions, corresponding to soils with mean annual temperatures of between 8-15˚C (47-59˚F) at 20" below the surface.[1] Compare *xeric*, *hydric*, *frigid*, and *cryic*.

mesotrophic: Freshwaters or upland communities that have intermediate nutrient levels, and are therefore moderately productive; intermediate between *oligotrophic* and *eutrophic*. The term is often applied to mires. **submesotrophic:** intermediate between mesotrophic and oligotrophic (low *productivity*). **permesotrophic:** intermediate between mesotrophic and eutrophic (moderate *productivity*).

metamorphic rocks: Rocks formed from recrystalization (without melting) of pre-existing rock (igneous or sedimentary) by high temperature and pressure. Compare *igneous rocks* and *sedimentary rocks*.

mineralization: Decomposition of organic matter by microbes, converting bound, organic forms of minerals into ionic forms readily absorbed by plants (e.g., conversion of inorganic forms of nitrogen into ammonium (NH_4^+) is called nitrogen mineralization).

mineralogy: The study of minerals, including their distribution, identification, and properties. The mineral composition of bedrock has a strong influence on the texture and nutrient composition of sediments that develop from it. Minerals in bedrock are the primary source of many of the nutrients that plants need to grow.

minerotrophic: Water or soils, enriched or containing nutrients important for plant growth; usually used in a relative or comparative sense. Compare *oligotrophic* and *ombrotrophic*.

monomictic: A freshwater body that experiences vertical mixing once a year.

montane: Refers to relatively cool, moist upland slopes below timberline in the mountains.

monzonite (quartz monzonite): A granitic rock with the feldspar component consisting of at least 10% calcium feldspar.

mottles: Alternating spots of grayish and reddish soil formed when soil saturation occurs but is not continuous through the year. Mottles are now called "redoxymorphic features" by soil scientists). The depth to mottling is an indicator of where the *water table* is present for a significant portion of the year.

muck: Dark colored, fine, well-decomposed and unrecognizable organic material generally with a higher mineral sediment content than *peat*. Compare *peat*.

natural communities: Recurring assemblages of species found in particular physical environments. Each type is distinguished by three characteristics: (1) a definite plant species composition, (2) a consistent physical structure (such as forest, shrubland, or grassland); and, (3) a specific set of physical conditions (such as different combinations of nutrients, *drainage*, and climate conditions).

non-native (alien): Referring to species having various original distributions, but mostly introduced from Europe or Asia, now occurring in an area to which it is not native. Purple loosestrife is an example of an alien species.

O horizon: A soil layer found at the ground surface consisting of partially decomposed leaf litter and other organic matter, with little or no mineral soil component. Thick when conditions are either very wet and/or very cold and *acidic*.

oligotrophic: Nutrient-poor waters or soils with low primary *productivity*. Compare *mesotrophic, eutrophic*.

ombrotrophic: Peatlands that are fed entirely by precipitation, receiving essentially no surface runoff or groundwater. Ombrotrophic peatlands are typically "raised peatlands" and are not found in New Hampshire.

outwash: Glacial drift that has been transported, reworked, sorted, and stratified by glacial meltwaters beyond the margin of the glacier. Compare *ice-contact deposits*, *scree*, *talus*, *till*.

oxbow: Former river channels that have been abandoned as a river changes its course, leaving a depression in the terrace. Occasionally, oxbow ponds develop in the old river channel depressions; they are persistently full of water and have species and processes similar to upland ponds.

palustrine: Referring to non-saline inland wetlands.

peat: Coarse, unconsolidated, largely undecomposed accumulations of organic matter formed under *hydric* conditions or excess moisture; **peatland:** any graminoid, shrub, forested, or moss-dominated wetland formed on peat deposits. Compare *muck*.

permesotrophic: see *mesotrophic*.

pH: The log-scale measure of acidity or alkalinity of a substance, based on the concentration of hydrogen *ions* (H^+) in a liter of solution; expressed in terms of $pH = \log_{10}(1/[H^+])$, where $[H^+]$ is the hydrogen ion concentration. The scale ranges from 1 to 14, with each unit representing a 10x change in acidity (e.g., pH 6 is 10 times as acidic as pH 7). Values below 7 are *acidic*, values above 7 are *alkaline* (*basic*), and 7 is neutral. In this document, the pH scale is broken into several ranges according to Wherry's (1919) definitions: pHs in the 3s are *superacid*; 4s are *mediacid*; 5s are *subacid*; and 6s (*minimacid*) and 7s (*minialkaline*) are collectively referred to as *circumneutral*.

physiognomic: Referring to the structural characteristics of vegetation (e.g., forest, *woodland*, scrub, *herbaceous*).

phytogeography: The study of the geography of plants, particularly their distribution at different taxonomic levels.[1]

pit: see *hollow*.

poor: Infertile soils that have lower *exchange capacity, base-saturation, pH*, and/or nitrogen availability than intermediate or *rich* soils. Corresponds to *oligotrophic* (very low) and *sub-mesotrophic* (low) *productivity*/nutrient regime categories. Compare *rich*.

productivity: The total biomass of vegetation generated over time in a given area (gross primary productivity), usually measured as above ground biomass. Productivity varies greatly at both regional and local scales.

recharge: Movement of groundwater from the surface into the groundwater table.

resilience: A measure of the ability of an ecosystem or *natural community* to recover from external disturbance to a former state (e.g., characteristics of nutrient cycling, species composition, and diversity).

resistance: A measure the ability of an ecosystem or community to absorb an external disturbance without resulting in major changes to such key characteristics (e.g., nutrient cycling, and species composition and diversity).

rhyolite: A fine-grained to glassy *acidic igneous rock* with a similar mineralogical and chemical composition to *granite*. Weathers slowly to produce *acidic*, nutrient poor soils.[2]

rich: Fertile soils that have higher *exchange capacity, base-saturation, pH*, and/or nitrogen availability than intermediate or "*poor*" soils. Usually corresponds to the *permesotrophic* (high) or, less commonly, the *mesotrophic* (moderate) nutrient regime categories. *Calcicoles* (*calciphiles*) are characteristic indicators of rich soils. Compare *poor*.

river channel: Area between *riverbanks* covered by water for at least a portion of the year.

riverine: Referring to rivers.

riverbank: The elevated ground bordering and containing a river.

salt-pan: An undrained natural depression in which water gathers and leaves a deposit of salt upon evaporation.[4]

scree: Defined by some authors as synonymous with talus, but used in this document in a narrower sense corresponding to **stone to gravel sized** coarse *weathered* rock debris, found on slopes at cliff bases. Often lies at the angle of repose. Compare *outwash, talus, till*.

sedimentary rocks: Rocks formed by consolidation of sediments deposited by wind or water. Compare *igneous rocks* and *sedimentary rocks*.

seepage: Lateral water flow through soil; transports nutrients to and through wetlands from soil and bedrock source areas. May emerge at the land surface where hydraulic pressure and an underlying impervious layer forces water from the subsurface or it may remain below the surface where its presence is much more obscure. Many fens are influenced by some degree of groundwater seepage; seeps are small emergence zones on sloped uplands where seepage water emerges.

seral: Relating to or constituting an ecological sere (a sequence of ecological communities that successively occupies an area). See *succession*.

serpentine: Referring to a group of physically and chemically related minerals. They are often dull green in color (also yellow and brown) with a greasy luster. The two most common minerals of this group are antigorite and chrysotile. See also *serpentinite*.

serpentinite: Metamorphic rocks formed from *ultramafic* parent rocks, composed primarily of minerals of the *serpentine* group. Often (inaccurately) referred to as serpentine rock. See also *serpentine*, *ultramafic*.

siliceous: Containing silica or high concentrations of silica; *granite* is a siliceous rock type.

softwater: Water that lacks dissolved minerals, esp. calcium.

soil development: The process of physical and chemical alteration of parent material under the influence of climate, hydrology, organisms, and time.

soil horizons: More or less horizontal layers of soil that have distinct physical and chemical characteristics resulting from soil forming processes. The original soil material, climate, and the amount and quality of water that percolates through the soil profile are critical factors affecting the development of soil horizons. See also definitions of major types of horizons, including *O*, *A*, *E*, *B*, and *C*.

soil orders: Major groups of soils, defined according to the presence and characteristics of certain horizons, including their degree of definition, color, and depth as influenced by the intensity and length of time that soil forming processes have been at work. Four soil orders are found in New Hampshire.

soligenous: Pertaining to ground water. Refers to *peatlands,* such as *fens*, that are supplied with ground water.[2] Compare *limnogenous* and *soligenous*.

soligenous peatland: A type of minerotrophic *peatland* associated with a reliable source of *seepage* water that flows through or over the surface peat.[11] Sloped fens are a type of soligenous peatland.

Spodosols: Order of soils found in cool, cold, wet, or *acidic* upland areas where intense leaching produces distinct horizons including a moderate to thick O horizon, a grayish E horizon, and often a reddish brown B horizon due to the deposition of iron and aluminum oxides from above. Common under northern hardwood and spruce - fir communities. Compare *Histosols*, *Inceptisols*.

stratified drift: Sediments that have been sorted (by particle size) and stratified into layers by moving glacial meltwaters away from the glacial margin.

subalpine: Vegetation zone intermediate between alpine and spruce - fir forests, characterized by stunted spruce and fir trees and a more limited number of alpine species than in the higher elevation *alpine*

region. Generally occurs between 3000-4900 ft. on exposed ridges and summits on thin soils, sometimes expanded by historical fires. Compare *alpine*.

submesotrophic: see *mesotrophic*.

succession: Any sequential change in vegetation that follows an environmental change (e.g., disturbance) or some influence of the organisms themselves.

syenite: A coarse-grained, *felsic igneous rock*, characterized by a lack of quartz, the presence of feldspars, with or without feldspathoids and such ferromagnesian minerals as biotite, hornblende, augite, and more alkaline types. Typically yields *acidic* or *circumneutral* soils.[2]

talus: A sloping mass of coarse rock debris accumulated at the foot of a cliff or slope formerly consisting of a cliff. Debris size consists mostly of stones (>3-24") and boulders (>24" diameter). Compare *scree, till, outwash*.

terrace: A nearly flat portion of a landscape which is terminated by a steep edge; elevated portions of alluvial sediments, rock-cut benches, or other planar features along a stream valley.[1,4] Terraces can be within the active *floodplain* and flooded at some interval or may be ancient floodplain terraces that no longer flood due to downcutting of river channels and lower river volumes. Ancient floodplain terraces that are beyond the approximate 100 year flood return interval are referred to in this document simply as "terraces." Terraces within the 100 year floodplain are referred to as either "floodplains" or "floodplain terraces."

till (glacial till): Deposited glacial material consisting of unsorted, unstratified clay, sand, gravel, and rock fragments intermingled in any proportion. Compare *scree, talus, outwash*.

topogenous: Pertaining to surface runoff. Refers to *peatlands* where the primary water source is topographic runoff. Compare *limnogenous* and *soligenous*.

transitional: Applied to the forest region between spruce - fir/northern hardwoods and central hardwood forest regions that generally lacks both *boreal* and *central hardwood* species, but that has an abundance of *Alleghanian* species. Compare *boreal, central hardwood*, and *coastal plain*.

trophic: Pertaining to nutrients and *productivity*. See also nutrient regime and productivity classes under *oligotrophic*, *mesotrophic*, and *eutrophic*.

ultramafic: Dark colored bedrock rich in magnesium and iron, creating a high Mg-Ca ratio. Often produces a toxic effect on plants and limits growth to certain Mg-tolerant species (e.g., *serpentine*). Ultramafic rocks are igneous rocks composed of *mafic* minerals – primarily pyroxene and/or olivine. They are commonly partially metamorphosed to *serpentinite*. See also *serpentine, serpentinite*.

variants: A lesser form of described variation within a *natural community* type related to environmentally-based (as opposed to successionally-based) variation. Variants are characterized by relatively minor vegetation differences and minor or major soil differences. This may include a shift in dominant tree species where the understory vegetation remains identical, or a simple shift in abundance of one or more species. A variant of a natural community is analogous to a subspecies of a species.

water table: The upper surface or limit of groundwater, or that level below which the soil is saturated with water.[7]

weathering: The physical and chemical process of breaking down the original complex molecules of primary minerals in parent material (e.g., bedrock, *till*) and soil to more available forms.

woodland: Applied in the classification to wooded communities with 25-65% cover by trees.

xeric: Characterized by a lack of moisture. Compare *mesic, hydric*.

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Appendix 1. Explanation of Global and State Rank Codes.

Ranks describe rarity both throughout a species' range (globally, or "G" rank) and within New Hampshire (statewide, or "S" rank). The rarity of sub-species and varieties is indicated with a taxon ("T") rank. For example, a G5T1 rank shows that the species is globally secure (G5) but the sub-species is critically imperiled (T1).

Code	*Examples*		*Description*
1	G1	S1	Critically imperiled because extreme rarity (generally one to five occurrences) or some factor of its biology makes it particularly vulnerable to extinction.
2	G2	S2	Imperiled because rarity (generally six to 20 occurrences) or other factors demonstrably make it very vulnerable to extinction.
3	G3	S3	Either very rare and local throughout its range (generally 21 to 100 occurrences), or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction because of other factors.
4	G4	S4	Widespread and apparently secure, although the species may be quite rare in parts of its range, especially at the periphery.
5	G5	S5	Demonstrably widespread and secure, although the species may be quite rare in parts of its range, particularly at the periphery.
U	GU	SU	Status uncertain, but possibly in peril. More information needed.
H	GH	SH	Known only from historical records, but may be rediscovered. A G5 SH species is widespread throughout its range (G5), but considered historical in New Hampshire (SH).
X	GX	SX	Believed to be extinct. May be rediscovered, but evidence indicates that this is less likely than for historical species. A G5 SX species is widespread throughout its range (G5), but extirpated from New Hampshire (SX).

Modifiers are used as follows.

Code	*Examples*		*Description*
Q	G5Q	GHQ	Questions or problems may exist with the species' or sub-species' taxonomy, so more information is needed.
?	G3?	3?	The rank is uncertain due to insufficient information at the state or 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 species' status appears to fall between two ranks, the ranks may be combined. For example:

G4G5	The species may be globally secure (G5), but appears to be at some risk (G4).
G5T2T3	The species is globally secure (G5), but the sub-species is somewhat imperiled (T2T3).
G4?Q	The species appears to be relatively secure (G4), but more information is needed to confirm this (?). Further, there are questions or problems with the species' taxonomy (Q).
G3G4Q S1S2	The species is globally uncommon (G3G4), and there are questions about its taxonomy (Q). In New Hampshire, the species is very imperiled (S1S2).

Appendix 2. Exemplary Natural Community Reporting Form.

The Natural Heritage Bureau places particular emphasis on and gives conservation priority to "exemplary" natural communities (see introduction for more detail). If you think you have found an exemplary natural community, you can use the reporting form included on the next two pages.

Send completed forms and maps to:
Data Manager
DRED / NHB
P.O. Box 1856
Concord, NH 03302

Exemplary Natural Community Reporting Form

Please provide the following information when reporting the location of a natural community to the New Hampshire Natural Heritage Bureau (NHNHB). *Particularly important information is indicated by an asterisk; other items are desirable but not required.* Call (603) 271-2214 with any questions. Thank you!

Location

*Town: _____ County: _____

*Site Name _____

*Directions: _____

*Please attach a map. USGS Quad Name: _____

Note: A xeroxed portion of a USGS topographic map is **required**, with an outline of the area you actually visited. Optional: add another outline of what you believe to be the full extent of the natural community, beyond the area actually visited.

Identification

*Your ad hoc name (e.g., *Typha* emergent marsh): _____

NHNHB Community Name: _____

Classification document used (name, date): _____

Other classification (NWI, SAF, etc): _____

*Broad ecological group (e.g., riparian forest and woodland; coastal marsh):

_____

*Community Structure

_____ Forest (canopy cover >60%)
_____ Woodland (canopy cover 25-60%)
_____ Shrubland (<25% trees; >25% shrubs or shrubs the dom. life form)

_____ Herbaceous (herb dom; <25% woody)
_____ Nonvascular (lichen, bryophyte, or algae dom.)
_____ Sparse vege. (substrate-dominated; <25% vege.)

Cover type: (of upper or dominant stratum)

_____ Generally coniferous-dominated
_____ Generally mixed (ca. 25-75% each)
_____ Generally deciduous-dominated

Cover class or %: closed (>75%); high (50-75%); moderate (25-50%); low (5-25); sparse (1-5%); scattered (<1%); absent (0%): if uncertain, use a range (e.g., "moderate to high").

Canopy cover: _____

Shrub layer cover: _____

Herb layer cover: _____

Nonvascular cover: _____

Bare substrate cover: _____ Substrate type (outcrop, boulder, cobble etc): _____

Community Composition

*Dominant canopy species: _____

_____

Other common canopy species: _____

_____

Dominant understory species: _____

_____

Dominant shrub layer species: _____

_____

Dominant herb layer species: _____

_____

*Other characteristic species (indicators of distinctive conditions, e.g., high pH soil, elevation, geographic region, other particularly abundant species):

_____

_____

Environment

*Topographic position (e.g., ridge crest, toe slope): _____

Geology/rock type: _____

Soil texture or type (peat, muck, sand, silt etc or NRCS name): _____

*Moisture regime		*Flood regime	
Hydric	_____	Inundated	_____
Wet-mesic	_____	Seasonally flooded	_____
Mesic	_____	Temporarily flooded	_____
Dry-mesic	_____	Saturated	_____
Dry (xeric)	_____		

Other important environmental factors (e.g., steep slope, wind exposure):

_____

Quality

*Estimated size of community (contiguous or close together in natural landscape): _____

*Confidence in size estimate: High _____ Medium _____ Low _____

Size of surrounding natural landscape (total natural area): _____

*Quality of surrounding landscape (e.g., natural high quality; natural low quality, residential)

Within 1/4 mile: _____

Within 1 mile: _____

*Maturity (for forests/woodlands: age &/or DBH of canopy trees; density of large snags/acre; time since last major disturbance): _____

_____

*Evidence or knowledge of human disturbance (logging, old roads, ditches, foot trails):

_____

How much has human disturbance impacted the integrity of the natural community?: _____

_____

Exotic species (species, abundance, ecological effect): _____

_____

_____

*Disruption of natural disturbance regime (e.g., fire suppression, flood alteration): _____

_____

Other Site Information

Other natural community types present: _____

_____

Rare species present: _____

_____

*Owner/manager of site: _____

Current protective designation? (TNC Preserve, State Park, etc.):

_____

Documentation

*Name of contributor: _____

Describe any additional information or documentation you have for this occurrence/site:

_____

_____

Others knowledgeable about the community or site: _____

*Date natural community last observed: _____

INDEX OF NATURAL COMMUNITIES

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