Natural Communities of New Hampshire

Second Edition

Daniel D. Sperduto
William F. Nichols

New Hampshire Natural Heritage Bureau

NEW HAMPSHIRE NATURAL HERITAGE BUREAU

To administer the New Hampshire Native Plant Protection Act (RSA 217-A), the New Hampshire Natural Heritage Bureau (NH Natural Heritage) collects and analyzes data on the status, location, and distribution of native plant species and natural communities in the state. In addition, the bureau develops and implements measures for the protection, conservation, enhancement, and management of native New Hampshire plants and natural communities, determines which plant species are threatened and endangered, and acts as an information resource program to assist and advise state and local agencies, and the public.

NH Natural Heritage is located within the NH Department of Resources and Economic Development's Division of Forests and Lands. 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.

NH Natural Heritage 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 CONSERVATION LICENSE PLATE

The NH Natural Heritage Bureau received significant funding for this project from New Hampshire's Conservation License Plate program (the "Moose Plate"). Purchase of a Conservation License Plate promotes, protects, and invests in New Hampshire's natural, cultural, and historic resources. You can purchase a Conservation License Plate at your municipal office, whether you are registering your car for the first time or renewing an existing registration. In addition, you can purchase a gift certificate for someone else to use when registering or renewing his or her car. For details about the Conservation License Plate Program, visit: www.mooseplate.com.

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A NOTE ON THE SECOND EDITION

Since *Natural Communities of New Hampshire* was first published in 2004, we have collected and analyzed additional plot data and learned more about the composition of the state's natural communities. As a result, we have refined the classification in a variety of important ways: several new communities have been added while others have been combined, split apart, or deleted entirely, leading to some changes in overall classification structure and hierarchy.

In addition, numerous edits were made throughout the text. All of these changes reflect our improved understanding of New Hampshire's landscape and its biodiversity. The end result is an improved classification that will increase the manual's utility and application for users in the state.

INTRODUCTION

NATURAL COMMUNITIES are recurring assemblages of plants and animals found in particular physical environments. New Hampshire is a mosaic of natural communities, encompassing habitats as varied as alpine meadows, riverbanks, forests, tidal marshes, ponds, and cliffs. Communities range from common and widespread types that cover hundreds or thousands of acres across broad areas of the state, to uncommon or rare types that are small and restricted to a specific part of the state, such as the White Mountains or Seacoast region.

Across much of the landscape, a few forest types form a matrix, with other natural community types occurring as patches embedded within that matrix. Each natural community type occurs in specific settings in the landscape, such as wind-exposed rocky summits at high elevations, or muddy coastal river shores flooded daily by tides. Natural community types vary with changes in physical settings, resulting in predictable patterns across the landscape.

Each community has a distinct set of environmental conditions that support certain species adapted to those conditions. For example, a ***rich mesic forest*** typically has a canopy of hardwoods such as 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 woodlands***, in contrast, develop on extremely dry, nutrient-poor sands and gravels, and are characterized by drought- and fire-resistant pitch pine, scrub oak, lowbush blueberries, and a variety of rare moths and butterflies that depend upon these plants and conditions.

Classifying natural communities is a useful way of viewing the landscape because it allows us to distill the broad range of complex interactions between organisms and their environments into a limited number of units. Three primary characteristics distinguish natural communities from one another:

- plant species composition;
- vegetation structure (e.g., forest, shrubland, or marsh); and
- a specific combination of physical conditions (e.g., water, light, nutrient levels, and climate).

Natural community types are usually defined in terms of plants because they are relatively easy to study, often compose the physical structure to which most other living things respond, and are sensitive indicators of physical *and* biological conditions in the environment. Since plant communities often correspond closely to distinct assemblages of other types 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?

Classifying 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. 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 intensified the pressure on natural landscapes, and society has become increasingly concerned about protecting biodiversity. One approach to protecting biodiversity is the identification and conservation of natural communities. 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 protected and maintained, many other forms of life will benefit; if they cannot, the species they contain may be in

jeopardy.

Classification of natural communities 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 the vegetation of an area is common or uncommon, (3) know if the community is a big or small example of its type, (4) identify the combination of circumstances that likely affect the organisms present, and (5) infer how management and stewardship may influence the species present. Ultimately, classifying natural communities provides a tool to help develop conservation and management strategies that ensure the survival of all species.

CLASSIFICATION APPROACH AND LIMITS

One of the primary challenges in identifying and describing natural communities is that vegetation patterns are influenced by a spectrum of ecological factors that operate at multiple scales. However, it is this spectrum of factors that shapes the differences between natural communities. Below we describe our conceptual approach to classification issues (succession, size, scale) and relationships of this classification system to other systems.

Succession. This classification strives to define both late-successional species associations and those that are maintained in earlier successional stages by natural disturbance (e.g., fire in pine barrens and on rocky ridges and flooding in alder thickets or river channels). Other early successional occurrences or those significantly disturbed or manipulated by humans may be difficult to classify based solely on current vegetation composition, particularly for upland forests. In these cases, the best indicators of future conditions may be soil attributes, landform, and late-successional dominants in the understory.

Size. Different communities have different size ranges. Some 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. This natural size range must be taken into account when assessing the quality of a particular occurrence of a natural community.

Scale and comprehensiveness. Ideally, a classification system would be comprehensive, have similar magnitudes of variation *within* community types, and reflect distinct and definable differences *between* community types. However, no classification system can perfectly reflect community diversity in the landscape. This is due in part to 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 specific; and some types are simply missing because they have not yet been described (e.g., most deepwater aquatic marine, riverine, and lacustrine communities). Although these inherent scale and knowledge limitations exist, this manual provides our current best attempt at a comprehensive classification scheme, and it can be modified as we learn more.

Data analysis. The data available for classification vary in quantity and quality depending on the community being defined. Each community description in this document 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 large 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. 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, Sperduto and Nichols 2004) and community descriptions resulting from research on particular habitats within certain regions of the state (Leak 1982; Fincher 1991; Smith 1992; Fincher and Smith 1994; and others 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 somewhat more broadly scaled and less specific in concept to the natural communities described in this document. The NVC has been adopted by the Federal Geographic Data Committee for use by all federal agencies.

Relationships to soil types. The scale of natural community types is usually coarser than that of most mapped soil types, such that the extent of several defined soil series polygons might correspond to the boundary of one community occurrence. Some soil types, however, particularly wetland soil series, are more broadly defined and may directly correspond to individual communities. Soil descriptions in this manual usually 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.

NATURAL COMMUNITY SYSTEMS

Particular associations of natural communities repeatedly co-occur in the landscape and are linked by a common set of driving forces, such as landforms, flooding, soils, and nutrient regime. These are referred to as **natural community systems**. Systems are at an appropriate scale for many conservation applications, including mapping and predictive modeling, correspondence to wildlife and wildlife habitats, and as direct conservation targets in conservation planning. They can be used as a tool to track locations and compare entire sites without having to refer to all communities at a site, particularly when these communities may intergrade and be difficult to map. They allow general classification of a system when detailed information is not available or detailed surveys are not feasible. Systems can provide a more practical scale for conservation planning and site comparisons. Finally, systems can sometimes make more suitable mapping units than communities for integrating wildlife occurrence data and habitat needs with plant information, for example in the case of a kettle hole bog system that contains multiple peatland communities. The classification and mapping of exemplary natural community systems can therefore be effective at identifying high priority conservation targets. New Hampshire's natural community systems are listed and described in Natural Community Systems of New Hampshire (Sperduto 2011) and on the NHB website.

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

FIELD IDENTIFICATION OF NATURAL COMMUNITIES

You do not need to be a botanist to identify many of the natural communities in New Hampshire, but you do need a modest level of familiarity with plants and a working knowledge of the state'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. Some plants do require more in-depth

botanical knowledge, however. 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, University of New Hampshire Cooperative Extension, the NH Natural Heritage Bureau itself, 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. Most of the natural community descriptions in this classification include specific locations of good examples. Additionally, the NH Natural Heritage Bureau's website features an extensive list of sites where exemplary natural communities and rare plants can be visited (see the Visiting NH's Biodiversity guides at www.nhnaturalheritage.org).

EXEMPLARY NATURAL COMMUNITIES

The Natural Heritage Bureau places particular emphasis on and gives conservation priority to "exemplary" natural communities. For rare natural communities, all occurrences are considered exemplary. For more common community types, only the best examples are designated exemplary. In general, high-quality natural communities have experienced relatively little human impact. These exceptional conditions are desirable, because they are most likely to support the greatest variety of native species and the ecological processes on which they depend. However, an upland forest or wooded swamp need not be "old growth" to merit exemplary status. They typically have a range of features that distinguish them, such as a full suite of characteristic species, natural regeneration within canopy gaps, multiple age classes, diverse physical structure, abundant snags and fallen woody debris, intact soil processes, and little direct evidence of human disturbance. Exemplary natural communities represent many of the best remaining examples of New Hampshire's flora, fauna, and underlying ecological processes. The NH Natural Heritage Bureau identifies and documents these exemplary communities, to track their condition and inform the public of their conservation value.

CLASSIFICATION FORMAT

Each natural community description is divided into distinct sections. Below is a brief explanation of these sections, 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., ***sycamore floodplain forests*** are S1). See Appendix 1 for a complete explanation of ranking definitions. Natural community names are written in ***bold italic*** font in the text.

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., *Lysimachia borealis* (starflower)]. Rare species are noted with an asterisk (*).

VARIANTS: Variants describe a finer level of classification within a natural community type, where the differences are 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) on factors such as relatively minor vegetation differences or shifts in soil type. 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 (1, 2, or 3) or range of numbers (i.e., 1–2 or 2–3) is assigned to each community to reflect the classification confidence and robustness of data that support the community concept and its description. These numbers are defined as follows:

1. High confidence. 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 confidence. 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. Low confidence. Classification is based on few samples (1–4), largely qualitative field descriptions and analysis (i.e., species lists with little abundance information), or has 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 woodland*** occurrences, but they are distinct and corroborated by descriptions from other states. All community descriptions in this guide are based solely on data from New Hampshire occurrences with known locations.

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 development 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.

Natural community's primary distribution
Natural community is occasional and relatively less abundant than in its primary distribution.
Natural community may be present, but occurrence is currently undocumented.

PATTERNS IN THE LANDSCAPE: THE NATURAL DIVISIONS OF NEW HAMPSHIRE

The landscape can be viewed at many spatial scales—from broad regions that cross state borders or even entire continents to individual natural communities that occur at a local level. As we shift focus from one scale to another, different patterns in the landscape become apparent. The pattern we see depends both on what features we choose to emphasize (i.e., physical or biological), and on which factors have the greatest influence at a given scale.

Distinct biophysical units are defined based on combinations of physical features, such as climate, landforms, and soils, with patterns observed for biological features, such as the distribution of trees and other species. In this section, we review the major physical and biological patterns in the landscape, and the ten biophysical units (ecological regions) that are defined for New Hampshire. These ecological regions are referred to throughout this document in natural community distribution descriptions.

CLIMATE AND REGIONAL VEGETATION PATTERNS

Most New Hampshire plant species have broad geographic ranges centered in one of four different North American climate regions: arctic-alpine, boreal, temperate, and coastal plain. Some plants occupy only particular portions of a climate region. Other plants might not fit a specific region at all; these include species found throughout North America or the northern hemisphere, non-native plants, and plants with unique or unusual distribution patterns.

ARCTIC-ALPINE

Plants in New Hampshire's arctic-alpine region are restricted to alpine and subalpine peaks above 4,000 ft. in elevation, with a few occurring on lower elevation cliffs, in ravines, and along rivers in the mountains. Most of these plants also occur in other alpine areas of northeastern North America, but are separated from their primary ranges in northern Canada. Examples of arctic-alpine region species include Bigelow's sedge*, alpine blueberry, and highland rush. A few species are endemic to northeastern North America, and one, Robbins' cinquefoil*, occurs only in the White Mountains.

BOREAL

The boreal region encompasses the great northern conifer forest, extending from Alaska to eastern Canada (similar boreal forests occupy northern portion of Europe and Asia). In New Hampshire, boreal region species occur from the White Mountains northward, and in peatlands throughout the state. Boreal region plants include balsam fir, black spruce, paper birch, larch, and quaking aspen. Numerous species in New Hampshire are restricted to the southeastern portion of the North American boreal forests, or occupy the transition zone between boreal and eastern deciduous forests, including red spruce, red pine, northern white cedar, sheep laurel, and rhodora.

TEMPERATE

The eastern temperate region is located south of the boreal forest and east of the Great Plains, an area coincident with eastern deciduous forest. In New Hampshire, temperate region species occur throughout the state, below 2,500 ft. elevation in forests and wetlands. Most New Hampshire species with temperate distributions occupy particular sub-regions or portions of the eastern deciduous forest. Hemlock, yellow

birch, white pine, sugar maple, American beech, red maple, and black cherry occur throughout New Hampshire. Oaks, hickories, and dogwoods, representative of Appalachian or central hardwood species, occur mainly in central and southern parts of the state.

COASTAL PLAIN

The coastal plain occupies a band 10 to 100 miles wide along the Atlantic and Gulf coasts. In New Hampshire, coastal plain species occur in the Seacoast region, and at low elevations in the Merrimack River Valley and the Lakes Region. Most are wetland or sand plain species, including Atlantic white cedar, dwarf huckleberry*, sweet pepperbush, beach grass*, golden heather*, and Virginia chain fern. Many of New Hampshire's coastal plain region plants are rare or uncommon.

LANDFORMS

The overall shape of the land surface is the product of millions of years of upheaval, erosion, and repeated glaciation of ancient rock formations. As the glaciers advanced and retreated, they eroded bedrock and modified the distribution of the loose rock fragments and sediments collectively known as surface deposits. Together, bedrock and surface deposits determine the shape of the land. Landforms affect the flow and storage of water and modify local climate conditions. In turn, water flow and storage, along with local climate conditions, influence soil characteristics and vegetation. Finally, soil characteristics strongly influence plant species composition and cover, two features that are important in distinguishing natural communities.

BEDROCK

Bedrock determines the shape of the landscape, yet is exposed on only a small percentage of New Hampshire's surface area. Close examination of the state's bedrock reveals a complex mosaic of different rock types. Three bands of bedrock, oriented from northeast to southwest, occupy north, central, and southeastern New Hampshire. The southeastern band of rock is the oldest, up to 650 million years old. Bedrock in the northern part of the state is of more recent origin, 520 to 475 million years old, central region bedrock is even younger, 455 to 365 million years old. Within each band are smaller, more recent igneous intrusions formed by molten material. A warm, wet climate prevailed during most of New Hampshire's 650 million year geologic history, enabling erosion to produce large masses of surface deposits prior to glaciation.

GLACIATION

Glaciers first covered New Hampshire 1.6 million years ago, marking the first in a series of glacial advances and retreats during the Pleistocene epoch. The last glaciation period ended 10,000 to 11,000 years ago, after the retreat of the Wisconsin Age ice sheet. Continental glaciers removed less than 200 ft. of the land surface in most parts of the state, but gouged lake basins from weakened areas of bedrock, plucked rocks from fractured ledges, smoothed hills and ridges, and transported and re-deposited surface material. At high elevations, alpine glaciers further eroded the landscape, scooping steep-walled, U-shaped ravines called cirques into mountainsides. Prior to glaciation, the rugged White Mountains likely resembled the smooth, rolling skyline of the present-day Smoky Mountains of North Carolina.

SURFACE DEPOSITS

Surface deposits—mixes of boulders, stones, cobble, gravel, sand, silt, and clay—cover most of New Hampshire's bedrock. Three types of surface deposits occur in the state: ice-deposited glacial till, water-deposited sediments, and other deposits formed or modified after glaciation. Surface deposits strongly influence soils and plant communities.

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

New Hampshire's lowlands are comprised of sediments deposited in rivers, streams, lakes, and marine environments during glacial retreat. Many of these aquatic environments are now smaller, or have dried up entirely. This type of sedimentation continues to this day, but is less extensive than during the glacial period.

The particle size of deposited sediments is determined by water velocity and turbulence. Cobbles, stones, and gravels settle to the streambed in turbulent or relatively high-velocity conditions. Particles of sand, silt, and clay are smaller; they settle only as floods subside and stream velocity decreases. Changes in flow volume and velocity produce layers of different-sized sediments called stratified deposits. Sediments set down in stream or river environments, called fluvial or alluvial deposits, are mostly coarse, ranging from cobble to silt. By contrast, lakebed sediments consist mostly of silt and fine sand. Near-shore marine deposits consist of silt and clay.

Fluvial deposits include ice-contact sediments deposited inside or along the margins of a melting glacier, and sediments deposited beyond the terminus of a glacier. Ice-contact deposit landforms include eskers and kames. Eskers are long, narrow, sinuous ridges of stratified sand and gravel that formed in a stream channel inside or along the margin of a melting glacier. Kames are irregularly shaped ridges, hills, or terraces of stratified sediments formed in meltwater pockets within a glacier, or in streams along the edge of a glacier. Kames that formed along the margin of a glacier are called kame terraces. These typically flat-topped and steep-sided terraces are a common landscape feature in today's river and stream valleys.

Melting glaciers fed rivers that transported and deposited large amounts of coarse and fine sediments downstream. The sediments settled and formed outwash deposits in major river valleys, on glacial lake plains, and in river delta areas. Occasionally blocks of ice were stranded and partially buried by outwash deposits. These blocks eventually melted, forming kettle holes in the landscape. Lakes and ponds now occupy many of these depressions.

As the glaciers receded, wind-blown dunes formed as meltwater levels dropped and exposed sandy deposits along the margins of glacial lakes and on outwash plains. Today, active dunes occur only along the coast, and along a few sandy river terraces of the Merrimack River.

Floodplains are flat areas bordering a river. During flood events, water spreads over the floodplain, slows,

and deposits gravel, sand, silt, and clay. River terraces are historic floodplains formed during glacial meltdown periods, or more recently due to channel migration or downcutting. Sand and silt are the most common deposits forming floodplains and river terraces, although coarser outwash or kame materials may occur adjacent to existing rivers. Oxbows are narrow, often curved depressions in a floodplain, remnants of former river channels left behind after a river changed course. Ponds sometimes occupy oxbows.

Glacial lakebed deposits consist of clay, silt, and fine sand that settled to the bottom of historic glacial lakes, temporary bodies of water created behind ice or debris dams. Eventually the ice and debris dams failed, the glacial lakes drained, and glacial meltwater streams deposited material on top of the glacial lakebed deposits. Deep fluvial and lake sediments are exposed on steep terrace slopes of the existing Connecticut and Merrimack Rivers.

Marine sediments characterize some coastal lowlands and valley bottoms of New Hampshire. Much of the landscape that is now above sea level in the coastal region was underwater when the glaciers were receding, as the land had not yet rebounded from the glaciers' weight. Fine silt and clay sediments were deposited on the seabed, and in many places coarse outwash deposits covered the marine deposits. Because marine silts and clays impede water infiltration and root penetration, wetlands are common in areas where marine deposits are near the ground surface.

OTHER SURFACE DEPOSITS

Small areas of the state's landscape are comprised of mineral materials that originated from sources other than water or glacial deposition. 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, but in some cases the cliff has largely wasted away, leaving only a boulder-strewn slope. Scree forms like talus but from smaller debris (less than 3"). Bedrock exposures are found in areas where till was either not deposited, or where the till was very shallow and eroded away. Such exposures are frequent on convex mountain ridges and some summits. Felsenmeer describes areas of frost-shattered stony debris that occur in the alpine zone. Landslides are avalanches of rock, soil, and other debris on steep mountain slopes. A landslide typically eliminates all vegetation in its path and creates a debris cone of mixed rubble at its base.

SOILS

New Hampshire's soils developed from bedrock and surface deposits following the retreat of glaciers. The percolation of water, physical and chemical weathering of rocks and sediments, and the actions of plants and animals all modify the parent material to form soil. Soils provide plants with a substrate for growth and a source of water and nutrients. As biophysical environments, soils encompass mineral and organic matter, fungi, bacteria, invertebrates, plant roots, and other organisms. Soil properties vary with climate, landform, topographic setting, surface material, and water movement.

Water movement through soil is dictated by the soil's drainage class. Soil drainage is a function of topographic setting and physical soil properties such as texture, density, and porosity. Water remains at or above the surface for most or all of the year in topographic depressions with restricted outflow or on soils with low porosity. Conversely, water remains well below the surface on steep slopes or in soils with high porosity. The Natural Resources Conservation Service categorizes the former as poorly or very poorly drained, and the latter as excessively or somewhat excessively well drained. Intermediate drainage classes include well drained, moderately well drained, and somewhat poorly drained.

ECOLOGICAL REGIONS: SECTIONS AND SUBSECTIONS

Ecological regions are useful large-scale natural divisions that can be defined based on variation in plant

distributions and variation in aspects of the physical environment such as climate, landforms, and soils. The U.S. Forest Service has extensively studied and mapped these divisions (Keys and Carpenter 1995) as a hierarchical system of progressively smaller units. Three regional Divisions are defined for the eastern United States, two of which occur in New Hampshire (Warm and Hot Continental Divisions). At a finer scale, New Hampshire contains three division 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 finer-scale physical and biological attributes. There are ten subsections in New Hampshire. Each section and subsection is briefly described below.

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** subsection is a narrow zone along the immediate coast. This subsection is characterized by low topographic relief and is underlain by metamorphic bedrock, including schist and gneiss. 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 features restricted to this region.

The **Gulf of Maine Coastal Plain** subsection occupies most of the southern portion of this section in New Hampshire, excluding the area immediately adjacent to the coast (see above). 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, resulting in this subsection's characteristic rolling topography. 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 rugged, mountainous topography interspersed with numerous lakes and glacial outwash features. An unusual geologic feature of this subsection is the ring-dike of the Ossipee Range, which is carved from an ancient collapsed volcano, giving this range its notable circular shape. Other distinctive features are numerous hills and ridges of glacial till, extensive plains of glacio-fluvial deposits, large wetlands, and many of the state's largest natural lakes.

VERMONT-NEW HAMPSHIRE UPLAND SECTION

The Vermont-New Hampshire Upland section covers the southwestern portion of the state. From its highest summits (reaching over 3,000 ft.), this section primarily slopes southeastward to its boundary with the Lower New England Section. It is a sloping plateau dissected by steep, narrow valleys and underlain by granite, gneiss, and schist. This section 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, and drumlins are distinctive glacial features. Soils are typically shallow and stony. The metamorphic bedrock (phyllites and schists) of the Vermont Piedmont subsection yields 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 enrichment is reflected in the composition and distribution of plant communities.

The narrow **Northern Connecticut River Valley** subsection, like the Merrimack River Valley to the east,

is filled with glacial outwash and glacial lake deposits that abut lower slopes of adjacent hills comprised of glacial till. Over time, the processes of erosion and sedimentation have formed distinctive river terraces in these glacial deposits. There is much metamorphic bedrock in this section, which weathers to yield soils with relatively high nutrient status.

WHITE MOUNTAIN SECTION

The White Mountain section includes all of the White Mountains and the hilly country of northern New Hampshire. Elevations range from about 1,000 ft. to over 6,000 ft. This section has three subsections: (1) White Mountain, (2) Mahoosuc-Rangeley Lakes, and (3) Connecticut Lakes.

The **White Mountain** subsection is underlain by granite and schist. The Presidential Range crowns this subsection. The bare summits of the higher peaks 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 well drained and derived from 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 pelite 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 also characterized by drumlins and other glacial deposits such as kames and eskers.

OPEN UPLANDS

This section contains descriptions of alpine and subalpine communities, landslides and talus barrens, cliffs, rocky maritime communities, coastal and inland 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 stressful physical settings with 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 wooded rocky ridges (see Wooded Uplands section).

ALPINE AND SUBALPINE COMMUNITIES

New Hampshire's alpine zone 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 more similar to that of the eastern Canadian arctic, hundreds of miles to the north, than the forest just hundreds of feet below. Because of the similarity to arctic tundra, this vegetation is referred to as alpine tundra. Sixty-two percent of the plant species in the Presidential Range are restricted to alpine tundra. Among these, *Nabalus boottii* (Boott's rattlesnake-root)* is endemic to northeastern U.S. alpine areas, *Potentilla robbinsiana* (Robbins' cinquefoil)* is endemic to the White Mountains, and *Geum peckii* (White Mountain avens)* is endemic to the White Mountains and several stations in Nova Scotia. Permafrost and frost phenomena occur in parts of the Presidential Range, the largest and most diverse of the region's alpine areas. The vegetation here is exposed to high winds, a short growing season, low temperatures, heavy cloud cover, frequent fog, and high precipitation, 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, it declines in elevation with increasing latitude (Cogbill and White 1991; Cogbill et al. 1997). In New Hampshire, climatic treeline occurs at approximately 4,900 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 examples are generally smaller and have communities with fewer alpine/subalpine-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 blueberry), *Empetrum atropurpureum* (red crowberry) and/or *E. nigrum* (black crowberry), and the lichen *Cetraria islandica*. The larger and higher peaks have more alpine-restricted species such as *Carex bigelowii* (Bigelow's sedge)*, *Juncus trifidus* (highland rush), *Anthoxanthum monticola* (alpine sweet grass)*, *Diapensia lapponica* (diapensia)*, *Solidago leiocarpa* (Cutler's goldenrod)*, *Salix uva-ursi* (bearberry willow)*, and *Betula minor* (dwarf birch)*. High elevation ledges and landslides in forested settings, "cold-air talus slopes," and lower elevation rocky mountain stream or riverbanks may also harbor what are generally considered alpine species (e.g., *Juncus trifidus*, *Empetrum atropurpureum*, *Agrostis mertensii*, and *Geum peckii**) or other species that reach the southern terminus of their North American distribution in montane areas of northern New England, including *Draba cana* (canescent whitlow-mustard)*, *Hieracium robinsonii* (Robinson's hawkweed)*, and *Pinguicula vulgaris* (violet butterwort)*.

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

locations with severe exposures, appear to have been open for many centuries at least, based on the earliest recorded accounts of their appearance. However, fire may still have influenced the relative cover of forests vs. more open areas on these subalpine sites (Whitney and Moeller 1982).

There are five broad groups of vegetation that comprise the spectrum of variation in the alpine zone. These groups relate to major differences in soil moisture and substrate, longevity of snowpack, elevation, and degree of exposure. One of the five groups, alpine/subalpine peatlands, is described in the wetland section of this manual under "Open Peatlands." The remaining four community groups include the following:

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. Dwarf shrub - sedge - rush tundra without trees; and
4. Heath - krummholz communities on somewhat lower peaks where a broader diversity of montane shrubs mix with krummholz and alpine shrubs.

Within each group, different communities occur along an elevational gradient. In addition to the five groups of vegetated communities, there are several sparsely-vegetated communities that occur in rocky habitats of the alpine/subalpine zone.

ALPINE HERBACEOUS SNOWBANK AND OTHER WET-MESIC ALPINE COMMUNITIES

Alpine snowbanks and other mesic to wet-mesic alpine communities are moderately well to poorly drained. 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 community is associated with late-melting snowbanks in the alpine zone, and is dominated by a diverse mixture of alpine and lowland herbs and shrubs. Deep snowbanks both abbreviate the growing season and limit the exposure of plants to the extreme weather and desiccating conditions of the alpine environment. The snowbanks form at small and large scales ranging from several square yards to tens of acres, often in lee positions of summits, ridges, outcrops, ravines, drainages, and at the tundra-treeline interface. The biggest examples are found in the larger alpine ravines, where they occur on slopes and benches, in and along headwall gullies and streams, and immediately below headwalls, as well as along drainages leading into the ravines. Snow depth is usually greatest at the bases of headwalls, and accumulates to depths of more than 50 ft. in Tuckerman Ravine. These snowbanks may melt as early as mid-May, but can last well into the summer in some years. Soils range from mesic to hydric.

Composition varies from herb dominated to herb and shrub dominated mixes with up to 60% robust shrub cover (willows and green alder). Denser shrub cover (>60%) 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. Soil pH ranged from 4.9–6.3 (n=7).

CHARACTERISTIC VEGETATION: This community is both diverse and variable; 90 vascular plants have been documented from three examples. The most abundant and frequent species (5% or greater cover) include *Geum peckii* (White Mountain avens)*, *Solidago macrophylla* (large-leaved goldenrod), *Calamagrostis*

canadensis (bluejoint), *Veratrum viride* (American false hellebore), *Vaccinium cespitosum* (dwarf blueberry)*, *Houstonia caerulea* (little bluet), *Trichophorum cespitosum* (tufted clubsedge), *Symphyotrichum puniceum* (purple-stemmed American-aster), *Phegopteris connectilis* (long beech fern), *Deschampsia flexuosa* (wavy hair grass), *Lonicera villosa* (mountain honeysuckle), *Spiraea alba* var. *latifolia* (meadowsweet), and *Alnus viridis* ssp. *crispa* (green alder).

Common species (sometimes locally abundant) include *Rubus pubescens* (dwarf raspberry), *Calamagrostis pickeringii* (Pickering's reed grass), *Streptopus amplexifolius* (clasping-leaved twistedstalk), *Rhododendron groenlandicum* (Labrador tea), *Vaccinium uliginosum* (alpine blueberry), *Carex bigelowii* (Bigelow's sedge)*, *Athyrium angustum* (lady fern), *Carex brunnescens* (brownish sedge), *Thalictrum pubescens* (tall meadow-rue), *Coptis trifolia* (three-leaved goldthread), *Clintonia borealis* (yellow bluebead-lily), *Platanthera dilatata* (white northern bog-orchid), *Sphagnum girgensohnii* (peat moss), other Sphagna, and a high diversity of non-*Sphagnum* bryophytes.

Less frequent species (sometimes locally common) include *Salix argyrocarpa* (Labrador willow)*, *Viola palustris* (northern marsh violet)*, *Arnica lanceolata* (lance-leaved arnica)*, *Oxyria digyna* (mountain-sorrel)*, *Phleum alpinum* (mountain Timothy)*, *Veronica wormskjoldii* (American alpine speedwell)*, *Epilobium hornemannii* (Hornemann's willow-herb)*, *Salix planifolia* (tea-leaved willow)*, *Campanula rotundifolia* (Scotch bellflower), *Bistorta vivipara* (alpine bistort)*, *Nabalus boottii* (Boott's rattlesnake-root)*, *Vahlodea atropurpurea* (arctic hair grass)*, *Stellaria borealis* (boreal stitchwort), and *Streptopus x oreopolus* (mountain twistedstalk).

VARIANTS: Three variants are described below.

1. **Typic variant:** This peaty expression of the community 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, White Mountain avens*, bluejoint, American false hellebore, little bluet, wavy hair grass, tufted clubsedge, dwarf blueberry*, purple-stemmed American-aster, and long beech fern. Some examples are more shrubby and characterized by Labrador willow*, glandular birch*, and 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 lowland herbs and peat mosses found in the other two variants. Non-*Sphagnum* bryophytes are abundant. Soils are moderately well to well-decomposed, seepy peats along or near perennial streams in relatively exposed snowbank settings (e.g., Alpine Garden). It does share several species with one or both of the other two variants, including large-leaved goldenrod, White Mountain avens*, American false hellebore, bluejoint, and tufted clubsedge, but is differentiated by the presence of tea-leaved willow*, alpine bistort*, 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.
3. **Mesic herb variant:** This variant has more well drained mineral soils (A horizons) with mesic conditions in mid to late summer compared to the other two variants that are seepy or saturated for much of the growing season. Herbs most often found in lowlands dominate along with only a few alpine plants. Dominants include large-leaved goldenrod, wavy hair grass, dwarf blueberry*, yellow bluebead-lily, and *Chamaepericlymenum canadense* (bunchberry). Bigelow's sedge* and alpine blueberry may also be present.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is restricted to alpine areas of the White Mountains, from about 4,400–5,500 ft. in elevation. Good and large examples occur in the Alpine Garden, and at the top of 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 alpine tundra community dominated by a mix of forbs, sedges, and heath shrubs, many of which are rare, even elsewhere in the alpine zone. It is restricted to Mount Washington. While these meadows have some plants in common with ***alpine herbaceous snowbank/rills***, and may occur adjacent to them, they lack many of the key diagnostic species of snowbanks.

Soils are moist organic turfs (O and A horizons) near drainages and snowbanks, and on sloping benches. Bliss (1963) documented pH (4.7–4.9) and calcium levels (70–1500 ppm) in this community.

CHARACTERISTIC VEGETATION: Diagnostic plants include *Geum peckii* (White Mountain avens)*, *Trichophorum cespitosum* (tufted clubsedge), *Bistorta vivipara* (alpine bistort)*, *Salix uva-ursi* (bearberry willow)*, *Solidago leiocarpa* (Cutler's goldenrod)*, *Nabalus boottii* (Boott's rattlesnake-root)*, and *Anthoxanthum monticola* (alpine sweet grass)*. *Campanula rotundifolia* (Scotch bellflower) and *Carex scirpoidea* (scirpus-like sedge)* are also diagnostic and indicate the somewhat higher base cation status in this community compared to elsewhere in the alpine zone.

Species found in other alpine communities that are also frequent in this community include *Carex bigelowii* (Bigelow's sedge)*, *Agrostis mertensii* (northern bentgrass), *Juncus trifidus* (highland rush), *Vaccinium uliginosum* (alpine blueberry), *V. vitis-idaea* (mountain cranberry), and *Sibbaldiopsis tridentata* (three-toothed cinquefoil).

Species absent in ***moist alpine herb - heath meadows*** that are diagnostic in the somewhat similar ***alpine herbaceous snowbank/rills*** include *Solidago macrophylla* (large-leaved goldenrod), *Deschampsia flexuosa* (wavy hair grass), *Vaccinium cespitosum* (dwarf blueberry)*, *Calamagrostis canadensis* (bluejoint), *Veratrum viride* (American false hellebore), and *Houstonia caerulea* (little bluet).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: In New Hampshire, this community is found only on Mt. Washington in the Alpine Garden, from 5,000–5,500 ft.

SOURCES: Bliss 1963a; Sperduto and Cogbill 1999.

• Alpine ravine shrub thicket (S1S2)

GENERAL DESCRIPTION: Extensive examples of this community occur where winter snow accumulation is substantial, especially on north-facing, lower slopes of Tuckerman Ravine, Great Gulf, and other large ravines on Mt. Washington. It forms on steep to nearly level rock, talus, and cobbly substrates, generally above 4,000 ft. elevation. Deep, late-melting snowpacks bury the community for much of the year and add a significant amount of moisture to the otherwise well drained rocky soils. It is dominated primarily by *Alnus viridis* ssp. *crispa* (green alder) and other deciduous shrubs. Forbs are common in the understory. This community has not been sampled extensively, but is distinct and forms extensive thickets in Tuckerman Ravine.

CHARACTERISTIC VEGETATION: Dense thickets (>60% cover) are dominated by green alder in this community. *Spiraea alba* var. *latifolia* (meadowsweet) is common, and *Amelanchier bartramiana* (mountain shadbush), *Salix argyrocarpa* (Labrador willow)*, and other willows are occasional along streams. Lowland plants characteristic of ***alpine herbaceous snowbank/rill*** and spruce - fir forest communities are present in low to moderate abundance. These include *Deschampsia flexuosa* (wavy hair

grass), *Athyrium angustum* (lady fern), *Solidago macrophylla* (large-leaved goldenrod), *Dryopteris intermedia* (evergreen wood fern), *D. campyloptera* (mountain wood fern), and *Symphyotrichum puniceum* (purple-stemmed American-aster). Areas with less than ~60% shrub cover have a better developed herb layer and are treated as shrubby examples of ***alpine herbaceous snowbank/rill*** communities.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community occurs in alpine ravines of the Presidential Range, above 4,000 ft. A good example is found in Tuckerman Ravine, particularly on its north-facing slopes.

SOURCES: NHB field surveys.

DWARF SHRUB - SEDGE - RUSH MEADOWS AND SHRUBLANDS

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 blueberry, cranberry, and diapensia* dwarf shrubs, *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 and other wet-mesic alpine communities.

• Alpine heath snowbank (S1S2)

GENERAL DESCRIPTION: This community is found in well drained, relatively protected lee positions on alpine summits where winter snow accumulates to significant depths. It also occurs just above the transition to krummholz. The elevation range for this community is approximately 4,600–5,500 ft. Dwarf shrubs and lowland plants are present in greater abundance than in ***sedge - rush - heath meadows*** and total vegetative cover is high. This community is equivalent to Bliss' (1963) dwarf shrub heath community.

Compositionally, this community differs from the ***sedge - rush - heath meadow*** by the presence of *Rhododendron groenlandicum* (Labrador tea), *Empetrum nigrum* (black crowberry), *Vaccinium cespitosum* (dwarf blueberry)*, and various lowland plants restricted to snowbank areas. In contrast to the wetter ***alpine herbaceous snowbank/rill*** community, it lacks wet-site species such as peat mosses, *Veratrum viride* (American false hellebore), and *Calamagrostis canadensis* (bluejoint). It is distinguished from ***subalpine dwarf shrublands*** by the higher cover of species common in the protected snowbank communities (see list above) and by the presence of alpine species that are absent or in very low cover in dwarf shrublands.

CHARACTERISTIC VEGETATION: This community is characterized by some combination of Labrador tea, black crowberry, dwarf blueberry*, *Deschampsia flexuosa* (wavy hair grass), *Lysimachia borealis* (starflower), *Spinulum annotinum* (common interrupted-clubmoss), *Chamaepericlymenum canadense* (bunchberry), and *Maianthemum canadense* (Canada-mayflower).

Species found here and in other alpine communities include *Vaccinium uliginosum* (alpine blueberry), *V. vitis-idaea* (mountain cranberry), *Phyllodoce caerulea* (purple mountain-heath)*, *Harrimanella hypnoides* (moss-plant)*, *Arctous alpina* (alpine bearberry)*, *Diapensia lapponica* (diapensia)*, *Betula glandulosa* (glandular birch)*, and *Salix herbacea* (snow-bed willow)*. *Carex bigelowii* (Bigelow's sedge)* and *Juncus trifidus* (highland rush) are present but with a relatively low cover. Wet-site species such as peat mosses, American false hellebore, and bluejoint are absent.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is restricted to the Presidential Range and Franconia Ridge from 4,600–5,500 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 *Carex bigelowii* (Bigelow's sedge)* and a 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, and at scattered locations elsewhere. Snow accumulation is typically minimal or ephemeral due to high winds. The frequently cloudy conditions of these mountains are favorable for Bigelow's sedge* to dominate to the near exclusion of other species, in part because of its photosynthetic efficiency in low-light environments. These meadows are best developed between 5,800–6,200 ft. elevation. They rarely occur outside the Presidential Range, and when they do they are small.

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 precipitation and cloud-interception, and thus reduced solar radiation and evapotranspiration.

Among mesic, well drained alpine tundra communities of the Presidential Range, ***Bigelow's sedge meadows*** occur in the harshest, most windblown settings. The other extreme is marked by ***alpine heath snowbanks***, which occur in more protected areas with longer-lasting snow cover. The central part of this exposure gradient is occupied by ***sedge - rush - heath meadows*** (the most common community in the Presidential Range's alpine zone).

CHARACTERISTIC VEGETATION: Bigelow's sedge* is the dominant species. Scattered other species include *Minuartia groenlandica* (mountain sandplant), *Vaccinium vitis-idaea* (mountain cranberry), *Vaccinium uliginosum* (alpine blueberry), and *Juncus trifidus* (highland rush). Mosses and lichens are common and include *Polytrichum juniperum* var. *alpestre*, *Calliergon stramineum*, *Cetraria islandica*, and *C. mitis*.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is mostly restricted to the Presidential Range in NH, between 5,800 and 6,200 ft., but may occur in small patches on some outlying peaks. Good examples are on the north and west sides of the summit cone of Mt. Washington, on the upper slopes of Mt. Adams, and on Monticello Lawn and other upper slopes of Mt. Jefferson.

SOURCES: Bliss 1963a; Sperduto and Cogbill 1999.

• Sedge - rush - heath meadow (S1)

GENERAL DESCRIPTION: This alpine meadow is the most widespread community found in the Presidential Range and other high alpine areas of New England, occurring mostly above 4,800 ft. It is dominated by various mixtures of *Carex bigelowii* (Bigelow's sedge)*, *Juncus trifidus* (highland rush), and dwarf shrubs. The variation in dominant species has alternatively been treated as three separate communities by Bliss (1963), who attributes these differences to soil conditions controlled by moisture and exposure gradients.

Among mesic, well drained alpine tundra communities, the ***sedge - rush - heath meadow*** is centrally located on the exposure gradient. The most protected areas with longer-lasting snow cover are marked by ***alpine heath snowbanks***. At the other extreme, ***Bigelow's sedge meadows*** occur in exposed, high precipitation/fog drip, low snow cover areas. In addition to being environmentally intermediate, the ***sedge - rush - heath meadow*** is floristically intermediate between these other two communities as well.

Soils consist of a thin (0–11 cm) loamy sand A horizon 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 blueberry), *V. vitis-idaea* (mountain cranberry), and *Sibbaldiopsis tridentata* (three-toothed cinquefoil). *Minuartia groenlandica* (mountain sandplant) is frequently present but in low abundance. *Trichophorum cespitosum* (tufted clubsedge), *Agrostis mertensii* (northern bentgrass), *Diapensia lapponica* (diapensia)*, *Huperzia appressa* (mountain firmoss)*, and *Anthoxanthum monticola* (alpine sweet grass)* are occasional; *Rhododendron lapponicum* (Lapland rosebay)* is rare. *Empetrum atropurpureum* (red crowberry) is absent and *E. nigrum* (black crowberry), *Abies balsamea* (balsam fir), and *Betula cordifolia* (heart-leaved paper birch), indicative of ***subalpine dwarf shrubland***, 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. **Heath - rush variant:** This more common variant typically occurs at lower elevations, often starting just above heath snowbank or krummholz near treeline. It is dominated by heaths and conspicuous clumps of highland rush. Bigelow's sedge* is present but of relatively minor importance. This variant is restricted to elevations above 4,600 ft. in the Presidential Range and on Franconia Ridge and Mt. Moosilauke. It is transitional to but considered distinct from the ***subalpine dwarf shrubland*** community, which lacks Bigelow's sedge* and occurs on lower peaks (from 3,400–4,800 ft.).
2. **Sedge - heath - rush variant:** Bigelow's sedge* is more prominent in this less common variant, which reaches its best development high on west and north exposures of the Presidential Range. Less frequent are highland rush and dwarf heath shrubs. Vascular plant cover is relatively low and lichen, soil, and exposed rock cover are relatively high. ***Bigelow's sedge meadows***, a community similar to this variant, differ by the dominance of Bigelow's sedge* to the near exclusion of other species.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community mostly occurs between 4,800 and 5,600 ft. in the Presidential Range, but also as low as 4,600 ft. on Franconia Ridge and Mt. Moosilauke.

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

• Subalpine dwarf shrubland (S2)

GENERAL DESCRIPTION: This community is found on exposed, well drained summits, upper slopes, and ridges from 3,400–4,800 ft., primarily on peaks outside the Presidential Range. It often occurs in association with heath - krummholz communities, but in locally more exposed settings where it lacks the abundance of *Kalmia angustifolia* (sheep laurel), *Rhododendron groenlandicum* (Labrador tea), and krummholz. This community is also floristically related to the ***sedge - rush - heath meadow*** at higher elevations, but typically lacks *Carex bigelowii* (Bigelow's sedge)* and has lower amounts of *Juncus trifidus* (highland rush). It is essentially a subalpine analogue to ***sedge - rush - heath meadow*** and ***diapensia shrubland*** communities. Vegetation is typically dwarfed (up to 20 cm but most often less than 10 cm in height) and dominated by *Empetrum* spp. (crowberries), subalpine *Vaccinium* spp. (blueberries), and *Sibbaldiopsis tridentata* (three-toothed cinquefoil).

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

This community reaches its best development on the most exposed sites of subalpine peaks where it can

occupy patch sizes of more than one acre. It also occurs as smaller patches within heath - krummholz communities, in areas with shallow, well drained soils around bedrock outcrops. The cover of red crowberry in this community appears to be highest 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 communities.

CHARACTERISTIC VEGETATION: This community is dominated by *Vaccinium uliginosum* (alpine blueberry) and *V. vitis-idaea* (mountain cranberry), along with other dwarf shrubs, particularly *Empetrum atropurpureum* (red crowberry) and/or three-toothed cinquefoil, and a moderately low cover of highland rush, *Minuartia groenlandica* (mountain sandplant), and stunted *Betula cordifolia* (heart-leaved paper birch) and *Abies balsamea* (balsam fir). Lichens are common and include *Cetraria islandica* and *Cladina rangiferina*, among others. Species that are more diagnostic of other communities but which may be present here in low cover include Bigelow's sedge*, *Diapensia lapponica* (diapensia)*, *Vaccinium angustifolium* (lowbush blueberry), Labrador tea, *Empetrum nigrum* (black crowberry), *Solidago leiocarpa* (Cutler's goldenrod)*, and *S. simplex* ssp. *randii* var. *monticola* (montane Rand's goldenrod). *Paronychia argyrocoma* (silverling)* may be present in low elevation examples of this community.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Restricted to White Mountain peaks outside the Presidential Range, from 3,400–4,800 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.

• Diapensia shrubland (S1)

GENERAL DESCRIPTION: This community occurs in exposed alpine environments where winds are severe enough to keep snow cover light in winter. *Diapensia lapponica* (diapensia)* and other dwarf shrubs are the dominant plants. The 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 that freeze deeply. Active frost heaving of the soil is common.

CHARACTERISTIC VEGETATION: This community is indicated by the dominance of diapensia* (usually >5% cover) along with mixtures of *Vaccinium uliginosum* (alpine blueberry), *V. vitis-idaea* (mountain cranberry), *Juncus trifidus* (highland rush), *Sibbaldiopsis tridentata* (three-toothed cinquefoil), *Minuartia groenlandica* (mountain sandplant), *Carex bigelowii* (Bigelow's sedge)*, and *Agrostis mertensii* (northern bentgrass). On higher peaks, *Rhododendron lapponicum* (Lapland rosebay)*, *Kalmia procumbens* (alpine-azalea)*, and *Solidago leiocarpa* (Cutler's goldenrod)* are 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, *Rhododendron groenlandicum* (Labrador tea) and *Vaccinium cespitosum* (dwarf blueberry)* are absent.

VARIANTS: Two variants are described:

1. **Lapland rosebay variant:** This much more common variant occurs in the Presidential Range from 4,400–5,500 ft. and is characterized by a more diverse composition of alpine species compared to the other variant. Alpine-azalea* and Lapland rosebay* are diagnostic and *Salix uva-ursi* (bearberry willow)*, Cutler's goldenrod*, and Bigelow's sedge* are frequent.
2. **Alpine blueberry variant**: This uncommon variant is a less diverse and occurs on smaller and

lower elevation peaks from 4,000–4,600 ft. Alpine blueberry is more common, bearberry willow*, Cutler's goldenrod*, and Bigelow's sedge* are less frequent, and alpine-azalea* and Lapland rosebay* are absent.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Found in the White Mountains on exposed summits and open windblown ridges, mostly above 4,300 ft. Good examples of the Lapland rosebay* variant occur on Mt. Eisenhower, Mt. Franklin, Mt. Monroe, and at Bigelow Lawn, and the Alpine Garden on Mt. Washington. Good examples of the alpine blueberry variant occur on Mt. Guyot, the north ridge of Mt. Lafayette, and Bondcliff.

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

KRUMMHOLZ AND HEATH - KRUMMHOLZ

In the alpine environment, strong winds and blowing snow prune tree branches so severely that an upright tree cannot produce enough new growth to offset losses. The spruce and fir trees that survive here instead adopt a stunted life form, often growing sideways and low to the ground. The twisted trunks and branches form waist-high, bonsai-like patches, clumps, and thickets of trees called krummholz (a German word meaning "crooked wood"). Krummholz is primarily found near or at timberline, often as a continuous linear zone. It also occurs in protected areas such as saddles and concavities at higher elevations within the alpine zone. The stunted trees rarely attain more than 1.5–2.0 m in height. The primary krummholz-formers are *Picea mariana* (black spruce) and *Abies balsamea* (balsam fir), though *Picea rubens* (red spruce) can occur at lower elevations.

At lower elevations, krummholz trees mix with heath shrubs forming "heath - krummholz" communities. Heaths that characterize these communities include cranberry and blueberry shrubs, often joined by various mixtures of *Rhododendron 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 *Kalmia procumbens* (alpine-azalea)*are absent, though these species may be occasional in adjacent areas, especially ones that are more exposed and support ***subalpine dwarf shrubland*** or ***subalpine rocky bald*** communities. The lichens *Cladina rangiferina, C. alpestris*, and *Cetraria islandica* are common and often abundant. Both of the heath - krummholz community types can 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 (~4,900 ft.). Exposure of rock, talus, gravel, or stone is usually substantial (>25%).

In parts of the White Mountains, heath - krummholz communities form a mosaic with alpine/subalpine peatlands 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 4,000 ft. in elevation.

• Black spruce - balsam fir krummholz (S2S3)

GENERAL DESCRIPTION: This community is characterized by pure or nearly pure krummholz (>60% cover) 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. ***Black spruce - balsam fir krummholz*** typically forms a narrow transition zone to alpine tundra on steep slopes or a wider transition on relatively shallow slopes. Snow swept off more exposed alpine/subalpine areas tends to accumulate in and around this community, 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 ***black spruce - balsam fir krummholz*** can reach at least 130–140 years of age. Climatic treeline occurs at approximately 4,900 ft., although this community can occur as low as 3,500 ft., and examples with more red spruce as low as 3,000 ft.

Soils are typically 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 cordifolia* (heart-leaved paper birch) is also frequent, with *Picea rubens* (red spruce) common at the low-elevation limits of krummholz. Species occurring in forests dominated by red spruce and balsam fir at lower elevations are often present, such as *Chamaepericlymenum canadense* (bunchberry), *Clintonia borealis* (yellow bluebead-lily), *Lysimachia borealis* (starflower), *Gaultheria hispidula* (creeping spicy-wintergreen), *Solidago macrophylla* (large-leaved goldenrod), and various mosses.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community 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, knee-high example of this community 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: This is the higher of two heath - krummholz communities in New Hampshire, ranging from 3,500–4,900 ft. in elevation. It is characterized by a patchy layer of low krummholz intermixed with a dense dwarf shrub layer and a variable rock and gravel component. *Kalmia angustifolia* (sheep laurel), *Rhododendron canadense* (rhodora), and *Ilex mucronata* (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 patches reaching approximately 1.5 m. The shrub layer is typically dwarfed and does not exceed 15–20 cm height (max 30 cm). Snowpacks associated with heath - krummholz communities are probably moderately shallow (deeper than in very exposed areas and shallower than in heath snowbank communities). At lower elevation settings for this community, or in more protected positions, *Picea rubens* (red spruce) increases in cover and achieves somewhat taller heights than in higher elevation, more exposed positions.

Soils in this community tend to be shallow organic turfs (O and A horizons) over bedrock, stone or gravel mixtures, or steep boulder talus. Areas of exposed rock, stone, and/or talus are common.

This community is transitional to ***subalpine dwarf shrubland*** 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 cordifolia* (heart-leaved paper birch) are common krummholz trees. Red spruce is occasional at lower elevations and *Picea mariana* (black spruce) more frequent at higher elevations. Frequent and dominant dwarf shrubs include *Empetrum atropurpureum* (red crowberry), *Vaccinium uliginosum* (alpine blueberry), *V. vitis-idaea* (mountain cranberry), and occasionally *V. boreale* (northern blueberry)*, *V. angustifolium* (lowbush blueberry), and *Empetrum nigrum* (black crowberry). Lichens are common and often abundant, including *Cladina rangiferina*, *C. alpestris*, and *Cetraria islandica*. Mosses are frequent but poorly documented. The

regionally rare moss *Cynodontium schisti* has been found in this community.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is restricted to high elevation peaks in the White Mountains from 3,500–4,900 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 the two heath - krummholz communities in NH, ranging from about 3,000–3,500 ft. 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), *Ilex mucronata* (mountain holly), and *Picea rubens* (red spruce) are prominent members of this community that help distinguish it from its higher elevation counterpart (see ***Labrador tea heath - krummholz***). 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 (3–30º) 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 ***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 have deeper organic soils, less rock exposure, and more wet-site plants (see ***wooded subalpine bog/heath snowbank*** and ***alpine/subalpine bog***).

CHARACTERISTIC VEGETATION: *Betula cordifolia* (heart-leaved paper birch), *Abies balsamea* (balsam fir), and red spruce are the primary krummholz trees in this community; *Picea mariana* (black spruce) is rare or absent below 3,500 ft. (except in wet, acidic sites such as bogs). Diagnostic plants include abundant sheep laurel and less frequent rhodora, mountain holly, and *Aronia melanocarpa* (black chokeberry). Other prominent heaths and dwarf shrubs include *Vaccinium uliginosum* (alpine blueberry), *V. vitis-idaea* (mountain cranberry), *V. angustifolium* (lowbush blueberry), *V. boreale* (northern blueberry)*, and *Empetrum atropurpureum* (red crowberry) or *E. nigrum* (black crowberry). *Rhododendron groenlandicum* (Labrador tea) is frequent but on average less abundant than in ***Labrador tea heath - krummholz***. *Sibbaldiopsis tridentata* (three-toothed cinquefoil) is occasional. *Cladina rangiferina, C. alpestris* and *Cetraria islandica* are common lichens. Mosses are common but species are poorly documented. The regionally rare moss *Cynodontium schisti* has been documented in this community. *Geocaulon lividum* (false toadflax)* is another rare plant known from examples in the Mahoosuc Range.

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 top 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.

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 barrens***, result from frost action. ***Subalpine rocky balds*** are severely exposed, rugged peaks that are sparsely vegetated. Both are associated with distinct physical settings that are less well studied than the more well-vegetated alpine and subalpine communities.

• Felsenmeer barren (S2)

GENERAL DESCRIPTION: Felsenmeer (a German word meaning "sea of rocks") is abundant in the Presidential Range, sometimes covering extensive areas (up to hundreds of acres), but is less common in other alpine areas. This natural community consists mostly of chaotic jumbles of large, lichen-encrusted rocks. The barrens are a product of frequent freeze and thaw cycles in the alpine zone. Water expands as it freezes in rock cracks, a process that eventually shatters the rocks into smaller fragments. Soil only occurs in scattered patches among the rocks. As a result, vascular plants are absent or sparse, and lichens are the dominant life form. Mt. Washington is sometimes called the "Big Rock Pile" in recognition of its extensive upper slopes of felsenmeer.

CHARACTERISTIC VEGETATION: Lichens are the dominant life form in felsenmeer. Crustose, umbillicate, and foliose types 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), *U. polyphylla* (petaled rock tripe), *U. hyperborea* (blistered rock tripe), *Lasillia papulosa* (toadskin lichen), *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 elevations above 5,000 ft. in the Presidential Range. Good examples occur on the cone of Mt. Washington, Bigelow Lawn, and 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 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 community is essentially a poorly developed or truncated version of heath - krummholz and ***subalpine dwarf shrubland*** communities that dominate more vegetated portions of subalpine peaks. The extent of bedrock exposure on several peaks has been expanded by human-caused fires, but most of these summits likely always had some open subalpine communities.

Bedrock is typically granitic (e.g., granite, syenite). This is the best community in the state 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 process occurs in massive, formerly buried igneous rocks (like granite) that tend to expand upward and outward as overlying bedrock is eroded away. In cold climates, frost wedging accelerates this erosional process. South Baldface Mtn. and Percy Peaks are excellent examples of exfoliation balds similar to those in the Sierra Nevada of California and other parts of the world.

CHARACTERISTIC VEGETATION: Scattered dwarf shrubs may include *Sibbaldiopsis tridentata* (three-toothed cinquefoil), *Vaccinium uliginosum* (alpine blueberry), *V. angustifolium* (lowbush blueberry), *V. vitis-idaea* (mountain cranberry), *V. boreale* (northern blueberry)*, *Empetrum nigrum* (black crowberry), *E. atropurpureum* (red crowberry), *Kalmia angustifolia* (sheep laurel), and *Rhododendron canadense* (rhodora). Herbs may include *Agrostis mertensii* (northern bentgrass), *Juncus trifidus* (highland rush), *Minuartia groenlandica* (mountain sandplant), and *Deschampsia flexuosa* (wavy hair grass). Stunted trees may include *Picea rubens* (red spruce), *Abies balsamea* (balsam fir), and *Betula cordifolia* (heart-leaved paper birch). *Paronychia argyrocoma* (silverling)* is found in cracks and on gravel benches on several peaks.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community mostly occurs from 3,000 to 3,500 ft., with a few examples found at higher elevations. In New Hampshire, it is found in the White Mountains, parts of the North Country, and on several outlying peaks of central and southwestern parts of the state. 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).

LANDSLIDES AND TALUS BARRENS

Landslide scars are visible as linear tracks on mountain slopes where rock, soil, and vegetation slumped and slid down slope, sometimes quite violently. They can be very narrow or quite broad. Landslides, sometimes called “debris avalanches,” occur for several reasons including gravity acting on substrates covering very steep slopes, substrate saturation, heavy snow accumulation, freeze-thaw processes, and earthquakes. Some landslide tracks occur in entrenched slopes such as steep stream valleys and avalanche tracks, whereas others occur on non-entrenched slopes.

Landslides eliminate the existing forest, creating opportunities for pioneer and early successional species. The upper parts of landslide tracks consist of cliffs, outcrops, and loose scree and talus material. The lower parts often consist of a debris cone where the material was deposited. The White Mountains currently have more than 500 landslide scars in various stages of recovery. The process of forest recovery may take centuries.

Talus barrens are open slopes covered by 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 barren and thicket (S3S4)

GENERAL DESCRIPTION: This community is found on the lower portions of landslide tracks. These areas are characterized by substrates of exposed basal till and deposits of mixed rubble debris, with this stony material sometimes appearing plastered to the exposed bedrock. This is an ephemeral community type; vegetation succeeds through barren and thicket stages and eventually becomes forest. Lower tracks succeed to forest more rapidly than the open rock areas above, but talus barrens in landslide tracks still require decades to establish lichens, and centuries to accumulate enough soil to support sparse woodlands. Forest re-development is slow on steep, eroded till areas. Birch, spruce, and fir saplings are often stunted at less

than a foot high for 20 years or more. The most rapid succession occurs in deposit areas where pioneer hardwoods completely crowd out light-dependent pioneer herbs within 30 years. Shade-tolerant forest herbs may take up to 70 years to recover after a landslide.

CHARACTERISTIC VEGETATION: Pioneer species include sedges, grasses, rushes, *Dennstaedtia punctilobula* (eastern hay-scented fern), *Oclemena acuminata* (sharp-toothed nodding-aster), other weedy forbs, willows, and alder. Common pioneer woody species include *Betula cordifolia* (heart-leaved paper birch), *B. papyrifera* (paper birch), *Prunus pensylvanica* (pin cherry), *Abies balsamea* (balsam fir), *Acer spicatum* (mountain maple), and *Alnus* spp. (alders). Understory species include numerous grasses, composites, and *Rubus* spp. (brambles), among others. Mosses and lichens are also common. At higher elevations, alpine/subalpine species may occur, such as *Minuartia groenlandica* (mountain sandplant), *Vaccinium uliginosum* (alpine blueberry), *Juncus trifidus* (highland rush), *Sibbaldiopsis tridentata* (three-toothed cinquefoil), and *Agrostis mertensii* (northern bentgrass).

CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: This community is found throughout the White Mountains. Good examples occur in Franconia and Crawford Notches, and on North and South Tripyramid, Mt. Osceola, Mt. Flume, North Twin Mtn., and Mt. Guyot/West Bond.

SOURCES: NHB field surveys; Flaccus 1959.

• Montane lichen talus barren (S3)

GENERAL DESCRIPTION: Lichen talus barrens are open slopes of lichen-covered rocks with little or no soil accumulation. Vascular plant cover is generally <5%. ***Montane lichen talus barrens*** occur in the mountains, mostly above 2,200 ft. in elevation but occasionally as low as 1,500 ft. Active talus barrens have a greater frequency of rockfall, avalanches, rock movement (especially for smaller-sized talus blocks), or landslides. This community occurs in association with ***birch - mountain maple wooded talus*** and ***subalpine cold-air talus shrublands***. Scattered individuals of species found in those communities may occur in talus barrens. While this is a physically distinct community, there has been limited documentation of lichens, invertebrates, and small mammals in these barrens.

Little soil is able to accumulate, especially in large-block talus barrens, and drought conditions likely prevail during much of the growing season. Soil that does accumulate is often very nutrient poor (oligotrophic).

CHARACTERISTIC VEGETATION: Lichens are the dominant organisms, and include crustose, umbillicate, and foliose growth forms. Although only limited lichen data have been collected in this community, species present likely have a montane distribution similar to the vascular plants found in or around these barrens. Occasional montane or boreal vascular plant species may include *Picea rubens* (red spruce), *Abies balsamea* (balsam fir), *Betula cordifolia* (heart-leaved paper birch), *B. papyrifera* (paper birch), *B. alleghaniensis* (yellow birch), and *Acer spicatum* (mountain maple). Both this community and ***temperate lichen talus barrens*** may have such species as *Polypodium virginianum* (rock polypody), *Ribes* spp. (gooseberries and currents), and *Deschampsia flexuosa* (wavy hair grass).

CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: This community is found above 2,200 ft. elevation (occasionally as low as 1,500–1,800 ft.) in lower and mid slope positions 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 lichen-covered rocks and little or no soil accumulation. Vascular plant cover is generally <5%. Lichens that are temperate in distribution are the dominant life form in this community, but invertebrates and small mammals are probably common among the rocks as well. The community is usually found below 1,800 ft. elevation, generally south of but also in the White Mountains. Active talus barrens have a greater frequency of rockfall, avalanches, rock movement (especially for smaller-sized talus blocks), or landslides. ***Temperate lichen talus barrens*** often occur in association with ***red oak - black birch wooded talus***. Scattered individuals of species characteristic of that community may occur in talus barrens. While this is a physically distinct community, there has been limited documentation of lichens, invertebrates, and small mammals in these barrens.

Little soil is able to accumulate, especially in large-block talus barrens, and drought conditions likely prevail during much of the growing season. Soil that does accumulate is often very nutrient poor (oligotrophic).

CHARACTERISTIC VEGETATION: Lichens are the dominant life form. Although only limited lichen data have been collected in this community, species present likely have a temperate distribution similar to the vascular plants found in or around these barrens. Scattered associated plant species include *Quercus rubra* (red oak), *Betula populifolia* (gray birch), *B. lenta* (black birch), *Capnoides sempervirens* (pink-corydalis), and other species found at lower elevations (see ***red oak - black birch wooded talus*** description). Few species characteristic of northern hardwood and spruce - fir forests occur here. As in ***montane lichen talus barrens***, this community may contain such species as *Polypodium virginianum* (rock polypody), *Ribes* spp. (gooseberries and currents), and *Deschampsia flexuosa* (wavy hair grass).

CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: This community is found primarily below 1,800 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. Outcrops angled less than 65 degrees are referred to as “rock slabs” and are more similar in terms of vegetation and ecological characteristics to rocky ridge communities. Cliffs are distinct from other outcrops in many ways: they are often highly fractured, have less soil accumulation, remain largely free of snow cover in winter, are more exposed to the elements in general, and are sometimes overhanging and thus protected from terrestrial runoff. Most cliffs in New Hampshire are acidic in character. The rarer circumneutral cliffs are associated with at least two geologic circumstances: 1) where the bedrock is intermediate, mafic, calc-silicate or carbonate-bearing; and/or 2) where bedrock fracturing enables water to flow through the rock, transporting mineral nutrients to seepage areas on the cliff face. Each of these interrelated factors can contribute to significant changes in nutrient level over short distances creating both acidic and circumneutral zones on the same cliff. These zones often have corresponding shifts in species composition. Several plant species are preferential to or restricted to cliffs.

Cliffs in the alpine zone are clearly different than their counterparts at lower elevations, but they are not defined as a separate community type. Plant cover is typically sparse and consists mostly of alpine plants found in the surrounding alpine communities, as well as disturbance- and exposure-tolerant species found at lower elevations. Most cliffs in New Hampshire’s alpine areas are acidic and dry or dry-mesic, with a few small circumneutral or cliff seep areas.

CLIFF SEEPS

Cliff seeps are portions of cliffs characterized by perennial or near-perennial seepage from bedrock groundwater fractures or terrestrial runoff. They are not a distinct natural community type, but rather occur as microhabitats within larger cliff communities. Soil accumulation is largely limited to bedrock cracks, small ledges, or thin layers on the rock surface. Cliff seeps are under-studied, but there is apparent variation in species composition that relates to differences in pH, mineral composition of bedrock, base cation status, and climate, all of which may vary considerably even at a single site. Mosses and liverworts are often dominant in cliff seeps.

Seeps on acidic cliffs are characterized by *Oclemena acuminata* (sharp-toothed nodding-aster), *Drosera rotundifolia* (round-leaved sundew), *Viola pallens* (smooth white violet), *V. cucullata* (blue marsh violet), *Phegopteris connectilis* (long beech fern), *Chrysosplenium americanum* (golden-saxifrage), *Rubus hispidus* (bristly blackberry), *R. pubescens* (dwarf raspberry), *Solidago rugosa* (wrinkle-leaved goldenrod), *Cinna latifolia* (slender wood-reed), *Circaea alpina* (small enchanter's-nightshade), *Platanthera dilatata* (white northern bog-orchid), *Cardamine pensylvanica* (Pennsylvania bitter-cress), *Epilobium* spp. (willow-herbs), *Carex scabrata* (eastern rough sedge), and *Nabalus altissimus* (tall rattlesnake-root). Common tree seedlings and 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*.

Species found in circumneutral seeps in northern or subalpine examples include *Trichophorum alpinum* (alpine clubsedge), *T. cespitosum* (tufted clubsedge), *Cystopteris bulbifera* (bulbil fragile fern), *Woodsia glabella* (smooth cliff fern)*, *Dasiphora floribunda* (shrubby-cinquefoil), *Calamagrostis stricta* ssp. *inexpansa* (northern neglected reed grass)*, *Pinguicula vulgaris* (violet butterwort)*, *Muhlenbergia glomerata* (spike muhly), and *Packera schweinitziana* (New England groundsel). *Micranthes virginiensis* (early small-flowered-saxifrage) and *Ageratina altissima* (white snakeroot) may occur at lower elevations. Bryophytes are common to abundant and include *Preissia quadrata*, *Conocephalum conicum*, *Crytomnium hymenophylloides*, *Timmia megapolitana*, *Thamnobryum alleghaniense*, and species rare to uncommon in the state such as *Distichium capillaceum*, *Gymnostomum aeruginosum*, and *Mnium thomsonii*.

Alpine cliff seep species include *Salix herbacea* (snow-bed willow)*, *Geum peckii* (White Mountain avens)*, *Arnica lanceolata* (lance-leaved arnica)*, *Saxifraga rivularis* (alpine-brook saxifrage)*, and *S. cernua* (nodding saxifrage)*.

Good examples of acidic cliff seeps occur at the Flume (Lincoln) and Smarts Brook (Thornton). Circumneutral cliff seeps can be found at Ice Gulch (Randolph) and Connecticut River State Forest (Pittsburg). Good examples of alpine cliff seeps occur on the west ridge of Mt. Lincoln and in Tuckerman and Huntington Ravines.

• Montane - subalpine acidic cliff (S4)

GENERAL DESCRIPTION: This cliff community is characterized by a mixture of species indicative of acidic and montane conditions. Circumneutral indicators are absent. Higher elevation examples of this community may contain subalpine species, and some examples in the alpine zone contain only alpine-restricted species. These cliffs occur primarily in the White Mountain region, and are most spectacular in the large ravines of the Presidential Range.

Montane and alpine species also found in this community include heart-leaved paper birch and dwarf shrubs such as mountain cranberry, three-toothed cinquefoil, velvet-leaved blueberry, Labrador tea, alpine blueberry, and diapensia*.

CHARACTERISTIC VEGETATION: Characteristic vegetation includes *Deschampsia flexuosa* (wavy hair grass), *Sibbaldiopsis tridentata* (three-toothed cinquefoil), *Cystopteris fragilis* (fragile fern), *Solidago simplex* ssp. *randii* var. *monticola* (montane Rand's goldenrod), *Danthonia spicata* (poverty oatgrass), *Capnoides sempervirens* (pink-corydalis), and *Paronychia argyrocoma* (silverling)*.

Other plant species that may be present include herbs such as *Solidago bicolor* (white goldenrod), *S. nemoralis* (gray goldenrod) and other goldenrods, *Symphyotrichum* ssp. (American-asters), *Achillea millefolium* ssp. *lanulosa* (common yarrow), *Aquilegia canadensis* (red columbine), *Danthonia compressa* (flattened oatgrass), *Poa compressa* (flat-stemmed blue grass), *Elymus repens* (creeping wild-rye), *Agrostis* spp. (bentgrasses), *Panicum* spp. (panicgrasses), *Dennstaedtia punctilobula* (eastern 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-leaved blueberry), *V. angustifolium* (lowbush blueberry), *V. vitis-idaea* (mountain cranberry), *Spiraea alba* var. *latifolia* (meadowsweet), *Kalmia angustifolia* (sheep laurel), *Rhododendron groenlandicum* (Labrador tea), *Sorbus americana* (American mountain-ash), *S. decora* (showy mountain-ash), *Acer pensylvanicum* (striped maple), *A. 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 to support them. These include *Betula papyrifera* (paper birch), *B. cordifolia* (heart-leaved paper birch), *B. alleghaniensis* (yellow birch), *Quercus rubra* (red oak), *Populus tremuloides* (quaking aspen), *P. grandidentata* (big-toothed aspen), *Acer saccharum* (sugar maple), *Pinus resinosa* (red pine), *P. strobus* (white pine), *Juniperus virginiana* (eastern red cedar), *Picea mariana* (black spruce), *P. rubens* (red spruce), *Abies balsamea* (balsam fir), and *Tsuga canadensis* (hemlock).

Sites with *Agrostis mertensii* (northern bentgrass), *Juncus trifidus* (highland rush), and *Trichophorum cespitosum* (tufted clubsedge) indicate subalpine conditions. Some of these sites also have *Empetrum atropurpureum* (red crowberry) and *Vaccinium uliginosum* (alpine blueberry) on shelves or cliff brows.

White Mountain saxifrage (*Saxifraga paniculata* ssp. *neogaea*)* and nodding saxifrage (*Saxifraga cernua*)* are two very rare plant species restricted to cliffs in the alpine zone.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community occurs north of and including the Sunapee Uplands and Sebago-Ossipee Hills and Plain subsections at 1,200–3,500 ft. elevations (locally to 1,000 ft. and 4,000 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 - subalpine circumneutral cliff (S2S3)

GENERAL DESCRIPTION: Circumneutral cliffs 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). They support caliciphilic plant species absent from more acidic cliff communities, including alpine clubsedge, shrubby-cinquefoil, White Mountain saxifrage*, violet butterwort*, and scirpus-like sedge*; many of these species require seasonally to perennially wet seepage zones with elevated levels of calcium. These cliffs occur in only a few locations in New Hampshire, and are restricted to parts of large cliffs and ravines in the mountains.

CHARACTERISTIC VEGETATION: Diagnostic vascular plants include *Dryopteris fragrans* (fragrant wood fern)*, *Woodsia glabella* (smooth cliff fern)*, *W. ilvensis* (rusty cliff fern), *Cryptogramma stelleri* (slender rock-brake)*, *Campanula rotundifolia* (Scotch bellflower), *Oligoneuron album* (white flat-topped-goldenrod)*, *Draba cana* (canescent whitlow-mustard)*, *Boechera stricta* (Canada rockcress), *Carex*

scirpoidea (scirpus-like sedge)*, *C. eburnea* (bristle-leaved sedge)*, *Sambucus racemosa* (red elderberry), *Dasiphora floribunda* (shrubby-cinquefoil), and *Thuja occidentalis* (northern white cedar). Other circumneutral site species that may be present but are more diagnostic of ***temperate circumneutral cliffs*** include *Pellaea atropurpurea* (purple cliff-brake)*, *Asplenium trichomanes* (maidenhair spleenwort), and *Micranthes virginiensis* (early small-flowered-saxifrage). Generally only a few of these circumneutral indicators are present at any one site.

Many vascular plant species growing on circumneutral cliffs are not necessarily indicators of enriched conditions. On nine circumneutral cliffs surveyed in the White Mountains, bryophytes were better indicators of calcareous and circumneutral conditions than vascular plants (44% of all bryophytes were base-rich indicators compared to 14% of vascular plants). Among these bryophytes, the most characteristically strict calciphiles (and rare to uncommon in the state) were *Distichium capillaceum*, *Gymnostomum aeruginosum*, and *Tortella tortuosa*; other base-rich or circumneutral indicators included *Amphidium mougeotii*, *Diplophyllum apiculatum*, *Mnium thomsonii*, and *Myurella siberica*. *Polytrichastrum alpinum* is frequent but probably not restricted to circumneutral cliffs.

Other plant species include *Antennaria* spp. (pussytoes), *Cystopteris fragilis* (fragile fern), *C. tenuis* (Mackay's brittle fern), *C. bulbifera* (bulbil fragile fern), *Trisetum spicatum* (narrow false oat), *Arabis pycnocarpa* (hairy eared-rockcress)*, *Epilobium ciliatum* (fringed willow-herb), *Eurybia radula* (rough wood-aster) and other American-asters, *Solidago arguta* (forest goldenrod), *S. bicolor* (white goldenrod), *S. nemoralis* (gray goldenrod) and other goldenrods, *Danthonia spicata* (poverty oatgrass), *D. compressa* (flattened oatgrass), *Agrostis* spp. (bentgrasses), *Achillea millefolium* ssp. *lanulosa* (common yarrow), *Aquilegia canadensis* (red columbine), *Poa compressa* (flat-stemmed blue grass), *Panicum* spp. (panicgrasses), *Elymus repens* (creeping wild-rye), *Deschampsia flexuosa* (wavy hair grass), and *Dennstaedtia punctilobula* (eastern hay-scented fern).

Shrubs that may be present in low cover include *Dasiphora floribunda* (shrubby-cinquefoil), *Juniperus horizontalis* (creeping juniper)*, *Diervilla lonicera* (bush honeysuckle), *Spiraea alba* var. *latifolia* (meadowsweet), *Acer pensylvanicum* (striped maple), *A. spicatum* (mountain maple), *Swida rugosa* (round-leaved dogwood), *Sibbaldiopsis tridentata* (three-toothed cinquefoil), *Rubus* spp. (brambles), and *Amelanchier* spp. (shadbushes).

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

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is generally found above 900 ft. and up to 3,500 ft. (locally to 4,000 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.

• Temperate acidic cliff (S4)

GENERAL DESCRIPTION: This is the most common type of cliff in New Hampshire. They are found throughout the state below 2,200 ft. elevation. Montane, subalpine, and circumneutral indicator species are absent. Wet seepage areas sometimes support abundant mosses and liverworts, and vascular plants typical of fens and swamps.

CHARACTERISTIC VEGETATION: Characteristic vegetation includes *Dryopteris marginalis* (marginal wood

fern), *D. intermedia* (evergreen wood fern), *Asplenium trichomanes* ssp. *trichomanes* (maidenhair spleenwort), *Polypodium virginianum* (rock polypody), *Dennstaedtia punctilobula* (eastern hay-scented fern), *Cystopteris tenuis* (Mackay's brittle fern), *Solidago nemoralis* (gray goldenrod), *S. juncea* (early goldenrod), *S. bicolor* (white goldenrod), *Symphyotrichum* ssp. (American-asters), *Achillea millefolium* ssp. *lanulosa* (common yarrow), *Aquilegia canadensis* (red columbine), *Capnoides sempervirens* (pink-corydalis), *Aureolaria pedicularia* var. *intercedens* (intervening fern-leaved false foxglove), *Deschampsia flexuosa* (wavy hair grass), *Danthonia spicata* (poverty oatgrass), *D. compressa* (flattened oatgrass), *Agrostis* spp. (bentgrasses), *Poa compressa* (flat-stemmed blue grass), *Panicum* spp. (panicgrasses), and *Elymus repens* (creeping wild-rye).

Shrubs that may be present in low cover include *Diervilla lonicera* (bush honeysuckle), *Vaccinium angustifolium* (lowbush blueberry), *Spiraea alba* var. *latifolia* (meadowsweet), *Kalmia angustifolia* (sheep laurel), *Acer pensylvanicum* (striped maple), *A. 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 accumulates. These include *Betula papyrifera* (paper birch), *Quercus rubra* (red oak), *Populus tremuloides* (quaking aspen), *P. grandidentata* (big-toothed aspen), *Acer saccharum* (sugar maple), *Pinus strobus* (white pine), *Juniperus virginiana* (eastern red cedar), and *Picea rubens* (red spruce).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is generally found below 2,200 ft. and south of the White Mountains. A good example occurs on Joe English Hill (New Boston).

SOURCES: NHB field surveys.

• Temperate circumneutral cliff (S2)

GENERAL DESCRIPTION: This community corresponds to circumneutral cliffs at low elevations (below 1,000 ft.) in southern or central NH. It occurs where the parent bedrock is intermediate, mafic, calc-silicate, or carbonate-bearing and where fractured rock groundwater transports base cations to the cliff face (particularly under overhangs). Montane and subalpine indicator species are absent. This community may occupy most of the area of a cliff, or be restricted to specific zones within a larger acidic cliff.

CHARACTERISTIC VEGETATION: Plants characteristic of this community include *Cryptogramma stelleri* (slender rock-brake)*, *Asplenium trichomanes* ssp. *quadrivalens* (Meyer's maidenhair spleenwort), *Woodsia ilvensis* (rusty cliff fern), *W. obtusa* (blunt-lobed cliff fern)*, *Pellaea atropurpurea* (purple cliff-brake)*, and *Micranthes virginiensis* (early small-flowered-saxifrage).

Other plant species include *Solidago bicolor* (white goldenrod), *S. nemoralis* (gray goldenrod) and other goldenrods, *Symphyotrichum* ssp. (American-asters), *Achillea millefolium* ssp. *lanulosa* (common yarrow), *Campanula rotundifolia* (Scotch bellflower), *Aquilegia canadensis* (red columbine), *Antennaria* spp. (pussytoes), *Danthonia spicata* (poverty oatgrass), *D. compressa* (flattened oatgrass), *Agrostis* spp. (bentgrasses), *Poa compressa* (flat-stemmed blue grass), *Panicum* spp. (panicgrasses), *Elymus repens* (creeping wild-rye), *Deschampsia flexuosa* (wavy hair grass), *Dennstaedtia punctilobula* (eastern hay-scented fern), and *Cystopteris tenuis* (Mackay's brittle fern).

Shrubs that may be present in low cover include *Dasiphora floribunda* (shrubby-cinquefoil), *Diervilla lonicera* (bush honeysuckle), *Spiraea alba* var. *latifolia* (meadowsweet), *Acer pensylvanicum* (striped maple), *A. spicatum* (mountain maple), *Swida 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 accumulates. These include *Betula papyrifera* (paper birch), *Quercus rubra* (red oak), *Populus tremuloides* (quaking aspen), *P.*

grandidentata (big-toothed aspen), *Acer saccharum* (sugar maple), *Pinus strobus* (white pine), *Juniperus virginiana* (eastern red cedar), *Thuja occidentalis* (northern white cedar), and *Picea rubens* (red spruce).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is generally found below 1,000 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.

ROCKY MARITIME COMMUNITIES

New Hampshire's maritime rocky shore communities occur on the offshore Isles of Shoals and exposed locations along the mainland. The nine small islands of the Isles of Shoals, four of which are in New Hampshire, are considerably more exposed to and battered by the ocean than most nearby mainland shores. Maritime rocky shore natural communities reflect different degrees of exposure to tides, waves and storm surges, salt spray and salinity, and drought. Nesting birds are also influential. Vascular plants are absent in the intertidal zone. Blue-green algae and lichens may be present in the upper intertidal zone while lower intertidal rocky shores support a great diversity of marine algae. Rocky barrens occur above the intertidal zone where exposure to storm waves and salt spray is still substantial. Shrub thickets occur on slightly higher ground which is even less exposed to ocean forces. Herbaceous meadows form where seabird activity is high.

• Maritime cobble beach (S1)

GENERAL DESCRIPTION: This community, characterized by a low to moderate cover of forbs and graminoids, is found along short stretches of cobble beaches. They occur above the reach of spring tides, but are overwashed during severe storms. These dynamic beaches can be significantly altered over relatively short periods of time. On Lunging Island, one of the Isles of Shoals, the cobble beach rose 3 m in elevation over a 20 year time span (R. Randall, pers. comm.) as a result of storm waves moving sand, gravel, cobble, and larger rock landward onto the beach.

The substrate is primarily cobble and/or gravel.

CHARACTERISTIC VEGETATION: Frequent species are *Achillea millefolium* ssp. *lanulosa* (common yarrow), *Ambrosia artemisiifolia* (common ragweed), *Cakile edentula* (American sea-rocket), *Calystegia sepium* (hedge false bindweed), *Chenopodium album* (white goosefoot), *Elymus repens* (creeping wild-rye), *Galeopsis bifida* (split-lipped hemp-nettle), *Lathyrus japonicus* var. *maritimus* (beach vetchling), *Raphanus raphanistrum* (wild radish), *Rumex crispus* (curly dock), *Sisymbrium altissimum* (tumbling hedge-mustard), *Solanum dulcamara* (climbing nightshade), and *Solidago sempervirens* (seaside goldenrod). Due to the dynamic nature of this community, a higher proportion of non-natives may occur here compared to most other natural community types. One of the cobble beaches on the Isles of Shoals supports the only extant population of *Leymus mollis* (American lyme grass)* in New Hampshire. The state historical *Mertensia maritima* (seaside bluebells)* was also documented from this location.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is known from the Isles of Shoals (Rye) and Odiorne Point State Park (Rye) in the Coastal Lowland subsection.

SOURCES: NHB field surveys.

• Maritime rocky barren (S2)

GENERAL DESCRIPTION: This sparsely vegetated community is dominated by exposed bedrock and occurs between the ***intertidal rocky shore*** and the ***maritime meadow*** or ***maritime shrub thicket*** communities. Plant cover is affected by concentrations of seabird guano, lack of soil, and exposure to heavy surf, wind, and salt spray. A low cover of herbs and even fewer shrubs creeps down into protected crevices from more densely vegetated communities above.

Soil is primarily restricted to protected crevices in the bedrock.

CHARACTERISTIC VEGETATION: The most frequent species are *Achillea millefolium* ssp. *lanulosa* (common yarrow), *Elymus repens* (creeping wild-rye), *Festuca rubra* ssp. *pruinosa* (frosty red fescue), *Lepidium ruderale* (stinking pepperweed), *L. virginicum* (poor-man's pepperweed), *Polygonum aviculare* (dooryard knotweed), *Portulaca oleracea* (common purslane), *Solanum dulcamara* (climbing nightshade), *Solidago sempervirens* (seaside goldenrod), *Spergularia rubra* (red sand-spurry), and *Symphyotrichum novi-belgii* (New York American-aster). Several other species can occur with an even sparser cover.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is restricted to the Isles of Shoals (Rye) where it occurs on all nine islands, and to some exposed coastal shorelines on the mainland. All examples occur within the Coastal Lowland subsection.

SOURCES: NHB field surveys.

• Maritime meadow (S1)

GENERAL DESCRIPTION: This community, characterized by forbs and graminoids, dominates upland habitats landward of ***maritime rocky barrens*** on most of the smaller islands in the Isles of Shoals. It also occurs on the larger islands where sizable seabird nesting colonies occur. Shrub cover is markedly reduced or absent. The density of herb cover can vary greatly here. Cover is less dense in exposed areas with thin, dry soils, and denser in protected areas with thicker, moister soils. Substrates consist of sandy loams rich in organic matter.

This community is invariably linked to seabird nesting colonies, as guano deposition from gulls and cormorants plays a significant role in maintaining species composition and structure (Ellis et al. 2006). Gulls and cormorants also pull and trample vegetation in nesting areas. George (1980) notes "the influence of larger birds on Duck Island, where hardly a sprig of a living woody form can be found, and where the air reeks of guano is the extreme example." Vegetation cover and composition in turn influences whether the nesting habitat is more suitable for terns, gulls, or cormorants (D. Hayward and S. Fuller, pers. comm.).

CHARACTERISTIC VEGETATION: On thinner, drier soils in more exposed areas, herb cover is sparse to moderate and characterized by *Achillea millefolium* ssp. *lanulosa* (common yarrow), *Ambrosia artemisiifolia* (common ragweed), *Symphyotrichum novi-belgii* (New York American-aster), *Solidago rugosa* (wrinkle-leaved goldenrod), *Rumex acetosella* ssp. *pyrenaicus* (sheep dock), and *Festuca rubra* ssp. *pruinosa* (frosty red fescue), with lesser amounts of *Bromus tectorum* (cheat brome), *Lysimachia arvensis* (scarlet pimpernel), *Lepidium ruderale* (stinking pepperweed), *L. virginicum* (poor-man's pepperweed), *Persicaria maculosa* (lady's-thumb smartweed), *Polygonum aviculare* (dooryard knotweed), *Portulaca oleracea* (common purslane), and *Solanum nigrum* (European black nightshade).

In more protected areas where soil accumulation and moisture increase, a moderate to dense cover of herbs can occur. Together with the species mentioned above, additional herbs characteristic of these less exposed areas are *Artemisia vulgaris* (common wormwood), *Elymus repens* (creeping wild-rye), *Ligusticum scothicum* (Scotch lovage), *Persicaria punctata* (dotted smartweed), *Raphanus raphanistrum* (wild radish),

Sisymbrium altissimum (tumbling hedge-mustard), *S. officinale* (common hedge-mustard), *Solidago sempervirens* (seaside goldenrod), and *Stellaria media* (common stitchwort). The few shrubs and lianas that may be present include *Rubus allegheniensis* (common blackberry), *R. idaeus* ssp. *strigosus* (strigose red raspberry), *Solanum dulcamara* (climbing nightshade), and *Toxicodendron radicans* (poison-ivy).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is restricted to the Isles of Shoals (Rye) in the Coastal Lowland subsection.

SOURCES: NHB field surveys; Ellis et al. 1994; George 1980.

• Maritime shrub thicket (S1)

GENERAL DESCRIPTION: This community is dominated by shrubs with a low abundance of stunted trees and understory herbs. ***Maritime shrub thickets*** are restricted to only a few locations along New Hampshire's maritime coastline. These locations include the Isles of Shoals and an upland area on the mainland's coastline that is particularly exposed to maritime elements.

The substrate consists of relatively thin, dry to dry-mesic, sandy loams.

CHARACTERISTIC VEGETATION: Common shrubs include *Amelanchier canadensis* (eastern shadbush), *A. spicata* (dwarf shadbush), *Gaylussacia baccata* (black huckleberry), *Morella caroliniensis* (small bayberry), *Parthenocissus quinquefolia* (Virginia-creeper), *Aronia melanocarpa* (black chokeberry), *Rosa rugosa* (beach rose), *R. virginiana* (Virginia rose), *Rubus allegheniensis* (common blackberry), *R. idaeus* ssp. *strigosus* (strigose red raspberry), *Toxicodendron radicans* (poison-ivy), and occasionally *Sibbaldiopsis tridentata* (three-toothed cinquefoil) and stunted trees such as *Acer rubrum* (red maple) and *Prunus serotina* (black cherry). Herbaceous species include *Achillea millefolium* ssp. *lanulosa* (common yarrow), *Symphyotrichum novi-belgii* (New York American-aster), *Fallopia scandens* (climbing bindweed), *Fragaria virginiana* (common strawberry), *Maianthemum stellatum* (star-like false Solomon's-seal), *Sedum* spp. (stonecrops), *Poa compressa* (flat-stemmed blue grass), *P. pratensis* (Kentucky blue grass), *Agrostis capillaris* (Rhode Island bentgrass), *Anthoxanthum odoratum* (large sweet grass), *Elymus repens* (creeping wild-rye), and *Festuca rubra* ssp. *pruinosa* (frosty red fescue).

VARIANTS: Two variants are described:

1. **Typic maritime island variant**: Vegetation as described above. This variant covers most of the natural upland habitat landward of ***maritime rocky barrens*** on Star Island and on other larger islands in the Isles of Shoals nearby in Maine (i.e., Appledore, Cedar, and Smuttynose). Vegetation structure varies depending on degree of exposure and soil depth. A short to moderate-height shrub thicket comprised of stunted and low-growing shrubs grows on thin-soiled, exposed ridgelines and areas close to shorelines (near rocky barrens). Moderate-height to tall shrub thickets grow in more protected island interiors with deeper soils.
2. **Mainland variant**: The mainland example occurs on a dry sandy, cobble berm and is impacted by high cover of invasive species. Common shrubs are *Rhus hirta* (staghorn sumac), *Toxicodendron radicans* (poison-ivy), *Lonicera morrowii* (Morrow's honeysuckle), and *Rosa rugosa* (beach rose). Stunted, scattered tree species include *Prunus serotina* (black cherry) and *Juniperus virginiana* (eastern red cedar). Herbs include several found in the typic variant along with *Lathyrus japonicus* var. *maritimus* (beach vetchling), *Oenothera biennis* (common evening-primrose), *Artemisia vulgaris* (common wormwood), *Rumex crispus* (curly dock), and others.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: In NH, this community is restricted to Star Island on the Isles of Shoals (Rye) and Odiorne Point State Park in the Coastal Lowland subsection.

SOURCES: NHB field surveys.

COASTAL DUNES AND INLAND BEACH STRANDS

Coastal sand dune systems consist of several natural community types, each corresponding to one of four broad zones: beach, foredune, interdune, and backdune. The beach is most exposed to onshore winds and salt spray and sparsely vegetated as a result. The foredune is somewhat less exposed and is typically dominated by *Ammophila breviligulata* (beach grass)* with few other species. The interdune is usually dominated by beach grass* and has a broader diversity of species. At one location, a hudsonia shrubland has formed in the interdune. The more protected portions of the dune (backdune) are characterized by maritime dune woodlands, shrub thickets, and interdunal swales. The sandy beach, beach grass, hudsonia shrubland, and shrub thicket communities are treated in this section while the wooded dunes and interdunal swale communities are treated elsewhere in the document. Some amount of active sand shifting is a common physical feature of all four zones. The two primary physical processes that produce the different communities are (1) the degree of exposure to or protection from on-shore winds, and the resulting degree of sand stabilization, and (2) soil moisture.

Open riparian plains and dunes are globally rare and known in the state only from the upper Merrimack River. Dunes are a very rare geologic phenomenon away from the coast in New England.

Inland beach strands in New Hampshire are known only from Ossipee Lake, a region of the state with an extensive sand plain. The beach strands occur along portions of the lakeshore where ice-push and wave action have created large berms. These berms are comprised of sand mixed with organic matter deposited by waves. Dry site and coastal plain species are characteristic.

OPEN COASTAL DUNE COMMUNITIES

• Maritime sandy beach (S1)

GENERAL DESCRIPTION: This community occurs on ocean beaches beginning at the extra-high tide line then landward to the base of the foredune. These upper beaches are over-washed by waves during severe storms and vegetation is routinely exposed to strong winds, sand abrasion, and salt spray. Shifting sands are also a constant disturbance. As a result, vegetation is sparse (<1% cover) and generally limited to salt-tolerant, succulent annuals. The rest of the community consists of bare sand. Strand lines of seaweeds and other plant material may be present from storm events. The federally threatened piping plover (*Charadrius melodus*) nests in this community. All of New Hampshire's ***maritime sandy beaches*** have been impacted by foot traffic, especially from beachgoers during the summer months.

CHARACTERISTIC VEGETATION: Plant species cover and diversity are low. Scattered plants may include *Cakile edentula* (American sea-rocket), *Salsola kali* (saltwort), *Raphanus raphanistrum* (wild radish), *Ammophila breviligulata* (beach grass)*, and *Lathyrus japonicus* var. *maritimus* (beach vetchling).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Restricted to certain areas along the coast from Seabrook to Rye (NH Coastal Lowland subsection).

SOURCES: NHB field surveys.

• Beach grass grassland (S1)

GENERAL DESCRIPTION: This community is most prominent on the foredune portion of coastal sand dune systems, but also occurs in interdune and backdune areas, and as narrow strands of vegetation along the upper edge of some beaches without dunes. Each of these settings has actively shifting sand, but the foredune examples support a greater diversity of flora. *Ammophila breviligulata* (beach grass)*, the dominant species of this community, is well adapted to the dynamic environment of moving sand and creates extensive colonies by spreading underground stems called rhizomes.

CHARACTERISTIC VEGETATION: Beach grass* is the dominant species of this community. *Solidago sempervirens* (seaside goldenrod) is a common associate, and the rare *Hudsonia tomentosa* (hairy hudsonia)* is occasional. Areas dominated by extensive mats of hairy hudsonia* are described as a separate community type, the ***hudsonia maritime shrubland***. Other rare species may include *Aristida tuberculosa* (seaside threeawn)* and *Cyperus grayi* (Gray's umbrella sedge)*. Occasional associates are *Danthonia spicata* (poverty oatgrass), *Schizachyrium scoparium* (little bluestem), *Lathyrus japonicus* var. *maritimus* (beach vetchling), *Lechea maritima* (beach pinweed), *Polygonum articulatum* (coastal jointed knotweed), and *Cyperus lupulinus* var. *macilentus* (Great Plains umbrella sedge).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Mostly restricted to Seabrook Beach and "The Sands" in Seabrook (NH Coastal Lowland subsection).

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

• Hudsonia maritime shrubland (S1)

GENERAL DESCRIPTION: This community occurs in interdunal areas where sand movement from wind and waves, although still quite significant, is more limited than in ***beach grass grassland*** dominated foredunes. These interdunes are occasionally overwashed when portions of foredunes are blown out during severe storms, and waterborne sand is deposited at these times.

Hudsonia tomentosa (hairy hudsonia)* is adapted to withstand a certain degree of sand burial and can form dense stands in more stabilized areas. In other areas, patches of sparsely vegetated or completely unvegetated sand can occur. Due to its sand-binding ability, hairy hudsonia* is considered a keystone species in this community because it allows other plant species to become established (NatureServe 2007). Only one example occurs in New Hampshire, between a beach grass* covered foredune and beach cottages on the remains of the back portion of an interdune. Historically, this community likely was common (as it is today on Plum Island's dune system nearby in MA) within the once extensive dune system that stretched along the coast from the state line in Seabrook through Hampton Beach.

The xeric sand (to gravelly-sand) substrate is wind and water deposited and supports essentially no soil development.

CHARACTERISTIC VEGETATION: Occasional associates of the dominant hairy hudsonia* include *Ammophila breviligulata* (beach grass)*, *Artemisia campestris* ssp. *caudata* (field wormwood)*, *Carex silicea* (sea-beach sedge), *Cyperus grayi* (Gray's umbrella sedge)*, *Festuca rubra* ssp. *pruinosa* (frosty red fescue), *Lathyrus japonicus* var. *maritimus* (beach vetchling), *Lechea maritima* (beach pinweed), *Polygonum articulatum* (coastal jointed knotweed), *Solidago sempervirens* (seaside goldenrod), *Astraeus hygrometricus* (earthstar fungus), and several lichen species. Less frequent associates are *Aristida tuberculosa* (seaside threeawn)*, *Artemisia stelleriana* (beach wormwood), *Bromus tectorum* (cheat brome), *Cyperus lupulinus* var. *macilentus* (Great Plains umbrella sedge), *Oenothera biennis* (common evening-primrose), *Schizachyrium scoparium* (little bluestem), *Sporobolus cryptandrus* (sand dropseed)*, and few others. Collectively, these herbaceous associates have a sparse cover (<5%).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Restricted to one interdunal site at Seabrook Beach (Seabrook) in the Coastal Lowland subsection.

SOURCES: NHB field surveys.

• Bayberry - beach plum maritime shrubland (S1)

GENERAL DESCRIPTION: This community is primarily found on the backdune but may also occur in small, protected hollows of 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 region's dune communities and their flora, including at NH's only dune system (Seabrook Dunes).

CHARACTERISTIC VEGETATION: This community is characterized by short to moderate height shrub thickets dominated by *Morella caroliniensis* (small bayberry) and *Prunus maritima* (beach plum). Other species include *Toxicodendron radicans* (poison-ivy), *Rosa virginiana* (Virginia rose), *Oenothera biennis* (common evening-primrose), *Achillea millefolium* ssp. *lanulosa* (common yarrow), and *Fallopia scandens* (climbing bindweed). *Artemisia campestris* ssp. *caudata* (field wormwood)* is occasionally found at the edge of these thickets. A related maritime-influenced shrubland is dominated primarily by small bayberry (without beach plum) and may be a distinct variant.

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: In New Hampshire, this community only occurs on Ossipee Lake, where ice-push and wave action have created large berms around portions of the lakeshore. These open berms are comprised of sand (from the extensive sand plain in and around Ossipee Lake) mixed with organic matter deposited by waves. Scattered shrubs and herbs grow on the berms, starting at 1–1.5 meters above late-summer water levels. Dry site and coastal plain plant species are characteristic. This community is associated with several other regionally rare sandy pond shore communities that form narrow bands at slightly-lower elevations along the shore line.

CHARACTERISTIC VEGETATION: This community is characterized by a rare assemblage of species that includes *Hudsonia tomentosa* (hairy hudsonia)*, *H. ericoides* (golden heather)*, *Quercus ilicifolia* (scrub oak), and *Schizachyrium scoparium* (little bluestem). Other frequent and characteristic species include *Prunus susquehanae* (Appalachian dwarf cherry), *Vaccinium macrocarpon* (large cranberry), *Gaylussacia baccata* (black huckleberry), *Aronia melanocarpa* (black chokeberry), *Juniperus communis* var. *depressa* (common juniper), *Lechea intermedia* (round-fruited pinweed), *Panicum virgatum* (switch panicgrass), *Danthonia spicata* (poverty oatgrass), *Dichanthelium boreale* (northern rosette-panicgrass), and *D. clandestinum* (deer-tongue rosette-panicgrass). Occasional patches 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 at a few locations around the margins of Ossipee Lake, including the Ossipee

Lake Natural Area (Ossipee).

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

WOODED UPLANDS

Natural communities where trees comprise more than 25% cover are classified as wooded uplands. Wooded uplands are sub-classified as woodlands (25–60% tree cover) and forests (60–100% tree cover). North America's Boreal Forest biome intersects with the Eastern Deciduous Forest biome in New England. A distinct transition or "tension" zone emerges between the two biomes, expressed both latitudinally and elevationally. This results in a pattern of three major forest zones in New England (Westveld et al. 1956; Bormann et al. 1970; Cogbill and White 1991; Cogbill et al. 2002). NH Natural Heritage refers to these zones as: 1) **Acadian spruce - fir forests**, characterized by northern conifers, 2) **Laurentian mixed forests,** which include northern hardwoods and transition hardwood - conifer communities, and 3) **Appalachian oak and pine forests**, characterized by central or Appalachian hardwoods that mix with pines.

Within each zone, individual forest communities vary greatly in size. A few common communities occupy extensive areas, forming regional forest matrices. A greater number of communities occur as smaller patches embedded within the forest matrix, corresponding to sites with different microclimates, site conditions, and disturbance regimes. The communities that form the forest matrix of one region, however, may also occur as patches in adjacent regions. For example, spruce - fir forests, common in the White Mountains, occur in southern New Hampshire only as isolated patches on summits like Mount Monadnock.

ACADIAN SPRUCE - FIR FOREST ZONE

The Acadian forest region takes its name from the Acadian peninsula, and encompasses northern New England, southern Quebec, and the maritime provinces of Canada. This region is transitional between the transcontinental boreal forest to the north and high-elevation spruce - fir forests of the central Appalachians. Red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*) are the characteristic trees of this region, but species like red pine (*Pinus resinosa*), Jack pine (*P. banksiana*)*, and northern white cedar (*Thuja occidentalis*) can dominate on rocky ridges and slopes.

FORESTS

Spruce - fir forests occur in cool climates and are dominated by conifers. In New Hampshire, they grow in both high-elevation and low-elevation settings. Higher elevation spruce - fir forests in New Hampshire typically occur between 2,500 ft. and 4,900 ft. elevation (Leak and Graber 1974; Cogbill and White 1991). These forests cloak the upper portions of many of the state's mountains. Lower elevation spruce - fir forests occur in settings 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. They are located elevationally below northern hardwoods and are often associated with lake basins, streamsides, river and kame terrace sediments, and peatlands.

The various spruce - fir forest communities in New England support a vascular flora of approximately 280 species, 25 of which are abundant (Cogbill 1987). Eighty-seven species of vascular plants and 26 species of mosses and lichens were identified in spruce - fir forests at Nancy Brook RNA (Royte et al. 1996). A number of prominent species have an Alleghanian distribution, (which includes the glaciated northeastern United States, the 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 cordifolia* (heart-leaved paper birch), *B. alleghaniensis* (yellow birch), *Pinus strobus* (white pine), *Populus grandidentata* (big-toothed aspen), *Acer spicatum* (mountain maple), and *A. pensylvanicum* (striped maple). All of these species are absent in the transcontinental boreal forest. Red spruce, common in New England's spruce - fir forests, is replaced by black spruce (*Picea mariana*) and white spruce (*P. glauca*) in the boreal forest. Heart-leaved paper birch in our montane forests is replaced by *Betula papyrifera* (paper birch) to the

north. *Abies balsamea* (balsam fir) occurs in both forest regions. Deciduous shrubs and trees tend to be more prevalent here than in boreal forests to the north (La Roi 1967).

Acadian spruce - fir forests are subject to a variety of natural disturbances. Wind damage is the most prominent of these disturbances; it can take the form of a large-scale, catastrophic event (hurricanes), small-scale patch windthrow, and fir-wave phenomena (Reiners and Lang 1979; Foster and Reiners 1983). Periodic insect infestations also significantly impact these forests. In particular, naturally-occurring outbreaks of spruce budworm heavily impact large swaths of spruce - fir forest every 40–60 years. To a lesser extent, fire can alter successional patterns in these communities. Small-scale fires are occasional in the White Mountains and North Country. Finally, acid deposition, or "acid rain" has been widely noted as a major contributing factor to the decline of spruce - fir forests. 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.

The disturbance history of an Acadian spruce - fir forest strongly influences its structure and composition. Large gaps tend to regenerate with even-aged tree 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., paper birches). Balsam fir and paper birch are fast-growing and short-lived, making them generally more successful gap colonizers than red spruce. In the understory, herbaceous and bryophyte plant cover is closely correlated with light availability; more open canopy gaps tend to have greater understory plant cover, whereas dense, closed canopies tend to have lower understory cover.

Five communities are described in this section. Two high-elevation types, ***high-elevation spruce - fir forest*** and ***high-elevation balsam fir forest***, are based on the general pattern of increasing prominence of balsam fir and heart-leaved paper 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*** at low elevations below northern hardwood forests and ***black spruce - red spruce forest*** at mid elevations. The fifth type, ***northern white cedar forest/woodland***, is somewhat anomalous, in that it is not dominated by spruce or fir. However, it is included in this section because it is an upland forest community dominated by a northern conifer, and restricted to the northern part of the state.

• High-elevation spruce - fir forest (S4)

GENERAL DESCRIPTION: ***High-elevation spruce - fir forests*** occur on upper mountain slopes and ridgetops in New Hampshire. It is generally found from 2,500–3,500 ft. in elevation in the mountains, but it also occurs lower on ridges and other infertile sites, and higher in relatively protected settings (e.g., ravines).

The composition of these forests is significantly influenced by disturbance history and to a lesser extent by variations in soil and elevation. Species composition also varies along a moisture gradient. In drier conditions, the community has more heath shrubs and other dry-site species, and can be transitional on shallow-to-bedrock sites to the ***red spruce - heath - cinquefoil rocky ridge*** community. In moister conditions, it has greater bryophyte cover. Red spruce and balsam fir are typical canopy dominants in most expressions, though sometimes the importance of heart-leaved paper birch and paper birch may increase after disturbance. Some post-disturbance patches may be strongly birch-dominated, and these "birch glades" can persist for decades.

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 swamps). The needle litter of conifers is low in nutrients, and due to its acidity it decomposes slowly and contributes to organic matter accumulation. Condensation from cloud-intercept contributes a significant amount of moisture to this forest community. Colder temperatures and deep, late-

melting snowpacks at high elevations also contribute to high moisture levels, low soil temperatures, a shortened growing season, and accumulation of soil humus.

CHARACTERISTIC VEGETATION: The canopy consists of various combinations of *Picea rubens* (red spruce), *Abies balsamea* (balsam fir), and *Betula cordifolia* (heart-leaved paper birch), *B. papyrifera* (paper birch), and *B. alleghaniensis* (yellow birch). Common understory plants that are more restricted to or more abundant in this community than lower elevation forests include *Chamaepericlymenum canadense* (bunchberry), *Amelanchier bartramiana* (mountain shadbush), *Sorbus decora* and *S. americana* (mountain-ashes), *Picea mariana* (black spruce), *Ilex mucronata* (mountain holly), *Vaccinium myrtilloides* (velvet-leaved blueberry), *Linnaea borealis* ssp. *americana* (American twinflower), and *Gaultheria hispidula* (creeping spicy-wintergreen). Understory plants shared with northern hardwood forests include *Dryopteris intermedia* (evergreen wood fern), *D. campyloptera* (mountain wood fern), *Phegopteris connectilis* (long beech fern), *Huperzia lucidula* (shining firmoss), *Oxalis montana* (northern wood sorrel), *Lysimachia borealis* (starflower), *Maianthemum canadense* (Canada-mayflower), *Coptis trifolia* (three-leaved goldthread), and *Clintonia borealis* (yellow bluebead-lily). 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. Rare plant species that occur in some of New Hampshire's spruce - fir forests include *Neottia cordata* (heart-leaved twayblade)*, *N. convallarioides* (broad-leaved twayblade)*, and *Geocaulon lividum* (false toadflax)*.

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 a corresponding absence or lower abundance of both *Picea rubens* (red spruce) and *Betula cordifolia* (heart-leaved paper birch). The canopy height in this community is typically in the 2–10 m range, a reduction from the taller stature of trees at lower elevations (which grow to 20–25 m height). At higher elevations, 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 3,500 and 4,500 ft. in elevation, above which the transition to ***black spruce - balsam fir krummholz*** or heath - krummholz communities occurs. The range varies considerably with topography and exposure, with some examples occurring below 3,500 ft. on exposed ridges and summits, or as high as 5,200 ft. in more protected valleys or cirques. Pease's (1964) concept of balsam fir "scrub" probably includes both krummholz and the upper portion of this community where the fir trees are scrubby in form and low in stature, from about 4,200–4,500 ft. in elevation.

These forests are often characterized by patches of wind-induced mortality known as "fir-waves." Fir waves are linear blowdown patches or standing dead trees oriented perpendicular to the prevailing wind, and arranged in a progression of different aged waves adjacent to one another. A common theory suggests that trees ultimately succumb due to the persistent loss of needles and roots resulting from chronic wind stress.

Certainly some (or many) examples of this natural community in the White Mountains are "virgin" old-growth 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 similar to those found in ***high-elevation spruce - fir forests***: 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. Condensation from cloud-intercept contributes a significant amount of moisture to this forest community. Colder temperatures and deep, late-melting snowpacks at high elevations also contribute to high moisture levels, low soil temperatures, a shortened growing season, and accumulation of soil humus.

High-elevation balsam fir forests may grade into ***black spruce - balsam fir krummholz***, alpine/subalpine communities, or heath - krummholz communities above.

CHARACTERISTIC VEGETATION: Balsam fir is the dominant tree. Heart-leaved paper 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 *Neottia cordata* (heart-leaved twayblade)*.

The shrub layer may be sparse, but is usually characterized by some combination of *Sorbus decora* (showy mountain-ash), *Ilex mucronata* (mountain holly), *Vaccinium myrtilloides* (velvet-leaved blueberry), *Gaultheria hispidula* (creeping spicy-wintergreen), and *Linnaea borealis* ssp. *americana* (American twinflower). A low diversity of herbs is also characteristic; species present may include *Dryopteris campyloptera* (mountain wood fern), *Streptopus lanceolatus* (lance-leaved twistedstalk), *Coptis trifolia* (three-leaved goldthread), *Mitella nuda* (naked bishop's-cap), *Oxalis montana* (northern wood sorrel), *Lysimachia borealis* (starflower), *Clintonia borealis* (yellow bluebead-lily), and *Maianthemum canadense* (Canada-mayflower).

Pease (1964) also notes that other species may be encountered in sheltered openings of this community, such as *Ribes lacustre* and *R. glandulosum* (currants), *Kalmia angustifolia* (sheep laurel), *Rhododendron groenlandicum* (Labrador tea), *R. canadense* (rhodora), *Vaccinium uliginosum* (alpine blueberry), *V. cespitosum* (dwarf blueberry)*, *V. angustifolium* (lowbush blueberry), *V. vitis-idaea* (mountain cranberry), *Solidago macrophylla* (large-leaved goldenrod), and *Spinulum annotinum* (common interrupted-clubmoss).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Balsam fir forests are found from approximately 3,500–4,500 ft. elevation throughout the White Mountains, with locally higher or lower limits depending on exposure (occurs as high as 4,900 ft.). Most peaks above 3,500 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 community is characterized by black and red spruce on poorly to moderately well drained soils. It occurs in the North Country and in the White Mountains around heathlands and sloping and level fens in mid- to high-elevation valley bottoms beginning at 2,000–3,000 ft. elevation. Shrub, herb, and bryophyte species compositions resemble those of other spruce - fir forests (e.g., ***lowland***

spruce - fir forest). Compared to ***black spruce swamps***, this community occurs on mineral soil, and has a lower abundance of heaths and a broader diversity of shrubs and conifers.

Known examples from the upper Pemigewasset River valley occur on mineral soils with a significant silt component and a moderately shallow organic layer. The silt impedes drainage, contributing to an increase in soil moisture. The mid- to high-elevation valley positions also trap cold sinking air, indirectly contributing to the nutrient-poor conditions. These are cryic soils (the coldest soil temperature regime in the state). Examples in the North Country occur on firm, gravelly silt loams overlain by a thin organic layer.

CHARACTERISTIC VEGETATION: *Picea mariana* (black spruce) and *P. rubens* (red spruce) are the dominant trees. *Abies balsamea* (balsam fir) is less abundant, and sometimes even locally absent. Characteristic shrub and herb species that are common to other spruce - fir communities include *Osmundastrum cinnamomeum* (cinnamon fern), *Osmunda claytoniana* (interrupted fern), *Kalmia angustifolia* (sheep laurel), *Rhododendron groenlandicum* (Labrador tea), *Gaultheria hispidula* (creeping spicy-wintergreen), *Chamaepericlymenum canadense* (bunchberry), *Amelanchier bartramiana* (mountain shadbush), and various bryophytes.

CLASSIFICATION CONFIDENCE: 2–3

DISTRIBUTION: This type is documented from the upper East Branch Pemigewasset River valley in the White Mountains (2,000–3,000 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*** occupy cold valley bottoms below northern hardwood forests in northern New Hampshire. They form along stream drainages, adjacent to swamps and peatlands, and in former lake basins. *Picea rubens* (red spruce), *Abies balsamea* (balsam fir), mosses, and lichens are abundant, and a variety of herbs and shrubs may be present. The community is floristically similar to ***high-elevation spruce - fir forest***, but differs in landscape setting, soil drainage, and wind-stress characteristics. Tree species present in lowland forests, but absent in their high-elevation counterpart, include *Picea glauca* (white spruce), *P. mariana* (black spruce), and *Pinus strobus* (white pine). The composition of these forests often varies in a complex way in response to 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 abundant as in spruce swamps. ***Lowland spruce - fir forests*** are often associated with spruce swamps and open peatlands.

Spruce budworm infestations are a major disturbance factor in this community in extreme northern New Hampshire, occurring on 40–60 year cycles. Windthrow is also common, though the frequency and intensity of windthrow is less than in the ***high-elevation spruce - fir forest*** community.

Nutrient-poor soils derive from various parent materials including compact and loose glacial tills, and water-deposited lake-bottom, river, and kame terrace sediments. Silty, compact basal tills with impeded drainage are frequent north of the White Mountains, often associated with low-grade pelite bedrock. Coarse, well drained ice-contact deposits include outwash, eskers, and kames. In the White Mountains region this community 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: Red spruce and balsam fir dominate in various combinations, with *Betula papyrifera* (paper birch) and *B. alleghaniensis* (yellow birch) being common associates. *Betula cordifolia* (heart-leaved paper birch) is occasional, and *Tsuga canadensis* (hemlock) and white pine are infrequent or absent (see ***hemlock - spruce - northern hardwood forest***). 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* (American larch) are occasional.

Species absent or uncommon in ***high-elevation spruce - fir forests*** that are occasional in this community include *Acer pensylvanicum* (striped maple), *Aralia nudicaulis* (wild sarsaparilla), *Trillium erectum* (red wakerobin), and *Tiarella cordifolia* (foam-flower). Characteristic species also found in ***high-elevation spruce - fir forest*** include *Dryopteris campyloptera* (mountain wood fern), *D. intermedia* (evergreen wood fern), *Coptis trifolia* (three-leaved goldthread), *Chamaepericlymenum canadense* (bunchberry), *Linnaea borealis* ssp. *americana* (American twinflower), *Amelanchier bartramiana* (mountain shadbush), *Sorbus decora* and *S. americana* (mountain-ashes), *Picea mariana* (black spruce), *Ilex mucronata* (mountain holly), *Vaccinium myrtilloides* (velvet-leaved blueberry), and *Gaultheria hispidula* (creeping spicy-wintergreen). 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 *Neottia cordata* (heart-leaved twayblade)* and *N. convallarioides* (broad-leaved twayblade)* in moist or seepy mossy areas.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Found at low to mid elevations (generally below 2,500 ft.) in northern New Hampshire in the White Mountain, Mahoosuc-Rangeley Lakes, and Connecticut Lakes subsections. Also found locally in valley bottoms in adjacent subsections to the south. Good examples occur near Norton Pool (Pittsburg), along Spruce Brook/Upper Ammonoosuc River (Kilkenny), near Elbow Pond (Woodstock), and along the Big River (Barnstead).

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

• Northern white cedar forest/woodland (S1)

GENERAL DESCRIPTION: This community is a *Thuja occidentalis* (northern white cedar) dominated upland forest found on ledgy ridges, mesic till uplands, and occasionally on river terrace slopes and flats. These locations are better drained than northern white cedar seepage forests or swamps. Ledges may be crumbly and soils may be loose. Some examples are associated with intermediate or calcareous soils.

CHARACTERISTIC VEGETATION: Northern white cedar is dominant along with lower quantities of *Abies balsamea* (balsam fir), *Acer spicatum* (mountain maple), *Betula alleghaniensis* (yellow birch), and *B. cordifolia* (heart-leaved paper birch). Understory vegetation is typically sparse but includes *Rubus idaeus* ssp. *strigosus* (strigose red raspberry), *Aralia nudicaulis* (wild sarsaparilla), *Lysimachia borealis* (starflower), *Maianthemum canadense* (Canada-mayflower), *Oclemena acuminata* (sharp-toothed nodding-aster), *Oxalis montana* (northern wood sorrel), *Dryopteris intermedia* (evergreen wood fern), and *D. 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.

WOODED ROCKY RIDGES AND TALUS SLOPES

These communities occur as small or large patches within the Acadian spruce - fir forest. They are found on rocky ridges, with thin soils and extensive areas of exposed bedrock, or talus slopes, where piles of boulders have accumulated as a result of the erosion of cliff faces. Northern conifers are dominant in these communities, and include red spruce (*Picea rubens*), black spruce (*P. mariana*), red pine (*Pinus resinosa*), and Jack pine (*P. banksiana*)*.

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

GENERAL DESCRIPTION: This dry, conifer-dominated woodland community is the most common of the four rocky ridge communities in mountainous regions of central and northern New Hampshire. It occurs between 1,700 and 3,000 ft. elevation, and is characterized by *Picea rubens* (red spruce), *Sibbaldiopsis tridentata* (three-toothed cinquefoil), dense low heath shrubs, a sparse herb layer, and lichens. It lacks most plant species found in the oak - pine zone at lower elevations in southern New Hampshire as well as plants found at higher elevations in alpine and subalpine habitats.

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% cover by bare rock) to larger open barrens of several acres or more with extensive outcrops. In the absence of fire, soils accumulate and this community can succeed to forests over time. It transitions to oak - pine rocky ridge woodlands (e.g., ***red oak - pine rocky ridge***) at lower elevations and heath - krummholz communities at higher elevations. ***Jack pine rocky ridge*** is a floristically similar community characterized by an abundance of Jack pine*.

The dominant tree species in this community, red spruce, is restricted to the northern Appalachian region, in contrast to the more boreal distributions of both Jack and red pine. It is not tolerant of fire, but readily colonizes the thin soils of rocky ridges. Red spruce mixes and competes with red oak at elevations below 2,000 ft., and with red pine up to about 2,700 ft.

Soils are thin, dry, and acidic with a shallow O horizon over coarse gravelly or sandy A and B horizons or bedrock. Most examples occur on bedrock that yields acidic soil conditions.

CHARACTERISTIC VEGETATION: The tree canopy is dominated by red spruce. *Abies balsamea* (balsam fir) is occasional and sometimes codominant while *Pinus resinosa* (red pine) is frequent but not dominant. Other trees may include *Pinus strobus* (white pine), *Betula papyrifera* (paper birch), *B. cordifolia* (heart-leaved paper birch), and *Sorbus* spp. (mountain-ashes). *Quercus rubra* (red oak) is occasional only at lower elevation transitions to other communities.

A prominent low shrub layer is dominated by *Vaccinium angustifolium* (lowbush blueberry), and contains variable amounts of *V. myrtilloides* (velvet-leaved blueberry), *Kalmia angustifolia* (sheep laurel), and three-toothed cinquefoil. *Rhododendron canadense* (rhodora) is also occasional, particularly in moister microhabitats. Tall shrubs are generally sparse but may include *Amelanchier bartramiana* (mountain shadbush) and *Viburnum nudum* var. *cassinoides* (withe-rod) in more protected areas.

Herbs are relatively sparse, though they can be locally abundant, and may include *Solidago simplex* ssp. *randii* var. *monticola* (montane Rand's goldenrod), *Aralia hispida* (bristly sarsaparilla), *Maianthemum canadense* (Canada-mayflower), *Deschampsia flexuosa* (wavy hair grass), and *Danthonia spicata* (poverty oatgrass). The rare *Paronychia argyrocoma* (silverling)* is sometimes present in cracks of open ledges. Lichens and mosses are common but poorly documented; *Cladonia rangiferina* (reindeer lichen) and *Polytrichum* spp. (haircap mosses) may be abundant.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Found primarily on cold, dry, northern rocky ridges, summits, or slopes with shallow-to-bedrock acidic soils at elevations 1,700–3,000 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: This community has a woodland to shrubland structure of 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 (2,500–4,000 ft.) ridges, on flat or gentle 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 mesic to wet-mesic conditions, shallow peaty soils, fewer bedrock outcrops, and a more robust heath layer.

CHARACTERISTIC VEGETATION: Trees in this community's 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), *R. groenlandicum* (Labrador tea), *Ilex mucronata* (mountain holly), *Kalmia angustifolia* (sheep laurel), and *Viburnum nudum* var. *cassinoides* (withe-rod). *Alnus incana* ssp. *rugosa* (speckled alder) is notably absent or in low abundance.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community occurs in several locations in the White Mountains at elevations ranging from 2,500–4,000 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 (S1)

GENERAL DESCRIPTION: This *Pinus banksiana* (Jack pine)* dominated woodland community occurs on only a few rocky ridges at elevations between 1,800 and 3,900 ft. in the White Mountains. Floristically, it is similar to *Pinus resinosa* (red pine) and *Picea rubens* (red spruce) rocky ridges, but it is considered distinct from them due to differences in dominant tree species. There are also probable differences in ecological histories and site dynamics that contribute to the apparent "steady states" of these Jack pine* populations.

Jack pine* is primarily a boreal tree, generally found at high northern latitudes, but it has a disjunct, southern population in New Hampshire. Most Jack pine* cones are serotinous, meaning they require heat to open and release their seeds. Non-serotinous cones are also typically present, however, and these may be important for the perpetuation of stands that bun infrequently.

Soils consist of a shallow O horizon above thin, dry, acidic mineral materials, either over bedrock or horizons of coarse gravel or sand.

Jack pine* is a rare species in New Hampshire, known only from a dozen or so locations in two regions of the state. Most of these locations consist of a few scattered individual trees and as such, do not constitute examples of the ***Jack pine rocky ridge*** community.

CHARACTERISTIC VEGETATION: Jack pine* is abundant in combination with red spruce, red pine, *Abies balsamea* (balsam fir), *Betula cordifolia* (heart-leaved paper birch), and *B. papyrifera* (paper birch). A low shrub layer is characterized by *Vaccinium angustifolium* (lowbush blueberry), *V. myrtilloides* (velvet-leaved blueberry), *Kalmia angustifolia* (sheep laurel), and *Sibbaldiopsis tridentata* (three-toothed cinquefoil). Tall shrubs are generally sparse but may include *Amelanchier bartramiana* (mountain shadbush) and *Viburnum nudum* var. *cassinoides* (withe-rod). Herbs are relatively sparse, but can be locally abundant, and may include *Solidago simplex* ssp. *randii* var. *monticola* (montane Rand's goldenrod), *Maianthemum canadense* (Canada-mayflower), *Deschampsia flexuosa* (wavy hair grass), and *Danthonia spicata* (poverty oatgrass). Rare species other than Jack pine* may include *Paronychia argyrocoma* (silverling)* and *Minuartia glabra* (Appalachian sandplant)*.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Occurs on shallow-to-bedrock landscapes of mid to high elevation (1,800–3,900 ft.) mountain ridges in the White Mountain subsection. Good examples occur on Welch Mtn. (Waterville Valley) and Carter Ledge (Albany).

SOURCES: NHB field surveys; Baldwin 1979.

• Red pine rocky ridge (S2)

GENERAL DESCRIPTION: *Pinus resinosa* (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 south-facing slopes between 750–2,700 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. 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 better developed. Shade-intolerant species tend to be less abundant or absent in forested examples [e.g., *Capnoides sempervirens* (pink-corydalis), *Sibbaldiopsis tridentata* (three-toothed cinquefoil), *Deschampsia flexuosa* (wavy hair grass), and *Danthonia spicata* (poverty oatgrass)].

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.

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

This is a distinct, narrowly defined community that intergrades with other northern rocky ridge communities. It is considered distinct from the *Quercus rubra* (red oak) and *Pinus banksiana* (Jack pine) types due to differences in dominant tree species and probable differences in ecological histories or circumstances. This community type includes outcrops in other landscape positions (i.e., not rocky ridges), such as along rocky lake shores that exhibit similar vegetation assemblages. Red pine naturally occurs as a scattered tree in southern New Hampshire and at lower elevations, but only in the mountains does it grow

in large stands. Planted stands of red pine are occasional in the southern part of the state, however.

CHARACTERISTIC VEGETATION: Red pine is dominant in the canopy. Other tree species may include red oak and *Pinus strobus* (white pine) at lower elevations (generally <1,900 ft.), and *Picea rubens* (red spruce), *Betula papyrifera* (paper birch), *B. cordifolia* (heart-leaved paper birch), and *Abies balsamea* (balsam fir) at higher elevations (above 1,900 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* (mountain shadbush), *Viburnum nudum* var. *cassinoides* (withe-rod), *Sorbus americana* (American mountain-ash), *Aronia* spp. (chokeberries), *Ilex mucronata* (mountain holly), and *Acer pensylvanicum* (striped maple). Characteristic low heath shrubs include *Vaccinium angustifolium* (lowbush blueberry), *V. myrtilloides* (velvet-leaved 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* ssp. *latiusculum* (bracken fern), *Polypodium virginianum* (rock polypody), *Epigaea repens* (trailing-arbutus), *Cypripedium acaule* (pink lady's-slipper), pink-corydalis, *Carex lucorum* (Blue Ridge sedge), wavy hair grass, poverty oatgrass, and *Oryzopsis asperifolia* (white-grained rice grass). Mosses and lichens are typically abundant on rock outcrop areas.

VARIANTS: Two variants are described:

1. **Low-elevation variant**: Lower elevation examples (ca. 750–2,000 ft.) have a more frequent occurrence of southern species such as huckleberries, red oak, pink-corydalis, trailing-arbutus, *Solidago arguta* (forest goldenrod), pink lady's-slipper, *Gaultheria procumbens* (eastern spicy-wintergreen), Blue Ridge sedge, and *Piptatherum pungens* (short-awned mountain-rice grass). This variant is more likely to contain such rarities as *Polygonum douglasii* (Douglas' knotweed)* and *Minuartia glabra* (Appalachian sandplant)*. It is floristically similar to ***red oak - pine rocky ridge***.
2. **High-elevation variant**: Northern species prevail at somewhat higher elevations (1,900–2,700 ft.), such as red spruce, *Solidago simplex* ssp. *randii* var. *monticola* (montane Rand's goldenrod), three-toothed cinquefoil, American mountain-ash, and mountain shadbush. This variant is floristically similar to ***red spruce - heath - cinquefoil rocky ridge***.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Red pine approaches its southern limit in New Hampshire and this community is known only from middle elevations of 750–2,700 ft. in the White Mountain, Sunapee Upland, and Sebago-Ossipee subsections. It is most common, and reaches its best development, between 1,400 ft. and 2,400 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.

• Spruce - moss wooded talus (S2S3)

GENERAL DESCRIPTION: This community forms in cold environments, on 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 limit of ***high-elevation spruce - fir forest*** (similar to elevation range of ***lowland spruce - fir forest***). This type occurs in association with the ***subalpine cold-air talus shrubland*** community at a few sites. Documented examples occur at elevations ranging from 700–2,200 ft. Ice often remains beneath the boulders until late spring or early summer.

CHARACTERISTIC VEGETATION: The community has woodland to open forest tree canopy structure characterized by *Picea rubens* (red spruce), *Abies balsamea* (balsam fir), *Tsuga canadensis* (hemlock),

Betula 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* (stair-step moss) and *Bazzania trilobata* (liverwort), although many other species are undoubtedly present. Characteristic shrubs and herbs include *Rhododendron groenlandicum* (Labrador tea), *Gaultheria hispidula* (creeping spicy-wintergreen), *Vaccinium angustifolium* (lowbush blueberry), *Ribes* spp. (gooseberries and currents), and *Mitella nuda* (naked bishop's-cap). *Galium kamtschaticum* (boreal bedstraw) may be present in some examples. Rare species may include *Neottia convallarioides* (broad-leaved twayblade)* and historic reports of *Epilobium hornemannii* (Hornemann's willow-herb)* and other subalpine plants (Pease 1964).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Restricted to the White Mountain subsection and proximal areas of adjacent subsections. Most examples occur above 2,300 ft. elevation, but disjunct occurrences can be found down to 800 ft. Good examples include Devil's Hopyard (Stark), Ice Gulch (Randolph), and the base of Rattlesnake Mountain (Rumney).

SOURCES: NHB field surveys; Mohlenbrock 1987.

• Subalpine cold-air talus shrubland (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 and possibly the down-slope drainage of cold air over and through the talus from above. The air moves over late-melting ice beneath this community, and even on hot mid-summer days, cold air can be felt emerging from under the talus. This subalpine microclimate supports spruce, heath shrubs, lichens, and mosses more characteristic of subalpine heath - krummholz communities and montane habitats. Elevations for this community are significantly lower than subalpine communities on mountain summits.

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 soil development. Substrates vary from open rock to shallow or moderately well-developed peaty duff layer. Soils are very nutrient-poor (oligotrophic).

CHARACTERISTIC VEGETATION: This community has a sparse, stunted tree canopy (generally <10–20 ft.) composed of *Picea mariana* (black spruce) and/or *P. rubens* (red spruce), with lesser amounts of *Betula cordifolia* (heart-leaved paper 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 shrubs include *Rhododendron groenlandicum* (Labrador tea), *Kalmia angustifolia* (sheep laurel), *Empetrum nigrum* (black crowberry), *E. atropurpureum* (red crowberry), *Vaccinium vitis-idaea* (mountain cranberry), *V. uliginosum* (alpine blueberry), *V. myrtilloides* (velvet-leaved blueberry), *V. angustifolium* (lowbush blueberry), and infrequently *Rhododendron canadense* (rhodora) and *Gaultheria hispidula* (creeping spicy-wintergreen). Mosses and lichens are abundant but not well documented to the species level. Herbaceous species are notably sparse or absent.

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 2,300–3,400 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.

LAURENTIAN MIXED FOREST ZONE

Laurentian mixed forests are hardwood and conifer forests of cool temperate climates. They extend from the Great Lakes to the greater St. Lawrence River region, covering much of northern New England and adjacent portions of eastern Canada. Laurentian refers to the St. Lawrence River and watershed, which forms the heart of this continental forest region. In New Hampshire, Laurentian mixed forest communities are separated into three broad categories: 1) Northern hardwood forests, characterized by *Betula alleghaniensis* (yellow birch), *Acer saccharum* (sugar maple), and *Fagus grandifolia* (American beech); 2) Hemlock - hardwood - pine forests, characterized by some combination of *Tsuga canadensis* (hemlock), *Pinus strobus* (white pine), and *Quercus rubra* (red oak); 3) Wooded rocky ridges and talus slopes.

Bormann (1970) summarizes approximate elevational limits for some trees in New Hampshire including white pine (1,500 ft.), hemlock (2,000 ft.), and red oak (1,500 ft.). On southern slopes, red oak can reach 1,800–2,000 ft. in elevation, and occasionally as high as 2,200 ft. (e.g., Mt. Parker in Bartlett). White pine seedlings and saplings are occasionally found as high as 3,600 ft. (Mahoosuc Range and top of Cannon Cliff). *Larix laricina* (American larch) is not commonly found at higher elevations in the White Mountains, but has been observed at 5,000 ft. on Mt. Lincoln. Northern hardwood forests are generally found between 1,000 and 2,500 ft. in elevation, but the tolerance range of individual species varies.

NORTHERN HARDWOOD FORESTS

New Hampshire's northern hardwood forests are characterized by *Betula alleghaniensis* (yellow birch), *Acer saccharum* (sugar maple), and *Fagus grandifolia* (American beech). 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 are positioned latitudinally and elevationally between the Acadian spruce - fir and hemlock - hardwood - pine forests. Areas transitional to spruce - fir forests are marked by increased prominence of red spruce, *Abies balsamea* (balsam fir), and yellow birch while areas transitional to hemlock - hardwood - pine forests are typically accompanied by more *Quercus rubra* (red oak), white pine, *Ostrya virginiana* (ironwood) and decreased dominance of American beech, yellow birch, and sugar maple (Westveld et al. 1956; Sperduto 1992). *Fraxinus americana* (white ash), hemlock, and *Tilia americana* (basswood) are occasional or frequent on the lower reaches of northern hardwood forests.

Herbs such as *Aralia nudicaulis* (wild sarsaparilla) and *Lysimachia borealis* (starflower) are common to both northern hardwood and hemlock - hardwood - pine forests. Species of the northern hardwood forests generally not found in hemlock - hardwood - pine forests include *Dryopteris campyloptera* (mountain wood fern), *Lonicera canadensis* (American honeysuckle), *Polystichum braunii* (Braun's holly fern), and other northern herbs also found in the spruce - fir forest. Other species may be present in hemlock - hardwood - pine forests but tend to be more abundant in northern hardwoods including *Oxalis montana* (northern wood sorrel), *Huperzia lucidula* (shining firmoss), *Clintonia borealis* (yellow bluebead-lily), and *Streptopus* spp. (twistedstalks).

• Northern hardwood - spruce - fir forest (S4)

GENERAL DESCRIPTION: ***Northern hardwood spruce - fir forests*** are a transitional forest type found at intermediate elevation positions between ***sugar maple - beech - yellow birch forests*** and spruce - fir forests. They occur 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 hardwoods, but they become dominant with increased elevation, where yellow birch or sometimes *Betula papyrifera* (paper birch) become the primary hardwoods. Sugar maple and American beech disappear above 2,500 ft. elevation, leaving only the birches, spruce, and fir. American mountain-ash (*Sorbus americana*), American honeysuckle (*Lonicera canadensis*), *Acer spicatum* (mountain maple), and *Viburnum lantanoides* (hobblebush) often occur in the shrub layer. Understory plants are similar to those in the ***sugar maple - beech - yellow birch forest***, but they may achieve higher average cover in this community, particularly *Dryopteris intermedia* (evergreen wood fern) and *D. campyloptera* (mountain wood fern). Common herbaceous species include *Oxalis montana* (northern wood sorrel) and *Clintonia borealis* (yellow bluebead-lily). Characteristic species more frequent or abundant in this type than in lower elevation hardwood forests include mountain-ashes and American honeysuckle.

VARIANTS: Two variants are described:

1. **Typic variant**: As described above.
2. **Yellow birch variant**: This yellow birch dominated variant occurs along high-gradient stream drainages, in ravines, or associated with large boulders or talus. It occupies a narrow elevation zone between hardwood forests below and spruce - fir forests above, Yellow birch is well adapted to establishing itself on large boulders. Boulders are festooned with bryophytes and herbs including *Polypodium virginianum* (rock polypody), *Oclemena acuminata* (sharp-toothed nodding-aster), northern wood sorrel, mountain and evergreen wood ferns, *Hylocomnium splendens* (feather moss), and *Bazzania trilobata* (liverwort).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Occurs in the White Mountains and locally on other mountains at elevations from 2,100–2,800 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. It is 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***, ***hemlock - oak - 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. Yellow birch is successful in establishing itself in these gaps, and although it is not as shade tolerant as American beech and sugar maple, it is long-lived and consequently an important late-successional dominant (approximately 200–400+ years).

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 moderately well drained fine sandy loams. Soils form from till derived from granitic igneous rocks and metamorphic rocks such as schist and gneiss, yielding soils with relatively low mineral nutrient content. Soils tend to be drier than in ***rich mesic forests*** and ***high-elevation spruce - fir forests***, but more mesic than at sites with increased American beech cover.

CHARACTERISTIC VEGETATION: Sugar maple and American 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* (paper birch), *Acer pensylvanicum* (striped maple), *A. spicatum* (mountain maple), and *Fraxinus americana* (white ash). *Viburnum lantanoides* (hobblebush) is frequent and often abundant in the shrub layer. *Lonicera canadensis* (American honeysuckle) may be present but is infrequent and more likely to be encountered in more enriched and/or moist forests. *Dryopteris intermedia* (evergreen 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 evergreen wood fern. *Huperzia lucidula* (shining firmoss) is frequent and generally more abundant than in lower elevation forests.

Other characteristic species with high constancy include *Clintonia borealis* (yellow bluebead-lily), *Maianthemum canadense* (Canada-mayflower), *Oxalis montana* (northern wood sorrel), *Lysimachia borealis* (starflower), *Oclemena acuminata* (sharp-toothed nodding-aster), and *Uvularia sessilifolia* (sessile-leaved bellwort). Occasional (low constancy) species include *Aralia nudicaulis* (wild sarsaparilla), *Trillium erectum* (red wakerobin), *T. undulatum* (painted wakerobin), *Streptopus lanceolatus* (lance-leaved twistedstalk), *Solidago macrophylla* (large-leaved goldenrod), *Medeola virginiana* (Indian cucumber root), *Cinna latifolia* (slender wood-reed), and *Parathelypteris noveboracensis* (New York fern).

Species that are less frequent here and more typical in either higher elevation spruce - fir or lower elevation hemlock and/or hardwood forests include *Mitchella repens* (partridge-berry), *Chamaepericlymenum canadense* (bunchberry), *Coptis trifolia* (three-leaved goldthread), *Monotropa uniflora* (one-flowered Indian-pipe), *Cypripedium acaule* (pink lady's-slipper), and *Gaultheria procumbens* (eastern spicy-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 (1,900–2,600 ft.), total biomass of the herbaceous layer often increases while productivity of the overstory decreases, though total floristic composition may not change significantly. *Dryopteris intermedia* (evergreen wood fern) and/or *D. campyloptera* (mountain wood fern) are often the most abundant species, and may form a "fern glade" or a lush understory combined with other herbs. 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 1,400–2,500 ft. (although it occurs both locally higher and lower), 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 forest community is characterized by a canopy of *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 1,000 ft. up to 2,000 ft. It also occurs on river and kame terrace sites where former and current stream channels cut through terraces of different elevations, moisture levels, and sediment textures.

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

CHARACTERISTIC VEGETATION: Hemlock and red spruce are dominant. Birches, particularly yellow birch more than *Betula 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 overstory and understory while American beech is occasional but not prominent.

The woody understory frequently contains *Viburnum lantanoides* (hobblebush) and *Acer pensylvanicum* (striped maple). Herbaceous plant composition is often different from one example to the next. However, northern plants such as *Oxalis montana* (northern wood sorrel), *Clintonia borealis* (yellow bluebead-lily), *Streptopus lanceolatus* (lance-leaved twistedstalk), *Huperzia lucidula* (shining firmoss), and *Dryopteris campyloptera* (mountain wood fern) tend to be more abundant than in hemlock - hardwood forests without spruce. Other species common in nutrient poor soils and occurring here are *Viburnum nudum* var. *cassinoides* (withe-rod), *Aralia nudicaulis* (wild sarsaparilla), *Trillium undulatum* (painted wakerobin), *Lysimachia borealis* (starflower), *Dryopteris intermedia* (evergreen wood fern), *Dendrolycopodium* spp. (tree-clubmosses), 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. Although American beech is not prominent, it may be most frequent in this variant. 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 the primary canopy and understory tree species. Balsam fir, sugar maple, and American beech are sparse or absent. Yellow birch is usually present in the canopy and understory. This variant occurs from less than 1,000 ft. to over 1,500 ft. elevation in hilly and mountainous areas, particularly in the White Mountains. It 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. Other conifers may be present in lesser abundance. *Pinus strobus* (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* (American larch) may be occasional on lower terraces with shallower water tables. In some examples where red spruce dominates, this variant approaches ***lowland spruce - fir forest*** types. Understory vegetation includes hobblebush, wild sarsaparilla, starflower, and mosses. The rare plant *Pyrola asarifolia*

(pink shinleaf)* 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 conifer terrace flat variant but with a mixture of mid and late successional softwoods and hardwoods. Sugar maple, red maple, and yellow, paper and gray birches, and to a lesser extent American beech, mix with softwoods. The understory is comprised of species common in nutrient poor soils. This variant may correspond to terrace flats with finer textured soils. Somewhat poorly drained terraces (not floodplains) dominated by hemlock are ***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 700–2,000 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 - oak - northern hardwood forest (S4)

GENERAL DESCRIPTION: This is a common mixed coniferous - deciduous forest of middle elevations (800–1,500 ft. elevation) in central New Hampshire. It also occurs as more isolated patches on mesic sites in southern parts of the state, and in valley-bottom settings in the mountains (locally to 2,000 ft. elevation). The canopy is characterized by a mix of classic northern hardwood species such *Acer saccharum* (sugar maple), *Betula alleghaniensis* (yellow birch), and *Fagus grandifolia* (American beech), along with (*Tsuga canadensis*) hemlock. *Quercus rubra* (red oak) and *Pinus strobus* (white pine) are also typically present, but diminish in abundance in examples in the mountains or at higher elevations. This community is fairly distinct but transitions to ***hemlock - beech - oak - pine forest*** at lower elevations and south of the mountains where sugar maple and yellow birch are infrequent.

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: Hemlock and American beech are the primary late-successional tree species. Red oak and yellow birch are often present as associates. Hemlock and/or American beech may only be present in the understory in successional examples. Other trees are less constant and more variable in prominence including sugar maple, white pine, *Fraxinus americana* (white ash), *Acer rubrum* (red maple), *Picea rubens* (red spruce), and *Abies balsamea* (balsam fir).

The most consistent plants in the shrub layer are *Acer pensylvanicum* (striped maple) and *Viburnum lantanoides* (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* (three-leaved goldthread). Herbs that are more abundant than in most ***hemlock - beech - oak - pine forests*** include *Oxalis montana* (northern wood sorrel), *Dryopteris intermedia* (evergreen wood fern), and *Huperzia lucidula* (shining firmoss).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This forest occurs from the White Mountain subsection southward, but is sparse to 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 - HARDWOOD - PINE FORESTS

Hemlock - hardwood - pine forests are positioned latitudinally and elevationally between northern hardwood and Appalachian oak and pine forests. Tree species such as *Quercus rubra* (red oak), *Pinus strobus* (white pine), and *Tsuga canadensis* (hemlock) are most prominent in hemlock - hardwood - pine forests, and tend to be present in greater proportions than in northern hardwood forests. *Acer saccharum* (sugar maple) and *Betula alleghaniensis* (yellow birch) are usually absent as canopy dominants, as are boreal and higher-elevation species including *Abies balsamea* (balsam fir) and *Picea rubens* (red spruce). Appalachian species (e.g., hickories, southern oaks, and southern herbs) are also absent or low in cover. Hemlock and American beech are the primary late-successional species in hemlock - hardwood - pine forests, with maximum ages of hemlock exceeding 500 years and that of American beech exceeding 300 years.

Plants that tend to be more prominent in hemlock - hardwood - pine forests than in northern hardwood forests include *Hamamelis virginiana* (American witch-hazel), *Ostrya virginiana* (ironwood), *Viburnum acerifolium* (maple-leaved viburnum), *Gaultheria procumbens* (eastern spicy-wintergreen), and *Gaylussacia baccata* (black huckleberry). However, numerous herbs are frequent in both forest types, including *Lysimachia borealis* (starflower), *Aralia nudicaulis* (wild sarsaparilla), and *Maianthemum canadense* (Canada-mayflower). Hemlock - hardwood - pine forests are found throughout central and southern New Hampshire and at lower elevations in the White Mountain region (generally below 1,500 ft.), particularly low elevation river valley bottoms and lower, south-facing mountain slopes (e.g., the Saco, Androscoggin, and Baker Rivers). These river valleys harbor outposts of various southern species.

Most of the northern hardwood and hemlock - hardwood - pine forests in New Hampshire are characteristic of the nutrient poor (oligotrophic) end of the enrichment spectrum, due to the prominence of glacial drift derived from granite and other bedrock types that yield acidic soil conditions (Leak 1982; Bailey and Hornbeck 1992).

• Hemlock forest (S4)

GENERAL DESCRIPTION: This is a common community in which a canopy of pure or nearly pure *Tsuga canadensis* (hemlock) covers a dark, relatively open understory with few herbaceous species. Hemlock is shade-tolerant and appears to maintain itself by out-competing other tree species for light and nutrients.

Hemlock persists in low abundance in the understory for decades and then takes advantage of periodic canopy gaps. Few other species grow 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 exceed 500 years. Deer often winter in these areas where movement in light snow cover is easier. Hemlock is an important component in many other types of natural communities, where it often mixes with other softwoods and/or hardwoods, but it reaches its maximum dominance in this community.

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 sites with rocky, coarse, and/or thin soils poor in nutrients, including ravines, gorges, river and kame terraces, and other microsites below 2,000 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 cycles aluminum. Soils freeze more deeply than sites with hardwoods due to interception of snowfall by the dense hemlock canopy.

CHARACTERISTIC VEGETATION: Floristically, ***hemlock forests*** are remarkably similar throughout the region. Hemlock is strongly dominant in the canopy, to the near exclusion of other species. The deep shade and acidic soils of this community result in a typically sparse or absent woody and herbaceous understory. Species characteristic of (but not exclusive to) these forests include *Oxalis montana* (northern wood sorrel), *Dryopteris* spp. (wood ferns), *Maianthemum canadense* (Canada-mayflower), *Monotropa uniflora* (one-flowered Indian-pipe), *Mitchella repens* (partridge-berry), *Acer rubrum* (red maple), *Betula alleghaniensis* (yellow birch), 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 2,000 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: These communities occur on coarse till soils and are characterized by the dominance and perpetuation of *Fagus grandifolia* (American beech) to the near exclusion of other woody species. Understory vegetation is typically sparse or absent. American 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.

American 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 it is today (Cogbill et al. 2002). Throughout the region, beech-scale nectria canker has had a significant effect on American beech in all community types where it occurs.

Soils are derived from coarse washed till and sandy sediments. They are light textured and well to extremely well drained, and have moderate to low water holding capacity. Soil moisture conditions are dry-mesic to mesic. 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 and herbaceous species are more indicative of ***hemlock - beech - oak - pine forest***, ***hemlock - oak - northern hardwood forest***, or ***sugar maple - beech - yellow birch forest*** communities.

CHARACTERISTIC VEGETATION: American beech tends to be the primary or exclusive dominant both in the overstory and in the 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 (as well as others that have some abundance of American beech). *Dendrolycopodium* spp. (tree-clubmosses) and other species noted to occur in ***hemlock - oak - northern***

hardwood forests may be present.

American beech stands seem to be the preferred habitat for the rare *Triphora trianthophora* (three-birds 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. Though still somewhat inconspicuous, three-birds orchid* is most easily found during their 2–3 day flowering period.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This forest type is found on till uplands at low to mid elevations south of and including the White Mountain subsection, generally at elevations of <500–1,400 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, poorly developed herbaceous layer, 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 hardwood forests*** by the rarity or lack of *Picea rubens* (red spruce), *Abies balsamea* (balsam fir), and *Acer saccharum* (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. *Quercus rubra* (red oak), *Betula lenta* (black birch), and *B. 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* (American witch-hazel), *Viburnum acerifolium* (maple-leaved viburnum), *Gaultheria procumbens* (eastern spicy-wintergreen), *Medeola virginiana* (Indian cucumber root), *Aralia nudicaulis* (wild sarsaparilla), *Mitchella repens* (partridge-berry), *Lysimachia borealis* (starflower), *Maianthemum canadense* (Canada-mayflower), *Monotropa uniflora* (one-flowered Indian-pipe), *Dryopteris intermedia* (evergreen wood fern), *Parathelypteris noveboracensis* (New York fern), and *Dendrolycopodium* spp. (tree-clubmosses).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is found in central and southern NH south of the White Mountains from 50–1,000 ft. elevation. Good examples occur at Great Hill Pond and Hemenway State Reservation (Tamworth), College Woods (Durham), Boulder Trail in Pawtuckaway State Park (Nottingham), Sheldrick Forest (Wilton), and part of the east side of Pine River Esker (Ossipee).

SOURCES: NHB field surveys.

• 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 where it is uncommon). 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 patches from hurricanes. Both soil and disturbance related variation is apparent in species composition.

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.

This community grades into oak - pine forests such as ***dry red oak - white pine forest*** on drier soils, to northern hardwood forests such as ***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 it from ***hemlock - oak - northern hardwood forests***.

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 American 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 American beech dominates to the exclusion of nearly all other tree species (these types are described as separate communities; see ***hemlock forest***, ***hemlock - white pine forest***, and ***beech forest***). Other abundant or frequent early to mid- successional tree species include *Betula papyrifera* (paper birch), *Acer rubrum* (red maple), and *A. pensylvanicum* (striped maple). Other occasional species that may be present in low abundance include *Prunus serotina* (black cherry), *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), *Betula lenta* (black birch), *B. alleghaniensis* (yellow birch), and *B. populifolia* (gray birch). *Picea rubens* (red spruce) and *Abies balsamea* (balsam fir) are uncommon or absent.

Canopy dominance combinations vary and may yield primarily hardwoods, a mix of hardwood and conifer, or mostly conifer-dominated stands. Hemlock prefers more mesic to wet-mesic, coarse or infertile soils, or sites with distant fire histories. American beech tends to occur on drier to more mesic coarse soils (e.g., washed tills). White pine grows well on early to mid-successional sites of all types, particularly those with an agricultural history, and does well longer term on either drier, coarser soils or those with fire histories. Black birch reaches its best development on mesic sites, but it may be present on somewhat drier sites as well.

The understory woody and herbaceous plant association is distinct from northern hardwood and spruce - fir forest types. Good differential species that are found primarily in this community include *Hamamelis virginiana* (American witch-hazel) and *Gaultheria procumbens* (eastern spicy-wintergreen). Species that are less frequent than in northern hardwoods include *Lonicera canadensis* (American honeysuckle), *Oxalis montana* (northern wood sorrel), *Clintonia borealis* (yellow bluebead-lily), *Streptopus* spp. (twistedstalks), *Dryopteris campyloptera* (mountain wood fern), and *Huperzia lucidula* (shining firmoss). Other characteristic species, many of which also occur in northern hardwood forests, include *Aralia nudicaulis* (wild sarsaparilla), *Uvularia sessilifolia* (sessile-leaved bellwort), *Mitchella repens* (partridge-berry), *Lysimachia borealis* (starflower), *Maianthemum canadense* (Canada-mayflower), *Epifagus virginiana* (beech-drops), *Monotropa uniflora* (one-flowered Indian-pipe), and *Dryopteris intermedia* (evergreen wood fern). The globally rare *Isotria medeoloides* (small whorled pogonia)* is most often found in this forest type.

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 *Parathelypteris noveboracensis* (New York fern), *Osmundastrum cinnamomeum* (cinnamon fern), *Osmunda claytoniana* (interrupted fern), *Athyrium angustum* (lady fern), and *Dennstaedtia punctilobula* (eastern hay-scented fern; especially in gaps). *Dendrolycopodium* spp. (tree-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 hazelnut) or *C. cornuta* (beaked hazelnut) are frequent on river terraces (beaked hazelnut extends further north).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is found from 50–1,400 ft. elevation (locally to 1,800 ft. or slightly higher on south facing and/or shallow bedrock sites) in southern and central parts of the state, with some extensions north into the White Mountain subsection. 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.

• Dry red oak - white pine forest (S3S4)

GENERAL DESCRIPTION: This forest community is dominated by *Quercus rubra* (red oak) and/or *Pinus strobus* (white pine), and occurs on dry sandy or rocky sites maintained by periodic fire. It is structurally and functionally similar to fire-maintained Appalachian oak and pine forest types, but lacks southern oaks and pitch pine. These dry, acidic forests typically have a "thin woods" aspect to them, created by a somewhat sparse forest canopy cover transitional to a woodland structure and a sparse tall woody layer in the understory. White pine is sparse or absent in some examples, particularly on ridges in the White Mountains.

Some early successional ***hemlock - beech - oak - pine forests*** can superficially resemble this community. For example, red oak and white pine can dominate the overstory in forests that develop from abandoned pastures or in cut-over areas on mesic or dry-mesic soils, but in the absence of drier soils and fire, hemlock and American beech will eventually increase in prominence. Drier soils and increased light on the forest floor allow dry-site species to establish and help distinguish this community from more mesic, early successional examples of ***hemlock - beech - oak - pine forest***.

Soils are dry and well to excessively drained. 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 more widespread in the state than other types of dry forest. In many examples, the absence of fire will increase the cover of late successional species such as *Fagus grandifolia* (American beech) and/or *Tsuga canadensis* (hemlock). At these sites, the return of natural, semi-natural, and/or controlled fire regimes may be necessary for the long-term maintenance of red oak. This community is often associated with ***red oak - pine rocky ridges***.

CHARACTERISTIC VEGETATION: This community has an open forest canopy dominated by *Quercus rubra* (red oak) and *Pinus strobus* (white pine). Infrequent tree species may include *Acer rubrum* (red maple), *Betula papyrifera* (paper birch), *B. populifolia* (gray birch), *B. lenta* (black birch), *Fagus grandifolia* (American beech), and *Tsuga canadensis* (hemlock). Red oak may dominate to the near exclusion of white

pine on rocky ridges and in northern examples (White Mountain region) on southern or western exposures, particularly on shallow-to-bedrock sites. White pine is often 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.

The understory is dominated by *Vaccinium angustifolium* (lowbush blueberry), *Gaylussacia baccata* (black huckleberry), *Comptonia peregrina* (sweet-fern), and *Pteridium aquilinum* ssp. *latiusculum* (bracken fern). Other species that may be present include *Viburnum acerifolium* (maple-leaved viburnum), *Carex pensylvanica* (Pennsylvania sedge), *C. lucorum* (Blue Ridge sedge), and *Oryzopsis asperifolia* (white-grained rice grass).

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.

• Red pine - white pine forest (S2S3)

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 *Pinus resinosa* (red pine) and *P. strobus* (white pine) with little or no *P. rigida* (pitch pine). *Abies balsamea* (balsam fir) is prominent in the understory in many examples.

CHARACTERISTIC VEGETATION: Red pine, white pine, and balsam fir are characteristic tree species. Species in the shrub and herb layers include *Vaccinium angustifolium* (lowbush blueberry), *V. myrtilloides* (velvet-leaved blueberry), *Gaultheria procumbens* (eastern spicy-wintergreen), *Oryzopsis asperifolia* (white-grained rice grass), and *Maianthemum canadense* (Canada-mayflower). Most examples lack *Quercus ilicifolia* (scrub oak), *Carex lucorum* (Blue Ridge sedge), and *Piptatherum pungens* (short-awned mountain-rice grass), species that are frequent in ***pitch pine - scrub oak woodlands***. Mosses are often common.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community 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.

WOODED ROCKY RIDGES AND TALUS SLOPES

These communities occur as small or large patches within Laurentian mixed forests. They are found on rocky ridges, with thin soils and extensive areas of exposed bedrock, or talus slopes, where piles of boulders have accumulated as a result of the erosion of cliff faces. There is only one rocky ridge community that is restricted to this forest zone within New Hampshire, the ***red oak - pine rocky ridge***, and two wooded talus communities. These wooded talus communities occur in distinct elevation ranges, with little overlap. The ***red oak - black birch wooded talus*** is found between 500 and 1,800 ft., while the ***birch - mountain maple wooded talus*** occurs between 1,600 and 3,000 ft.

• Red oak - pine rocky ridge (S3S4)

GENERAL DESCRIPTION: This is the most common rocky ridge community type between 1,000 and 2,000 ft. elevation in southern and central New Hampshire, though it also occurs as high as 2,200 ft. elevation on warm, south-facing slopes of the Saco River valley in the White Mountains. It is characterized by a scattered, moderately short or stunted tree canopy of *Quercus rubra* (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 open woodland structure and ridgeline position create good views at many sites, and they are often popular hiking destinations.

Ecologically, this community is very similar to the ***Appalachian oak - pine rocky ridge*** and shares many of the same species. However, it is distinguished by the absence of definitively southern and Appalachian species generally found below 1,000–1,300 ft., by the occasional presence of a few northern or higher elevation species, and by the prominence of red oak. Red oak is a broadly adapted temperate species, most abundant on dry sites where trees of mesic sites cannot survive. In New Hampshire, it grows well on mid-elevation ridges and mountains, while most other oaks become scarce above 1,000 ft. This community also overlaps elevationally with ***red pine rocky ridges***, with which it may sometimes intergrade.

CHARACTERISTIC VEGETATION: Several tree species are more abundant and frequent in this community than in ***Appalachian oak - pine rocky ridges***. 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 shrubs include *Vaccinium angustifolium* (lowbush blueberry; nearly constant), *V. myrtilloides* (velvet-leaved blueberry), *Gaylussacia baccata* (black huckleberry), *Diervilla lonicera* (bush honeysuckle), *Gaultheria procumbens* (eastern spicy-wintergreen), *Comptonia peregrina* (sweet-fern), and *Juniperus communis* var. *depressa* (common juniper). *Arctostaphylos uva-ursi* (red bearberry) is occasional on lower elevation examples. Frequent herbaceous species include the lawn forming *Carex lucorum* (Blue Ridge sedge) as well as *Deschampsia flexuosa* (wavy hair grass; nearly constant), *Schizachyrium scoparium* (little bluestem), *Danthonia spicata* (poverty oatgrass), *Carex foenea* (straw sedge), *Capnoides sempervirens* (pink-corydalis), *Maianthemum canadense* (Canada-mayflower), *Solidago bicolor* (white goldenrod), *Melampyrum lineare* (American cow-wheat), and *Pteridium aquilinum* ssp. *latiusculum* (bracken fern). Lichens and mosses are abundant on rocks.

Higher elevation examples (1,400–1,900 ft.) have more red spruce, *Sibbaldiopsis tridentata* (three-toothed cinquefoil), and *Sorbus* spp. (mountain-ashes), whereas lower elevation examples have southern species such as Blue Ridge sedge, common juniper, and *Aureolaria pedicularia* var. *intercedens* (intervening fern-leaved false foxglove). Lower elevation examples may also contain species such as *Capnoides sempervirens* (pink-corydalis) and *Arctostaphylos uva-ursi* (red bearberry).

Species characteristic of this community and absent in ***Appalachian oak - pine rocky ridges*** include *Polygonum douglasii* (Douglas' knotweed)*, *Minuartia glabra* (Appalachian sandplant)*, *Sorbus americana* (American mountain-ash), *Boechera stricta* (Canada rockcress), and *Sibbaldiopsis 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* (blue huckleberry), and *Sassafras albidum* (sassafras).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community typically occurs between 1,000 and 2,000 ft. elevation in southern 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.

• Birch - mountain maple wooded talus (S3)

GENERAL DESCRIPTION: This community, dominated by birches and other hardwood species, occurs on mountain slopes generally between 1,600 ft. and 3,000 ft. The exposed, higher elevation settings exclude species more characteristic of central and southern parts of the state. This community tends to have an open woodland character, with frequent and sometimes large canopy gaps and small inclusions of lichen-dominated talus barren. Trees are often less than 30 ft. in height, and shrubs and herbs are scattered or locally abundant among the rocky openings.

The talus blocks in this community weather to yield acidic soil conditions. Soil development is variable, and moisture conditions range from dry to mesic. Larger talus slopes may have colder and moister microclimates produced by subsurface cold-air drainage and late-melting ice at their base.

CHARACTERISTIC VEGETATION: Characteristic trees include *Betula alleghaniensis* (yellow birch), *B. papyrifera* (paper birch), *B. cordifolia* (heart-leaved paper birch), *Sorbus americana* or *S. decora* (mountain-ashes), and *Acer spicatum* (mountain maple). *Picea rubens* (red spruce) may be present in low quantities. Shrubs and herbs include species typical of other talus communities including *Ribes glandulosum* (skunk currant), *Vaccinium angustifolium* (lowbush blueberry), *Parthenocissus quinquefolia* (Virginia-creeper), *Polypodium virginianum* (rock polypody), *Fallopia cilinodis* (fringed bindweed), and *Deschampsia flexuosa* (wavy hair grass), as well as species preferential to northern or higher elevation areas such as *Vaccinium myrtilloides* (velvet-leaved blueberry), *V. vitis-idaea* (mountain cranberry), *Solidago simplex* ssp. *randii* var. *monticola* (montane Rand's goldenrod), *Juncus trifidus* (highland rush), *Clintonia borealis* (yellow bluebead-lily), and numerous others. Mosses and lichens are often present but have not been specifically studied or documented. Moss cover is less dense than in ***spruce - moss wooded talus***.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Generally restricted to central and northern New Hampshire (in Sunapee Uplands, the three northern subsections, and possibly Sebago-Ossipee subsection) at elevations above 2,200 ft., but may occasionally be found down to 1,500 ft. Good examples occur on Cannon Mountain (Franconia Notch), Whitewall Mountain (Zealand Notch), and Lost River Gorge (Woodstock).

SOURCES: NHB field surveys; Mohlenbrock 1987.

• Red oak - black birch wooded talus (S3S4)

GENERAL DESCRIPTION: This sparse woodland to woodland community occurs on talus slopes of moderately low to mid elevations (500–1,800 ft.) in southern and central New Hampshire, and in lower elevation valleys of the White Mountains. Hardwood canopy and tall shrub compositions are variable, but nearly all have *Quercus rubra* (red oak) in some quantity, though not necessarily abundant or dominant.

A very similar community, ***Appalachian wooded talus***, occurs at even lower elevations on warmer talus slopes in southern New Hampshire, but contains species with distinct southern affinities that are absent from this type. The ***red oak - black birch wooded talus*** community also has many species in common with the dry variant of ***rich red oak rocky woods*** but the latter differs by three factors: a woodland to forest structure; substrates of very rocky till with talus being less frequent or absent; and the presence of enriched-site indicators.

Talus in this community yields soil that is acidic to weakly enriched and moderately nutrient-poor

(submesotrophic). Rock types include the Littleton Formation, granites, monzonites, and quartzites.

CHARACTERISTIC VEGETATION: *Quercus rubra* (red oak) is the most constant tree species, but not always abundant. Other tree and tall shrub associates may include *Betula lenta* (black birch), *B. alleghaniensis* (yellow birch), *Fagus grandifolia* (American beech), *Ostrya virginiana* (ironwood), *Acer saccharum* (sugar maple), *A. rubrum* (red maple), *A. spicatum* (mountain maple), *A. pensylvanicum* (striped maple), and occasionally *Prunus pensylvanica* (pin cherry). *Betula papyrifera* (paper birch) and *B. 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* (American witch-hazel), *Rubus* spp. (brambles), *Viburnum acerifolium* (maple-leaved viburnum), *Ribes* spp. (gooseberries and currents), and *Sambucus racemosa* (red elderberry). Vines and lianas are more prevalent than in most till forests and may include *Fallopia cilinodis* (fringed bindweed), *Parthenocissus quinquefolia* (Virginia-creeper), *P. inserta* (thicket-creeper), *Toxicodendron radicans* (poison-ivy), and *Celastrus scandens* (American bittersweet).

The herbaceous layer contains many species characteristic of most talus slope communities including *Maianthemum racemosum* (feathery false Solomon's-seal), *Dryopteris marginalis* (marginal wood fern), and *Polypodium virginianum* (rock polypody). In drier or more open areas, species such as *Capnoides sempervirens* (pink-corydalis), patches or lawns of *Carex lucorum/pensylvanica* (Blue Ridge and Pennsylvania sedges), *Oryzopsis asperifolia* (white-grained rice grass), *Pteridium aquilinum* ssp. *latiusculum* (bracken fern), *Solidago bicolor* (white goldenrod), and *S. caesia* (axillary goldenrod) may be present (see also ***rich red oak rocky woods*** description for expanded list of dry vs. dry-mesic species.) Common herbs of the region are also frequent, including *Maianthemum canadense* (Canada-mayflower), *Aralia nudicaulis* (wild sarsaparilla), and *Lysimachia borealis* (starflower). Foliose lichens are common on larger rocks.

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 500–1,600 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 1,600 ft., but the type may reach 1,800–2,000 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.

APPALACHIAN OAK AND PINE FOREST ZONE

Appalachian oak and pine forests primarily occur in warm-temperate climates of the central and Appalachian states, but they extend into southern and coastal New Hampshire and Maine. In these forests, the climate is warmer and drier, elevations are lower, the growing season is longer, and fire was historically more frequent than in the Laurentian and Acadian forests to the north.

Plants with ranges centered in Appalachian states further south distinguish New Hampshire's Appalachian oak and pine forests from other forests in the state. Species largely absent from Laurentian forests include *Quercus alba* (white oak), *Q. velutina* (black oak), *Q. coccinea* (scarlet oak), *Q. montana* (chestnut oak), *Q. ilicifolia* (scrub oak), *Carya* spp. (hickories), *Sassafras albidum* (sassafras), *Pinus rigida* (pitch pine), *Kalmia latifolia* (mountain laurel), and *Benthamidia florida* (flowering dogwood). Many of these species reach the northeastern end of their ranges in central New England.

Communities of the Appalachian oak and pine forests are most frequent at low elevations of the lower

Connecticut River valley, lower Merrimack River valley, and the southeast. They 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 of these settings, fire is likely an important factor in the maintenance of oak and pine dominance.

Appalachian 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. (maples), and *Betula* spp. (birches) tend to be more abundant. In general, the Appalachian oaks (e.g., white oak, black oak, scarlet oak, and chestnut oak), and pitch pine decrease in frequency or drop out altogether at moderate elevations (800–1,000 ft.) and/or in more northerly locations of central New Hampshire. *Quercus rubra* (red oak) and *Pinus strobus* (white pine) climb to 1,500 ft., and less frequently occur even higher on southern ridges and slopes of the White Mountains.

Two broad community groups are described within the oak - pine zone:

1) **Dry forests and woodlands**, with a variable and often well-developed heath layer; and

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

DRY FORESTS AND WOODLANDS

The ability of many oak species of dry forests and woodlands to root or stump sprout contributes to their perpetuation under regular fire regimes. Oak forests appear to be fire-dependent over long periods in the Northeast and 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 American beech on drier sites and sugar maple and American beech on more mesic sites. Repeated fire would tend to knock back fire-sensitive American beech and sugar maple. Blowdown gaps may also play a role in creating openings for red oak regeneration, but the relative importance of gaps compared to other factors is unknown.

Shrub and herbaceous species common to nearly all dry acidic oak - hickory - pine forests include *Vaccinium angustifolium* (lowbush blueberry), *V. pallidum* (hillside blueberry), *Gaylussacia frondosa* (blue huckleberry), *G. baccata* (black huckleberry), *Viburnum acerifolium* (maple-leaved viburnum), *Comptonia peregrina* (sweet-fern), *Hamamelis virginiana* (American witch-hazel), *Gaultheria procumbens* (eastern spicy-wintergreen), *Carex pensylvanica/lucorum* (Pennsylvania and Blue Ridge sedges), *Deschampsia flexuosa* (wavy hair grass), *Oryzopsis asperifolia* (white-grained rice grass), *Danthonia spicata* (poverty oatgrass), *Pteridium aquilinum* ssp. *latiusculum* (bracken fern), *Lysimachia quadrifolia* (whorled yellow-loosestrife), and *Lechea intermedia* (round-fruited pinweed). *Vaccinium myrtilloides* (velvet-leaved blueberry) and *Kalmia angustifolia* (sheep laurel) are occasional, but are also characteristic of other habitats such as high-elevation ridges, subalpine krummholz, and bogs. Also frequently present are *Acer rubrum* (red maple), *Betula papyrifera* (paper birch), and *B. populifolia* (gray birch).

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

• Dry Appalachian oak forest (S3)

GENERAL DESCRIPTION: These 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. They are distinguished from ***dry red oak - white pine forests***, which tend to lack significant representation of the southern or Appalachian species. Fire is likely required for the long term persistence of oak forests.

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: Frequent oaks include *Q. rubra* (red oak), *Quercus velutina* (black oak), and *Q. alba* (white oak), with lesser amounts of *Q. coccinea* (scarlet oak) and *Q. montana* (chestnut oak). Hickories such as *Carya ovata* (shagbark hickory) and *C. glabra* (pignut hickory) may be present, but are typically less prevalent than oaks. *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) is occasional, primarily as an understory tree, indicating its potential future prominence on some sites.

There is a strong heath understory with *Vaccinium angustifolium* (lowbush blueberry), *V. pallidum* (hillside blueberry), *Gaylussacia baccata* (black huckleberry), *G. frondosa* (blue huckleberry), and *Kalmia angustifolia* (sheep laurel). In some examples, other species co-occur with heath shrubs including *Corylus americana* (American hazelnut), *Crocanthemum canadense* (Canada frostweed), *Comandra umbellata* (bastard-toadflax), and *Piptatherum pungens* (short-awned mountain-rice grass).

In addition to the characteristic shrubs and herbs mentioned above which are common to most acidic oak - pine communities, several other species may occur. They include *Benthamidia florida* (flowering dogwood), *Kalmia latifolia* (mountain laurel), *Carex pensylvanica* (Pennsylvania sedge), *C. foenea* (straw sedge), *C. retroflexa* (reflexed sedge)*, *Solidago odora* (licorice goldenrod)*, *Antennaria plantaginifolia* (plantain-leaved pussytoes), *Viola pedata* (bird-foot violet)*, *Hieracium venosum* (rattlesnake hawkweed), *Galium pilosum* (hairy bedstraw)*, *Spiranthes lacera* (slender ladies'-tresses), *Aureolaria pedicularia* var. *intercedens* (intervening fern-leaved false foxglove), *Polygonum tenue* (slender knotweed)*, *Tephrosia virginiana* (wild goat's-rue)*, *Baptisia tinctoria* (yellow wild indigo), *Desmodium marilandicum* (smooth small-leaved tick-trefoil)*, and *D. rotundifolium* (round-leaved trailing tick-trefoil)*. *Quercus prinoides* (dwarf chestnut oak) and *Q. ilicifolia* (scrub oak) are occasional.

This community typically has a strong heath understory while herbaceous species are infrequent. In some examples, however, heath shrubs may be scarce while herbs, grasses, and sedges are more prominent, though such dry-mesic, less acidic examples may grade into the ***semi-rich oak - sugar maple forest*** community.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Found 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 (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 ***dry Appalachian oak forests*** by having considerable pine in the canopy, particularly pitch pine. In New Hampshire, this community appears to be limited to the lower Merrimack River valley region, where it is uncommon to rare. It is fire-adapted and fire-prone, and requires maintenance of an adequate fire-regime for long-term perpetuation.

This community may grade into other oak and pine types, including ***pitch pine - scrub oak woodlands***. Some of the rare insects (particularly butterfly and moth faunas) associated with those woodlands presumably occur in this forest type as well.

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

CHARACTERISTIC VEGETATION: Dominants consist of pitch pine, *Pinus strobus* (white pine), and Appalachian oaks including *Quercus coccinea* (scarlet oak), *Q. velutina* (black oak), *Q. alba* (white oak), and *Q. montana* (chestnut oak). *Pinus resinosa* (red pine) may be present in low abundance, but it is the more southern Appalachian species that distinguish this community from the more northern ***mixed pine - red oak woodland***. Pines may be locally abundant or dominant to the near exclusion of tree oaks in some examples, while other expressions 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 the forested canopies.

Southern plants may include *Solidago odora* (licorice goldenrod)*, *Ionactis linariifolia* (flax-leaved stiff-aster), *Lespedeza capitata* (round-headed bush-clover), and *Desmodium* spp. (tick-trefoils). In openings, species such as *Liatris novae-angliae* (northern blazing star)* and *Lupinus perennis* (wild lupine)* may be present.

Plants characteristic of most acidic, dry-site oak - pine forests include *Ostrya virginiana* (ironwood), *Vaccinium angustifolium* (lowbush blueberry), *V. pallidum* (hillside blueberry), *Gaylussacia baccata* (black huckleberry), *G. frondosa* (blue huckleberry), *Viburnum acerifolium* (maple-leaved viburnum), *Hamamelis virginiana* (American witch-hazel), *Gaultheria procumbens* (eastern spicy-wintergreen), *Lysimachia quadrifolia* (whorled yellow-loosestrife), *Lechea intermedia* (round-fruited pinweed), *Carex pensylvanica* (Pennsylvania sedge), *C. lucorum* (Blue Ridge sedge), *Deschampsia flexuosa* (wavy hair grass), *Oryzopsis asperifolia* (white-grained rice grass), *Danthonia spicata* (poverty oatgrass), and *Pteridium aquilinum* ssp. *latiusculum* (bracken fern). *Vaccinium myrtilloides* (velvet-leaved blueberry) and *Kalmia angustifolia* (sheep laurel) may also be occasional.

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.

• Pitch pine - scrub oak woodland (S1S2)

GENERAL DESCRIPTION: This community occurs on xeric, excessively well drained soils and is characterized by *Pinus rigida* (pitch pine) and *Quercus ilicifolia* (scrub oak). Pitch pine forms a discontinuous canopy over scrub oak and low heaths. Several successional or disturbance related expressions can be present, including scrub oak thickets, pockets of pure pitch pine forest, grassy openings, and heath barrens. A fire return interval of 50–100 years is required for maintaining community structure, dynamics, and composition (floristic and faunal). In some of New Hampshire's examples, logging history has also influenced canopy structure and composition. A large number of rare Lepidoptera are associated with this community.

CHARACTERISTIC VEGETATION: This community is dominated by pitch pine and a tall shrub layer of scrub oak. Common associates are *Vaccinium angustifolium* (lowbush blueberry), *V. pallidum* (hillside

blueberry), *Comptonia peregrina* (sweet-fern), *Carex lucorum* (Blue Ridge sedge), *Piptatherum pungens* (short-awned mountain-rice grass), and *Pteridium aquilinum* ssp. *latiusculum* (bracken fern). Other species include *Corylus americana* (American hazelnut), *Aronia melanocarpa* (black chokeberry), *Gaultheria procumbens* (eastern spicy-wintergreen), *Solidago* spp. (goldenrods), *Symphyotrichum* ssp. (American-asters), *Lechea* spp. (pinweeds), *Comandra umbellata* (bastard-toadflax), *Schizachyrium scoparium* (little bluestem), and *Oryzopsis asperifolia* (white-grained rice grass).

VARIANTS: Two variants are described.

1. **Merrimack Valley variant**: This variant only occurs at the Concord Pine Barrens, on deltaic deposits associated with 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. The diversity of both common and rare vascular plants is high in this variant and includes such species as *Lupinus perennis* (wild lupine)*, *Asclepias amplexicaulis* (clasping milkweed)*, *Hudsonia ericoides* (golden heather)*, *Hieracium venosum* (rattlesnake hawkweed), and *Ceanothus americanus* (New Jersey redroot). A suite of Lepidoptera fauna associated with wild lupine* and other plants are either restricted to or more frequent in this variant. Rare Lepidoptera that feed on wild lupine* include *Lycaeides samuelis* (Karner blue butterfly)*, *Incisalia irus* (frosted elfin)*, and *Erynnis persius* (Persius dusky wing)*.
2. **Ossipee variant**: This variant occurs on deep, sandy outwash deposits between Ossipee and Silver Lakes (Ossipee Pine Barrens). More northern plants that are diagnostic of this variant, although typically low in cover, are *Arctostaphylos uva-ursi* (red bearberry), *Sibbaldiopsis tridentata* (three-toothed cinquefoil), and *Diphasiastrum* x *sabinifolium* (savin-leaved clubmoss). This variant lacks most of 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 *Xylena thoracica* (pinion 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. 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.

• Mixed pine - red oak woodland (S1S2)

GENERAL DESCRIPTION: This community is dominated by *Pinus rigida* (pitch pine), *P. resinosa* (red pine), *P. strobus* (white pine), and *Quercus rubra* (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 occurs on sand plains that have longer intervals (>100 years) between fires than areas dominated by ***pitch pine - scrub oak woodlands*** (50–100 years). Some may have succeeded from that community, with or without the influence of logging. The composition of this community can be very similar, with increased cover of white pine, red pine, and 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***.

This community requires periodic fire for vegetation maintenance. Woodlands are less likely to burn if they are 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 of features 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 New Hampshire's native pines are typically present in quantity, including pitch pine, red pine, and white pine. Red oak is also present and equals or exceeds pine in abundance in several examples. Southern or Appalachian species are lacking (such as white and black oaks, hickories, and southern herbaceous species found in ***pitch pine - Appalachian oak - heath 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 at the beginning of this section can be present, including *Ostrya virginiana* (ironwood), *Gaylussacia baccata* (black huckleberry), *G. frondosa* (blue huckleberry), *Viburnum acerifolium* (maple-leaved viburnum), *Hamamelis virginiana* (American witch-hazel), *Gaultheria procumbens* (eastern spicy-wintergreen), *Lysimachia quadrifolia* (whorled yellow-loosestrife), *Lechea intermedia* (round-fruited pinweed), *Carex pensylvanica* (Pennsylvania sedge), *C. lucorum* (Blue Ridge sedge), *Deschampsia flexuosa* (wavy hair grass), *Oryzopsis asperifolia* (white-grained rice grass), *Danthonia spicata* (poverty oatgrass), and *Pteridium aquilinum* ssp. *latiusculum* (bracken fern).

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.

• Maritime wooded dune (S1)

GENERAL DESCRIPTION: This community is found in relatively protected areas of backdune portions of coastal sand dune systems. It has a densely wooded or woodland thicket structure. *Prunus serotina* (black cherry) and other trees attain their greatest height (up to 20 ft. tall) in the most protected areas and grade to a shorter woodland canopy with a dense shrub layer in more exposed 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 (a good example being the "sunken forest" just to the south at Plum Island in Massachusetts). It is threatened by ongoing developmental and recreational pressures.

CHARACTERISTIC VEGETATION: This community is dominated by a tree canopy of black cherry, *Populus tremuloides* (quaking aspen), *Acer rubrum* (red maple), and occasional *Pinus rigida* (pitch pine). Other species include *Toxicodendron radicans* (poison-ivy), *Amelanchier spicata* (dwarf shadbush), *Parthenocissus quinquefolia* (Virginia-creeper), *Viburnum dentatum* var. *lucidum* (smooth arrowwood), and *Rosa virginiana* (Virginia rose). Prominent exotic species include *Lonicera morrowii* (Morrow's honeysuckle) and *Berberis vulgaris* (common barberry). Common herb species include *Maianthemum canadense* (Canada-mayflower), *M. stellatum* (star-like false Solomon's-seal), *Aralia nudicaulis* (wild sarsaparilla), and *Moehringia lateriflora* (blunt-leaved grove-sandwort).

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: NHB field surveys; Dunlop et al. 1983.

• Pitch pine rocky ridge (S1)

GENERAL DESCRIPTION: This *Pinus rigida* (pitch pine) dominated community is found in southern and east-central New Hampshire on rocky summits and ridges with a history of fire. Pitch pine forms a stunted to moderate-height (5–30 ft. tall), sparse woodland (5–25%) to woodland (25–60%) canopy, sometimes in combination with other conifers and oaks. On the most barren and xeric microsites within the community, scattered bonsai-like pitch pine trees grow to 5–15 ft. tall and can exceed 70 years of age. This community is similar to other pine and oak dominated rocky ridge communities in having an abundance of heath shrubs, lichens, and bedrock outcrops. It differs by the predominance of pitch pine and probably by a more frequent or intense fire history, necessary to favor perpetuation of pitch pine over other trees. ***Pitch pine rocky ridges*** are similar to ***pitch pine - scrub oak woodlands*** in many ways, but are found in bedrock-controlled settings rather than on sand plains, and exhibit some differences in species composition. This community is rare in New Hampshire, and rare or uncommon in other New England states and New York. It is found at both low (270 ft.) and moderate (1,700 ft.) elevations.

Drought and fire play an important role in the maintenance of pitch pine and other fire-adapted species found in this community. Return intervals of less than 50 years would tend to perpetuate pitch pine; longer return intervals could lead to more mixed composition, greater overall tree cover, and possible succession to other community types maintained by longer return intervals. Barren outcrops are common, ranging from 25–75% cover, forming small to large patches (<0.1 to 1+ acres) within this community. Without fire, a greater abundance of fire-intolerant species and tree cover in general can be expected in areas with soil cover. Xeric, barren outcrop areas may remain open for longer periods due to the amount of time required to build up soil.

CHARACTERISTIC VEGETATION: Canopy composition ranges from nearly pure pitch pine to pitch pine co-dominating with a variable mix of other pines, oaks, birches, and *Picea rubens* (red spruce). At low elevations (below 1,000 ft.), Appalachian oaks and other southern species may be present, including *Quercus alba* (white oak), *Q. montana* (chestnut oak), *Q. velutina* (black oak), *Q. prinoides* (dwarf chestnut oak), and *Sassafras albidum* (sassafras). At higher elevations, *Pinus resinosa* (red pine) and red spruce can mix with pitch pine. Trees found at either elevation include *Quercus rubra* (red oak), *Pinus strobus* (white pine), *Betula papyrifera* (paper birch), *B. populifolia* (gray birch), and *Acer rubrum* (red maple).

Shrub cover is moderate (5–40%) and typically consists of low or dwarf shrubs; extensive thickets of *Quercus ilicifolia* (scrub oak) form in some places. Other common shrubs include *Gaylussacia baccata* (black huckleberry), *Vaccinium angustifolium* (lowbush blueberry), *V. pallidum* (hillside blueberry), *Kalmia angustifolia* (sheep laurel), *Juniperus communis* var. *depressa* (common juniper), *Gaultheria procumbens* (eastern spicy-wintergreen), *Sibbaldiopsis tridentata* (three-toothed cinquefoil), *Aronia melanocarpa* (black chokeberry), and *Amelanchier* spp. (shadbushes). At higher elevation sites, scrub oak and hillside blueberry are absent, and tall shrubs are limited to scattered individuals of other species.

Herbaceous cover is sparse, but a moderate diversity of grasses and sedges is typical. *Deschampsia flexuosa* (wavy hair grass) and *Pteridium aquilinum* ssp. *latiusculum* (bracken fern) are always present. Other frequent species include *Solidago puberula* (downy goldenrod), *Maianthemum canadense* (Canada-mayflower), *Comandra umbellata* (bastard-toadflax), *Carex tonsa* (shaved sedge), *C. brevior* (short-beaked sedge), *Danthonia spicata* (poverty oatgrass), and *Schizachyrium scoparium* (little bluestem). *Carex cumulata* (clustered sedge)* is a rare plant documented from a few examples; *Nabalus serpentarius* (lion's-foot rattlesnake-root)* is a rare herb found at one site. Lichens are common, growing extensively on and around barren rock outcrops, and include reindeer lichens (*Cladonia* spp.) which grow under and among heath shrubs.

This community differs from ***pitch pine - scrub oak woodlands*** on sand plains by having a greater

abundance of lichens on thin soils and on rock outcrops, a higher frequency of wavy hair grass, and at higher elevation sites, plants such as three-toothed cinquefoil, red pine, and red spruce.

CLASSIFICATION CONFIDENCE: 1–2

DISTRIBUTION: This natural community is restricted to southern and east-central NH from 270–1,700 ft. elevation in the Coastal Plain and Sebago-Ossipee subsections. An example occurs at Rock Rimmon (Manchester).

SOURCES: NHB Field Surveys; Ellis (2007).

• Appalachian oak - pine rocky ridge (S3)

GENERAL DESCRIPTION: This community is characterized by a moderately short or stunted woodland tree canopy (25–60% cover, 15–40 ft. tall), a significant short-medium shrub layer (25–70%, 1–7 ft. tall), and a sparse (<1%) to moderately dense herb layer. Rock exposures typically cover 25–50% of the ground surface. This community occurs on fire-prone sites, and fire contributes to the maintenance of shallow, impoverished soils and an open canopy structure. 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 this community due to their generally small size (<0.25 acres).

Soils are typically acidic shallow-to-bedrock sandy loams, droughty (xeric to dry moisture regime), very gravelly or stony, and derived from 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). 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 variety of plants. Appalachian and other transitional tree and understory species that are characteristic of this community and distinguish it from ***red oak - pine rocky ridges*** include *Pinus rigida* (pitch pine), *Quercus alba* (white oak), *Q. velutina* (black oak), *Q. montana* (chestnut oak), *Q. ilicifolia* (scrub oak), *Q. coccinea* (scarlet oak), *Carya ovata* (shagbark hickory), *Juniperus virginiana* (eastern red cedar), and *Sassafras albidum* (sassafras). *Quercus rubra* (red oak) is consistently present in quantity in the tree layer; *Pinus strobus* (white pine) and *Ostrya virginiana* (ironwood) are common. *Pinus resinosa* (red pine) is occasional but more frequent on ***red oak - pine rocky ridges***. Forests and woodlands dominated or co-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), *Viburnum acerifolium* (maple-leaved viburnum), *Juniperus communis* var. *depressa* (common 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 classified as a distinct community south of New Hampshire, where they are more prevalent. Other occasional characteristic shrubs include *Diervilla lonicera* (bush honeysuckle), *Gaylussacia frondosa* (blue huckleberry), *Vaccinium myrtilloides* (velvet-leaved blueberry), *Gaultheria procumbens* (eastern spicy-wintergreen), and *Arctostaphylos uva-ursi* (red bearberry).

Characteristic and frequent herbaceous species include *Carex pensylvanica* or *C. lucorum* (Pennsylvania and Blue Ridge sedges), *Deschampsia flexuosa* (wavy hair grass; nearly constant), *Schizachyrium scoparium* (little bluestem), *Danthonia spicata* (poverty oatgrass), *Capnoides sempervirens* (pink-corydalis), *Maianthemum canadense* (Canada-mayflower), *Solidago bicolor* (white goldenrod), and *Pteridium aquilinum* ssp. *latiusculum* (bracken fern). Other characteristic but less frequent herbs include *Comandra umbellata* (bastard-toadflax), *Antennaria plantaginifolia* (plantain-leaved pussytoes), *Polypodium virginianum* (rock polypody), *Melampyrum lineare* (American cow-wheat), *Aquilegia*

canadensis (red columbine), *Aureolaria pedicularia* var. *intercedens* (intervening fern-leaved false foxglove), *Solidago odora* (licorice goldenrod)*, and *Panicum* spp. (panicgrasses). 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 250-1,300 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: A canopy of the Appalachian tree *Quercus montana* (chestnut oak) dominates or co-dominates this community. Most examples occur as woodlands on low-elevation rocky ridges and hilltops with frequent rock outcrops; some are more closed-canopy forests with fewer outcrops on dry, shallow-to-bedrock hillsides. Other than frequent chestnut oak, it is floristically similar to ***Appalachian oak - pine rocky ridge*** woodlands and ***dry Appalachian oak forests***. Chestnut oak is uncommon in New Hampshire, and more restricted in distribution than other Appalachian hardwood tree species.

Soils are typically shallow and well to excessively well drained stony sandy loams derived from granitic or other siliceous bedrock.

CHARACTERISTIC VEGETATION: Chestnut oak is dominant or co-dominant along with *Quercus 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* (American witch-hazel) and *Viburnum acerifolium* (maple-leaved viburnum). Herbs and dwarf trailing shrubs include *Aralia nudicaulis* (wild sarsaparilla), *Maianthemum canadense* (Canada-mayflower), *Eurybia macrophylla* (large-leaved wood-aster), *Lysimachia quadrifolia* (whorled yellow-loosestrife), *Comandra umbellata* (bastard-toadflax), *Carex pensylvanica* (Pennsylvania sedge), *C. lucorum* (Blue Ridge sedge), *Oryzopsis asperifolia* (white-grained rice grass), and *Chimaphila maculata* (spotted prince's-pine) among many others.

CLASSIFICATION CONFIDENCE: 1–2

DISTRIBUTION: This community is documented in southern NH in the Coastal Plain subsection. 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 known examples are typically impacted by humans and the degree of natural origin is somewhat uncertain. It 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), and *Amelanchier canadensis* (eastern shadbush). Other species may include *Alnus serrulata* (smooth alder), *Morella caroliniensis* (small bayberry), *Juniperus communis* var. *depressa* (common juniper), *Rhus hirta* (staghorn sumac), *Toxicodendron radicans* (poison-ivy), *Comptonia peregrina* (sweet-fern), *Nuttallanthus canadensis* (oldfield-toadflax), *Ligusticum scothicum* (Scotch lovage), *Lechea intermedia* (round-fruited pinweed), and *Cakile edentula* (American sea-rocket). At its seaward edge, the community grades into tidal vegetation.

Documented examples are disturbed and have numerous exotics including *Rhamnus cathartica* (European buckthorn), *Berberis vulgaris* (common barberry), *Lonicera morrowii* (Morrow's honeysuckle), *Poa pratensis* (Kentucky blue grass), and *Rumex acetosella* ssp. *pyrenaicus* (sheep dock).

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 oaks and hickories, white pine, and transitional hardwood trees. 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.

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 sandy loam soils tend to be dry-mesic while the moisture regime of the silt loams tends to be mesic.

CHARACTERISTIC VEGETATION: This community has a diverse tree canopy, dominated by *Quercus rubra* (red oak), *Q. velutina* (black oak), *Pinus strobus* (white pine), *Acer rubrum* (red maple), and sometimes *Betula lenta* (black birch). *Carya ovata* (shagbark hickory) is also frequently 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* (paper birch), *Fagus grandifolia* (American beech), and *Tsuga canadensis* (hemlock). Although American 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. When present, it consists of *Viburnum acerifolium* (maple-leaved viburnum), *Corylus cornuta* (beaked hazelnut), *Hamamelis virginiana* (American witch-hazel), and *Vaccinium corymbosum* (highbush blueberry). Low or trailing shrubs and tree-clubmosses are frequent as a group, but typically constitute low cover. They include *Toxicodendron radicans* (poison-ivy), *Gaultheria procumbens* (eastern spicy-wintergreen), *Mitchella repens* (partridge-berry), *Dendrolycopodium obscurum* (flat-branched tree-clubmoss), *D. hickeyi* (Hickey's tree-clubmoss), and *Diphasiastrum digitatum* (southern ground-cedar). Infrequent species include *Gaylussacia baccata* (black huckleberry), *Viburnum dentatum* var. *lucidum* (smooth arrowwood), *Juniperus virginiana* (eastern red cedar), *J. communis* var. *depressa* (common juniper), *Smilax* spp. (greenbriers), and the exotics *Berberis thunbergii* (Japanese barberry), *Frangula alnus* (glossy false buckthorn), and *Rhamnus cathartica* (European buckthorn). Although *Vaccinium angustifolium* (lowbush blueberry) is occasional, it is always in low abundance (<1–5%) and the well-developed heath layer of ***dry Appalachian oak 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* (Pennsylvania sedge) and/or *C. lucorum* (Blue Ridge sedge); less frequent are *Dennstaedtia punctilobula* (eastern hay-scented fern), *Carex debilis* var. *rudgei* (white-edged 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 *Packera obovata* (running groundsel)* 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 American 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.

• Oak - mountain laurel forest (S3)

GENERAL DESCRIPTION: This community consists of an oak or mixed canopy, a sparse layer of dry to dry-mesic site herbs, and a shrub understory dominated by *Kalmia latifolia* (mountain laurel). It 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, it is restricted to parts of the Lakes Region and south and southwest portions of the state.

The tree canopy typically consists of red and Appalachian oaks, but can be highly variable. While overstory composition may be similar to other dry-mesic forests in the state, this community is considered distinct because of the significant effect mountain laurel has on other vegetation and its important role in ecosystem functions and processes (e.g., biomass, nutrient cycling, and light). Dense laurel thickets often inhibit the growth of other vegetation, including tree regeneration. The broadleaf, evergreen character of mountain laurel (leaf longevity averages 2–3 years) and ability to root and butt-sprout contributes to its success at

these fairly nutrient-poor sites. Taller laurel growth is common on moist sites whereas scrubbier forms occupy drier sites. Broadleaf evergreen shrubs like mountain laurel are uncommon in upland forests in New Hampshire. Mountain laurel is found mostly on drier to somewhat moist upland sites and occasionally on hummocks in swamps or along lake shores.

Soils are acidic, nutrient-poor to weakly enriched, stony, medium to fine sandy loam soils (oligotrophic to submesotrophic).

CHARACTERISTIC VEGETATION: Various tree species may be present, including *Quercus rubra* (red oak), *Q. alba* (white oak), *Q. montana* (chestnut oak), *Betula lenta* (black birch), *B. papyrifera* (paper birch), *Tsuga canadensis* (hemlock), *Pinus strobus* (white pine), *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. 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* (American witch-hazel), *Benthamidia florida* (flowering dogwood), *Swida rugosa* (round-leaved dogwood), *Acer pensylvanicum* (striped maple), *Corylus cornuta* (beaked hazelnut), 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 *Medeola virginiana* (Indian cucumber root), *Maianthemum racemosum* (feathery false Solomon's-seal), *Lysimachia borealis* (starflower), *Oryzopsis asperifolia* (white-grained rice grass), *Carex pensylvanica* (Pennsylvania sedge), *Pteridium aquilinum* ssp. *latiusculum* (bracken fern), and *Parathelypteris 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.

• Appalachian wooded talus (S1S2)

GENERAL DESCRIPTION: This sparse woodland to woodland community occurs on talus slopes at low elevations (<500 ft.) in southern and coastal New Hampshire and supports southern and Appalachian species absent from talus slopes occurring more inland or at higher elevations. Vegetation and ecological processes are otherwise very similar to ***red oak - black birch wooded talus***. This is a small patch community (in the range of <1–10 acres in size). It is fairly distinct, but it may include both acidic and somewhat enriched variants.

Soils are acidic to weakly enriched with talus derived from several types of bedrock including the Littleton Formation, granites, monzonites, and quartzites.

CHARACTERISTIC VEGETATION: A combination of two or more of the following southern and Appalachian species are present: *Quercus alba* (white oak), *Q. velutina* (black oak), *Q. montana* (chestnut oak), *Q. ilicifolia* (scrub oak), *Sassafras albidum* (sassafras), *Kalmia latifolia* (mountain laurel), *Rhododendron prinophyllum* (early azalea), and *Benthamidia florida* (flowering dogwood). These species typically reach

the northern margin of their range in southern New Hampshire and are generally absent from the more inland and higher elevation wooded talus types in the state. Otherwise, species composition is similar to that found in ***red oak - black birch wooded talus***, including abundant *Betula lenta* (black birch).

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.

ENRICHED FORESTS AND ROCKY RIDGES

Enriched forests are floristically diverse hardwood forest and woodland communities associated with higher levels of mineral nutrients than other forest types. They typically occur as patches in deciduous forests of the Laurentian and Appalachian zones, and are associated with particular combinations of bedrock, soils, topography, and moisture. Rich woods are uncommon in New Hampshire, and provide habitat for many of the state's rare forest plant species.

New Hampshire's enriched woodlands are divided into rich mesic, rich dry-mesic, and semi-rich forests. Rich mesic forests are very moist and nutrient-enriched, and contain the most diverse and lush herbaceous layer of any New Hampshire forest type. Rich dry-mesic forests occur on steep, south-facing slopes, and contain species indicative of rich, warm, dry, and rocky conditions. The herbaceous layer is diverse, but shorter than and not as well-developed as rich mesic forests. Semi-rich forests are less enriched and diverse than rich mesic and rich-dry mesic forests. They contain species indicative of moderately enriched conditions, such as *Arisaema triphyllum* (Jack-in-the-pulpit), *Actaea* spp. (baneberries), *Tiarella cordifolia* (foam-flower), and *Polystichum acrostichoides* (Christmas fern)

Circumneutral rocky ridge is the only enriched rocky ridge community type in New Hampshire. It occurs as narrow bands of open, herb-dominated ridge above circumneutral cliffs. It is known from two locations in the western part of the state, and is one of New Hampshire's rarest community types.

• Rich mesic forest (S3)

GENERAL DESCRIPTION: Rich mesic forests are the most diverse hardwood forests in New Hampshire. This community supports numerous rich-site species including many of New Hampshire's rare upland forest plants. Sugar maple is the dominant tree, and white ash and basswood are less abundant associates. Ferns, forbs, and wide-leaved sedges are abundant. Characteristic herbs include northern maidenhair fern, silvery false spleenwort, blue cohosh, eastern waterleaf*, American ginseng*, Goldie's wood fern, bland sweet-cicely, squirrel-corn, plantain-leaved sedge, and blood-root. Herbaceous spring ephemerals include Dutchman's-breeches, American trout-lily, two-leaved toothwort, and wild leek. Examples of this community on high floodplains, steep river terraces, and till hillsides in the Connecticut River Valley support bitternut hickory, American bladdernut*, and showy orchid*, species that approach the northeastern limit of their geographic range in New Hampshire.

This community occurs below 2,600 ft. in settings with moist and nutrient-enriched conditions. Soil enrichment is influenced by several factors including: mineral composition of bedrock and till; topographic position; 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 all other forest types in New Hampshire.

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 occasionally 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 for certain vernal or southern species in this community.

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 most of the characteristic tree species. An organic-rich A horizon is found at some sites that presumably results 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 the Ammonoosuc Volcanic, Frontenec (formerly Waits River), Fitch, Elliot, Berwick, and Madrid Formations, and various syenites, diorites, basalt or diabase and perhaps gabbro. These rocks generally have higher concentrations of calcium compared to granitic rocks, and/or increased weatherable (including hornblende and hastingsite). These and other base-rich 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) as frequent associates. *Fagus grandifolia* (American beech) and *Betula alleghaniensis* (yellow birch) are often present, but less frequent. *Ostrya virginiana* (ironwood) is occasional and *Juglans cinerea* (white walnut) is infrequent in lower elevation examples (<1,500 ft.).

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

Most ***rich mesic forests*** are characterized by a combination of several of the following species, a suite of species that can be used to distinguish this community from nearly all others in New Hampshire: *Adiantum pedatum* (northern maidenhair fern), *Deparia acrostichoides* (silvery false spleenwort), *Botrychium virginianum* (rattlesnake fern), *Dryopteris goldiana* (Goldie's wood fern), *Caulophyllum thalictroides* (blue cohosh), *Dicentra canadensis* (squirrel-corn), *D. cucullaria* (Dutchman's-breeches), *Asarum canadense* (Canada wild ginger), *Carex platyphylla* (broad-leaved sedge), *C. plantaginea* (plantain-leaved sedge), *Piptatherum racemosum* (black-seeded mountain-rice grass), *Ageratina altissima* (white snakeroot), *Rubus odoratus* (flowering raspberry), *Sanguinaria canadensis* (blood-root), *Cypripedium parviflorum* var. *pubescens* (large yellow lady's-slipper)*, *Viola canadensis* (Canada white violet), *V. pubescens* (yellow forest violet), and *Aralia racemosa* (American spikenard). Potential rare species in northern examples may include *Pyrola asarifolia* (pink shinleaf)*, *Osmorhiza berteroi* (mountain sweet-cicely)*, *Carex albursina* (white bear sedge)*, *C. aestivalis* (summer sedge)*, *Solidago x calcicola* (rock goldenrod), and *Trillium*

grandiflorum (white wakerobin). Numerous forest-sedges are restricted to rich forests, particularly the "wide-leaved" sedges (Laxiflorae and Careyanae groups). Sedges include broad-leaved sedge, plantain-leaved sedge, *Carex leptonervia* (nerveless woodland sedge), *C. laxiflora* (broad loose-flowered sedge), *C. blanda* (eastern woodland sedge), *C. sprengelii* (long-beaked sedge), *C. hirtifolia* (pubescent sedge), *C. pedunculata* (long-stalked sedge), and *C. rosea* (rosy sedge). There are numerous other herbs that occur in this community that are 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 orchid)*, *Hydrophyllum virginianum* (eastern waterleaf)*, and *Staphylea trifolia* (American bladdernut)*.

VARIANTS: Two variants are described:

1. **Typic variant**: This variant is found at low to mid elevations from about 500–1,800+ 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 1,800–2,600 ft. High percent cover in the herb layer is typical, particularly by 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 elevation enriched forests include *Clintonia borealis* (yellow bluebead-lily), *Streptopus lanceolatus* (lance-leaved twistedstalk), *Carex intumescens* (greater bladder sedge), *Cinna latifolia* (slender wood-reed), *Huperzia lucidula* (shining firmoss), *Polystichum braunii* (Braun's holly fern), and *Dryopteris campyloptera* (mountain wood fern). Other ferns include silvery false spleenwort, *Athyrium angustum* (lady fern), *Matteuccia struthiopteris* ssp. *pensylvanica* (ostrich fern), and *Dryopteris intermedia* (evergreen wood fern). Additional enriched site species include *Milium effusum* ssp. *cisatlanticum* (millet grass), *Laportea canadensis* (wood nettle), *Allium tricoccum* (wild leek), *Osmorhiza berteroi* (mountain sweet-cicely)*, and *Solidago x calcicola* (rock goldenrod). Ash, ironwood, basswood, and numerous understory species present at lower elevations are absent, although an enriched character is still evident.

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 <500–2,600 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; locally elsewhere. High elevation variant examples occur from approximately 1,800–2,600 ft. elevation, but mostly above 2,000 ft. Good examples are at Black/Sugarloaf/Jeffers Mtns. (Haverhill/Benton), Weeks State Park (Lancaster), Sugarloaf Cove (Albany), and Sundown Ledge (Albany).

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

RICH DRY-MESIC FORESTS

• Rich red oak rocky woods (S2S3)

GENERAL DESCRIPTION: This community occurs on enriched colluvial talus and till slopes in central and southern New Hampshire, and extends into the lower elevation slopes of major valleys in the White Mountains. It has a woodland to thin forest structure and 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 has a more open canopy, a sparser herb layer, and a species composition that reflects rockier and drier conditions. It supports certain species preferential to talus or dry-rich rocky habitats, including vines, open-site, and disturbance tolerant species that occupy gaps.

Substrates consist of rocky, colluvial till or till and talus from cliffs above; the moisture regime is dry to dry-mesic with inclusions of wetter and drier microhabitats. Source bedrock types yield elevated levels of calcium and/or other base cations, creating moderately enriched soil conditions. Bedrock types include syenites, diorites, and Ammonoosuc Volcanic Formation. Some examples occur on otherwise acidic soils from rocky till and talus enriched by minor base cation bearing inclusions such as dikes or matrix bedrock that has been hydrothermally altered to produce base-rich weathering products (Bailey 2001). Accumulated organic and mineral sediments that have settled at cliff-bases and on rocky slopes also 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* (paper birch). Softwoods are sparse or absent. Understory shrub and herbaceous species that prefer enriched conditions and differentiate this community from till or talus forests on acidic soil include *Swida rugosa* (round-leaved dogwood), *Toxicodendron radicans* (poison-ivy), *Corylus cornuta* (beaked hazelnut), *Juglans cinerea* (white walnut), *Rubus odoratus* (flowering raspberry), *Micranthes virginiensis* (early small-flowered-saxifrage), *Geranium robertianum* (mountain crane's-bill), *Aralia racemosa* (American spikenard), *Clematis virginiana* (virgin's bower), *Asarum canadense* (Canada wild ginger), *Asplenium platyneuron* (ebony spleenwort), *Piptatherum racemosum* (black-seeded mountain-rice grass), *Carex rosea* (rosy sedge), *C. radiata* (eastern star sedge), *C. platyphylla* (broad-leaved sedge), and *C. sprengelii* (long-beaked sedge). Potential rare species of rich sites include *Boechera canadensis* (sicklepod rockcress)*, *B. laevigata* (smooth rockcress)*, *Geranium carolinianum* (Carolina crane's-bill)*, *Cardamine concatenata* (cut-leaved toothwort)*, *Adlumia fungosa* (Allegheny-vine)*, and *Carex aestivalis* (summer sedge)*. *Milium effusum* ssp. *cisatlanticum* (millet grass) is an uncommon species that may be found at rich sites.

Species characteristic of both acidic and enriched soils include *Dryopteris marginalis* (marginal wood fern), *Polypodium virginianum* (rock polypody), *Ribes* spp. (gooseberries and currants), *Parthenocissus quinquefolia* (Virginia-creeper), *P. inserta* (thicket-creeper), *Celastrus scandens* (American bittersweet), *Fallopia cilinodis* (fringed bindweed), *Solidago caesia* (axillary goldenrod), *Maianthemum racemosum* (feathery false Solomon's-seal), *Fragaria vesca* (woodland strawberry), and *Deschampsia flexuosa* (wavy hair grass). Examples in the White Mountain region may have the northern plants *Boechera stricta* (Canada rockcress), *Clematis occidentalis* (purple virgin's bower)*, and *Polystichum braunii* (Braun's holly fern).

VARIANTS: Talus and rocky till slopes are inherently diverse and variable, but they do exhibit some fairly discrete differences related to the overall soil moisture status, resulting in distinct dry-mesic and dry variants:

1. **Dry-mesic variant**: In dry-mesic rock and 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. Mesic conditions can occur in gullies or other runoff areas, on lower portions of the talus, or at the base of the cliff. Ferns, sugar maple, and ash are often higher in cover in this variant, with oak somewhat less frequent. The more mesic nature of this variant is indicated by the following rich-site species: *Erythronium americanum* (American trout-lily), *Adiantum pedatum* (northern maidenhair fern), *Caulophyllum thalictroides* (blue cohosh), *Ageratina altissima* (white snakeroot), *Cardamine diphylla* (two-leaved toothwort), *Allium tricoccum* (wild leek), *Dicentra canadensis* (squirrel-corn),

D. cucullaria (Dutchman's-breeches), Allegheny-vine*, *Deparia acrostichoides* (silvery false spleenwort), *Panax quinquefolius* (American ginseng)*, and many others. Other dry to mesic site ferns include *Athyrium angustum* (lady fern), *Dryopteris intermedia* (evergreen wood fern), *Polystichum acrostichoides* (Christmas fern), the very rare *Diplazium pycnocarpon* (narrow-leaved glade fern)*, and Braun's holly fern in northern examples. Numerous broad-leaved forest sedges (Laxiflorae and Careyanae groups) may be present including broad-leaved sedge and *C. plantaginea* (plantain-leaved sedge).

2. **Dry variant**: Drier portions of till and talus slopes or those that are only seasonally moist tend to have species characteristic of both acidic and rich soils on talus slopes (e.g., marginal wood fern, rock polypody, 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 sparser. Rich site species that appear to be somewhat tolerant of drier or seasonally moist conditions include blackseed rice-grass, *Woodsia ilvensis* (rusty cliff fern), early small-flowered-saxifrage, poison-ivy, *Carex rosea* (rosy sedge), Canada rockcress, and mountain crane's-bill. Species characteristic of drier talus (yielding both acidic and enriched soils) that are sparse or absent on moist talus include *Aralia hispida* (bristly sarsaparilla), *Cardamine parviflora* (small-flowered bitter-cress), *Antennaria plantaginifolia* (plantain-leaved pussytoes), *Chenopodium foggii* (Fogg's goosefoot)*, *C. album* (white goosefoot), *Hedeoma pulegioides* (American false pennyroyal), *Pteridium aquilinum* ssp. *latiusculum* (bracken fern), *Carex lucorum* (Blue Ridge sedge), *C. pensylvanica* (Pennsylvania sedge), *C. tonsa* (shaved sedge), wavy hair grass, *Oryzopsis asperifolia* (white-grained rice grass), *Elymus hystrix* (eastern bottle-brush grass), and *E. trachycaulus* (slender wild-rye).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community occurs in hilly or mountainous areas mostly below 1,200 ft. elevation (occasionally 1,800–2,000 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 (Moultonborough), 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 community of central and southern New Hampshire that occurs on open ridges and upper slopes of hills and low mountains with soils influenced by intermediate bedrock. It is characterized by open park-like stands of stunted or short *Quercus* spp. (oaks), *Carya* spp. (hickories), *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), *Ostrya virginiana* (ironwood), a variety of rich-site herbs, and dense lawns of *Carex pensylvanica* (Pennsylvania sedge). *Carex lucorum* (Blue Ridge sedge), a species very similar to Pennsylvania sedge, may occur in this community but is more typical of nutrient-poor acidic soils on rocky ridges and sandy areas.

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, rocky ridge or forest communities with acidic soils.

CHARACTERISTIC VEGETATION: Characteristic trees include *Quercus rubra* (red oak), *Carya ovata* (shagbark hickory), white ash, sugar maple, ironwood, and *Pinus strobus* (white pine). The dense lawns of Pennsylvania sedge are diagnostic of somewhat enriched conditions and help distinguish this community from ***rich Appalachian oak rocky woods*** and ***rich red oak rocky woods***. Diagnostic enriched-site species

that differentiate this community from other rocky ridges include *Woodsia ilvensis* (rusty cliff fern), *Asplenium platyneuron* (ebony spleenwort), *Carex radiata* (eastern star sedge), *Minuartia michauxii* (Michaux's sandplant)*, *Anemone americana* (blunt-lobed hepatica), *Campanula rotundifolia* (Scotch bellflower), *Galium circaezans* (forest licorice bedstraw), *Tilia americana* (basswood), sugar maple, and *Fraxinus americana* (white ash). Herbs that are characteristic of rocky ridges in general are common and include *Anemone quinquefolia* (wood windflower), *Aquilegia canadensis* (red columbine), *Deschampsia flexuosa* (wavy hair grass), *Oryzopsis asperifolia* (white-grained rice grass), *Antennaria plantaginifolia* (plantain-leaved pussytoes), *Solidago caesia* (axillary goldenrod), and *Dryopteris marginalis* (marginal wood fern).

At least one occurrence contains species characteristic of mafic "traprock" bedrock and deserves further research. Species here include *Selaginella rupestris* (ledge spikemoss), *Agalinis tenuifolia* (slender-leaved agalinis), and *Cerastium strictum* (American 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 cliff fern)*, *Ranunculus fascicularis* (early crowfoot)*, *Carex retroflexa* (reflexed sedge)*, *C. cephalophora* (oval-headed sedge), and *Triodanis perfoliata* (clasping-leaved Venus'-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 michauxii* (Michaux's sandplant)* 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 lower elevation portions of the White Mountain subsection. Landscapes are shallow-to-bedrock areas of ridges and slopes on hills, low mountains, and lower slopes of higher mountains. Elevations range from 400–1,600 ft. More northern examples may exist but are not well documented. Good examples are found on The Rattlesnakes (Holderness), Fall Mtn. (Walpole), Mt. Pawtuckaway (Nottingham), and Harts Ledge (Bartlett).

SOURCES: NHB field surveys.

• Rich Appalachian oak rocky woods (S2)

GENERAL DESCRIPTION: This community occurs on hills below 1,000 ft. in southern New Hampshire. It is characterized by Appalachian oaks, hickories, and a diverse assemblage of rich-site herbs near their northern distributional limit. The community has a woodland to thin forest structure and an open understory with few shrubs. It supports a large number of southern species, many of which are rare in New Hampshire.

This community is most frequent on south-facing aspects, and occasionally occurs on ridgetops. Soils on these hillsides are often thin and rocky. The substrate is somewhat to very rocky till, or till and talus. Moisture status ranges from dry to dry-mesic. 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 in the thin canopy include *Quercus rubra* (red oak), *Q. alba* (white oak), *Ostrya virginiana* (ironwood), *Fraxinus americana* (white ash), *Carya ovata*

(shagbark 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 montana* (chestnut oak) are occasional. *Quercus velutina* (black oak) and *Q. coccinea* (scarlet oak) may also be present.

Species indicative of an elevated nutrient status that distinguish this community from other oak - hickory forests include *Micranthes virginiensis* (early small-flowered-saxifrage), *Ranunculus fascicularis* (early crowfoot)*, *Anemone americana* (blunt-lobed hepatica), *Symphyotrichum patens* (late purple American-aster)*, *Boechera canadensis* (sicklepod rockcress)*, *B. laevigata* (smooth rockcress)*, *B. missouriensis* (green rockcress)*, *Aureolaria virginica* (downy false foxglove)*, *Carex platyphylla* (broad-leaved sedge), *C. retroflexa* (reflexed sedge)*, *Lespedeza virginica* (slender bush-clover)*, *Pycnanthemum incanum* (hoary mountain-mint)*, *Paronychia canadensis* (smooth forked whitlow-wort)*, *Thalictrum thalictroides* (anemone meadow-rue)*, *Asclepias quadrifolia* (four-leaved milkweed)*, *Asplenium platyneuron* (ebony spleenwort; present in most examples in low abundance), and *Woodsia obtusa* (blunt-lobed cliff fern)*.

Other species present may include *Viburnum rafinesquianum* (downy arrowwood)*, *Muhlenbergia sobolifera* (rock muhly)*, *Antennaria plantaginifolia* (plantain-leaved pussytoes), and *Viola pedata* (bird-foot violet)*, as well as many other species common in oak - hickory forests. *Carex pensylvanica* (Pennsylvania sedge) may occur in this community, but generally only in low abundance; forests with understories dominated by extensive lawns of this species are described in the ***red oak - ironwood - Pennsylvania sedge woodland*** community.

VARIANTS: Two variants are described:

1. **Till variant**: (As described above). This variant occurs on rocky till slopes.
2. **Talus variant**: Occurs on slopes with till and talus. Most of the species mentioned for the till variant can also occur in the talus variant. Species more frequent or abundant on talus include *Swida rugosa* (round-leaved dogwood), *Juglans cinerea* (white walnut), *Betula lenta* (black birch), *Toxicodendron radicans* (poison-ivy), *Rubus odoratus* (flowering raspberry), *Geranium robertianum* (mountain crane's-bill), *Aralia racemosa* (American spikenard), *Clematis virginiana* (virgin's bower), *Piptatherum racemosum* (black-seeded mountain-rice grass), and *Carex sprengelii* (long-beaked sedge). Species characteristic of both acidic and enriched soils include *Parthenocissus quinquefolia* (Virginia-creeper), *P. inserta* (thicket-creeper), *Ribes* spp. (gooseberries and currants), *Dryopteris marginalis* (marginal wood fern), *Polypodium virginianum* (rock polypody), *Fallopia cilinodis* (fringed bindweed), *Solidago caesia* (axillary goldenrod), *Maianthemum racemosum* (feathery false Solomon's-seal), and *Deschampsia flexuosa* (wavy hair grass).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Occurs in 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.

SEMI-RICH 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. *Acer saccharum* (sugar maple) is dominant, with a variable presence of *Fagus grandifolia* (American beech) and *Fraxinus americana* (white ash). It is distinguished from ***rich mesic forests*** by a lack of indicators of strong enrichment and a more limited diversity of rich-site indicator species overall. 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; hydrologic flow through soil and fractured bedrock; soil moisture content; other soil characteristics (e.g., base saturation, texture, and organic matter content); and biological interactions (e.g., litter quality and soil and rock mychorrizae).

Soils are loam or fine sandy loams with a more developed A horizon than that found in most northern hardwoods. Soils have higher nutrient availability, productivity, and base-saturation than acidic northern hardwoods, but less than ***rich mesic forests***. Intermediate or calcium-rich bedrock types such as syenite or diorite can release calcium and other mineral nutrients upon weathering. Enriched soils can also develop on sites prone to colluviation, where organic matter and sediments accumulate in coves and narrow valleys, and at the bases of steep slopes.

CHARACTERISTIC VEGETATION: These somewhat enriched forests are most often dominated by sugar maple and sometimes American beech. White ash is occasional and abundant at some sites, but not present in all examples. *Tilia americana* (basswood) may be present in low abundance. Herbaceous species that help distinguish this semi-rich community from more acidic and/or drier northern hardwood communities include *Arisaema triphyllum* (Jack-in-the-pulpit), *Viola rotundifolia* (round-leaved violet), *Actaea* spp. (baneberries), *Tiarella cordifolia* (foam-flower), *Solidago flexicaulis* (zig-zag goldenrod), *Osmorhiza claytonii* (bland sweet-cicely), *Panax quinquefolius* (American ginseng)*, *Milium effusum* ssp. *cisatlanticum* (millet grass), *Deparia acrostichoides* (silvery false spleenwort), and *Polystichum acrostichoides* (Christmas fern). Some differential semi-rich shrub species include *Swida alternifolia* (alternate-leaved dogwood), *Sambucus racemosa* (red elderberry), and *Ostrya virginiana* (ironwood). Normally, there are only 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* (evergreen wood fern), *Athyrium angustum* (lady fern), *Uvularia sessilifolia* (sessile-leaved bellwort), *Trillium erectum* (red wakerobin), and *T. undulatum* (painted wakerobin). 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: Three variants are described:

1. **Typic variant**: As described above; found on till soils at low to mid elevations (up to 1,600 ft. and locally higher). Herbaceous cover is sparse to moderate, or occasionally abundant.
2. **High-elevation/near-boreal variant**: This variant occurs at higher elevations (1,600–2,600 ft.) in the White Mountains and somewhat lower in the North Country. Herbs are abundant, and it often contains significant fern cover. *Betula alleghaniensis* (yellow birch) is more prominent, white ash is rare above 2,000 ft., and basswood and ironwood are generally absent compared to other variants. Species which are usually frequent or in higher abundance include red elderberry, foam-flower, zig-zag goldenrod, *Clintonia borealis* (yellow bluebead-lily), *Streptopus lanceolatus* (lance-leaved twistedstalk), *Huperzia lucidula* (shining firmoss), *Dryopteris campyloptera* (mountain wood fern), *D. intermedia* (evergreen wood fern), *Athyrium angustum* (lady fern), *Polystichum braunii* (Braun's holly fern), *Carex intumescens* (greater bladder sedge), and *Cinna latifolia* (slender wood-reed).
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. Sugar maple and yellow birch are usually important canopy species, with variable mixes of other hardwoods, including 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 hazelnut), alternate-leaved dogwood, *Lonicera canadensis* (American honeysuckle), Jack-in-the-pulpit, sessile-leaved bellwort, zig-zag goldenrod, red wakerobin, *Gymnocarpium dryopteris* (northern oak fern), and greater bladder sedge. Potential rare species include *Pyrola asarifolia* (pink shinleaf)*, primarily known from the White Mountain region and northward on alluvial soils such as abandoned overflow channels.

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 about 500–1,600 ft. elevation. Good examples are at 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 1,600–2,000 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 (800–1,200 ft. elevation) but probably occurs elsewhere. Good examples are Peabody River (Gorham), Zealand River (Twin Mountain), Swift River (Albany), and Wild River (Beans Purchase).

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

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

GENERAL DESCRIPTION: This community occurs at low elevations in central and southern New Hampshire, mostly below 1,500 ft. It forms on sites that are somewhat drier than ***semi-rich mesic sugar maple forests***, and can contain significant amounts of Appalachian species such as *Carya* spp. (hickories), *Ostrya virginiana* (ironwood), *Fraxinus americana* (white ash), and other southern or drier site species. Oaks, sugar maple, and white ash dominate with a moderate to well developed woody understory and a scattered to moderately abundant herb layer. It is distinguished from more nutrient-poor forest types by having species indicative of weakly enriched conditions, and from ***rich mesic forests*** by the absence of strong enrichment indicators (see below). It also lacks many of the rare and uncommon species diagnostic of rich rocky wood communities such as *Carex platyphylla* (broad-leaved sedge), *C. retroflexa* (reflexed sedge)*, *Micranthes virginiensis* (early small-flowered-saxifrage), *Ranunculus fascicularis* (early crowfoot)*, *Symphyotrichum patens* (late purple American-aster)*, certain *Boechera* spp. (rockcresses), *Aureolaria virginica* (downy false foxglove)*, *Lespedeza virginica* (slender bush-clover)*, *Pycnanthemum incanum* (hoary mountain-mint)*, *Paronychia canadensis* (smooth forked whitlow-wort)*, *Thalictrum thalictroides* (anemone meadow-rue)*, *Asclepias quadrifolia* (four-leaved milkweed)*, *Asplenium platyneuron* (ebony spleenwort), and *Woodsia obtusa* (blunt-lobed cliff fern)*.

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 includes types 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 riverine or 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), *Quercus rubra* (red oak), and white ash. *Pinus strobus* (white pine) is frequent. *Tilia americana* (basswood), *Betula lenta* (black birch), and *Prunus serotina* (black cherry) occur in some examples, and are occasionally abundant. *Tsuga canadensis* (hemlock) and *Fagus grandifolia* (American beech) are occasional to infrequent and <5–15% each when present. Ironwood is often abundant or dominant in the understory, and *Carpinus caroliniana* ssp. *virginiana* (American hornbeam) is occasionally abundant. Among these trees, those usually indicative of at least somewhat enriched conditions are sugar maple, ash, basswood, ironwood, and American hornbeam.

Tall shrubs include an abundance of *Viburnum acerifolium* (maple-leaved viburnum) and lesser amounts and constancy of *Hamamelis virginiana* (American witch-hazel), *Viburnum dentatum* var. *lucidum* (smooth arrowwood), *Corylus cornuta* (beaked hazelnut), and in disturbed examples, *Berberis* spp. (barberries).

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

Species often present that are not restricted to enriched conditions include *Mitchella repens* (partridge-berry; often abundant), *Lysimachia borealis* (starflower), *Uvularia sessilifolia* (sessile-leaved bellwort), *Solidago caesia* (axillary goldenrod), *Maianthemum canadense* (Canada-mayflower), *Aralia nudicaulis* (wild sarsaparilla), *Monotropa uniflora* (one-flowered Indian-pipe), *Dryopteris carthusiana* (spinulose wood fern), and *Athyrium angustum* (lady fern).

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, though all of the above mentioned species may also occur in that community. Iindicators of strong enrichment that are notably absent include *Caulophyllum thalictroides* (blue cohosh), *Asarum canadense* (Canada wild ginger), *Adiantum pedatum* (northern maidenhair fern), and *Dryopteris goldiana* (Goldie's wood fern).

VARIANTS: Two variants are described.

1. **Typic variant**: As described above.
2. **Appalachian variant**: This variant can contain any of the species found in the typic variant, but also includes a significant component of Appalachian species in the tree canopy, particularly *Carya ovata* (shagbark hickory). Other diagnostic species include *Quercus velutina* (black oak), *Q. alba* (white oak), and *Benthamidia florida* (flowering dogwood).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: The typic variant occurs through central and southern New Hampshire. The Appalachian variant can be 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 occur above 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.

• 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 support plant species restricted to enriched conditions (calciphiles). Ecological processes and species composition is most similar to the ***red oak - pine rocky ridge*** and ***red spruce - heath - cinquefoil rocky ridge*** communities described elsewhere, with which it shares many species (see those descriptions). Soils are similar to other rocky ridges as well, 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 in this community include *Juniperus horizontalis* (creeping juniper)*, *Lonicera dioica* (wild honeysuckle), *Oligoneuron album* (white flat-topped-goldenrod)*, and *Orobanche uniflora* (one-flowered broom-rape). *Dasiphora floribunda* (shrubby-cinquefoil) and *Carex scirpoidea* (scirpus-like sedge)* may also occur here or on adjacent cliffs. Species characteristic of sites with intermediate bedrock can also be present including *Woodsia ilvensis* (rusty cliff fern) and *Campanula rotundifolia* (Scotch bellflower). New Hampshire examples tend to have fewer calciphiles than other New England examples. Other frequent species (not restricted to basic soils) include *Arctostaphylos uva-ursi* (red bearberry), *Sibbaldiopsis tridentata* (three-toothed cinquefoil), *Vaccinium angustifolium* (lowbush blueberry), *Sorbus americana* (American mountain-ash), *Alnus viridis* ssp. *crispa* (green alder), *Deschampsia flexuosa* (wavy hair grass), *Danthonia spicata* (poverty oatgrass), and *Lechea intermedia* (round-fruited 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 1,900–2,100 ft. elevation. A good example is at Holt's Ledge (Lyme).

SOURCES: NHB field surveys.

WOODED WETLANDS AND FLOODPLAIN FORESTS

This section contains descriptions of floodplain forests, forested swamps, and other forested communities that are temporarily flooded or hydrologically influenced by a seasonally high water table where tree cover 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 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 a diverse set of communities that occur 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 other depressions.

Frequency, intensity and duration of flooding depend 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 characterized by flood intervals that typically exceed 100 years, which is reflected by greater soil horizon development and an increased proportion of upland plant species. Floodplain sloughs, vernal pools, and other depressions 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., 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* (meadow garlic)*, *Mikania scandens* (climbing hempvine)*, *Carex cristatella* (crested sedge)*, *Carex seorsa* (weak stellate sedge)*, *Acer nigrum* (black maple)*, and *Betula nigra* (river birch)*.

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, this habitat is imperiled as a result of land use, dam construction, and river channelization, impacts causing fragmentation and loss of floodplain forests and alterion of natural processes that create and sustain them. 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 rivers (fourth-order and higher) are typically dominated by *Acer saccharinum* (silver maple) and/or *A. saccharum* (sugar maple) (Bechtel and Sperduto 1998). The best examples are larger than 30 acres, with other associated communities along the open floodplain or on higher terraces. There are two silver maple and two sugar maple community types.

The two silver maple floodplain forests represent the "classic" type associated with large rivers in New Hampshire. Their canopies are dominated by mature *Acer saccharinum* (silver maple), which forms a tall, arching, cathedral-like ceiling above the level floodplain adjacent to the river channel. While shrubs are poorly represented, vines [e.g., *Vitis riparia* (river grape) and others] tend to be abundant, especially along edges and in canopy gaps. Herbaceous species richness is intermediate compared to other 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. Sugar maple floodplain forests may be characterized by occasional enriched site conditions, lower flood frequency but higher flood intensity, and their adjacency to upland forests. The average percent canopy cover in the sugar maple floodplain types 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 silver maple dominated floodplain forest community types in New Hampshire. These riparian forests are found along large rivers, often associated with a confluence between the mainstem and a tributary. They also develop along river meanders or other slow moving areas of the river course. They are flooded annually with peak floods in spring from snowmelt and drainage higher in the watershed, though flood regimes are now artificially controlled on rivers where this community type occurs. This community occupies lower floodplains with deep, alluvial, silty soils. There is a high degree of microtopographic variation, with sand levees, vernal pools, soil depressions surrounding large tree trunks, and sloughs. Sloughs and drainage channels can be up to six feet deep and often support marsh vegetation soon after floodwaters recede.

On average, forb cover in this community is nearly twice that of other floodplain forest natural communities. Total herb cover is also higher, and fern cover is the highest of any floodplain forest type in the state. Conversely, the cover of graminoid, shrub, and sub-canopy trees 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 an almost yearly deposition of new soil material, the development of soil horizons is virtually absent. Organic debris from leaf litter and flood wash is occasionally buried under new silt and sand deposits creating layers of slowly decomposing organic matter.

These organic layers are often 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* (common hackberry) and *Juglans cinerea* (white walnut) can occur in Connecticut River examples, especially along the river or upland edge. Similar tree species are usually growing in the sub-canopy, but 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* ssp. *pensylvanica* (ostrich fern) and *Laportea canadensis* (wood nettle), both of which can grow 6 ft. tall. Other species are usually present, but never dominant, and include *Onoclea sensibilis* (sensitive fern), *Athyrium angustum* (lady fern), *Cinna arundinacea* (sweet wood-reed), *Boehmeria cylindrica* (small-spiked false nettle), *Impatiens capensis* (spotted touch-me-not), *Thalictrum pubescens* (tall meadow-rue), *Arisaema triphyllum* (Jack-in-the-pulpit), *Eutrochium maculatum* (spotted Joe-Pye weed), and *Parthenocissus quinquefolia* (Virginia-creeper). The rare *Arisaema dracontium* (green-dragon)* is found among ostrich fern in some low floodplain terraces along the Connecticut River.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community 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: In New Hampshire, this community is found primarily in central and southern parts of the state on various large and medium-sized rivers. The canopy is dominated by *Acer saccharinum* (silver maple), which forms a tall, arching, cathedral-like ceiling above the level floodplain adjacent to the river channel. *Ulmus americana* (American elm) is a frequent associate. The understory is distinguished by a diverse and variable ground cover, abundant *Onoclea sensibilis* (sensitive fern), and the presence of *Boehmeria cylindrica* (small-spiked false nettle) and *Cinna arundinacea* (sweet wood-reed). There is a high degree of microtopographic variation, with sand levees, vernal pools, soil depressions surrounding large tree trunks, and sloughs. It is most common on the Merrimack River and along medium-sized rivers such as the Ashuelot and the Contoocook. It also sometimes occurs as a very narrow border along riverbanks, transitional to other floodplain forest types (e.g., ***red maple floodplain forest***).

This is the most common silver maple floodplain forest community type in the state, except along the Connecticut River where ***silver maple - wood nettle - ostrich fern floodplain forest*** is more common. It is similar to that other community, but distinguished by a variety of factors. It tends to occur in sandier and generally more acidic soil on more medium-sized rivers. While flooding intensity and frequency are comparable in both of the silver maple types, this community may be characterized by floods of shorter duration and higher disturbance. A lack of species such as white ash (*Fraxinus americana*), common

hackberry (*Celtis occidentalis*), and white walnut (*Juglans cinerea*) hint at the more acidic nature of the soils in this type. Herb species diversity and richness is higher and more variable and tree species richness lower in this community as well.

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 east-central drainage basins. This community is usually found on rivers with drainage basins less than 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 silver maple with American elm as a subcanopy associate. Shrubs are not prevalent, except on edges and canopy gaps; patches of *Spiraea alba* var. *latifolia* (meadowsweet) can occur in drier microhabitats or *Cephalanthus occidentalis* (buttonbush) in wet sloughs or channels. The herb layer is usually dominated by sensitive fern or co-dominated by sensitive fern and false nettle. *Matteuccia struthiopteris* ssp. *pensylvanica* (ostrich fern) may be present in some examples but there is a notable lack of *Laportea canadensis* (wood nettle). *Toxicodendron radicans* (poison-ivy) is prevalent (only occasional in the other silver maple type). Typical graminoids include sweet wood-reed, *Cinna latifolia* (slender wood-reed), *Leersia virginica* (white cut grass), *Carex crinita* (fringed sedge), and *C. intumescens* (greater bladder sedge), all of which are absent or lower in cover in the other silver maple floodplain forest community.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community is found primarily in central and southern NH on various medium-sized rivers as well as along 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 high-gradient rivers in northern parts of the state. Flood regulation is less common on these rivers. The steeper-gradient river channels and strong pulse flood regime characteristic of these rivers leads to high energy, short duration flooding events. Evidence of energetic 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 variability of flooding intensity and frequency creates a diverse suite of microhabitats within sites.

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 sandy soil is usually finer textured than underlying 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 forming a super-canopy) of secondary importance. Occasionally *Tilia americana* (basswood), *Acer saccharinum* (silver maple), *A. rubrum* (red maple), and other trees 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 percent cover value. The most abundant or common species are *Solidago caesia* (axillary goldenrod), *Uvularia sessilifolia* (sessile-leaved bellwort), *Toxicodendron radicans* (poison-ivy), *Aralia nudicaulis* (wild sarsaparilla), *Carex pedunculata* (long-stalked sedge), and *Brachyelytrum aristosum* (northern short husk grass). The abundance of axillary goldenrod and northern short husk grass is the most floristically distinct aspect in this community. A naturalized grass, *Poa nemoralis* (wood blue grass), is also frequent. Overall, the composition of this type indicates somewhat drier conditions compared to soil moisture levels in other floodplain forest communities.

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 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 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 occurs primarily along northern rivers and is floristically intermediate between silver maple dominated floodplain forests and the ***sugar maple - ironwood - short husk floodplain forest***. It generally has the same structural features as those other communities, with over-arching hardwoods and a fern and forb understory with few shrubs. Compared to the other sugar maple type, this community has lower canopy density and higher fern cover but total and relative species richness values are similar. It is found either along the river's edge or on high terraces far from the river, but is flooded during spring runoff.

Northern examples occur on higher terraces and are similar to the ***sugar maple - ironwood - short husk floodplain forest***, with evidence of high intensity flood pulses. Southern examples tend to occur in back-channel landscape positions. 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.

Soils are variable, but tend to be well to moderately well drained sandy loams in northern examples, and somewhat poorly drained silty loams in southern examples. Soils are slightly enriched in most examples, supporting some rich-site herbs, but they are not as enriched as the ***silver maple - wood nettle - ostrich fern floodplain forest***.

CHARACTERISTIC VEGETATION: *Acer saccharinum* (silver maple) and *A. 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, along with occasional northern hardwood species, including *Betula alleghaniensis* (yellow birch). *Toxicodendron radicans* (poison-ivy) is a common vine, while *Brachyelytrum aristosum* (northern short husk grass) and *Carex intumescens* (greater bladder sedge) are common graminoids.

Onoclea sensibilis (sensitive fern) and *Matteuccia struthiopteris* ssp. *pensylvanica* (ostrich fern), diagnostic ferns of the two silver maple floodplain forest types, occur together with herbs more commonly found in upland northern forests. These herbs include *Uvularia sessilifolia* (sessile-leaved bellwort), *Maianthemum canadense* (Canada-mayflower), *M. racemosum* (feathery false Solomon's-seal), and *Eurybia divaricata* (white wood aster). Rich woods indicator herbs such as *Arisaema triphyllum* (Jack-in-the-pulpit) and *Caulophyllum thalictroides* (blue cohosh) are occasional, most often occurring in examples dominated by sugar maple (as opposed to silver maple).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Found along mostly central and northern rivers with high energy and flashy flood regimes. The back-terrace variant is found as far south as Concord, along the Merrimack River, but it is primarily found in the Saco and Androscoggin River 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 communities, 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 floodplain forests of minor rivers. The range of natural communities that may be present on a given 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 habitats 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 floodplains are hydrologically similar to those with silver maple dominated floodplain forests in that both are profoundly influenced by spring floods. However, red maple dominated or co-dominated floodplain forests and associated floodplain communities along minor rivers and large streams 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. Minor river 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 30 miles of the coast. All occur at less than 150 ft. elevation and are associated with heavy (silty) soils of marine or recent floodplain origin. Diagnostic species include swamp white oak, *Fraxinus pennsylvanica* (green ash), and others indicative of moist, fertile conditions. *Betula nigra* (river birch)*, a rare tree in New Hampshire, is codominant with swamp white oak in several examples of this community along tributaries of the lower Merrimack River.

Floodplains along three river systems with this natural community ranged from 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 (0–0.8 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 low floodplain variant examples of the ***red maple floodplain forest*** community.

CHARACTERISTIC VEGETATION: Both higher and lower floodplains are dominated by a mix of swamp white oak and *Acer rubrum* (red maple), with an understory of *Carpinus caroliniana* ssp. *virginiana* (American hornbeam), abundant *Onoclea sensibilis* (sensitive fern), and variable amounts of *Viburnum dentatum* var. *lucidum* (smooth arrowwood), *V. lentago* (nannyberry), *Ilex verticillata* (common winterberry), *Toxicodendron radicans* (poison-ivy), *Smilax herbacea* (carrion-flower), *Carex crinita* (fringed sedge), *Cinna arundinacea* (sweet wood-reed), and *Thelypteris palustris* var. *pubescens* (marsh fern). *Fraxinus americana* (white ash) is occasional. *Carex laxiculmis* (spreading 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: Three variants are described. While two are based on floristic differences associated with elevation above the river channel, a continuum of species compositional change is evident across the elevation gradient at most sites. A third variant is based on the abundance of river birch*.

1. **High variant**: This variant occurs on 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), *Vaccinium angustifolium* (lowbush blueberry), *Maianthemum canadense* (Canada-mayflower), *Uvularia sessilifolia* (sessile-leaved bellwort), and *Parathelypteris noveboracensis* (New York fern). Among floodplain forests in New Hampshire, shagbark hickory is most frequent in this variant.
2. **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 diagnostic to this community variant among non-silver maple floodplain forest communities. Other species indicative of the low variant include *Ulmus americana* (American elm), *Swida amomum* (silky dogwood), *Iris versicolor* (blue iris), *Lysimachia terrestris* (swamp yellow-loosestrife), and *Carex stricta* var. *strictior* (small tussock sedge).
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), white ash, and American elm are all common along with abundant river birch*. *Cardamine bulbosa* (bulbous bitter-cress)* and *Allium canadense* (meadow garlic)* are additional rare plants found in this type.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Restricted to within 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, where good examples exist. The Exeter, Lamprey, and Powwow Rivers all contain good examples of the low and high floodplain variants.

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

• Sycamore floodplain forest (S1)

GENERAL DESCRIPTION: In New Hampshire, this regionally uncommon 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.

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. This community has a relatively high plant species richness compared to other floodplain forest community types.

CHARACTERISTIC VEGETATION: This community is characterized by a sparse to moderately well developed canopy dominated by sycamore with a tall, well developed *Carpinus caroliniana* ssp. *virginiana* (American hornbeam) understory layer. Tree canopy associates include *Acer rubrum* (red maple), *A. saccharum* (sugar maple), *Ulmus americana* (American elm), *Carya cordiformis* (bitternut hickory), and less frequently *Juglans cinerea* (white walnut). 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 *Persicaria virginiana* (jumpseed), *Matteuccia struthiopteris* ssp. *pensylvanica* (ostrich fern), and *Calamagrostis canadensis* (bluejoint).

This floodplain forest may form a mosaic along with several other open and forested floodplain community types as part of a larger temperate minor river floodplain system. ***Semi-rich mesic sugar maple forest*** occurs on some river terraces adjacent to this floodplain community.

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: These red maple dominated floodplain forest communities occur on low floodplains of minor rivers and along tributaries of major rivers. They are common in southern and central New Hampshire, but absent from the northern part of the state. River channels are typically 20–100+ ft. wide with average summer water depths of 2–3+ ft. Small to moderate-size watersheds are typical upstream of red maple dominated floodplains.

Soils are usually somewhat poorly drained fine sandy loams and silt loams with very shallow or no organic horizons. Soil pHs average 5.1. Low floodplain soil surfaces are usually temporarily inundated during spring flood events. Reddish mottles occur at an average depth of 4 in. on the low floodplain to nearly 8 in. on the high floodplain. In contrast to most swamps, hummock-hollow microtopography is poorly developed or absent.

CHARACTERISTIC VEGETATION: Red maple dominates the tree canopy, with varying (but smaller) amounts of 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* (common 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 angustum* (lady fern), and lesser amounts of *Thelypteris* and *Parathelypteris* spp. (ferns), *Osmundastrum cinnamomeum* (cinnamon fern), and *Osmunda claytoniana* (interrupted fern). In two known 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 to low floodplain forest variants 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 and vine cover are higher, and depth to soil 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.

   Red maple dominates the tree canopy. Several tree species common in the high variant are infrequent here including *Carya ovata* (shagbark hickory), *Pinus strobus* (white pine), and *Quercus rubra* (red oak). *Acer saccharinum* (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), *Swida amomum* (silky dogwood), and *Impatiens capensis* (spotted touch-me-not). Other characteristic species are *Rubus occidentalis* (black raspberry), *Sambucus nigra* ssp. *canadensis* (common elderberry), *Alnus incana* ssp. *rugosa* (speckled alder), *Parthenocissus quinquefolia* (Virginia-creeper), *Vitis labrusca* (fox grape), *Apios americana* (common ground-nut), *Lycopus uniflorus* (northern water-horehound), *Boehmeria cylindrica* (small-spiked false nettle), sensitive fern, *Chelone glabra* (white turtlehead), *Oxalis stricta* (common yellow wood sorrel), *Geum laciniatum* (floodplain avens), *G. canadense* (white avens), and *Galium asprellum* (rough bedstraw).

2. **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 this variant can also occur at slightly higher elevations and at greater distances from the channel.

   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* ssp. *virginiana* (American hornbeam), *Viburnum lentago* (nannyberry), and *Doellingeria umbellata* (tall white-aster).

3. **High variant**: This variant typically occurs 1-3 ft. higher on the floodplain than the lower variants, and resembles mesic, mixed hardwood - conifer forests of the transitional or central hardwood region (e.g., ***hemlock - beech - oak - pine forests***). Some of them flood intermittently during peak floods (probably 5–100 year cycles). Black cherry and American elm are sparse or absent.

   Characteristic species include red oak, white pine, highbush blueberry, *Vaccinium angustifolium* (lowbush blueberry), *Gaultheria procumbens* (eastern spicy-wintergreen), *Kalmia angustifolia* (sheep laurel), *Clethra alnifolia* (sweet pepperbush), common winterberry, *Hamamelis virginiana* (American witch-hazel), and *Gaylussacia baccata* (black huckleberry). Withe-rod is frequent in this variant and the medium variant, but is notably infrequent in the low variant. *Toxicodendron radicans* (poison-ivy), American hornbeam, and 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), Baboosic Brook (Merrimack), Pointer Club Brook (Bedford/Merrimack), and Cohas Brook (Manchester).

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 floodplain community has a woodland or forested canopy. It is found in northern and occasionally central New Hampshire. It occurs along floodplains of major rivers in the mountains (montane rivers), along minor rivers and major streams (third- and fourth-order) in other settings with cold-climate conditions, and on broader 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. Woodland examples often have dense shrub and herbaceous layers.

Soils are frigid fine sandy loams or loams (NRCS frigid temperature regime). Several examples of this community are associated with flashy montane rivers and may be indicative of a more temporary or infrequently flooded regime than most floodplain forest community types. Examples occur from 500 ft. to more than 1,200 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 on sites at lower elevations along with one of the silver maple floodplain community types.

CHARACTERISTIC VEGETATION: Balsam fir is a diagnostic species, 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 also found in other floodplain forest communities but more frequent or abundant in this type include *Spiraea alba* var. *latifolia* (meadowsweet), *Corylus cornuta* (beaked hazelnut), *Calamagrostis canadensis* (bluejoint), *Brachyelytrum aristosum* (northern short husk grass), *Carex stricta* var. *strictior* (small tussock sedge), *C. novae-angliae* (New England sedge), and *C. intumescens* (greater bladder sedge). Northern or boreal plants are frequent as a group and include *Chamaepericlymenum canadense* (bunchberry), *Coptis trifolia* (three-leaved goldthread), and *Oclemena acuminata* (sharp-toothed nodding-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* var. *cassinoides* (withe-rod), *V. dentatum* var. *lucidum* (smooth arrowwood), *Solidago rugosa* (wrinkle-leaved goldenrod), *Osmunda regalis* var. *spectabilis* (royal fern), *Alnus incana* ssp. *rugosa* (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 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 alluvial shrubland***. Species most characteristic of this variant include *Sambucus racemosa* (red elderberry), *Viburnum opulus* (highbush-cranberry), *Rubus pubescens* (dwarf raspberry), *Tiarella cordifolia* (foam-flower), greater bladder sedge, *Thalictrum pubescens* (tall meadow-rue), *Geum rivale* (water avens), *Chelone glabra* (white

turtlehead), *Arisaema triphyllum* (Jack-in-the-pulpit), *Veratrum viride* (American false hellebore), *Ranunculus recurvatus* (hooked crowfoot), *Athyrium angustum* (lady fern), *Dryopteris cristata* (crested wood fern), and *Matteuccia struthiopteris* ssp. *pensylvanica* (ostrich fern).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community occurs primarily along mountain rivers of northern and occasionally central New Hampshire. Good examples can be found along Magalloway River (Errol), 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 and 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. Typical pHs are in the mediacid (4.0–4.9) to low subacid range (5.0–5.3). *Acer rubrum* (red maple), *Chamaecyparis thyoides* (Atlantic white cedar), *Quercus bicolor* (swamp white oak), *Nyssa sylvatica* (black gum), and *Pinus rigida* (pitch pine) dominate southern and central New Hampshire poor swamps, whereas *Picea* spp. (spruces) and *Abies balsamea* (balsam fir) dominate in the White Mountains and northward. *Onoclea sensibilis* (sensitive fern), indicative of minerotrophic swamps, 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 community 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: The canopy 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* (common winterberry), *Vaccinium corymbosum* (highbush blueberry), *Ilex mucronata* (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), *Lysimachia borealis* (starflower), and *Maianthemum canadense* (Canada-mayflower), as well as mosses. Other species include *Kalmia angustifolia* (sheep laurel), *Osmundastrum cinnamomeum* (cinnamon fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Parathelypteris simulata* (Massachusetts fern), *Coptis trifolia* (three-leaved goldthread), *Mitchella repens* (partridge-berry), and *Carex trisperma* (three-seeded sedge). The rare coastal plain species *Carex seorsa* (weak stellate sedge)* and *C. striata* (Walter's sedge)* occur in some examples.

Three-seeded sedge and sheep laurel, occasional in this community, are generally absent from ***seasonally flooded Atlantic white cedar swamps***. Massachusetts fern appears to be restricted to this and the ***Atlantic white cedar - giant rhododendron swamp*** type. *Rhododendron viscosum* (clammy azalea), characteristic of coastal cedar swamps in southern New England, is absent. Species indicative of northern or marshy

conditions that characterize the other types of Atlantic white cedar swamp 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 community occurs in basins that are more than 30 miles inland 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 890–1,040 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: Atlantic white cedar is diagnostic and dominant in the canopy. *Picea rubens* (red spruce) is abundant at most sites, along with frequent *Clintonia borealis* (yellow bluebead-lily) and *Gaultheria hispidula* (creeping spicy-wintergreen). Other less frequent but reasonably diagnostic species include *Abies balsamea* (balsam fir), *Larix laricina* (American larch), *Picea mariana* (black spruce), *Gaylussacia baccata* (black huckleberry), and *Chamaepericlymenum canadense* (bunchberry). *Kalmia angustifolia* (sheep laurel) and *Carex trisperma* (three-seeded sedge) 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 *Parathelypteris 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 - leatherleaf swamp (S1)

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

CHARACTERISTIC VEGETATION: In addition to Atlantic white cedar, leatherleaf, and sheep laurel, this type is characterized by other boggy plants including *Vaccinium macrocarpon* (large cranberry), *Woodwardia virginica* (Virginia chain fern), *Sarracenia purpurea* (purple pitcherplant), *Drosera rotundifolia* (round-leaved sundew), *Eriophorum virginicum* (tawny cottonsedge), and *Carex 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 *S. fallax* and *S. flavicomans**.

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 globally rare Atlantic white cedar swamp community occurs at fewer than ten locations in New England, and the only one north of Massachusetts is in Manchester. It is similar to ***Atlantic white cedar - yellow birch - pepperbush swamp***, and scattered plants characteristic of that type are also found in this type, but it differs for at least two reasons. First, the dominance of *Rhododendron maximum* (giant rhododendron)* is a striking feature; it constitutes a majority of the understory cover and is a significant contributor to total site biomass. Therefore it probably has a substantial influence on litter and soil quality. Second, the dense shading by giant rhododendron* limits understory growth and contributes to the community's species-poor character compared to other types. Tall shrubs other than giant rhododendron* and herbaceous species are generally sparse.

CHARACTERISTIC VEGETATION: Giant rhododendron* shrubs form a dense understory beneath a canopy composed primarily of *Chamaecyparis thyoides* (Atlantic white cedar). *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. *Sphagnum* moss is abundant. Other species that may be present include *Tsuga canadensis* (hemlock), *Vaccinium corymbosum* (highbush blueberry), *Lyonia ligustrina* (maleberry), *Ilex mucronata* (mountain holly), *Osmundastrum cinnamomeum* (cinnamon fern), and *Carex trisperma* (three-seeded sedge). Besides giant rhododendron*, no plant species are restricted to 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; NHB field surveys.

• Red maple - *Sphagnum* basin swamp (S4)

GENERAL DESCRIPTION: This is a common type of red maple swamp that occurs in perched basins of till landscapes or other low, flat areas with small watersheds (typically only 1/4 to 1 square mile). While they are influenced by seasonal subsurface and ephemeral runoff from surrounding uplands, there are typically no perennial streams running into or through the basins and there is minimal influence of groundwater. The canopy is dominated by *Acer rubrum* (red maple), although other tree species are commonly present. The tall shrub and herb layers are moderately light to dense, and peat mosses (*Sphagnum* spp.) have moderately patchy to dense cover. 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 both from upland runoff in the spring and from evapotranspiration over the course of the growing season.

CHARACTERISTIC VEGETATION: The tree canopy is dominated by red maple. Other tree species that may be sub-dominant to occasional include *Betula alleghaniensis* (yellow birch), *Tsuga canadensis* (hemlock),

Pinus strobus (white pine), and *Picea rubens* (red spruce). Swamps dominated by red spruce are considered ***red spruce swamps***. Overstory hemlock and white pine cover increases in somewhat more well drained swamps. *Nyssa sylvatica* (black gum) may also be present, but only in low cover (a greater abundance of black gum would indicate the ***black gum - red maple basin swamp*** community).

The shrub layer usually contains *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (common winterberry) as primary dominants, with lesser amounts of *Ilex mucronata* (mountain holly), *Viburnum dentatum* var. *lucidum* (smooth arrowwood), *Ilex laevigata* (smooth winterberry), *Spiraea alba* var. *latifolia* (meadowsweet), *Chamaedaphne calyculata* (leatherleaf), and the short shrubs *Kalmia angustifolia* (sheep laurel) and *Rubus hispidus* (bristly blackberry). *Osmundastrum cinnamomeum* (cinnamon fern) is typically abundant in the herbaceous layer, with lesser quantities of other herbs. *Carex trisperma* (three-seeded sedge), *C. folliculata* (northern long sedge), *C. canescens* (hoary sedge), *Thelypteris palustris* var. *pubescens* (marsh fern), and *Lycopus uniflorus* (northern water-horehound) are frequently present in low abundance. Upland herbs and shrubs may occupy hummocks; these species include *Aralia nudicaulis* (wild sarsaparilla), *Coptis trifolia* (three-leaved goldthread), and *Gaultheria procumbens* (eastern spicy-wintergreen). *Sphagnum* mosses are usually dominant or abundant in hollows and on lower sides of hummocks and include *S. fallax*, *S. girgensohnii*, and *S. papillosum*, among others. Wetter hollows in somewhat open swamps may have a greater abundance of species such as hoary sedge and *Calla palustris* (wild calla).

CLASSIFICATION CONFIDENCE: 1–2

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 (S3)

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 the two is the codominance of *Nyssa sylvatica* (black gum) with *Acer rubrum* (red maple) in the canopy of this community. 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 60% 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 most cases, black gum and red maple dominate the tree canopy, with varying but smaller contributions by other hardwood and softwood species. *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (common winterberry) are the primary shrub layer dominants, with a variable component of other tall and medium-height shrub species. *Osmundastrum cinnamomeum*

(cinnamon fern) is usually abundant in the herb layer, which consists of 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, relating mostly to woody structure:

1. **Boggy woodland/tall shrub thicket variant**: This variant includes swamps with a woodland or sparse woodland canopy and 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* (hoary sedge), may indicate a wetter hydroperiod than in other variants. Most lakeside occurrences of this community 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 *S. magellanicum*. *Sphagnum torreyanum*, a predominantly aquatic, coastal plain species, is locally dominant in hollows. These species 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 *Betula alleghaniensis* (yellow birch) are typically restricted to the understory. The shrub and herbaceous layers are highly variable but usually well developed and on average shorter 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 (purple pitcherplant) 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 the types present 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. Yellow birch and white pine are typical in the understory. While variable, the shrub layer is sparser on average in this variant than the previous 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* var. *spectabilis* (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*** contain an abundance of *Quercus bicolor* (swamp white oak) and are restricted to depressions and flats on marine sediments, other silty soils, and occasionally on sandy soils in the coastal zone and lower Merrimack River Valley. Species composition is often similar to ***red maple - Sphagnum basin swamps***, but there is a notable shift towards swamp white oak in the canopy. Other differences include a shallower organic layer, less peat moss, and species indicative of silty soils or slightly enriched conditions such as American hornbeam, American elm, and poison-ivy. They are also similar to ***swamp white oak floodplain forests*** in several respects. The primary differences from floodplain forests are 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 (e.g., cinnamon fern and highbush blueberry).

These swamps 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). Plant strata are characterized by a variable amount of *Sphagnum*, a low to moderate herb layer, and a moderate to dense shrub layer. This community usually has standing water in the spring that dries up by late summer.

CHARACTERISTIC VEGETATION: Swamp white oak dominates in the canopy. Understory species that are abundant or frequent include *Vaccinium corymbosum* (highbush blueberry), *Kalmia angustifolia* (sheep laurel), and *Osmundastrum cinnamomeum* (cinnamon fern). The species composition is similar to ***red maple - Sphagnum basin swamps***, with some indicators of more enriched soil conditions imparted by the silty mineral soils, such as occasional *Carpinus caroliniana* ssp. *virginiana* (American hornbeam), *Ulmus americana* (American elm), *Viburnum dentatum* var. *lucidum* (smooth arrowwood), and *Toxicodendron radicans* (poison-ivy).

Species that are less abundant compared to ***swamp white oak floodplain forests*** include American hornbeam, American elm, *Swida amomum* (silky dogwood), *Cinna arundinacea* (sweet wood-reed), *Athyrium angustum* (lady fern), and *Onoclea sensibilis* (sensitive fern).

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 community is characterized by a *Pinus rigida* (pitch pine) canopy that ranges from sparse woodland to thin forest structure. Tall and medium heath shrubs dominate in the understory. *Sphagnum* mosses range from occasional to abundant. It resembles pitch pine swamps found on Cape Cod and in the Pine Barrens of New Jersey. Soils are saturated or seasonally saturated and have a shallow organic horizon over sand. 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: Pitch pine in the canopy is accompanied by variable amounts of other species, including *Acer rubrum* (red maple), *Betula populifolia* (gray birch), and *Pinus strobus* (white pine). The shrub layer consists of *Chamaedaphne calyculata* (leatherleaf) (often dense), *Rhododendron canadense* (rhodora), *Lyonia ligustrina* (maleberry), *Kalmia angustifolia* (sheep laurel), *Aronia melanocarpa* (black chokeberry), *Vaccinium corymbosum* (highbush blueberry), *V. angustifolium* (lowbush

blueberry), *Ilex verticillata* (common winterberry), *Gaylussacia baccata* (black huckleberry), and *Spiraea alba* var. *latifolia* (meadowsweet). Herbs are scattered but may include *Dulichium arundinaceum* (three-way sedge), *Carex canescens* (hoary sedge), *C. stricta* var. *strictior* (small tussock sedge), *Scirpus cyperinus* (woolly bulrush), *Rubus pubescens* (dwarf raspberry), and *Osmunda regalis* var. *spectabilis* (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), at Goodwin Town Forest (Madison), and at Grassy Pond (Litchfield).

SOURCES: NHB field surveys.

CONIFER SWAMPS PRIMARILY OF CENTRAL OR NORTHERN NH

• Black spruce swamp (S3)

GENERAL DESCRIPTION: *Picea mariana* (black spruce) dominates this classic "bog forest" community (the endpoint of the peatland successional sequence), which often surrounds open bogs or fens or simply occupies entire closed-canopy basins. This is a forest or woodland swamp found either on nutrient-poor, moderately deep to deep peat soils in stagnant basins, or in stagnant areas within other wetland complexes. This community differs from ***red spruce swamps*** and ***larch - mixed conifer swamps*** by four noteworthy factors: a shift to black spruce in the tree canopy, usually a greater abundance or dominance of dwarf heath shrubs, lower abundance and frequency of *Osmundastrum cinnamomeum* (cinnamon fern), and generally deeper, wetter, and more nutrient-poor peat soils.

Black spruce exceeds 250 years of age in some New Hampshire swamps. While relatively intolerant of shade, this species is tolerant of saturated conditions. It 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). Black spruce usually dominates on oligotrophic peatlands of low pH (3.0–4.0), a pattern that relates well to the general ecological principal that coniferous evergreen species have a competitive advantage at low-nutrient sites because of the higher nutrient use efficiency afforded by evergreen foliage.

Soils consist of organic muck and peat material greater than 40 centimeters in depth. They are typically moderate to deep (>0.5 m) and nutrient-poor (oligotrophic). Some of these swamps have shallower peat soils and mix with ***lowland spruce - fir forests*** dominated by red spruce and balsam fir. Most sites are saturated, with the water table at or near the surface most of the year.

CHARACTERISTIC VEGETATION: Black spruce forms 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* (three-seeded sedge), and a low to modest cover of other herbs. Tall shrubs and other tree species include *Ilex mucronata* (mountain holly), *Viburnum nudum* var. *cassinoides* (withe-rod), *Lyonia ligustrina* (maleberry), *Aronia melanocarpa* (black chokeberry), and *Larix laricina* (American larch). Dwarf heath shrubs include *Rhododendron groenlandicum* (Labrador tea), *R. canadense* (rhodora), *Chamaedaphne calyculata* (leatherleaf), *Kalmia angustifolia* (sheep laurel), *K. polifolia* (bog laurel), *Vaccinium myrtilloides* (velvet-leaved blueberry), *V. oxycoccos* (small cranberry), and *Gaultheria hispidula* (creeping spicy-wintergreen). Herbaceous plants include peatland-restricted species such as *Maianthemum trifolium* (three-leaved false Solomon's-seal) and *Sarracenia purpurea* (purple pitcherplant), as well as other northern plants including *Coptis trifolia* (three-leaved goldthread) and *Chamaepericlymenum canadense* (bunchberry). Cinnamon fern is occasional. A diversity of *Sphagnum* moss species covers the entire ground surface.

VARIANTS: Two variants are described, with the variation deserving of further study.

1. **Typic woodland variant**: As described above. This variant includes most examples north of and including the White Mountain region. The more closed canopy expression of this variant, with a less well developed heath layer, a sparse to moderate tall shrub layer, and a well developed moss layer may deserve recognition as its own variant.
2. **Southern highbush blueberry - huckleberry variant**: This variant includes examples in southern and central New Hampshire containing species that reach their northern limit in central New England, including *Gaylussacia baccata* (black huckleberry), blue huckleberry (*Gaylussacia frondosa*), maleberry (*Lyonia ligustrina*), *Vaccinium corymbosum* (highbush blueberry), and Virginia chain fern (*Woodwardia virginica*).

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 1,000–3,500 ft., with small examples in the southern part of the state occurring below 500 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 Bear Brook State Park (Allenstown, Deerfield).

SOURCES: NHB field surveys; Montague and Givnish 1996.

• 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 layer. *Carex trisperma* (three-seeded sedge), *Osmundastrum cinnamomeum* (cinnamon fern), and carpets of *Sphagnum* moss form a lush understory beneath a sparse to moderate tall shrub layer and a sparse dwarf heath layer. Hummock-hollow topography is slightly to moderately well developed. The community is found in large swamp complexes or lake basins, along small, stagnant drainages, and in pockets or benches on mountain sideslopes.

These swamps are slightly more minerotrophic and less saturated than ***black spruce swamps***, as evidenced by the dominance of red spruce, a sparse dwarf heath shrub layer, and mineral soils with a shallow organic horizon. They also appear to be more abundant in the White Mountain region, possibly 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 the most abundant tree species, with lesser amounts of *Abies balsamea* (balsam fir), and occasionally some *Picea mariana* (black spruce), *Acer rubrum* (red maple), and *Betula* spp. (birches). *Ilex mucronata* (mountain holly) is common among tall shrubs, and *I. verticillata* (common winterberry), *Viburnum nudum* var. *cassinoides* (withe-rod), and *Alnus incana* ssp. *rugosa* (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 present in some central and southern New Hampshire examples. Dwarf heath shrubs are absent or in low abundance, but *Kalmia angustifolia* (sheep laurel) and *Gaultheria hispidula* (creeping spicy-wintergreen) 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 present in lesser abundance (generally <5% cover) include *Coptis trifolia* (three-leaved goldthread), *Clintonia borealis* (yellow bluebead-lily), *Chamaepericlymenum canadense* (bunchberry), *Rubus dalibarda* (dewdrop), *Oxalis montana* (northern wood sorrel), *Galium kamtschaticum* (boreal bedstraw), and *Dryopteris cristata* (crested wood fern). *Rubus pubescens* (dwarf raspberry) is an occasional trailing herb. *Sphagnum* moss forms 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)*, *Neottia cordata* (heart-leaved twayblade)*, and *N. convallarioides* (broad-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, white turtlehead, bog-orchids, and "brown mosses").
2. **Red spruce - hardwood - violet variant**: This variant usually has the same species as the typic variant, but also a greater prominence of hardwood trees, a greater diversity of herbs, and greater influence of upland runoff or seepage. Trees may include *Betula alleghaniensis* (yellow birch), red maple, and (occasionally) *Betula 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. Species indicative of this variant include *Viola pallens* (smooth white violet) and other violets (*Viola* spp.), *Chelone glabra* (white turtlehead), *Platanthera clavellata* (little club-spur bog-orchid), *P. dilatata* (white northern bog-orchid) and other bog-orchids, and *Veratrum viride* (American false hellebore), along with 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 the ***northern hardwood - black ash - conifer swamp*** community, 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 2,000 ft. Good examples of the typic variant include Elbow Pond (Woodstock), parts of Trudeau Road vicinity (Bethlehem), parts of Spruce Brook (Berlin), and 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.

MINEROTROPHIC SWAMPS

This group of communities contains 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 any single one of those sources. Numerous species indicative of relatively minerotrophic conditions are present, such as *Onoclea sensibilis* (sensitive fern), *Fraxinus* spp. (ashes), and *Swida* spp. (dogwoods). These species are generally absent in boggy, nutrient-poor swamps.

• Red maple - black ash swamp (S3)

GENERAL DESCRIPTION: These swamps contain plants indicative of seepage and/or enriched conditions. These swamps most often occur in one of three settings: 1) along borders of larger swamp systems, 2) in very slightly sloped wetlands where groundwater discharge and/or subsurface upland runoff influence the rooting zone of the swamp, or 3) where groundwater discharge in flat basins is pronounced or influenced by circumneutral or basic soils. Soils are usually poorly to very poorly drained mineral histic or histic epipedons (shallow muck or peat over grayish or gleyed subsoil). In the seacoast region, these swamps often occur on silt loam and silt soils of marine origin (e.g., Buxton or Scitico silt loams), or other soils with high base cation status.

CHARACTERISTIC VEGETATION: The tree canopy is dominated by *Acer rubrum* (red maple) with lesser quantities of *Fraxinus nigra* (black ash), *F. americana* (white ash), *Betula alleghaniensis* (yellow birch), and occasionally *Tilia americana* (basswood). A diverse assemblage of moss species is present (e.g., *Mnium* spp.); *Sphagnum* (peat mosses) are sparse or absent but when present include species restricted to mineral-rich conditions. Seepage indicators include *Micranthes pensylvanica* (swamp small-flowered-saxifrage), *Geum rivale* (water avens), *Caltha palustris* (marsh-marigold), *Chrysosplenium americanum* (golden-saxifrage), *Cardamine pensylvanica* (Pennsylvania bitter-cress), *Hydrocotyle americana* (American marsh-pennywort), *Circaea alpina* (small enchanter's-nightshade), *Packera schweinitziana* (New England groundsel), and *Lindera benzoin* (northern spicebush). Other common species are *Onoclea sensibilis* (sensitive fern), *Viola* spp. (violets), *Impatiens capensis* (spotted touch-me-not), *Toxicodendron radicans* (poison-ivy), *Alnus incana* ssp. *rugosa* (speckled alder), and *Swida sericea* (red-osier dogwood).

VARIANTS: Two variants are described.

1. **Typic variant**: As described above.
2. **Circumneutral variant**: This rare type has many of the same species found in the typic variant but is influenced to a greater degree by base-rich groundwater and contains more species indicative of richer conditions. These indicator species include *Rhamnus alnifolia* (alder-leaved buckthorn), *Cardamine bulbosa* (bulbous bitter-cress)*, *Liparis loeselii* (Loesel's wide-lipped orchid)*, *Carex bebbii* (Bebb's sedge), and *Lysimachia thyrsiflora* (tufted yellow-loosestrife)*.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is restricted to central and southern parts of the state. Good examples of the typic variant occur at College Woods (Durham) and Shaws Pond (New Durham); circumneutral variant in the vicinity of Wheelwright Pond (Lee).

SOURCES: NHB field surveys.

• Red maple - skunk cabbage swamp (S2)

GENERAL DESCRIPTION: This community contains fewer seepage indicators, is less species rich, may have less seepage, and is more often just seasonally saturated compared to the closely related ***red maple - black ash swamp***. It typically occurs on gentle slopes, occasionally at the base of steeper slopes, in (mesic-wet to) saturated settings receiving groundwater seepage and surface runoff. These swamps are generally moderately to weakly acidic with dark silty loams to shallow muck over mineral soils. Shrub cover is low to somewhat moderate. The herbaceous layer is moderately to well developed with *Symplocarpus foetidus* (skunk-cabbage) common early in the growing season. Compared to ***red maple - black ash swamps***, *Sphagnum* moss may be more frequent but even here its cover is typically low.

CHARACTERISTIC VEGETATION: The tree canopy is dominated by *Acer rubrum* (red maple) with lesser

quantities of *Fraxinus americana* (white ash), *Betula alleghaniensis* (yellow birch), *Ulmus americana* (American elm), and scattered *Quercus rubra* (red oak) and *Prunus serotina* (black cherry). Shrubs include *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (common winterberry), *Hamamelis virginiana* (American witch-hazel), *Sambucus nigra* ssp. *canadensis* (common elderberry), *Viburnum nudum* var. *cassinoides* (withe-rod), and *Toxicodendron radicans* (poison-ivy). The herb layer is dominated or codominated by *Symplocarpus foetidus* (skunk-cabbage). Common associates are *Impatiens capensis* (spotted touch-me-not), *Onoclea sensibilis* (sensitive fern), *Osmundastrum cinnamomeum* (cinnamon fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Matteuccia struthiopteris* ssp. *pensylvanica* (ostrich fern), *Athyrium angustum* (lady fern), and *Glyceria melicaria* (northeastern mannagrass). Moss cover is typically low.

Seepage indicator species are low in cover and include *Hydrocotyle americana* (American marsh-pennywort), *Carex scabrata* (eastern rough sedge), *Geum rivale* (water avens), *Rubus pubescens* (dwarf raspberry), *Glyceria melicaria* (northeastern mannagrass), and *Circaea canadensis* (broad-leaved enchanter's-nightshade). Other herbs usually present in low cover that frequently occur in seepy settings as well as some other wetland habitats are *Thalictrum pubescens* (tall meadow-rue), *Chelone glabra* (white turtlehead), and a few others.

CLASSIFICATION CONFIDENCE: 2–3

DISTRIBUTION: This community is restricted to southern parts of the state. Good examples occur at Heads Pond (Hooksett).

SOURCES: NHB field surveys.

• Red maple - lake sedge swamp (S3)

GENERAL DESCRIPTION: This swamp community is associated with perennial seepage and other minerotrophic areas on level to slightly sloping ground between uplands and open marshes. The canopy is dominated by *Acer rubrum* (red maple) with a dense herbaceous understory dominated by *Carex lacustris* (lake sedge). The cover of lake sedge is high (25–70+%). This species reaches its greatest density in this community and in minerotrophic seepage marshes. Some examples of this community are probably marshes in the process of succeeding to swamps.

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

CHARACTERISTIC VEGETATION: Characteristic features include a woodland canopy of red maple (25–60%) and a dense, tall layer of lake sedge. 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 the cover of all other herbaceous species combined. A modest shrub layer commonly contains *Ilex verticillata* (common winterberry), *Swida amomum* (silky dogwood), *Viburnum dentatum* var. *lucidum* (smooth arrowwood), *V. lentago* (nannyberry), *Toxicodendron radicans* (poison-ivy), and *Spiraea alba* var. *latifolia* (meadowsweet). The herb layer is diverse but has few species that exceed 1% cover. The few that may exceed 1% cover include *Onoclea sensibilis* (sensitive fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Carex stricta* (tussock sedge), and *Calamagrostis canadensis* (bluejoint). Other characteristic species found in low abundance include *Impatiens capensis* (spotted touch-me-not), *Chelone glabra* (white turtlehead), *Cicuta maculata* (spotted water-hemlock), *C. bulbifera* (bulblet-bearing water-hemlock), *Rubus pubescens* (dwarf raspberry), and *Equisetum sylvaticum* (wood horsetail). *Sphagnum* spp. (peat mosses) are typically absent or not abundant (<5% cover) in these swamps. When they do occur, they are often species indicative of seepage conditions (e.g., *Sphagnum squarrosum*). The rare species *Mikania scandens* (climbing hempvine)* occurs in some examples of 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 weakly minerotrophic 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 range from small to large (10–100 acres) and typically occupy headwater basins that give rise to drainages or occur along drainages where seepage or non-channelized upland runoff contributes to the water budget.

The community lacks seasonal over-bank flooding (as is 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. In contrast to ***red maple - black ash swamps*** and ***red maple - lake sedge swamps***, surface or near-surface runoff is the predominant source of external nutrients. These swamps are often found in a mosaic with other swamp communities in a larger **temperate minerotrophic swamp system**.

CHARACTERISTIC VEGETATION: Tree cover ranges from 25% to more than 60% and consists of *Acer rubrum* (red maple), with lesser quantities of *Ulmus americana* (American elm) and other hardwoods, and few or no conifers. A diverse shrub layer is typical; *Ilex verticillata* (common winterberry) is abundant and *Vaccinium corymbosum* (highbush blueberry) is usually present but less abundant than in nutrient-poor swamps. *Viburnum dentatum* var. *lucidum* (smooth arrowwood), *Alnus incana* ssp. *rugosa* (speckled alder), and *Spiraea alba* var. *latifolia* (meadowsweet) are occasional. *Toxicodendron vernix* (poison-sumac), *Toxicodendron radicans* (poison-ivy), *Sambucus nigra* ssp. *canadensis* (common elderberry), *Lindera benzoin* (northern spicebush), *Viburnum lentago* (nannyberry), and *Swida amomum* (silky dogwood) may be present. Sensitive fern and *Carex stricta* (tussock sedge) are usually abundant or co-dominant herbs. Other species include *Impatiens capensis* (spotted touch-me-not), *Iris versicolor* (blue iris), *Lysimachia terrestris* (swamp yellow-loosestrife), *Carex crinita* (fringed sedge), *Osmunda regalis* var. *spectabilis* (royal fern), *Calamagrostis canadensis* (bluejoint), *Thalictrum pubescens* (tall meadow-rue), and *Viola* spp. (violets). *Osmundastrum cinnamomeum* (cinnamon fern) is often present but not dominant throughout. *Carex bromoides* (brome-like sedge) is abundant in some examples. Mosses are often abundant and diverse, but *Sphagnum* moss typically comprises less than 5% cover, or is absent. Hummock-hollow topography ranges from absent to moderately well developed. Upland species found on large hummocks of more 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)]. Also, while this community is somewhat minerotrophic, plant species indicative of mineral-rich groundwater *seepage* are absent or sparse.

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.

• Seasonally flooded Atlantic white cedar swamp (S2)

GENERAL DESCRIPTION: This community is found along open or moving water such as lake, pond, and stream borders and in basins with impounded drainage. It 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 of this community 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 are generally among the highest recorded for cedar swamps in New Hampshire, falling between 4.4 and 6.5. Elevations range from 30 ft. to 250 ft. for coastal examples.

CHARACTERISTIC VEGETATION: Characteristic species include *Spiraea alba* var. *latifolia* (meadowsweet), *Triadenum virginicum* (Virginia marsh-St. John's-wort), *Iris versicolor* (blue iris), *Sagittaria latifolia* (common arrowhead), *Sparganium americanum* (American bur-reed), *Lycopus uniflorus* (northern water-horehound), *Bidens* spp. (beggar-ticks), *Cicuta bulbifera* (bulblet-bearing water-hemlock), *Carex stricta* (tussock sedge), *C. intumescens* (greater bladder sedge), and *Calamagrostis canadensis* (bluejoint). Many less frequent species occurring in this community are almost entirely absent from other Atlantic white cedar swamps. Herbaceous cover can be quite high. The invasive shrub *Frangula alnus* (glossy false buckthorn) is often present.

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

The largely hummock-restricted upland species *Aralia nudicaulis* (wild sarsaparilla) and *Lysimachia 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), *Ilex mucronata* (mountain holly), *Carex trisperma* (three-seeded sedge), and *Kalmia angustifolia* (sheep laurel).

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 fourth). Soils are typically alluvial or are shallow muck or peat over alluvial mineral soils. These swamps differ from floodplain forests by having a seasonally rather than temporarily flooded water regime, and being 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 meadow marshes or emergent marshes and have either a woodland or forest canopy structure.

CHARACTERISTIC VEGETATION: *Acer rubrum* (red maple) is the primary or sole tree species. *Ulmus americana* (American elm) may be an occasional associate. The shrub layer is poorly to moderately dense depending on the successional sequence. Shrubs that can occur include *Ilex verticillata* (common winterberry), *Alnus incana* ssp. *rugosa* (speckled alder), *Swida sericea* (red-osier dogwood), *Spiraea alba* var. *latifolia* (meadowsweet), *Lyonia ligustrina* (maleberry), *Vaccinium corymbosum* (highbush blueberry), and others.

Clonal graminoids such as *Carex stricta* (tussock sedge) and *Calamagrostis canadensis* (bluejoint) are the most frequent herbaceous dominants. Numerous other wetland herbs of marshes and swamps may be present including *Thelypteris palustris* var. *pubescens* (marsh fern), *Onoclea sensibilis* (sensitive fern), *Triadenum virginicum* (Virginia marsh-St. John's-wort), *Lysimachia terrestris* (swamp yellow-loosestrife), *Lycopus* spp. (water-horehounds), *Doellingeria umbellata* (tall white-aster), *Symphyotrichum novi-belgii* (New York American-aster), and *Sparganium americanum* (American bur-reed). *Sphagnum* moss cover is generally low.

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 (S3)

GENERAL DESCRIPTION: This is a northern seepage swamp community characterized by a diverse overstory and lush understory. It occurs on shallow peat or mineral soils. A hardwood - conifer mix is typical; less common are examples with dominance of either hardwoods or conifers. It shares numerous species with the red spruce - hardwood - violet variant of the ***red spruce swamp*** community, but several notable species differentiate this more nutrient-rich type. It occupies sites influenced by seepage or upland runoff, including gently sloping hillsides, headwater areas of drainages, minerotrophic upland margins of streamside or basin swamps, and local groundwater 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 are fairly small (1–10 acres); some examples in peatland basins may exceed 40–50 acres.

Fraxinus nigra (black ash) is characteristic and may occur in nearly pure stands, or as a canopy subdominant or associate. Although black ash does not grow as fast as *Acer rubrum* (red maple) or *Ulmus Americana* (American elm), it is fairly long-lived (>250 years). Its ability to stump sprout may be an important reproductive strategy in response to disturbance. .

This is a moderately rich swamp type influenced to some degree by groundwater seepage or near-surface upland runoff. When present, hummocks tend to be modest in size (ca. 0.3 m tall), though they 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). Perennially saturated soils are typical and surface rivulets and springs are occasional. On slopes, shallow peat or muck horizons often lie over grey silts or sands. Examples in flat peatland basins have moderately deep peats, averaging over 1 m.

CHARACTERISTIC VEGETATION: Tree cover ranges from 25–80%. The most abundant and constant species in the canopy are 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), red maple, *Picea glauca* (white spruce), *Populus balsamifera* (balsam poplar), *Fraxinus americana* (white ash), *Larix laricina* (American larch), *Picea mariana* (black spruce), and, mostly south of the White Mountains, *Tsuga canadensis* (hemlock).

The shrub layer is typically sparse to moderately well developed and may include *Alnus incana* ssp. *rugosa* (speckled alder), *Ilex verticillata* (common winterberry), *I. mucronata* (mountain holly), *Toxicodendron radicans* (poison-ivy), *Viburnum nudum* var. *cassinoides* (withe-rod), *Lonicera canadensis* (American honeysuckle), *Spiraea alba* var. *latifolia* (meadowsweet), and *Swida sericea* (red-osier dogwood). *Vaccinium corymbosum* (highbush blueberry) is notably absent.

There is a broad diversity of herbaceous species indicative of minerotrophic conditions, including *Geum rivale* (water avens), *Packera schweinitziana* (New England groundsel), *Tiarella cordifolia* (foam-flower), *Hydrocotyle americana* (American marsh-pennywort), *Chrysosplenium americanum* (golden-saxifrage), *Circaea alpina* (small enchanter's-nightshade), *Impatiens capensis* (spotted touch-me-not), *Solidago flexicaulis* (zig-zag goldenrod), *Chelone glabra* (white turtlehead), *Viola* spp. (violets), *Platanthera* spp. (bog-orchids), *Onoclea sensibilis* (sensitive fern), *Thelypteris palustris* var. *pubescens* (marsh fern), *Cinna latifolia* (slender wood-reed), *Glyceria striata* (fowl mannagrass), *G. melicaria* (northeastern mannagrass), *Carex gynandra* (nodding sedge), *C. stricta* (tussock sedge; particularly var. *strictior*), and *Sphagnum squarrosum* (peat moss). Other occasional species include *Chamaepericlymenum canadense* (bunchberry), *Coptis trifolia* (three-leaved goldthread), and *Galium kamtschaticum* (boreal bedstraw).

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)*, *Neottia cordata* (heart-leaved twayblade)*, and *N. convallarioides* (broad-leaved twayblade)*.

Species either absent or in lower abundance and constancy in this type compared to otherwise similar ***red spruce swamps*** include *Carex trisperma* (three-seeded sedge), *Osmundastrum cinnamomeum* (cinnamon fern), and *Sphagnum* mosses.

This swamp type is essentially a northern version of the ***red maple - black ash swamp*** and ***red maple - sensitive fern swamp*** found in central and southern NH. It differs from these more southern swamps by having less red maple and a low abundance (or absence) of southern species such as *Micranthes pensylvanica* (swamp small-flowered-saxifrage), *Symplocarpus foetidus* (skunk-cabbage), and *Lindera benzoin* (northern spicebush). Examples transitional to ***red maple - black ash 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 characterize this variant; 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 calciphiles, particularly in small canopy opening areas. Conditions appropriate for these species are found in localized areas where base-rich groundwater discharges within an otherwise more extensive and acidic swamp. These species include *Rhamnus alnifolia* (alder-leaved buckthorn), *Carex castanea* (chestnut sedge)*, *C. baileyi* (Bailey's sedge)*, *C. bebbii* (Bebb's sedge), *Cypripedium reginae* (showy lady's-slipper)*, *C. parviflorum* var. *pubescens* (large yellow lady's-slipper)*, and *Liparis loeselii* (Loesel's wide-lipped orchid)*. Many of these species are normally found in association with rich fens or northern white cedar swamps.
3. **Sloped black ash variant**: This black ash dominated swamp forms on gently sloped terrain, often

with visible evidence of surface seepage and non-entrenched drainage channels. Soils are grayish or gleyed silty loams, sometimes with a shallow muck layer. The sloped terrain, shallow organic layer, and dominance of black ash may justify designating this variant as a distinct natural community type. This variant has a distinctly northern distribution, occurring only 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 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.

• Larch - mixed conifer swamp (S3)

GENERAL DESCRIPTION: This is a mixed conifer swamp of northern basins, intermediate in mineral enrichment between the nutrient-poor ***black spruce swamp*** and the ***northern white cedar - balsam fir swamp***. *Larix laricina* (American larch) and *Abies balsamea* (balsam fir) are typically dominant, but other conifer and hardwood species are frequently present. Soils are saturated, deep to moderately-deep peats, which generally receive at least some groundwater inputs, providing the elevated levels of mineral nutrients.

CHARACTERISTIC VEGETATION: The canopy is dominated by a mix of larch and balsam fir. Other trees that may be present include *Picea mariana* (black spruce), *P. rubens* (red spruce), *P. glauca* (white spruce), *Thuja occidentalis* (northern white cedar), *Acer rubrum* (red maple), and *Fraxinus nigra* (black ash). *Ilex mucronata* (mountain holly) is common in the understory, and may be joined by *Ilex verticillata* (common winterberry) and *Alnus* spp. (alders). The herbaceous layer is variable in cover, but usually includes *Osmundastrum cinnamomeum* (cinnamon fern), *Carex trisperma* (three-seeded sedge), *Oxalis montana* (northern wood sorrel), *Rubus pubescens* (dwarf raspberry), and *Chamaepericlymenum canadense* (bunchberry).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Occurs in northern New Hampshire, primarily north of the White Mountains. Good examples can be seen at Cape Horn (Northumberland) and Mollidgewock Brook (Errol).

SOURCES: NHB field surveys.

• Northern white cedar - balsam fir swamp (S2)

GENERAL DESCRIPTION: These swamps of northern New Hampshire are moderately acidic to circumneutral forested peatlands dominated by *Thuja occidentalis* (northern white cedar). In mature examples, the overstory canopy reaches heights of 40 to 60 ft. The forested canopies (60–100% cover) often create deeply shaded understories. There are also occasional to frequent leaning trees and blowdowns, moderately well developed cedar tree subcanopies, sparse shrub understories, well-developed hummock-hollow topography, dense carpets of diverse mosses and liverworts, and sparse to moderate herb cover. Most examples of this community range from 1–50 acres, with at least a few swamps in New Hampshire exceeding 100 acres.

Northern white cedar is a boreal species that approaches its southeastern limit in New Hampshire. This tree species is essentially absent from the interior core of the White Mountains, but becomes increasingly frequent northward in the state. It is more common 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. 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. 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 swamp*** description).

Soils are moderately deep, well-decomposed (sapric), very poorly drained peats, usually over silt soils or occasionally bedrock, sand, or gravel. Peat depths average over 1 m deep. 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 6.1 with a range of 4.9–7.5.

CHARACTERISTIC VEGETATION: 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), *Larix laricina* (American larch), *Picea glauca* (white spruce), *P. rubens* (red spruce), and *P. mariana* (black spruce).

There is a sparse to moderate cover of tall shrubs, although composition is often diverse. *Lonicera canadensis* (American honeysuckle) and *Viburnum nudum* var. *cassinoides* (withe-rod) are the most frequent, *Ilex mucronata* (mountain holly), *Swida sericea* (red-osier dogwood), and *Acer spicatum* (mountain maple) are frequent, *Alnus incana* ssp. *rugosa* (speckled alder) is occasional, and *Ilex verticillata* (common winterberry), *Amelanchier bartramiana* (mountain shadbush), *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 *Gaultheria hispidula* (creeping spicy-wintergreen), *Linnaea borealis* ssp. *americana* (American twinflower), *Ribes lacustre* (bristly swamp currant), and *Taxus canadensis* (American yew). *Rhamnus alnifolia* (alder-leaved buckthorn) and *Vaccinium myrtilloides* (velvet-leaved blueberry) are occasional.

Characteristic herbs and shrubs that help differentiate this community from other northern white cedar swamps include *Mitella nuda* (naked bishop's-cap), *Carex pedunculata* (long-stalked sedge), *Orthilia secunda* (one-sided-shinleaf), *Platanthera obtusata* (blunt-leaved bog-orchid), and *Rhamnus alnifolia* (alder-leaved buckthorn). Characteristic and frequent herbs (in approximately descending order of frequency) include *Carex trisperma* (three-seeded sedge), *Osmundastrum cinnamomeum* (cinnamon fern), *Chamaepericlymenum canadense* (bunchberry), *Coptis trifolia* (three-leaved goldthread), *Rubus pubescens* (dwarf raspberry), long-stalked sedge, naked bishop's-cap, *Oxalis montana* (northern wood sorrel), *Rubus dalibarda* (dewdrop), *Lysimachia borealis* (starflower), *Carex intumescens* (greater bladder sedge), *Phegopteris connectilis* (long beech fern), *Carex leptalea* (bristly-stalk sedge), *Dryopteris cristata* (crested wood fern), *Tiarella cordifolia* (foam-flower), and *Athyrium angustum* (lady fern). Foam-flower appears to be a good indicator of somewhat enriched swamps [average pH when foam-flower is present=6.5 (n=6 sites)].

Bryophyte diversity and cover is high and includes *Hylocomnium splendens*, *Amblystegium riparium*, *Rhytidiadelphis triquetrus*, *R. subpinnatus*, *Thuidium delicatulum*, *Bazzania trilobata*, *Rhizomnium punctatum*, *R. appalachianum*, *Fissidens adiantoides*, *Calliergon cordifolium*, *Sphagnum girgensohnii*, *S. subtile*, *S. russowii*, *Plagiochila asplenioides*, and *Trichocolea tomentella*.

Rare plant species that may occur in this community include *Petasites frigidus* var. *palmatus* (northern sweet-coltsfoot)*, *Carex castanea* (chestnut sedge)*, *C. baileyi* (Bailey's sedge)*, *C. bebbii* (Bebb's sedge), *Calypso bulbosa* ssp. *americana* (fairy-slipper)*, *Cypripedium reginae* (showy lady's-slipper)*, *C. parviflorum* var. *makasin* (greater yellow lady's-slipper)*, *C. parviflorum* var. *pubescens* (large yellow

lady's-slipper)*, *C. arietinum* (ram's-head lady's-slipper)*, and *Liparis loeselii* (Loesel's wide-lipped orchid)*.

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 ft. to 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 supports more acid-tolerant species and 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 somewhat similar to that of ***northern white cedar - balsam fir swamps***. It differs by having abundant *Sphagnum* moss, a well developed shrub layer, lower average cover and diversity in the herb layer, a greater abundance or frequency of *Picea mariana* (black spruce), *Kalmia angustifolia* (sheep laurel), *Gaultheria hispidula* (creeping spicy-wintergreen), *Ilex mucronata* (mountain holly), and sometimes *Alnus incana* ssp. *rugosa* (speckled alder), and a sparse cover of herbaceous minerotrophic indicators.

Herbs may include *Carex trisperma* (three-seeded sedge), *Glyceria melicaria* (northeastern mannagrass), *Rubus dalibarda* (dewdrop), *R. pubescens* (dwarf raspberry), *Tiarella cordifolia* (foam-flower), *Oxalis montana* (northern wood sorrel), *Symphyotrichum puniceum* (purple-stemmed American-aster), *Dryopteris intermedia* (evergreen wood fern), *Athyrium angustum* (lady fern), *Osmundastrum cinnamomeum* (cinnamon fern), *Osmunda regalis* var. *spectabilis* (royal fern), and *Equisetum sylvaticum* (wood horsetail).

CLASSIFICATION CONFIDENCE: 2–3

DISTRIBUTION: Known from the Mahoosuc-Rangeley Lakes and CT Lakes subsections (ca. 1,200–1,300 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 seepage forest community is often located along a seasonally saturated, sloping transition zone between uplands and flat swamps, or along drainages. It has less developed micro-topography than swamp communities, and moderately to poorly drained soils. It is characterized by a sparse shrub layer, moderately low moss cover, and 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: Diagnostic upland and rich-site species infrequent or absent in other northern white cedar swamps include *Solidago flexicaulis* (zig-zag goldenrod), *Tiarella cordifolia* (foam-flower), *Arisaema triphyllum* (Jack-in-the-pulpit), *Clintonia borealis* (yellow bluebead-lily), *Carex arctata* (drooping woodland sedge), *Medeola virginiana* (Indian cucumber root), *Huperzia lucidula* (shining

firmoss), and *Acer saccharum* (sugar maple). Other species include *Glyceria melicaria* (northeastern mannagrass), *Carex trisperma* (three-seeded sedge), *C. pedunculata* (long-stalked sedge), *C. retrorsa* (retrorse sedge), *Gymnocarpium dryopteris* (northern oak fern), *Mitella nuda* (naked bishop's-cap), and *Packera schweinitziana* (New England groundsel).

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. In addition to *Thuja occidentalis* (northern white cedar), 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.

It occurs on poorly to very poorly drained soils, in moderately small tributary headwater basins where groundwater seepage influences the local hydrology.

CHARACTERISTIC VEGETATION: Northern white cedar is dominant and hemlock and red maple are abundant. Species present that are essentially absent from other northern white cedar communities include *Fraxinus americana* (white ash), *Hamamelis virginiana* (American witch-hazel), *Epigaea repens* (trailing-arbutus), and *Mitchella repens* (partridge-berry). Other common species include *Abies balsamea* (balsam fir), *Chamaepericlymenum canadense* (bunchberry), *Linnaea borealis* ssp. *americana* (American twinflower), *Rubus dalibarda* (dewdrop), *Phegopteris connectilis* (long beech fern), *Osmundastrum cinnamomeum* (cinnamon fern), *Platanthera lacera* (green fringed bog-orchid), and *Chelone glabra* (white turtlehead). One example has the rare *Petasites frigidus* var. *palmatus* (northern 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.

• Northern hardwood seepage forest (S3)

GENERAL DESCRIPTION: This is a swampy, semi-rich northern hardwood forest found on lower mountain slopes with frequent seep openings and seepage runs. Because of the frequency of wet areas, this forest is characterized by a mosaic of both upland and wetland plant species. In some examples, lush glade openings dominated by a dense cover of tall herbs are common and sizable, occasionally reaching 0.5 acre or more in size. The tree canopy is typically dominated by northern hardwoods, or sometimes by a hardwood - conifer mix. This community differs from ***red maple - black ash swamps*** by having higher angle slopes and by the co-dominance of *Acer saccharum* (sugar maple), *Betula alleghaniensis* (yellow birch), and occasionally *Abies balsamea* (balsam fir) or *Picea rubens* (red spruce). This community is most frequent in the Connecticut Lakes subsection of the North Country, where the combination of a cold northern climate and sloping silt soils with a densipan and impeded drainage are more common than further south in New Hampshire.

Soils are usually poorly to very poorly drained silt loams with 3–10 (–20)^{o} slopes. In drier portions of seepage forests, shallow mucky silt loams form over silt loam with some mottling apparent near the surface

(ca. 15–20 cm down). In wetter portions, deeper mucky silt loams form 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, and balsam fir. Other trees include *Picea glauca* (white spruce), and *Betula cordifolia* (heart-leaved paper birch). *Fraxinus nigra* (black ash) may be present, but is generally restricted to drainages and other wetter portions of the forest.

A well developed herb layer is dominated by *Glyceria melicaria* (northeastern mannagrass), *Impatiens capensis* (spotted touch-me-not), *Tiarella cordifolia* (foam-flower), *Symphyotrichum puniceum* (purple-stemmed American-aster), *Chamerion angustifolium* ssp. *circumvagum* (narrow-leaved fireweed), *Rubus pubescens* (dwarf raspberry), and *Athyrium angustum* (lady fern). Other herbs include *Epilobium ciliatum* (fringed willow-herb), *Galium triflorum* (fragrant bedstraw), *Thalictrum pubescens* (tall meadow-rue), *Clintonia borealis* (yellow bluebead-lily), *Actaea rubra* (red baneberry), *A. pachypoda* (white baneberry), *Chelone glabra* (white turtlehead), *Solidago flexicaulis* (zig-zag goldenrod), *Ageratina altissima* (white snakeroot), *Eutrochium maculatum* (spotted Joe-Pye weed), *Euthamia graminifolia* (common grass-leaved-goldenrod), *Carex gynandra* (nodding sedge), *Calamagrostis canadensis* (bluejoint), *Phegopteris connectilis* (long beech fern), *Dryopteris intermedia* (evergreen wood fern), *D. campyloptera* (mountain wood fern), *Polystichum braunii* (Braun's holly fern), and *Onoclea sensibilis* (sensitive fern).

Shrubs include *Rubus idaeus* ssp. *strigosus* (strigose red raspberry), *Sambucus racemosa* (red elderberry), *Viburnum lantanoides* (hobblebush), *Acer pensylvanicum* (striped maple), and *Alnus incana* ssp. *rugosa* (speckled alder). Rare or uncommon plants found in this community include *Cypripedium parviflorum* var. *pubescens* (large yellow lady's-slipper)*, *Galium kamtschaticum* (boreal bedstraw), and *Milium effusum* ssp. *cisatlanticum* (millet grass).

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 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 has a seasonally-high water table, and as such is a transitional community type exhibiting some characteristics of both upland forests and forested swamps. It occurs in imperfectly to somewhat poorly drained areas along stream drainages, high floodplains, inactive river terraces, and other upland-wetland ecotones, and 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. Although some sub-surface seepage may influence certain examples, this community is 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 are nutrient-poor. They vary from loamy sands to sandy loam till and river/kame terrace soils with a shallow water table (within 1 ft. of soil surface for portion of growing season). Mottles are evident within 1 ft. of the soil surface in some examples, while others have deep A horizons (tending to obscure mottles) over moist to wet sediments. Soils series include Au Gres, among other types.

CHARACTERISTIC VEGETATION: Hemlock and 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), *Q. rubra* (red oak), *Betula lenta* (black birch), *Ulmus americana* (American elm), and *Prunus serotina* (black cherry). *Fraxinus americana* (white ash) may also be prominent in the tree canopy in some upland-wetland ecotones. Other woody species can include *Fagus grandifolia* (American beech), *Picea rubens* (red spruce), *Abies balsamea* (balsam fir), *Acer pensylvanicum* (striped maple), *Vaccinium corymbosum* (highbush blueberry), *Viburnum nudum* var. *cassinoides* (withe-rod), *V. lantanoides* (hobblebush), *Sambucus nigra* ssp. *canadensis* (common elderberry), *Rosa palustris* (swamp rose), *Kalmia angustifolia* (sheep laurel), and *Rubus occidentalis* (black raspberry).

Although the overstory association can approximate certain upland forests, more mesic to wet conditions are indicated by the presence of *Osmundastrum cinnamomeum* (cinnamon fern), *Osmunda claytoniana* (interrupted fern), *Thelypteris palustris* var. *pubescens* (marsh fern), *Arisaema triphyllum* (Jack-in-the-pulpit), *Lonicera canadensis* (American honeysuckle), *Lindera benzoin* (northern spicebush), and various mosses. Other herbs may include *Parathelypteris noveboracensis* (New York fern), *Dryopteris intermedia* (evergreen wood fern), *Aralia nudicaulis* (wild sarsaparilla), *Oclemena acuminata* (sharp-toothed nodding-aster), *Mitchella repens* (partridge-berry), *Oxalis montana* (northern wood sorrel), and *Clintonia borealis* (yellow bluebead-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 - lady fern 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.

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

CHARACTERISTIC VEGETATION: The 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 (it 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 frequency. *Carpinus caroliniana* ssp. *virginiana* (American hornbeam) can be abundant as an understory tree. Shrubs present in moderately low abundance include *Toxicodendron radicans* (poison-ivy), *Ilex verticillata* (common winterberry), *Parthenocissus quinquefolia* (Virginia-creeper), *Viburnum dentatum* var. *lucidum* (smooth arrowwood), *Lindera benzoin* (northern spicebush), and *Clethra alnifolia* (sweet pepperbush). The herb layer is moderately well developed, with *Athyrium angustum* (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 are found in at least half the known examples and include *Micranthes pensylvanica* (swamp small-flowered-saxifrage), *Impatiens capensis* (spotted touch-me-not), *Carex radiata* (eastern star sedge), *C. rosea* (rosy sedge), *C. laxiculmis* (spreading sedge), *C. blanda* (eastern woodland sedge), and *Polystichum acrostichoides* (Christmas fern); those of generally acidic moist or wet sites include *Carex trisperma* (three-seeded sedge), *Glyceria striata* (fowl mannagrass), *Equisetum arvense* (field horsetail), *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 - pitch pine - cinnamon fern forest (S1S2)

GENERAL DESCRIPTION: The canopy in this forest is characterized by *Pinus rigida* (pitch pine), *Acer rubrum* (red maple), and a somewhat diverse mix of other wetland and upland tree species. The shrub layer is typically moderately well-developed, with *Vaccinium corymbosum* (highbush blueberry) being the most common. The herb and dwarf shrub layers are somewhat poorly developed, with scattered upland and wetland species, and species often found occupying intermediate positions between upland and wetland forest communities. These include *Chamaepericlymenum canadense* (bunchberry), *Rubus dalibarda* (dewdrop), *Coptis trifolia* (three-leaved goldthread), and *Gaultheria hispidula* (creeping spicy-wintergreen). *Sphagnum* moss cover is low to moderate.

This community forms “low” or wet forests that are seasonally saturated or otherwise maintain a seasonally high water table. Soils are somewhat poorly drained, dark brown fine sands, in transition zones between wetland and upland communities.

CHARACTERISTIC VEGETATION: This community is differentiated from various mesic upland forests (e.g., ***hemlock - beech - oak - pine forest***) of central and southern NH by the presence of a few wetland species in low to moderate abundance, including *Osmundastrum cinnamomeum* (cinnamon fern) and highbush blueberry. Pitch pine and red maple dominate, mixing with various combinations of *Pinus strobus* (white pine), *Quercus rubra* (red oak), *Picea rubens* (red spruce), and *P. mariana* (black spruce). Additional tree species in low cover at some sites include *Larix laricina* (American larch) and *Fagus grandifolia* (American beech). In addition to highbush blueberry in the shrub layer, other common species may include *Ilex mucronata* (mountain holly), *I. verticillata* (common winterberry), and *Viburnum nudum* var. *cassinoides* (withe-rod). Other shrubs that may be present are *Kalmia angustifolia* (sheep laurel), *Gaultheria procumbens* (eastern spicy-wintergreen), creeping spicy-wintergreen, *Rhododendron groenlandicum* (Labrador tea), *Chamaedaphne calyculata* (leatherleaf), *Gaylussacia baccata* (black

huckleberry), *Vaccinium myrtilloides* (velvet-leaved blueberry), and *V. angustifolium* (lowbush blueberry). Scattered upland and wetland herbs include cinnamon fern, bunchberry, false violet, three-leaved goldthread, *Carex trisperma* (three-seeded sedge), *Aralia nudicaulis* (wild sarsaparilla), *Lysimachia borealis* (starflower), *Medeola virginiana* (Indian cucumber root), *Maianthemum canadense* (Canada-mayflower), *Mitchella repens* (partridge-berry), and several other species. *Sphagnum* moss cover is low to moderate.

CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: This community occurs in central New Hampshire with good examples at White Lake State Park (Tamworth) and Cooper Cedar Woods (New Durham).

SOURCES: NHB field surveys.

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

GENERAL DESCRIPTION: This community occurs in settings with somewhat poorly drained mineral soils, 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. *Osmundastrum cinnamomeum* (cinnamon fern) and tall wetland shrubs such as *Vaccinium corymbosum* (highbush blueberry) are present in moderate abundance (approximately 1–15%). Other wetland plants are sparse.

Soils consist of sand, sandy loams, and silt loams, and typically have 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 differentiated from various mesic upland forests (e.g., ***mesic Appalachian oak - hickory forest*** and ***hemlock - beech - oak - pine forest***) 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 *Parathelypteris 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. It is also similar to the ***red maple - elm - lady fern silt forest***, but either lacks or has a lower abundance of *Athyrium angustum* (lady fern), *Onoclea sensibilis* (sensitive fern), and *Ulmus americana* (American elm).

VARIANTS: Two variants have been described.

1. **Southern variant**: Coastal or southern examples (as described above) may support Appalachian oaks, hickories, and possibly black huckleberry, species that are uncommon or absent from examples in central parts of the state. Species absent or in low abundance in this variant but more frequent in the central variant are *Abies balsamea* (balsam fir), *Picea rubens* (red spruce), *Viburnum lantanoides* (hobblebush), and *Clintonia borealis* (yellow bluebead-lily). Red oak is more frequent while northern hardwood species such as *Acer saccharum* (sugar maple), yellow birch, and American beech are less frequent.
2. **Central variant**: This variant is similar to the southern variant but supports species more frequent in central New Hampshire such as balsam fir, red spruce, hobblebush, and yellow bluebead-lily.

Appalachian oaks, hickories, and black huckleberry are absent, species occurring in coastal and southern examples. Red oak and highbush blueberry are less frequent; northern hardwood species such as sugar maple, yellow birch, and American beech are more frequent.

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 an impervious or slowly pervious soil layer (hardpan or densipan, silt, or clay material) forces water to the surface or in other situations where the ground surface intersects with the water table on sloped terrain. Most forest seeps occur on slopes and have mineral soil or a shallow muck horizon at the surface (less than 30 cm deep) and weakly acidic (subacid) to circumneutral pHs.

In many ways forest seeps are like 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 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 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 landscapes dominated by upland forests.

Much of the wetland flora found in seeps may also be found in seepage swamps, but 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 are collectively quite diverse. In a study of 17 seeps from around the state (three 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 one or two seeps. Because of this variability, we classify seeps broadly, relying on three acidity ranges indicated by certain species assemblages.

Species usually diagnostic of pronounced seepage include *Chrysosplenium americanum* (golden-saxifrage), *Carex scabrata* (eastern rough sedge), *Hydrocotyle americana* (American marsh-pennywort), *Circaea alpina* (small enchanter's-nightshade), *Glyceria melicaria* (northeastern mannagrass), *Impatiens capensis* (spotted touch-me-not), *Platanthera dilatata* (white northern bog-orchid), *Cardamine pensylvanica* (Pennsylvania bitter-cress), *Rubus pubescens* (dwarf raspberry), *Galium kamtschaticum* (boreal bedstraw), *Neottia convallarioides* (broad-leaved twayblade)*, *Scirpus microcarpus* (barber-pole bulrush), *Mnium* sp. (a moss), and certain *Sphagnum* species, such as *S. squarrosum*.

• Acidic *Sphagnum* forest seep (S3S4)

GENERAL DESCRIPTION: These 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 settings. The typic variant forms miniature spruce - fir swamps characterized by active seepage that limits peat accumulation and an abundance of plants restricted to seepage conditions. More open examples of the typic variant are transitional to acidic fen communities but they 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 subacid *Sphagnum* variant of the ***subacid forest seep*** by the absence of minerotrophic indicators such as *Tiarella cordifolia* (foam-flower), *Carex scabrata* (eastern rough sedge), and *Glyceria melicaria* (northeastern mannagrass).

Measured pHs do not exceed 5.5. Soils consist of shallow peat or muck layers (<30 cm) over seepy bedrock or, in headwater and streamside positions, over sandy loams.

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 and dwarf shrubs include *Veratrum viride* (American false hellebore), *Oclemena acuminata* (sharp-toothed nodding-aster), *Eurybia radula* (rough wood-aster), *Oxalis montana* (northern wood sorrel), *Thalictrum pubescens* (tall meadow-rue), *Coptis trifolia* (three-leaved goldthread), *Galium kamtschaticum* (boreal bedstraw), *Equisetum arvense* (field horsetail), *Osmundastrum cinnamomeum* (cinnamon fern), *Parathelypteris noveboracensis* (New York fern), *Carex disperma* (soft-leaved sedge), *C. leptalea* (bristly-stalk sedge), *C. intumescens* (greater bladder sedge), and *Gaultheria hispidula* (creeping spicy-wintergreen). *Neottia cordata* (heart-leaved twayblade)* and *N. convallarioides* (broad-leaved twayblade)* are rare species that may occur in this community. In examples transitional to acidic fens, the rare *Calamagrostis pickeringii* (Pickering's reed grass) might be expected. Heath shrubs and fen sedges may be present in some examples, but do not reach nearly the prominence they exhibit in acidic fens.

VARIANTS: Two variants are described.

1. **Typic variant**: As described above. This variant occurs 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 includes *Chamaedaphne calyculata* (leatherleaf), *Ilex mucronata* (mountain holly), *Rhododendron canadense* (rhodora), *Amelanchier bartramiana* (mountain shadbush), *Rubus idaeus* ssp. *strigosus* (strigose red raspberry), *Viburnum dentatum* var. *lucidum* (smooth arrowwood), *Eriophorum virginicum* (tawny cottonsedge), *Carex interior* (inland sedge), *C. trisperma* (three-seeded sedge), *C. pauciflora* (few-flowered sedge), *C. arctata* (drooping woodland sedge), *Drosera rotundifolia* (round-leaved sundew), and *Clintonia borealis* (yellow bluebead-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 2,500 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 foam-flower - graminoid and subacid *Sphagnum* variants have a shallow muck layer (typically 10–30 cm) over sand or silt loams on slopes ranging from 1–24º. Most examples of these two variants are headwater seeps associated with ephemeral or permanent streams. Measured pH's are subacid and range from 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 present in all variants include *Tiarella cordifolia* (foam-flower), *Carex scabrata* (eastern rough sedge), *Glyceria melicaria* (northeastern mannagrass), *Cinna latifolia* (slender wood-reed), *Rubus pubescens* (dwarf raspberry), *Impatiens capensis* (spotted touch-me-not), *Circaea alpina* (small enchanter's-nightshade), *Symphyotrichum puniceum* (purple-stemmed American-aster), *Chrysosplenium americanum* (golden-saxifrage), *Platanthera dilatata* (white northern bog-orchid), *Geum rivale* (water avens), *Mitella diphylla* (two-leaved miterwort), *Sphagnum* mosses, and other bryophytes. *Galium kamtschaticum* (boreal bedstraw) is an uncommon seep species present in some mountain examples. *Neottia cordata* (heart-leaved twayblade)* and *N. convallarioides* (broad-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* (American marsh-pennywort), *Epilobium coloratum* (eastern willow-herb), *Veratrum viride* (American false hellebore), *Carex leptalea* (bristly-stalk sedge), *C. disperma* (soft-leaved sedge), and *Equisetum sylvaticum* (wood horsetail).

Other frequent plants (with broader habitat ranges) include *Oclemena acuminata* (sharp-toothed nodding-aster), *Oxalis montana* (northern wood sorrel), *Viola* spp. (violets), *Galium* spp. (bedstraws; including *G. tinctorium* and *triflorum*), *Arisaema triphyllum* (Jack-in-the-pulpit), *Carex stipata* (awl-fruited sedge), *C. intumescens* (greater bladder sedge), *C. gynandra* (nodding sedge), and several ferns and fern allies. These include *Athyrium angustum* (lady fern), *Dryopteris campyloptera* (mountain wood fern), *D. intermedia* (evergreen wood fern), *Phegopteris connectilis* (long beech fern), *Onoclea sensibilis* (sensitive fern), *Osmundastrum cinnamomeum* (cinnamon fern), *Gymnocarpium dryopteris* (northern oak fern), and *Huperzia lucidula* (shining firmoss). Shrubs include *Acer spicatum* (mountain maple), *Alnus incana* ssp. *rugosa* (speckled alder), *Rubus* spp. (brambles), and *Viburnum lantanoides* (hobblebush), among others. Trees largely reflect the surrounding forest type.

VARIANTS: Key characteristics of the five variants are described below.

1. **Foam-flower - graminoid variant**: These seeps are typical of mid-elevation northern hardwood and semi-rich mesic forests in the White Mountain region, and to a lesser extent 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 foam-flower, eastern rough sedge, and/or northeastern mannagrass. Slender wood-reed may be present, though usually not

dominant. Total graminoid cover often exceeds 35%, fern cover ranges from 5–20%, and total herbaceous cover exceeds 75% (>100% in some examples due to dense, overlapping herbs). Most examples are less than 0.1 acre and have 13–18 herb species present (some larger examples have more species).

2. **Subacid *Sphagnum* variant**: This variant differs from the foam-flower - 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 foam-flower, two-leaved miterwort, eastern rough sedge, northeastern mannagrass, northern oak fern, and 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 foam-flower - graminoid variant are sparse or absent. Seepage plants may include *Viola* spp. (violets; including *Viola cucullata*), golden-saxifrage, nodding sedge, small enchanter's-nightshade, and dwarf raspberry, among others. Jack-in-the-pulpit and 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 sensitive fern, cinnamon fern, *Osmunda claytoniana* (interrupted fern), lady fern, wood horsetail, spotted touch-me-not, and awl-fruited sedge, among other seep plants. Graminoids are present but usually not a dominant life form as in the foam-flower - 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 dwarf raspberry, foam-flower, northern wood sorrel, boreal bedstraw, American marsh-pennywort, golden-saxifrage, small enchanter's-nightshade, *Thalictrum pubescens* (tall meadow-rue), white snakeroot, violets, lady fern, evergreen wood fern, *Matteuccia struthiopteris* ssp. *pensylvanica* (ostrich fern), interrupted fern, eastern rough sedge, bristly-stalk sedge, northeastern mannagrass, and slender wood-reed. Shrubs include 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 foam-flower - 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 (700–1,700 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). Subacid *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: These seeps have pHs near neutral (ca. 6.5–7.4) and feature a higher amount of nutrient availability compared to subacid or acidic seeps (below ca. 6.4 and 5.3, respectively). They occur as small ovoid seeps, as linear "seepage runs" within a forest, or zones along river terrace slopes. They are characterized by a mixture of seepage indicators and other wetland plants along with rich mesic hardwood plants. They are treated here as one broadly defined group with three variants. Larger examples are 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 intermediate bedrock and till or marine silt and clay sediments. In most examples, pHs range from 6.5–7.4.

CHARACTERISTIC VEGETATION: Diagnostic rich-site plants that differentiate this community include the trees *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), *F. nigra* (black ash), and *Tilia americana* (basswood), and herbs and shrubs including *Solidago flexicaulis* (zig-zag goldenrod), *Caulophyllum thalictroides* (blue cohosh), *Actaea pachypoda* (white baneberry), *Cypripedium parviflorum* var. *pubescens* (large yellow lady's-slipper)*, *Viola pubescens* (yellow forest violet), *Carex plantaginea* (plantain-leaved sedge), *Botrychium virginianum* (rattlesnake fern), *Adiantum pedatum* (northern maidenhair fern), *Laportea canadensis* (wood nettle), *Matteuccia struthiopteris* ssp. *pensylvanica* (ostrich fern), *Diplazium pycnocarpon* (narrow-leaved glade fern)*, *Polystichum acrostichoides* (Christmas fern), *Dryopteris goldiana* (Goldie's wood fern), and *Rubus odoratus* (flowering raspberry). Other documented species include *Thalictrum pubescens* (tall meadow-rue), *Viola* spp. (violets), *Galium* spp. (bedstraws), *Glyceria striata* (fowl mannagrass), *Athyrium angustum* (lady fern), *Gymnocarpium dryopteris* (northern oak fern), and *Thelypteris palustris* var. *pubescens* (marsh fern). *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.

1. **Northern hardwood variant**: Seepy fern and nettle glades with 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-slipper*, *Liparis loeselii* (Loesel's wide-lipped orchid)*, *Cystopteris bulbifera* (bulbil fragile fern), and *Carex bebbii* (Bebb's sedge), particularly in more northern calcareous regions. *Carex gynandra* (nodding sedge) is much more likely in northern seeps than in coastal seeps, where it is replaced by the similar species *C. crinita* (fringed sedge).
2. **Coastal/Appalachian variant**: Examples in coastal and southern New Hampshire contain many of the rich-site species occurring in the northern hardwood variant. The coastal/Appalachian variant also supports several additional species apparently absent from the northern variant. These include *Acer nigrum* (black maple)*, *Carpinus caroliniana* ssp. *virginiana* (American hornbeam), *Betula lenta* (black birch), *Lindera benzoin* (northern spicebush), *Amphicarpaea bracteata* (American hog-peanut), *Carex cristatella* (crested sedge)*, *C. crinita* (fringed sedge), *C. radiata* (eastern star sedge), and *C. rosea* (rosy sedge). Appalachian oaks and hickories are often prominent in the surrounding forest. Boreal conifers are absent while *Acer rubrum* (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* ssp. *affine* (tall scouring-rush) and ostrich fern, along with other seep or wetland plants such as *Carex scabrata* (eastern rough sedge), *Impatiens capensis* (spotted touch-me-not), *Chelone glabra* (white turtlehead), and *Alnus incana* ssp. *rugosa* (speckled alder).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: The northern hardwood variant occurs in subsections north of and including the White Mountains (Connecticut Lakes, Mahoosuc-Rangeley Lakes, White Mountain, and Vermont Piedmont), NH Upland, and Sebago-Ossipee subsections, probably mostly between 1,000–2,500 ft. elevation. The coastal/Appalachian variant occurs in the Coastal Lowland and probably the Coastal Plain and Northern Connecticut River subsections. Known examples are ca. 100 ft. elevation or less, although the type may be expected up to ca. 1,000 ft. elevation. The river terrace slope variant is known from the Coastal Plain, Northern Connecticut River, and Vermont Piedmont subsections (all <1,000 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. 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

Vernal pools, which are not considered true natural communities as they are defined in this classification, are small depressions that fill and hold water for at least two months in spring and then dry out during the summer. They have no inlets or outlets, and occur as patches within other habitats, including upland forests, floodplain forests, swamps, and sand plain basin marshes. Periodic natural drawdown and hydrologic isolation prevent the establishment of fish populations. With fish predators excluded, vernal pools serve as important feeding and breeding grounds for reptiles, amphibians, and invertebrates, several of which are adapted to, and completely dependent on, the cyclic and ephemeral nature of these wetland basins.

Amphibians migrate to vernal pools from their upland habitats on the first warm rainy night of spring (about 40° F – usually in early April). Characteristic amphibians include wood frogs, and spotted, blue-spotted, and Jefferson's salamanders. These amphibians mate and lay eggs in the pools, and then return to the forest. After hatching, successful growth and metamorphosis from larvae to adult must happen before water in the pools disappears. Wood frogs can develop in as few as 115 days, while spotted salamanders require over 155 days. If ponds dry by the end of July, they can support wood frogs, but probably not spotted salamanders. The rare marbled salamander, found only in the southern part of the state, lays its eggs in the bottoms of dry vernal pools in the fall and remains with the eggs throughout the winter until the pools fill with water in the spring. The eggs hatch, and the developing larvae eat newly hatched wood frog and spotted salamander larvae.

Other animals use vernal pools as well. Fairy shrimp lay desiccation-resistant eggs in leaf litter on the bottom of pools. In early spring, the eggs hatch and colorful orange, yellow, and turquoise crustaceans appear, swimming on their backs. Fingernail clams tightly seal themselves to survive the dry period. Many insects, including mosquitoes, have eggs or larvae that can withstand the seasonal drawdown by remaining in the moist leaf litter.

Vernal pools are unvegetated to sparsely vegetated, and defined by characteristic animal species, not vegetation. Plant species richness and cover are highly variable and depend on the extent of water

fluctuations, light, geographic location, variation in seed dispersal, and other factors. More than 400 plants occur in vernal pools in northeastern North America, including common vernal pool plant species such as highbush blueberry, buttonbush, and various graminoids. Vegetation is often restricted to elevated mounds or areas near the pool margins.

The loss of the tree canopy around vernal pools can have a significant impact on the wildlife species. With increased exposure, water temperature rises, and some animals cannot survive in the warmer water. In addition, the amount of leaf litter in the pool decreases, eliminating a critical component of the food web. Buffers help protect vernal pools from harmful human activities in the surrounding landscape.

OPEN WETLANDS AND RIPARIAN COMMUNITIES

This section contains descriptions of three 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 marshes, shrub thickets, and aquatic beds; and 3) open peatlands. Open river channels, riverbanks, and floodplains support riparian communities, mostly on mineral or rock substrate. Open marshes, shrub thickets, and aquatic beds occur in limnogenous stream, river, and lake shore settings, and in topogenous or topogenous/limnogenous open- or closed-basin settings. 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 RIVER CHANNELS, RIVERBANKS, AND FLOODPLAINS

In New Hampshire, the following communities occur largely in moderate- to high-energy environments along rivers and large streams. Most, including river channels, riverbanks, floodplains, and riverbank outcrops or seeps, occur on mineral or rock substrate with relatively little organic matter accumulation.

Marshes on muck substrate, aquatic beds, and other communities associated with low-energy settings along rivers and large streams are described in the “Marshes, shrub thickets, and aquatic beds” section of the classification.

RIVER CHANNELS AND LOW RIVERBANKS

A river channel is defined as the area between the tops of the riverbanks. Low riverbanks are typically inundated for substantial portions of the year. Substrates are variable in these settings, with sediment composition dependent on the slope gradient of the river and position relative to the main channel. High-energy environments where fast currents scour and transport finer particles downstream are indicated by sand, gravel, cobble, boulder, or bedrock substrate. 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: Seed-bearing plants are uncommon in permanently flooded, high-energy parts of channels, but *Podostemum ceratophyllum* (riverweed) sometimes forms low mats on submerged rocks in rapids, waterfalls, and other fast-flowing sections of streams and rivers, primarily in central and southeastern New Hampshire. This plant attaches itself to rocks using adhesive-secreting, hold-fast like

roots. The community usually occurs as a monoculture of riverweed, though pondweeds occasionally grow in gravel between riverweed covered rocks. This community type is presently described only from the Contoocook and Lamprey Rivers. Examples probably also occur in other rivers that contain riverweed, as sampled by Philbrick and Crow (1992).

River rapids occur where the slope of a river or stream is steep enough to support fast water velocity and whitewater. Water flows all year in at least the deeper portions (thalweg) of the channel. 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.

CHARACTERISTIC VEGETATION: 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 aquatilis* var. *diffusus* (white water crowfoot) and *Potamogeton nodosus* (long-leaved pondweed)*.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Good examples of this community occur in rapids of the Contoocook River (Henniker) and the Lamprey River (Epping). 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 globally-rare natural community is currently known only from river channels along the Saco River in New Hampshire and Maine. It forms narrow strips of vegetation, just above the river and below the forest edge. Grasses, forbs, mosses, and lichens are the dominant life forms, although vegetation is sparse overall. Widely scattered shrubs and saplings may be present. The association of the two rare perennial species *Hudsonia tomentosa* (hairy hudsonia)* and *Paronychia argyrocoma* (silverling)* is otherwise known only from ridge-top barrens on Panther Knob in West Virginia.

This community occupies the uppermost river channel zone, corresponding to the two-year floodplain at approximately 1.5–2.5 m above the river at low water. It is generally only 5–15 m wide (though it can be 20–40 m wide on some pointbars), and up to 100–200 m long. A few examples occur in narrow "flood chutes" between point bars and adjacent uplands. Most examples are roughly 0.2 ha; larger examples range from 0.5 ha to approximately 1 ha.

Substrate consists of water-sorted sediments, with variation occurring both within and between sites. At a given site, surface sediments range from a thin layer of nearly pure sand to a mixture of sand, gravel, and small cobbles.

The restricted distribution of this community results from a combination of flood-related disturbance and edaphic conditions along the river profile. Above cobbly low channels, higher river channel zones are scoured enough to prevent most woody plant growth, but stable enough for perennial species such as hairy hudsonia* and silverling* to survive and sometimes thrive. Still higher, adjacent to this community, is a sandy, depositional environment, often heavily vegetated by shrubs, saplings, and a variety of grasses and forbs. At this height in the channel, floodwater velocities slow to the point where depositional processes outpace erosion. Forested floodplains often occur above this zone.

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. Farther upstream, as sand becomes less abundant, hairy hudsonia* grows increasingly scarce. The distribution of silverling* is just the reverse; it is more common upstream than downstream. Within examples of this community, it occurs in the gravelly

areas lower in the river channel. In New Hampshire, silverling* is otherwise known only from mid- to high-elevation outcrops and cliffs, and hairy hudsonia* from sandy inland beach strands and coastal sand dune systems.

CHARACTERISTIC VEGETATION: Characteristic plant species in river channel portions of this community include hairy hudsonia*, silverling*, *Schizachyrium scoparium* (little bluestem), *Solidago simplex* ssp. *randii* var. *racemosa* (riverbank Rand's goldenrod), *Oenothera biennis* (common evening-primrose), *Polygonum articulatum* (coastal jointed knotweed), *Dichanthelium acuminatum* (hairy rosette-panicgrass), *Lechea intermedia* (round-fruited pinweed), and the moss *Polytrichum piliferum*. On pointbars, many of the same species are particularly important, but vegetation cover is often greater, particularly non-vascular species such as *Polytrichum piliferum* and *Cladonia cristatella* (British soldiers).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This natural community is apparently limited to a stretch of the upper Saco River in New Hampshire and Maine. A good example in New Hampshire is the Townline Gravel Barrens site (North Conway).

SOURCES: Rawinski 1985; Rawinski et al. 1988; Engstrom 1998; Nichols et al. 2001.

• Dwarf cherry river channel (S2)

GENERAL DESCRIPTION: This community typically occurs on channel bars and shelves scoured by floodwater and ice along the Connecticut and Pemigewasset Rivers. Following spring floods, they are typically dry (or merely moist) for most of the growing season and are characterized by the low-growing shrubs *Prunus pumila* var. *depressa* (eastern dwarf cherry) and *Prunus susquehanae* (Appalachian dwarf cherry). Dwarf cherries (also known as sand cherries) form clonal patches, sometimes trapping organic debris and creating fluvial sand dunes on their downstream side. The coarse substrate consists of sand, gravel, and cobble.

This community supports the highest cover of low shrubs (average cover 12%) of any open riparian community in the state. 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, and species richness ranges from few species with low cover to a moderate number of species 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.

CHARACTERISTIC VEGETATION: Dwarf cherry is always present and often dominant. Both species of dwarf cherry (*Prunus susquehanae* and *P. pumila* 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. (panicgrasses), *Agrostis perennans* (autumn bentgrass), and *Carex torta* (twisted sedge) may also be present. Forbs can include *Apocynum cannabinum* (hemp dogbane), *Solidago* spp. (goldenrods), *Symphyotrichum* ssp. (American-asters), *Galium* spp. (bedstraws), and several other less frequent herbs. Scattered, generally short shrubs and tree seedlings may include *Populus deltoides* (eastern cottonwood), *Acer saccharinum* (silver maple), *A. rubrum* (red maple), *Rubus hispidus* (bristly blackberry), *Toxicodendron radicans* (poison-ivy), *Swida* spp. (dogwoods), *Salix* spp. (willows), and *Alnus* spp. (alders). Exotic species are common in some examples.

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 community typically occurs along high-gradient riverbeds of small to medium-sized rivers in montane settings. The 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, though gravel and sand also occur among the boulders or cobble at some sites. Very little organic litter accumulates. This community is defined primarily by physical conditions and the presence of species tolerant of flood-scour disturbance.

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 at the 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.

CHARACTERISTIC VEGETATION: Woody seedlings often reflect the composition of the surrounding forest and include *Acer rubrum* (red maple), *Pinus strobus* (white pine), *Betula papyrifera* (paper birch), and *Quercus rubra* (red oak). Tall shrubs are usually present in low abundance. *Salix* spp. (willows) and *Alnus incana* ssp. *rugosa* (speckled alder) or *A. serrulata* (smooth alder) are found in most examples. Other characteristic shrubs may include *Rubus occidentalis* (black raspberry), *Sorbus decora* (showy mountain-ash), *Prunus pensylvanica* (pin cherry), *Corylus cornuta* (beaked hazelnut), *Myrica gale* (sweet gale), *Salix sericea* (silky willow), and *Rubus* spp. (brambles). *Vaccinium cespitosum* (dwarf blueberry)*, characteristic of alpine areas and northern riverbanks, may occur here or in adjacent riverbank habitat.

Grasses are common and may include *Agrostis* spp. (bentgrasses), *Phalaris arundinacea* (reed canary grass), *Schizachyrium scoparium* (little bluestem), *Deschampsia flexuosa* (wavy hair grass), *Calamagrostis canadensis* (bluejoint), *C. pickeringii* (Pickering's reed grass), *C. stricta* ssp. *inexpansa* (northern neglected reed grass)*, *Danthonia spicata* (poverty oatgrass), and *Panicum* spp. (panicgrasses). Other herbs include *Doellingeria umbellata* (tall white-aster), *Solidago bicolor* (white goldenrod), *Eutrochium maculatum* (spotted Joe-Pye weed), *Houstonia caerulea* (little bluet), *Carex torta* (twisted sedge), and *Fragaria virginiana* (common 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 community of high-energy environments 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 an example of 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. (bentgrasses), *Calamagrostis canadensis* (bluejoint), *Panicum* spp. (panicgrasses), *Schizachyrium scoparium* (little bluestem), *Andropogon gerardii* (big bluestem), *Carex torta* (twisted sedge), *Apocynum cannabinum* (hemp dogbane), *Symphyotrichum* ssp. (American-asters), *Solidago* spp. (goldenrods), *Persicaria* spp. (smartweeds), *Eutrochium* 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* (heart-leaved willow), *S. lucida* (shining willow), *Toxicodendron radicans* (poison-ivy), *Rubus* spp. (brambles), and seedling-sized *Acer saccharinum* (silver maple), *A. rubrum* (red maple), and *Alnus incana* ssp. *rugosa* (speckled alder). Southern and central New Hampshire examples may support *Lespedeza capitata* (round-headed bush-clover), *Argentina anserina* (common silverweed)*, *Physostegia virginiana* (obedient false dragonhead), and seedlings of *Platanus occidentalis* (sycamore) and *Populus deltoides* (eastern cottonwood).

CLASSIFICATION CONFIDENCE: 2

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.

• Mesic herbaceous river channel (S4)

GENERAL DESCRIPTION: GENERAL DESCRIPTION: This community occurs on low riverbanks, channel shelves, and bars subjected to flood and ice scour. Sandy to sand-cobble soils are flooded early in the growing season and range from being wet through much or all of the growing season in lower areas to more mesic on slightly higher ground. Even higher portions of this community in some examples dry out in late summer, supporting many stress tolerant short to medium height graminoids also found in sandy pond shores, such as cut grasses, rushes, bulrushes, spikesedges, and other sedges. Herbaceous cover ranges from sparse to moderate.

This community is one of the lowest in the channel supporting emergent species and may be adjacent to aquatic beds in deeper water. As with other communities associated with the river channel, this community migrates with channel shifts.

CHARACTERISTIC VEGETATION: This is a broadly defined community characterized by short to medium height, facultative wetland herbs and disturbance colonizers. Shrub and tree seedlings are absent to sparse. Species richness, composition, and cover from one example to the next can be quite variable and likely relates to the variable environmental conditions, propagule availability, and disturbance dynamics of stream channels. Graminoids that may be present include *Poa* spp. (blue grasses), *Panicum* spp. (panicgrasses), *Glyceria* spp. (mannagrasses), *Leersia* spp. (cut grasses), *Calamagrostis canadensis* (blue-joint), *Echinochloa* spp. (barnyard grasses), *Eragrostis* spp. (lovegrasses), *Agrostis* spp. (bentgrasses), *Phalaris arundinacea* (reed canary grass), *Juncus* spp. (rushes), *Eleocharis* spp. (spikesedges), *Carex* spp. (sedges), *Cyperus* spp. (umbrella sedges), and *Scirpus* spp. (bulrushes).

Forbs may include *Galium* spp. (bedstraws), *Cicuta* spp. (water-hemlocks), *Impatiens capensis* (spotted touch-me-not), several fern species, *Viola* spp. (violets), *Persicaria* spp. (smartweeds), *Hypericum* spp. (St. John's-worts), *Bidens* spp. (beggar-ticks), *Lycopus uniflorus* (northern water-horehound), *Iris versicolor* (blue iris), *Apocynum cannabinum* (hemp dogbane), *Eutrochium* spp. (Joe-Pye-weeds), *Lysimachia terrestris* (swamp yellow-loosestrife), *Lobelia cardinalis* (red lobelia), *Ludwigia palustris* (common water-

primrose), *Boehmeria cylindrica* (small-spiked false nettle), *Pilea pumila* (Canada clearweed), *Sium suave* (water-parsnip), *Cicuta* spp. (water-hemlocks), and several others.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is found statewide. Good examples occur along Berry's Brook (Rye), Lamprey River (Epping), Blackwater River (Salisbury), Livermore Falls (Holderness), Swift River (Albany), Saco River (Conway), and Merrimack River (Manchester).

SOURCES: NHB field surveys; Sperduto and Crow 1994; Nichols et al. 2001.

• 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, but 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%).

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* (heart-leaved willow), *S. nigra* (black willow), and *S. sericea* (silky willow), may characterize this community. Less frequent shrubs, seedling- (to sapling-) sized trees, and lianas include *Swida* spp. (dogwoods), *Alnus* spp. (alders), *Acer* spp. (maples), *Spiraea alba* var. *latifolia* (meadowsweet), *S. tomentosa* (rosy meadowsweet), *Rubus* spp. (brambles), *Ulmus americana* (American elm), and *Vitis* spp. (grapes). Some 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* (bluejoint), *Apocynum cannabinum* (hemp dogbane), and *Euthamia graminifolia* (common grass-leaved-goldenrod). Occasional species include *Solidago* spp. (goldenrods), *Eutrochium maculatum* (spotted Joe-Pye weed), *Lysimachia terrestris* (swamp yellow-loosestrife), *Viola* spp. (violets), *Persicaria* spp. (smartweeds), *Agrostis* spp. (bentgrasses), and *Panicum* spp. (panicgrasses). The non-native and invasive *Fallopia japonica* (Japanese knotweed) occurs in many 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 *Carex torta* (twisted sedge) dominated 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. Twisted sedge may occur in other natural communities but reaches its peak abundance in this type. Similar riparian communities have been described throughout the eastern United States.

The substrate is a variable mixture of rocks, gravel, and sand. The community sometimes reaches three feet

above the summer river level, but averages 10 inches.

CHARACTERISTIC VEGETATION: This community consists of a patchy herbaceous layer and scattered woody seedlings able to withstand frequent scouring by ice and floods. Twisted sedge is always present and forms large tussocks averaging 15% cover. Species present in low abundance include *Calamagrostis canadensis* (bluejoint), *Phalaris arundinacea* (reed canary grass), *Panicum* spp. (panicgrasses), *Apocynum cannabinum* (hemp dogbane), *Viola* spp. (violets), *Lysimachia terrestris* (swamp yellow-loosestrife), *Euthamia graminifolia* (common grass-leaved-goldenrod), *Eutrochium maculatum* (spotted Joe-Pye weed), *Onoclea sensibilis* (sensitive fern), *Salix* spp. (willows), *Rubus* spp. (brambles), *Spiraea alba* var. *latifolia* (meadowsweet), 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.

MEDIUM TO HIGH RIVERBANKS AND OPEN FLOODPLAINS

Medium to high riverbanks and open 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 finer 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 communities

• Herbaceous riverbank/floodplain (S4)

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 some meadow 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%. Soils are fine sands with some silt. This variant ranges from 1.0–1.8 m above midseason water levels. Its full distribution and abundance are not well documented.
2. **Bluejoint 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* (bluejoint). 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 bluejoint characterizes this variant. Associates include *Carex stricta* (tussock sedge), *C. lacustris* (lake sedge), reed canary grass, *Spiraea alba* var. *latifolia* (meadowsweet), *Swida amomum* (silky dogwood), *Viburnum dentatum* var. *lucidum* (smooth arrowwood), *V. 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* (wrinkle-leaved goldenrod), *Vitis aestivalis* var. *bicolor* (silverleaf summer grape), *Acer negundo* (ash-leaved maple), *Toxicodendron radicans* (poison-ivy), *Lonicera morrowii* (Morrow's honeysuckle), *Parthenocissus quinquefolia* (Virginia-creeper), *Rubus allegheniensis* (common blackberry), and *Fallopia japonica* (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 ferns, 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 in the riparian zone than the ***cobble - sand river channel*** but lower than ***alder alluvial shrublands***. 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 *Euthamia graminifolia* (common grass-leaved-goldenrod), *Potentilla norvegica* (Norwegian cinquefoil), *Carex scoparia* (pointed broom sedge), *C. debilis* var. *rudgei* (white-edged sedge), *C. stricta* (tussock sedge), *C. folliculata* (northern long sedge), *Bromus ciliatus* (fringed brome), *Muhlenbergia mexicana* (Mexican muhly), *Calamagrostis stricta* var. *inexpansa* (northern neglected reed grass)*, *Calamagrostis* spp. (bentgrasses), *Juncus effusus* ssp. *solutus* (loosened soft rush), *Ribes* spp. (currants), and several species of non-*Sphagnum* moss. Medium-height shrubs such as meadowsweet and *Spiraea tomentosa* (rosy meadowsweet) are occasional or locally abundant. In one rare example, the variant was dominated by a dense cover (75%) of *Osmunda claytoniana* (interrupted fern).

5. **Lesser bladder sedge variant:** This variant is dominated by *Carex vesicaria* (lesser bladder sedge) with lesser amounts of *Scirpus cyperinus* (woolly bulrush), *Glyceria canadensis* (rattlesnake mannagrass), reed canary grass, tussock sedge, and meadowsweet. Infrequent plants are *Cicuta bulbifera* (bulblet-bearing water-hemlock), *Persicaria sagittata* (arrow-leaved tearthumb), *Boehmeria cylindrica* (small-spiked false nettle), *Convolvulus arvensis* (field bindweed), and other species. This sedge-dominated meadow also supports a low shrub cover. The soil is silt and fine sand. Moderate-sized swales supporting this meadow are sometimes intermixed in a mosaic dominated by silky dogwood.

6. **Big bluestem variant:** *Andropogon gerardii* (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

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 bluejoint 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 lesser bladder sedge variant occurs along the Winnicut River. The big bluestem variant is found at Manchester River Outcrops

(Manchester), Garvins Falls (Concord), and Bellows Falls (Walpole).

SOURCES: Nichols et al. 2001.

• Bluejoint - goldenrod - virgin's bower riverbank/floodplain (S3S4)

GENERAL DESCRIPTION: This temporarily flooded, meadow-like community occurs on riverbanks and adjacent floodplains of small "flashy" rivers and major streams. It is characterized by tall graminoids, goldenrods and other tall forbs, vines, and less frequently, lianas, shrubs, ferns, and trees. This community averages 1.1 m above midseason river water levels. 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* (bluejoint), *Solidago rugosa* (wrinkle-leaved goldenrod), *S. 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 *Doellingeria umbellata* (tall white-aster), *Eutrochium* spp. (Joe-Pye weeds), *Euthamia graminifolia* (common grass-leaved-goldenrod), *Symphyotrichum* ssp. (American-asters), *Solidago canadensis* (Canada goldenrod), *Apios americana* (common ground-nut), *Thalictrum pubescens* (tall meadow-rue), *Iris versicolor* (blue iris), *Galium* spp. (bedstraws), *Viola* spp. (violets), *Persicaria* spp. (smartweeds), *Lycopus uniflorus* (northern water-horehound), *Lysimachia terrestris* (swamp yellow-loosestrife), *Lythrum salicaria* (purple loosestrife), *Impatiens capensis* (spotted touch-me-not), *Juncus* spp. (rushes), *Carex* spp. (sedges), *Scirpus* spp. (bulrushes), *Panicum* spp. (panicgrasses), *Glyceria* spp. (mannagrasses), *Agrostis* spp. (bentgrasses), *Elymus* spp. (wild-ryes), *Bromus ciliatus* (fringed brome), *Onoclea sensibilis* (sensitive fern), *Thelypteris palustris* var. *pubescens* (marsh fern), *Athyrium angustum* (lady fern), *Osmunda* and *Osmundastrum* spp. (ferns), 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* ssp. *rugosa* (speckled alder), *Salix* spp. (willows), *Spiraea* spp. (meadowsweets), *Rubus* spp. (brambles), *Vitis* spp. (grapes), *Acer saccharinum* (silver maple), *A. rubrum* (red maple), *Swida* spp. (dogwoods), *Ulmus americana* (American elm), *Toxicodendron radicans* (poison-ivy), *Sambucus nigra* ssp. *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.

Shrub-dominated communities

• Alder alluvial shrubland (S3)

GENERAL DESCRIPTION: This natural community is a patchy shrubland dominated either by *Alnus incana* ssp. *rugosa* (speckled alder) or *A. serrulata* (smooth alder). Other woody species and herbs are usually sparse in moderate-energy settings, but moderately dense to dense in lower-energy floodplains and settings with silt soils. This community often occurs as a band (<1–10 m wide) along rivers for hundreds of meters, or forms wider expanses on silt plains in broader valley bottoms.

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 often lean in the direction of river flow, with their bark 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 substrates.

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 from this community in having a more even and diverse mix of shrub species. Adjacent areas with more frequent overbank flow or recently drained beaver ponds can support communities such as ***bluejoint - goldenrod - virgin's bower riverbank/floodplain*** or ***tall graminoid meadow marsh*** (bluejoint variant).

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 soil averages 5.1. 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.

   Speckled alder or, less frequently, smooth alder dominates this variant. Bryophytes are almost entirely absent. Though not abundant, common associates are *Swida sericea* (red-osier dogwood), *Salix sericea* (silky willow), *Spiraea alba* var. *latifolia* (meadowsweet), *Solidago* spp. (goldenrods), *Doellingeria umbellata* (tall white-aster), *Euthamia graminifolia* (common grass-leaved-goldenrod), *Lysimachia terrestris* (swamp yellow-loosestrife), *Calamagrostis canadensis* (bluejoint), and *Panicum* spp. (panicgrasses). In some examples, herbs and shrubs contribute greater cover (5–15%) including *Clematis virginiana* (virgin's bower), *Onoclea sensibilis* (sensitive fern), *Ilex verticillata* (common winterberry), *Rubus occidentalis* (black raspberry), and *Acer rubrum* (red maple).

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. Speckled alder and bryophytes dominate this variant. Other significant species (5–10% cover) are *Viola* spp. (violets), *Eutrochium maculatum* (spotted Joe-Pye weed), and *Houstonia caerulea* (little bluet). The rare *Neottia 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. Also, cut over examples of that community 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. More southern examples may exist.

Frequent species include red-osier dogwood, bluejoint, *Glyceria melicaria* (northeastern mannagrass), *Thalictrum pubescens* (tall meadow-rue), *Rubus pubescens* (dwarf raspberry), *Impatiens capensis* (spotted touch-me-not), *Solidago rugosa* (wrinkle-leaved goldenrod), tall white-aster, spotted Joe-Pye weed, *Symphyotrichum puniceum* (purple-stemmed American-aster), sensitive fern, and *Dryopteris intermedia* (evergreen wood fern). Occasional species include *Betula papyrifera* (paper birch), *Viburnum edule* (squashberry), *Sambucus racemosa* (red elderberry), *Athyrium angustum* (lady fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Dryopteris cristata* (crested wood fern), *Solidago flexicaulis* (zig-zag goldenrod), *Tiarella cordifolia* (foam-flower), *Geum rivale* (water avens), *Ranunculus recurvatus* (hooked crowfoot), *Arisaema triphyllum* (Jack-in-the-pulpit), *Chelone glabra* (white turtlehead), *Brachyelytrum aristosum* (northern short husk grass), and *Carex intumescens* (greater bladder sedge).

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 is a broadly defined community consisting of shrub thickets on loam and fine- to medium-grained sands subjected to flooding early in the year. Shrub cover is typically moderate to high and often consists of a mix of several shrub species. Variation in species composition and cover likely relates to the variable environmental conditions and disturbance dynamics of stream channels, as well as propagule availability. This community may occur as broad floodplain thickets along major rivers or as narrow zones along large streams and rivers.

This community is distinct from ***alder alluvial shrubland***, which typically occurs on coarser sand in more moderate-energy settings. Some examples are dominated by one species [e.g., *Swida sericea* (red-osier dogwood)] and warrant consideration as their own community.

CHARACTERISTIC VEGETATION: Common shrubs that may be locally dominant include *Swida amomum* (silky dogwood), *Alnus incana* ssp. *rugosa* (speckled alder), *A. serrulata* (smooth alder), red-osier dogwood, *Salix* spp. (willows), *Viburnum dentatum* var. *lucidum* (smooth arrowwood), *Ilex verticillata* (common winterberry), and *Spiraea alba* var. *latifolia* (meadowsweet). Trees, lianas, and other shrubs include *Acer rubrum* (red maple), *A. saccharinum* (silver maple), *Ulmus americana* (American elm), *Toxicodendron radicans* (poison-ivy), *Vitis* spp. (grapes), *Rubus* spp. (brambles), *Clethra alnifolia* (sweet pepperbush; near the coast), *Viburnum lentago* (nannyberry), *V. nudum* var. *cassinoides* (withe-rod), *Rosa palustris* (swamp rose), *Frangula alnus* (glossy false buckthorn), *Spiraea tomentosa* (rosy meadowsweet), and *Sambucus nigra* ssp. *canadensis* (common elderberry).

A moderate diversity of herbs may also be present, including *Euthamia graminifolia* (common grass-leaved-goldenrod), *Solidago* spp. (goldenrods), *Symphyotrichum* ssp. (American-asters), *Eutrochium* spp.

(Joe-Pye weeds), *Lysimachia terrestris* (swamp yellow-loosestrife), *L. ciliata* (fringed yellow-loosestrife), *Galium* spp. (bedstraws), *Clematis virginiana* (virgin's bower), *Boehmeria cylindrica* (small-spiked false nettle), *Lycopus uniflorus* (northern water-horehound), *Impatiens capensis* (spotted touch-me-not), *Cicuta maculata* (spotted water-hemlock), *Viola* spp. (violets), *Thalictrum pubescens* (tall meadow-rue), *Cinna arundinacea* (sweet wood-reed), *Calamagrostis canadensis* (bluejoint), *Poa* spp. (blue grasses), *Agrostis* spp. (bentgrasses), *Glyceria* spp. (mannagrasses), *Carex* spp. (sedges), *Thelypteris palustris* var. *pubescens* (marsh fern), *Osmunda* and *Osmundastrum* spp. (ferns), and *Onoclea sensibilis* (sensitive fern).

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 (S3S4)

GENERAL DESCRIPTION: This thicket community occurs on riverbanks and open floodplains of large streams and small rivers throughout the state. The substrate is flooded when stream water levels are high in the spring. Shrub cover is moderate to high and dominated by *Spiraea alba* var. *latifolia* (meadowsweet). Other shrubs may be present in low (to low-moderate) cover. A shallow organic horizon often lies above a wet to mesic silt and fine sandy soil.

CHARACTERISTIC VEGETATION: Meadowsweet dominates this community. Several other woody species may be present, including *Viburnum nudum* var. *cassinoides* (withe-rod), *Rhododendron canadense* (rhodora), *Rubus* spp. (brambles), *Aronia melanocarpa* (black chokeberry), *Lyonia ligustrina* (maleberry), *Chamaedaphne calyculata* (leatherleaf), *Prunus virginiana* (choke cherry), and seedling- and sapling-sized *Acer rubrum* (red maple), *Prunus serotina* (black cherry), and *Abies balsamea* (balsam fir). Common herbs include *Calamagrostis canadensis* (bluejoint), *Bromus ciliatus* (fringed brome), *Carex lurida* (sallow sedge), *C. stricta* (tussock sedge), *C. debilis* var. *rudgei* (white-edged sedge), *C. intumescens* (greater bladder sedge), *Scirpus* spp. (bulrushes), *Lysimachia terrestris* (swamp yellow-loosestrife), *Lycopus* spp. (water-horehounds), *Iris versicolor* (blue iris), and *Solidago* spp. (goldenrods).

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.

• Mixed alluvial shrubland (S4)

GENERAL DESCRIPTION: This broadly defined community occurs on sandy to cobbly channel shelves. It forms a woody transition zone between more open riparian communities such as low riverbanks closer to the river channel and floodplain forests at higher elevations. It is distinguished by thickets of tree saplings and tall shrubs, often interspersed with sizable patches of bare, coarse substrate. Tree saplings and shrubs total more than 25% cover. Low shrub, grass, and herb species are often present. It has a variable mixture of medium to coarse sand, gravel, cobbles, and boulders, and is typically very well drained at low water. Most examples are less than one acre in size. They occur both as narrow bands and as broader patches. They are highly dynamic and likely shift with point bar migration. Invasive plant species are common and occasionally abundant in this natural community.

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.

Similar riparian shrub communities include two alder-dominated types: 1) ***alder alluvial shrubland***; and 2) ***alder - dogwood - arrowwood alluvial thicket***. ***Willow low riverbanks*** sit lower on the bank, are dominated by willows, and have coarser substrates, indicating higher-energy river flow.

CHARACTERISTIC VEGETATION: Variable patches of shrubs and tree saplings are interspersed with open, sand and cobble areas, ranging from 10% to 50% cover. *Spiraea alba* var. *latifolia* (meadowsweet), *Salix* spp. [willows, especially *Salix sericea* (silky willow) and *S. eriocephala* (heart-leaved willow)], and *Betula* spp. (birches) and other tree saplings are most characteristic. Some examples have *Swida amomum* (silky dogwood), *Salix nigra* (black willow), *Betula papyrifera* (paper birch), *B. populifolia* (gray birch), *Quercus rubra* (red oak), *Acer saccharinum* (silver maple), *A. rubrum* (red maple), *Fraxinus americana* (white ash), *Alnus serrulata* (smooth alder), *Pinus strobus* (white pine), *Prunus pumila* var. *depressa* (eastern dwarf cherry), *Comptonia peregrina* (sweet-fern), *Parthenocissus quinquefolia* (Virginia-creeper), *Rhus hirta* (staghorn sumac), and *Populus* spp. (aspens). These species may appear as scattered individuals where they are not dominant. Herbs are also common and can include *Solidago* spp. (goldenrods), *Schizachyrium scoparium* (little bluestem), *Dichanthelium clandestinum* (deer-tongue rosette-panicgrass), *Sorghastrum nutans* (Indian grass), *Phalaris arundinacea* (reed canary grass), and *Calamagrostis canadensis* (bluejoint). The state-rare *Pycnanthemum virginianum* (Virginia mountain-mint)* occurs in some examples.

Invasive species are common and include *Frangula alnus* (glossy false buckthorn), *Fallopia japonica* (Japanese knotweed), *Lonicera morrowii* (Morrow's honeysuckle), *Cynanchum louiseae* (black swallowwort), *Lythrum salicaria* (purple loosestrife), and *Robinia pseudoacacia* (black locust).

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.

RIPARIAN OUTCROPS, SEEPS, BLUFFS, AND SANDY PLAINS

Riverbank outcrops typically occur in river narrows and settings where ice and water scour are intense enough to expose considerable amounts of bedrock. Vegetative cover on these outcrops is low and includes both flood- and drought-tolerant species. Riverbank outcrop communities occur on bedrock that yields both acidic and circumneutral soil conditions. Riverside seeps occur on open bedrock, cobble, sand, or silt substrates of flood scoured shores of larger rivers, and both acidic and calcareous types are present in New Hampshire. Dry and mesic river bluff communities occur along the outside bends of meanders on major or minor rivers in sand plain settings (thick outwash and old glacial lakebed deposits). 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. Flood-tolerant forbs and grasses are the dominant life forms. 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.

Emergent seepage is absent, as are the species characteristic of seeps, although the community may occur in conjunction with seep communities. 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.

CHARACTERISTIC VEGETATION: Vegetation is usually extremely sparse, but characterized by a diverse array of forbs and grasses including *Hieracium* spp. (hawkweeds), *Symphyotrichum novi-belgii* (New York American-aster), *Euthamia graminifolia* (common grass-leaved-goldenrod), *Athyrium angustum* (lady fern), *Schizachyrium scoparium* (little bluestem), *Andropogon gerardii* (big bluestem), *Agrostis perennans* (autumn bentgrass), *Deschampsia anadyrensis* (glaucous hair grass), *Juncus tenuis* (path rush), and several other species. *Carex torta* (twisted sedge) and seedling-sized *Salix* spp. (willows), *Sorbus* spp. (mountain-ashes), and *Alnus incana* ssp. *rugosa* (speckled alder) may survive here, but remain scattered. Mosses may be abundant and help stabilize the soil.

Northern New Hampshire examples are likely to have *Danthonia compressa* (flattened oatgrass), *Vaccinium cespitosum* (dwarf blueberry)*, *Sibbaldiopsis tridentata* (three-toothed cinquefoil), *Trisetum spicatum* (narrow false oat), and less frequently, seedling-sized *Populus balsamifera* (balsam poplar) and *Thuja occidentalis* (northern white cedar). Dwarf blueberry* and three-toothed cinquefoil are typically otherwise restricted to alpine areas and high-elevation outcrops. The rare *Hieracium robinsonii* (Robinson's hawkweed)*, known in New Hampshire from only one site, occurs in this community.

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 occur 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 at river narrows. Height above the river channel appears to influence species composition and plant size. Wetland species are often restricted to the lower 2–3 m above the channel. 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* (Scotch bellflower), *Packera paupercula* (balsam groundsel)*, *Astragalus robbinsii* var. *jesupii* (Jesup's milk-vetch)*, *Allium schoenoprasum* (wild chives)*, *Woodsia ilvensis* (rusty cliff fern), and *Polystichum acrostichoides* (Christmas fern). Species found on ***acidic riverbank outcrops*** may also be found in this community, including *Symphyotrichum* ssp. (American-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 on the 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 riverside seeps*** by the absence of rich-site indicators and from ***acidic riverbank outcrops*** by the presence of acidic, wet-site indicators.

CHARACTERISTIC VEGETATION: Species include *Chamaedaphne calyculata* (leatherleaf), *Vaccinium macrocarpon* (large cranberry), *Rhododendron canadense* (rhodora), *Lyonia ligustrina* (maleberry), *Spiraea alba* var. *latifolia* (meadowsweet), *Alnus* spp. (alders), *Agalinis* spp. (agalinis), *Viola lanceolata* (lance-leaved violet), *Drosera rotundifolia* (round-leaved sundew), *Lysimachia terrestris* (swamp yellow-loosestrife), *Houstonia caerulea* (little bluet), *Hypericum* spp. (St. Johns-worts), *Carex canescens* (hoary sedge), *Scirpus cyperinus* (woolly bulrush), *Matteuccia struthiopteris* ssp. *pensylvanica* (ostrich fern), mosses, and liverworts. Northern occurrences may have such species as *Picea mariana* (black spruce), *Gaultheria hispidula* (creeping spicy-wintergreen), and *Rhododendron groenlandicum* (Labrador tea). When present, drier outcrop areas often support such species as *Schizachyrium scoparium* (little bluestem), *Andropogon gerardii* (big bluestem), *Panicum* spp. (panicgrasses), *Symphyotrichum* ssp. (American-asters), *Euthamia graminifolia* (common 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.

Soils tend to be turfy sands (i.e., sand impregnated with a tightly-woven, fine root mass) wedged in boulders, cobbles and cracks in outcrops. Annual flooding prevents the accumulation of organic matter. Less often, seep vegetation can be found in unconsolidated sediments of steep river terraces or on silty banks. Partial shading from trees and shrubs is common. These seeps appear to be restricted to areas with considerable calcareous bedrock influence, or at least mineral-enriched groundwater. The pH of seepage water ranges from 6.8 to 8.2.

CHARACTERISTIC VEGETATION: Dominant plant species can vary between examples, though characteristic and rare forbs, grasses, and sedges are always present. These may include *Lobelia kalmii* (brook lobelia)*, *Triantha glutinosa* (sticky false asphodel)*, *Parnassia glauca* (fen grass-of-Parnassus)*, *Packera paupercula* (balsam groundsel)*, *Mimulus moschatus* (musky monkey-flower)*, *Spiranthes lucida* (shining ladies'-tresses)*, *Carex garberi* (elk sedge)*, *Rhynchospora capillacea* (needle beaksedge)*, *Scirpus* spp., *Equisetum variegatum* (variegated scouring-rush), and *Houstonia caerulea* (little bluet).

On drier areas, a mix of *Andropogon gerardii* (big bluestem), *Schizachyrium scoparium* (little bluestem),

Deschampsia anadyrensis (glaucous hair grass), *Campanula rotundifolia* (Scotch bellflower), *Toxicodendron radicans* (poison-ivy), and *Prunus pumila* var. *depressa* (eastern dwarf cherry) may occur. Shrub border areas include *Swida sericea* (red-osier dogwood), *Alnus viridis* ssp. *crispa* (green alder), *Spiraea alba* var. *latifolia* (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.

• Riverwash plain and dunes (S1)

GENERAL DESCRIPTION: In New Hampshire, this globally rare community is known only from high terraces associated with the broad meanders of the upper Merrimack River in Canterbury. Flood and fire dynamics have been operating on these riverwash plains for thousands of years. Periodic scouring during major flood events buries the plains with fresh sand and gravel deposits. Subsequent re-working of sand deposits by wind has formed 0.5–1.5 m dunes on portions of the plains. The two largest examples of this community are 6–12 ha. in size and 1.5–3 m above the current average river level. A smaller example is 7.5 m above the river. The lowest plain was overtopped during the spring floods of 2006, reaching the base of some of the dunes.

Floodplains supporting this community range from unvegetated to wooded, depending on the degree of natural and human disturbance. This community can include woodland pockets surrounded by areas of open sand, but does not include extensive forested areas on these floodplains. Open areas support a sparse to moderate cover of drought-tolerant grasses, sedges, forbs, and a cryptogamic crust (some combination of mosses, lichens, fungi, bacteria, and algae). Shrubs and tree saplings are widely scattered overall, but are more abundant at the community margins.

Soils consist of fine sand near the surface, with a fine gravel "pavement."

CHARACTERISTIC VEGETATION: The open riverwash plains contain less than 1% cover of vascular plants and zero to 100% local cover of cryptogamic organisms. Vascular plants here include *Schizachyrium scoparium* (little bluestem), *Carex tonsa* (shaved sedge), *Lechea maritima* (beach pinweed), and *Polygonum articulatum* (coastal jointed knotweed). These plants are also found in active dune areas along with *Ionactis linariifolia* (flax-leaved stiff-aster), *Rumex acetosella* ssp. *pyrenaicus* (sheep dock), *Panicum* spp. (panicgrasses), *Andropogon gerardii* (big bluestem), and the rare *Cenchrus longispinus* (long-spined sandbur)*. Other plants in open to semi-wooded dune areas include *Poa compressa* (flat-stemmed blue grass), *Dichanthelium linearifolium* (linear-leaved rosette-panicgrass), *D. clandestinum* (deer-tongue rosette-panicgrass), *Eragrostis spectabilis* (purple lovegrass), *Agrostis scabra* (rough bentgrass), *Aristida basiramea* (fork-tipped threeawn), *Digitaria cognata* (fall crabgrass), *Juncus greenei* (Greene's rush), *Cyperus dentatus* (bulblet umbrella sedge), *C. filicinus* (beach umbrella sedge), *Trichostema dichotomum* (forked bluecurls), *Oenothera parviflora* (small-flowered evening-primrose), *Solidago bicolor* (white goldenrod), *S. nemoralis* (gray goldenrod), *Diphasiastrum tristachyum* (blue ground-cedar), *Rubus idaeus* ssp. *strigosus* (strigose red raspberry), *Juniperus communis* var. *depressa* (common juniper), and *Comptonia peregrina* (sweet-fern). Lawns of the rare *Carex siccata* (dry land sedge)* are found near woodland borders. Trees forming woodland inclusions include *Quercus coccinea* (scarlet oak), *Q. velutina* (black oak), *Q. rubra* (red oak), *Pinus strobus* (white pine), *P. rigida* (pitch pine), and *Prunus serotina* (black cherry).

CLASSIFICATION CONFIDENCE: 1–2

DISTRIBUTION: This natural community is globally restricted to New England, where it only occurs along a

limited stretch of the Merrimack River in Canterbury, New Hampshire and in the Kennebec Plains area of Maine. The two documented New Hampshire examples are the Canterbury Dunes on the town property off Intervale Road and on the point bar just upstream from Muchyedo Meander.

SOURCES: NHB Field Surveys; Field (2004); Pendleton (1995a and 1995b); Sperduto (1994a); TNC (1994); USGS (1927).

• Dry river bluff (S2S3)

GENERAL DESCRIPTION: This community consists of sloughing, dry, sandy riverbanks. They occur along the outside bends of meanders on major or minor rivers that flow through thick outwash and old glacial lakebed deposits on sand plain settings. Some examples are over one hundred feet high. Bluffs occur where a river cuts into a terrace to form steep slopes, often to the angle of repose. These slopes are highly unstable. As the river erodes sand at the base, the areas higher on the slope slide downward, continually exposing fresh sand. The sand is 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 sandy areas to a woodland structure, depending on past disturbance.

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 on some south and west-facing slopes and bluff edges support populations of the rare species *Lupinus perennis* (wild lupine)* and *Hudsonia ericoides* (golden heather)*. These plants are able to persist on these slopes despite the destabilizing effects of riverbank erosion and groundwater seepage. Some stretches of bluff at these sites are too unstable to support wild lupine* or golden heather*; other 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 perpetuation of this community depends on the preservation of large areas of riparian 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 oatgrass), *Bromus inermis* (smooth brome), *Elymus repens* (creeping wild-rye), *Agrostis gigantea* (redtop bentgrass), *Carex brevior* (short-beaked sedge) and other *Carex* in section Ovales, *C. tonsa* (shaved sedge), *Lespedeza capitata* (round-headed bush-clover), *Polygonum articulatum* (coastal jointed knotweed), *Lechea intermedia* (round-fruited pinweed), *Aralia hispida* (bristly sarsaparilla), *Ageratina altissima* (white snakeroot), *Viola sagittata* var. *ovata* (arrowhead violet), *Oenothera biennis* (common evening-primrose), *Erechtites hieraciifolius* (American burnweed), *Veronica officinalis* (common speedwell), *Lupinus perennis* (wild lupine)*, *Hudsonia ericoides* (golden heather)*, *Comptonia peregrina* (sweet-fern), *Betula populifolia* (gray birch), *B. papyrifera* (paper birch), and mosses.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is only found in limited areas within New Hampshire. Good examples occur along the Lower Saco (Conway) and Soucook (Concord) Rivers, and the Merrimack River (Concord).

SOURCES: NHB field surveys; Engstrom 1997.

MARSHES, SHRUB THICKETS, AND AQUATIC BEDS

The following communities occur in low-energy settings along streams and rivers, open-basins (those with outlets), closed-basins (no outlets) with broadly fluctuating water levels, and on shady, wave-exposed lake and pond shores. These settings contrast with both higher-energy riparian environments and stagnant basins that accumulate peat (covered elsewhere in the Open Wetlands and Riparian Communities section).

OPEN-BASINS AND STREAMSIDES

These drainage marsh communities occur on fine mineral to organic substrates (sand, muck, or shallow muck over sand or silt) along streams or open basins (i.e., those that have an outlet). Communities are mostly seasonally to semi-permanently flooded; aquatic beds are an exception, being permanently flooded or only intermittently exposed. Marshes and aquatic bed communities found along rivers and major streams typically occur 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.

Meadow marshes

This is a broad category of communities characterized by permanently saturated to seasonally flooded mineral, muck, or shallow fibrous peat soils, and 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 of water during spring snowmelt but have considerably lower water levels by mid to late summer. Rhizomatous, clonal species are common in marshes, and what species dominates at a site is strongly influenced by both 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 meadow marsh plants include *Calamagrostis canadensis* (bluejoint), *Glyceria canadensis* (rattlesnake mannagrass), *Leersia virginica* and *L. oryzoides* (cut grasses), *Phalaris arundinacea* (reed canary grass), *Dulichium arundinaceum* (three-way sedge), *Carex stricta* (tussock sedge), *C. lacustris* (lake sedge), *Scirpus cyperinus* (woolly bulrush), *Juncus canadensis* (Canada rush), *Eutrochium dubium* (coastal plain Joe-Pye weed), *E. maculatum* (spotted Joe-Pye weed), *Iris versicolor* (blue iris), and *Thalictrum pubescens* (tall meadow-rue). Meadow marshes may be successional to scrub-shrub swamps and ultimately forested swamps over the course of decades. Conversely, they may revert to either deeper water marshes or aquatic beds following submergence caused by damming of the drainage.

The federally endangered *Scirpus ancistrochaetus* (northeastern bulrush)* occurs in some meadow marshes (as well as emergent marshes). Other potential rare species of meadow marshes include *Mikania scandens* (climbing hempvine)*, *Lysimachia thyrsiflora* (tufted yellow-loosestrife)*, *Iris prismatica* (slender blue iris)*, *Carex trichocarpa* (hairy-fruited sedge)*, *Bidens laevis* (smooth beggar-ticks)*, and *B. discoidea* (small beggar-ticks).

In many cases, meadow marshes are mixed in composition or are transitional to shrub thickets. In other circumstances, one or two species clearly dominate. Numerous associations or dominance types can occur, which may deserve distinction as natural community types with expanded sampling and research.

• Tall graminoid meadow marsh (S4)

GENERAL DESCRIPTION: This meadow 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* (bluejoint), *Glyceria canadensis* (rattlesnake mannagrass), *Leersia virginica* and *L. oryzoides* (cut grasses), *Phalaris arundinacea* (reed canary grass), *Dulichium arundinaceum* (three-way sedge), *Carex stricta* (tussock sedge), *C. lacustris* (lake sedge), *Scirpus cyperinus* (woolly bulrush), *Juncus canadensis* (Canada rush), *Eutrochium dubium* (coastal plain Joe-Pye weed), *E. maculatum* (spotted Joe-Pye weed), *Iris versicolor* (blue iris), 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.

1. **Bluejoint variant**: This common variant is dominated by bluejoint. They are often inundated for shorter periods or do not sustain water as close to the surface for as long compared to other meadow marshes.
2. **Tussock sedge variant**: This variant is dominated by tussock sedge.
3. **Bulrush variant**: These marshes are dominated by bulrushes, most commonly woolly bulrush.
4. **Reed canary grass variant**: 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 common meadow marsh scrub-shrub type occurring along stream drainageways and open basins. It is similar to ***tall graminoid meadow marsh*** but has a substantial component of medium- and tall-height shrubs (up to 60% cover overall). Many examples are successional between marsh and shrub thicket or swamp. The substrate consists of a thin, well-decomposed organic layer over fine mineral soils or fine mineral soils with a high organic content.

CHARACTERISTIC VEGETATION: Species include a mixture of tall graminoids such as *Calamagrostis canadensis* (bluejoint) and *Carex stricta* (tussock sedge), other tall grasses and sedges, *Osmundastrum cinnamomeum* (cinnamon fern), *Osmunda regalis* var. *spectabilis* (royal fern), and medium-height shrubs *Spiraea alba* var. *latifolia* (meadowsweet), and *Myrica gale* (sweet gale). Tall shrubs include *Vaccinium corymbosum* (highbush blueberry), *Lyonia ligustrina* (maleberry), *Ilex verticillata* (common winterberry), *Alnus incana* ssp. *rugosa* (speckled alder), *Viburnum nudum* var. *cassinoides* (withe-rod), and *Salix* spp. (willows). *Sphagnum* moss is infrequent. This community is transitional to streamside poor fens that have a greater abundance of *Sphagnum* moss, *Chamaedaphne calyculata* (leatherleaf), sweet gale, and "peatland" sedges such as *Carex utriculata* (swollen-beaked sedge) and *C. lasiocarpa* (wire sedge).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Occurs throughout the state. Good examples can be found at Pawtuckaway State Park (Nottingham).

SOURCES: NHB field surveys.

• Sedge meadow marsh (S4)

GENERAL DESCRIPTION: This community is transitional between fens and marshes, with well-decomposed organic matter, often with a significant cover (25% to over 50%) of *Sphagnum* moss, but dominated by graminoids and forbs of at least weakly minerotrophic and more marshy tendencies (i.e., they are not restricted to fen habitats). Many are probably former swamps or medium level fens with grounded peat mats, occurring in beaver drainages or late-successional beaver meadows that developed into meadow marshes following dam-abandonment and subsequent paludification of the basin. This community likely succeeds into ***mixed tall graminoid - scrub-shrub marsh*** or shrub swamp or, depending on dominant hydrologic regime, to various types of forested swamps (for the northern variant these could be ***larch - mixed conifer swamp*** or ***northern hardwood - black ash - conifer swamp***). With paludification, this community could become a fen. With renewed impoundment by beavers, it could retrogress to a wetter marsh or aquatic bed.

This community is distinguished from ***floating marshy peat mats*** by vegetation differences and a mostly grounded (rather than floating) substrate. It is distinguished from ***marshy moats*** by the moat's position along peatland margins in that community, and by the relatively narrow width of most moats.

The substrate consists of mostly grounded, well-decomposed organic soils or mineral soils with a high organic content. It is often saturated, with pHs between 4.4 and 5.7 and with relatively little microtopography.

CHARACTERISTIC VEGETATION: Characteristic species include *Carex canescens* (hoary sedge), *C. stricta* (tussock sedge), *C. utriculata* (swollen-beaked sedge), *Calamagrostis canadensis* (bluejoint), *Dulichium arundinaceum* (three-way sedge), *Scirpus cyperinus* (woolly bulrush), *Juncus* spp. (rushes), *Iris versicolor* (blue iris), *Lycopus uniflorus* (northern water-horehound), *Lysimachia terrestris* (swamp yellow-loosestrife), *Triadenum virginicum* (Virginia marsh-St. John's-wort), *Sagittaria latifolia* (common arrowhead), *Sparganium americanum* (American bur-reed), and *Sphagnum* moss. Other species are *Carex echinata* (star sedge), *C. lacustris* (lake sedge), *C. lasiocarpa* (wire sedge), *Eleocharis* spp. (spikesedges), *Typha latifolia* (broad-leaved cattail), *Hypericum* spp. (St. John's-worts), *Doellingeria umbellata* (tall white-aster), and *Osmundastrum cinnamomeum* (cinnamon fern). Tree saplings, peatland heaths, and other shrubs typically occur with <5% cover and include *Acer rubrum* (red maple), *Alnus incana* ssp. *rugosa* (speckled alder), *Betula populifolia* (gray birch), *Cephalanthus occidentalis* (buttonbush), *Chamaedaphne calyculata* (leatherleaf), *Ilex verticillata* (common winterberry), *Lyonia ligustrina* (maleberry), *Myrica gale* (sweet gale), *Spiraea alba* var. *latifolia* (meadowsweet), *S. tomentosa* (rosy meadowsweet), *Toxicodendron vernix* (poison-sumac), and *Vaccinium corymbosum* (highbush blueberry).

VARIANTS: Two variants are presently recognized:

1. **Typic variant**: As described above. This variant is most common in central and southern New Hampshire and is distinguished from the next variant by the absence of species more frequent in northern NH [e.g., *Carex rostrata* (beaked sedge)*, *Eutrochium maculatum* (spotted Joe-Pye weed), and *Triadenum fraseri* (Fraser's marsh-St. John's-wort)] and/or the presence of species more common in southern NH (e.g., poison-sumac and highbush blueberry).
2. **Northern medium sedge meadow variant**: This variant is dominated by medium-sized sedges (1–2 ft. high) and other herbs and occurs in old, abandoned, "filled-in" beaver marshes in montane settings in the northern part of the state. Characteristic species are star sedge, beaked sedge*, and a diverse assemblage of marsh forbs. Other marsh plants may include *Agrostis* spp. (bentgrasses), bluejoint, *Glyceria canadensis* (rattlesnake mannagrass), *Leersia* spp. (cut grasses), tussock sedge, lake sedge, three-way sedge, woolly bulrush, *Juncus canadensis* (Canada rush), spotted Joe-Pye weed, *Galium* spp. (bedstraws), blue iris, northern water-horehound, *Symphyotrichum puniceum* (purple-stemmed American-aster), *Thalictrum pubescens* (tall meadow-rue), St. John's-worts, and Fraser's marsh-St. John's-wort. The rare *Carex rostrata* (beaked sedge)* can occur in this variant.

CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: This community is widespread in New Hampshire. Good examples of the typic variant occur in Deering Wildlife Sanctuary (Deering) and in Orenda-Stickey Wicket Wildlife Sanctuary (Marlow). Good examples of the northern medium sedge meadow variant occur at Norton Pool Preserve (Pittsburg) and Elbow Pond (Woodstock).

SOURCES: NHB field surveys.

• Short graminoid - forb meadow marsh/mudflat (S4)

GENERAL DESCRIPTION: This community consists of short (0.25–2.0 ft.) herbaceous vegetation such as sedges, rushes, grasses, and forbs in seasonally flooded to semi-permanently flooded or intermittently exposed situations, such as mudflats 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 (see sand plain basin marshes).

CHARACTERISTIC VEGETATION: Vegetation may include *Leersia oryzoides* (rice cut grass), *Glyceria borealis* (northern mannagrass), *Eleocharis palustris* (common spikesedge) and other spikesedge species, *Lindernia dubia* (yellow-seeded false pimpernel), *Gratiola aurea* (golden hedge-hyssop), *Bidens* spp. (beggar-ticks), *Hypericum boreale* (northern St. John's-wort), and *Sium suave* (water-parsnip).

CLASSIFICATION CONFIDENCE: 2–3

DISTRIBUTION: This community is found throughout the state. Good examples occur along the Merrimack River (Concord) and in the Dame Road vicinity (Durham).

SOURCES: NHB field surveys.

Emergent marshes

Emergent marshes are characterized by spongy-tissued perennial emergent species in semi-permanently flooded settings. Floating and submerged aquatic species are often intermixed with the dominant emergent vegetation. These marshes occur on muck, peat, or mineral soil.

Characteristic plants include *Schoenoplectus tabernaemontani* (soft-stemmed bulrush), *S. pungens* (three-square bulrush), *Eleocharis* spp. (spikesedges), *Juncus militaris* (bayonet rush), *Typha latifolia* (broad-leaved cattail), *Sparganium americanum* (American bur-reed), *Pontederia cordata* (pickerelweed), *Peltandra virginica* (green arrow-arum), *Sagittaria latifolia* (common arrowhead), *Potamogeton* spp. (pondweeds), *Nuphar variegata* (bullhead pond-lily), *Nymphaea odorata* (white water-lily), *Utricularia* spp. (bladderworts), *Elodea* spp. (waterweeds), *Vallisneria americana* (tape-grass), *Lemna* spp. (duckweeds), *Brasenia schreberi* (water-shield), and *Myriophyllum humile* (low water-milfoil).

Some rare species that may be found in emergent marshes include *Sparganium eurycarpum* (great bur-reed)*, *S. androcladum* (branched bur-reed)*, and *Bidens beckii* (Beck's 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.

• Emergent marsh (S5)

GENERAL DESCRIPTION: ***Emergent marshes*** are semi-permanently flooded herbaceous wetlands with seasonably variable water levels. They occur throughout the state, and are characterized by herbaceous

plants with spongy tissue (aerenchyma) emerging above the surface of the water. In most years, they remain inundated by shallow to moderately deep water throughout the growing season (generally less than 3 ft. of water). During drought years, water levels may drop below the surface in relatively shallow examples.

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 are 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 meadow marshes (see previous group of communities). Infrequently exposed zones with deeper water are classified as ***aquatic bed*** community.

CHARACTERISTIC VEGETATION: The community is dominated by aerenchymatous (spongy tissue) herbaceous plants that emerge above the surface of the water. These include *Sparganium* spp. (bur-reeds), *Sagittaria latifolia* (common arrowhead), *Peltandra virginica* (green arrow-arum), *Pontederia cordata* (pickerelweed), *Typha latifolia* (broad-leaved cattail), *Juncus* spp. (rushes), *Schoenoplectus tabernaemontani* (soft-stemmed bulrush), *S. subterminalis* (water bulrush), and *Dulichium arundinaceum* (three-way sedge). Floating-leaved aquatics that may be present include *Nymphaea odorata* (white water-lily), *Nuphar variegata* (bullhead pond-lily), *Potamogeton* spp. (pondweeds), and *Utricularia* spp. (bladderworts). The combination of species at a given location depends on factors such as water depth and amplitude of water level fluctuations.

CLASSIFICATION CONFIDENCE: 1

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 *Typha latifolia* (broad-leaved cattail), to the near exclusion of other species. It is 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 fresh and brackish marsh communities associated with basins and rivers.

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: Broad-leaved cattail is dominant and can exclude nearly all other species or may co-dominate with other herbs and shrubs. Narrow-leaved cattail and/or *Typha x glauca* (glaucous cattail) can locally dominate as well. Associates may include *Carex stricta* (tussock sedge), *Scirpus cyperinus* (woolly bulrush), *Glyceria* spp. (mannagrasses), *Calamagrostis canadensis* (bluejoint), *Phragmites australis* (common reed), *Sparganium americanum* (American bur-reed), *Lythrum salicaria* (purple loosestrife), *Lemna minor* (common duckweed), *Lycopus uniflorus* (northern water-horehound), *Lysimachia terrestris* (swamp yellow-loosestrife), *Acer rubrum* (red maple) seedlings and saplings, and several species of shrubs including *Spiraea alba* var. *latifolia* (meadowsweet), *Ilex verticillata* (common winterberry), *Vaccinium corymbosum* (highbush blueberry), *Viburnum dentatum* var. *lucidum* (smooth arrowwood), and *Lyonia ligustrina* (maleberry).

VARIANTS: Two variants are described.

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. Infrequent species include purple loosestrife, *Ludwigia palustris* (common water-primrose), *Pontederia cordata* (pickerelweed), *Nymphaea odorata* (white water-lily), *Sagittaria latifolia* (common arrowhead), *Myriophyllum* spp. (water-milfoils), *Elodea canadensis* (common waterweed), *Onoclea sensibilis* (sensitive fern), *Mimulus ringens* (Allegheny monkey-flower), *Scutellaria lateriflora* (mad dog skullcap), *Cardamine pensylvanica* (Pennsylvania bitter-cress), *Boehmeria cylindrica* (small-spiked false nettle), *Glyceria striata* (fowl mannagrass), and *Eleocharis acicularis* (needle spikesedge).

CLASSIFICATION CONFIDENCE: 1–2

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.

• Bayonet rush emergent marsh (S2)

GENERAL DESCRIPTION: ***Bayonet rush emergent marshes*** remain inundated for most or all of the growing season, although dry periods expose upper portions of the marsh. They are dominated by moderate to dense stands of *Juncus militaris* (bayonet rush) emerging from lake and river water, over 2 ft. deep at times. Bayonet rush is densest in water that is less than 1 ft. deep late in the season. Along shallow lake shores, these stands can extend out 100 ft. or more.

This community occurs in shallow waters of ponds, lakes, and rivers with sandy bottoms or with thin organic layers over sand.

CHARACTERISTIC VEGETATION: Bayonet rush is dominant. A common associate (subdominant in some examples) is *Schoenoplectus pungens* (three-square bulrush). Other common species include *Pontederia cordata* (pickerelweed), *Nymphoides cordata* (little floating-heart), *Lobelia dortmanna* (water lobelia), *Brasenia schreberi* (water-shield), *Utricularia* spp. (bladderworts), *Myriophyllum* spp. (water-milfoils), *Sparganium* spp. (bur-reeds), and *Glyceria borealis* (northern mannagrass).

Species within the upper portion of stands where the water may draw down later in the summer include *Gratiola aurea* (golden hedge-hyssop), *Lysimachia terrestris* (swamp yellow-loosestrife), *Persicaria hydropiperoides* (mild water pepper), *Triadenum virginicum* (Virginia marsh-St. John's-wort), *Eriocaulon aquaticum* (seven-angled pipewort), *Dulichium arundinaceum* (three-way sedge), *Eleocharis* spp. (spikesedges), *Juncus pelocarpus* (brown-fruited rush), and *Coleataenia longifolia* (redtop-panicgrass). The invasive *Lythrum salicaria* (purple loosestrife) also may be present.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community is found along sandy shorelines on some lakes and rivers in central and southern New Hampshire. Good examples include the Ossipee River (Freedom and Effingham) and Massabesic Lake (Auburn and Manchester).

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 waterbody nutrient status. Some types of aquatic beds have been more thoroughly sampled, such as those found along sandy pond shores and in closed-basin sand plain marshes, and are described as specific natural communities (see those sections for descriptions.)

• Aquatic bed (S5)

GENERAL DESCRIPTION: This is a broadly defined community dominated by floating-leaved and submersed herbaceous species. It occurs in quick water streams and shallow quiet water areas of ponds, lakes, oxbows, streams, and rivers. Water depths typically are at least 2–3 ft. in mid-late summer or shallower but semi-permanently to permanently flooded. 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 2–3 ft.

CHARACTERISTIC VEGETATION: Common species include *Nuphar variegata* (bullhead pond-lily), *Brasenia schreberi* (water-shield), *Nymphoides cordata* (little floating-heart), *Utricularia vulgaris* ssp. *macrorhiza* (greater bladderwort), *Lemna minor* (common duckweed), *Spirodela polyrhiza* (common duck-meal), *Wolffia columbiana* (Columbian water-meal), *Vallisneria americana* (tape-grass), *Potamogeton* spp. (pondweeds), and *Myriophyllum* spp. (water-milfoils). Less frequent are *Schoenoplectus subterminalis* (water bulrush), *Ranunculus aquatilis* var. *diffusus* (white water crowfoot), and *Ceratophyllum demersum* (common hornwort).

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)*, *Bidens beckii* (Beck's water-marigold)*, *Sagittaria cuneata* (northern arrowhead)*, *Lemna valdiviana* (pale duckweed)*, *L. trisulca* (ivy-leaved duckweed)*, *Isoetes engelmannii* (Engelmann's quillwort)*, and *I. lacustris* (lake quillwort)*.

VARIANTS: Two variants are described.

1. **Quiet water variant**: This is the typic variant. It occurs in shallow, quiet water areas of ponds, lakes, oxbows, streams, and rivers. Free-floating, submerged, and floating-leaved rooted vegetation are common. Characteristic species are described above.
2. **Quick water variant**: A lower cover of free-floating species occurs in this variant in moderate to quick water streams. It is characterized by submersed and floating-leaved rooted vegetation such as *Potamogeton nodosus* (long-leaved pondweed)*, other pondweeds (e.g., *P. foliosus**, *P. gramineus*, and *P. richardsonii**), *Ranunculus aquatilis* var. *diffusus* (white water crowfoot), *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 wetlands with a reliable source of groundwater seepage (i.e., soligenous) that also

appear to be influenced to some extent by water from stream overflow (limnogenous) and upland runoff (topogenous) sources. For soils, they typically have shallow organic material over mineral substrates. Some have moderately deep organic matter, however, and are transitional to open peatland communities. They are distinguished from open peatland communities by having a robust herbaceous layer that includes minerotrophic forbs.

• Herbaceous seepage marsh (S3)

GENERAL DESCRIPTION: These 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 cover except along the borders. While these communities are technically still marshes, they are really intermediate between fens and marshes, both floristically and environmentally. They contain a mixture of graminoids, forbs, and ferns including indicators of seepage and minerotrophic conditions. Some examples also have a moderate cover of alder and may be successional to ***alder wooded fen*** or ***alder seepage thicket***.

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 of seepage marshes dominated by *Carex lacustris* (lake sedge) are described as ***lake sedge seepage marshes***. 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), lake sedge, *Eutrochium maculatum* (spotted Joe-Pye weed), *Osmunda regalis* var. *spectabilis* (royal fern), *Thelypteris palustris* var. *pubescens* (marsh fern), *Symplocarpus foetidus* (skunk-cabbage), *Micranthes pensylvanica* (swamp small-flowered-saxifrage), and *Carex scabrata* (eastern rough sedge). Other minerotrophic indicators are usually present in lower abundance and may include *Packera schweinitziana* (New England groundsel), *Hydrocotyle americana* (American marsh-pennywort), *Chrysosplenium americanum* (golden-saxifrage), *Impatiens capensis* (spotted touch-me-not), *Mentha canadensis* (American wild mint), *Chelone glabra* (white turtlehead), *Lysimachia terrestris* (swamp yellow-loosestrife), *Carex stipata* (awl-fruited sedge), *C. leptalea* (bristly-stalk sedge), *C. prasina* (leek-green drooping sedge), *Equisetum fluviatile* (river horsetail), and *Toxicodendron vernix* (poison-sumac). Other occasionally abundant species indicative of at least weakly minerotrophic conditions may include *Symphyotrichum puniceum* (purple-stemmed American-aster), *Comarum palustre* (marsh-cinquefoil), *Carex lasiocarpa* (wire sedge), *Calamagrostis canadensis* (bluejoint), *Equisetum arvense* (field horsetail), and *Spiraea alba* var. *latifolia* (meadowsweet). Common meadow marsh plants may be present as well, including *Carex lurida* (sallow sedge). Mosses include *Mnium* spp. and *Philonotis fontana*, among many others.

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.

• Lake sedge seepage marsh (S3)

GENERAL DESCRIPTION: This is a narrowly defined but relatively common type of seepage marsh, which occurs as small patches or bands between emergent marshes and swamps or uplands. It is strongly

dominated by *Carex lacustris* (lake sedge), a tall plant that spreads by rhizomes and dominates slightly sloping marsh areas with reliable groundwater seepage or those saturated by perennial near-surface flow, including those by in-flow and out-flow portions of marshes.

Soils are typically silty with a shallow muck layer under a thick thatch of dead sedge leaves.

CHARACTERISTIC VEGETATION: *Carex lacustris* (lake sedge) dominates, but many other species more frequent in ***herbaceous seepage marshes*** may be present. These include *Onoclea sensibilis* (sensitive fern) (high frequency among known examples), *Thelypteris palustris* var. *pubescens* (marsh fern), *Typha latifolia* (broad-leaved cattail), *Calamagrostis canadensis* (bluejoint), *Lysimachia terrestris* (swamp yellow-loosestrife), *Carex utriculata* (swollen-beaked sedge), *Boehmeria cylindrica* (small-spiked false nettle), and *Impatiens capensis* (spotted touch-me-not), among numerous others. Common meadow marsh plants may be present as well, including *Carex lurida* (sallow sedge). Woody species such as *Acer rubrum* (red maple) and *Toxicodendron radicans* (poison-ivy) may occur in low abundance. Mosses include *Mnium* spp. and *Philonotis fontana*, among many others.

CLASSIFICATION CONFIDENCE: 2–3

DISTRIBUTION: This community is broadly distributed but intermittently documented in the state. Good examples occur in Pawtuckaway State Park (Nottingham) and at Great Bog (Portsmouth).

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). They lack a number of characteristics that distinguish shrub thicket communities that are found in peatlands, including deep peat soils, abundant peat mosses, prominent medium-height heath shrub layer, and other peatland indicator species. See also ***sweet gale - alder shrub thicket*** described in the Sandy Pond Shore section.

• Highbush blueberry - winterberry shrub thicket (S4)

GENERAL DESCRIPTION: This is a common and widespread 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* (common winterberry) are the dominant shrubs.

Soils are mostly mineral, and vary in organic content. In some settings, leaf litter covers the soil surface and bryophytes and herbs are in low abundance. In other settings this community can grade into tall shrub fens with organic soils.

This community is distinguished from tall shrub peatland types by the absence of deep peat soils, abundant peat mosses, and the presence of a prominent medium-height heath shrub layer and other peatland indicators such as *Picea mariana* (black spruce) and *Sarracenia purpurea* (purple pitcherplant).

CHARACTERISTIC VEGETATION: Dominant shrubs include common winterberry and/or highbush blueberry. Seedling and sapling sized *Acer rubrum* (red maple) are often present. Herbs are typically scarce but may include *Osmundastrum cinnamomeum* (cinnamon fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Thelypteris palustris* var. *pubescens* (marsh fern), *Lycopus uniflorus* (northern water-horehound), and a few others. Somewhat more minerotrophic examples may contain *Salix* spp. (willows), *Alnus* spp. (alders), *Viburnum nudum* var. *cassinoides* (withe-rod), and *Cephalanthus occidentalis* (buttonbush) in low to moderate abundance (never dominant). Dominance by buttonbush indicates the seasonally to semi-permanently flooded ***buttonbush shrubland*** community.

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* (maleberry), *Chamaedaphne calyculata* (leatherleaf), *Ilex mucronata* (mountain holly), *Aronia floribunda* (purple 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.

• Alder seepage thicket (S3)

GENERAL DESCRIPTION: This tall shrub swamp occurs in nutrient-enriched settings within depressions and on slopes fed by groundwater seepage. Alders dominate over a diverse and moderately well-developed herbaceous layer of species indicative of mineral enrichment or groundwater seepage. Mineral soils with a shallow muck layer are typical in this community, and are saturated or seasonally saturated.

CHARACTERISTIC VEGETATION: *Alnus incana* ssp. *rugosa* (speckled alder) is the dominant tall shrub, forming a canopy that can vary from dense to moderately open. The herb layer is diverse, and can include *Caltha palustris* (marsh-marigold), *Chrysosplenium americanum* (golden-saxifrage), *Impatiens capensis* (spotted touch-me-not), *Tiarella cordifolia* (foam-flower), *Carex gynandra* (nodding sedge), *Glyceria* spp. (mannagrasses), *Calamagrostis canadensis* (bluejoint), and *Onoclea sensibilis* (sensitive fern), as well as numerous other herbs and mosses generally absent in peatlands.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community can be found throughout New Hampshire, but is more frequent in the northern part of the state. Good examples occur at South Bay Bog (Pittsburg) and Coleman State Park (Stewartstown).

SOURCES: NHB field surveys.

• Buttonbush shrubland (S4)

GENERAL DESCRIPTION: This community occurs in small basins and oxbow ponds with standing water present for most or all of the growing season. The persistence of standing water throughout much of the growing season limits shrub and herb diversity. It is dominated by *Cephalanthus occidentalis* (buttonbush), perhaps the most flood-tolerant deciduous shrub in New Hampshire. While this community is typically flooded, 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. These wetlands provide brood cover for wood ducks (*Aix sponsa*).

This community can occur in basins on glacial till that are characterized by well-decomposed organic soils, perched water tables, and seasonally to semi-permanently flooded hydrology. However, some examples occur on alluvial soils in oxbow depressions that are periodically inundated by riverbank overflow.

CHARACTERISTIC VEGETATION: 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* ssp. *rugosa* (speckled alder), *Ilex verticillata* (common

winterberry), *Rosa palustris* (swamp rose), *Chamaedaphne calyculata* (leatherleaf), *Kalmia angustifolia* (sheep laurel), *Viburnum dentatum* var. *lucidum* (smooth arrowwood), *Thelypteris palustris* var. *pubescens* (marsh fern), *Osmunda regalis* var. *spectabilis* (royal fern), *Osmundastrum cinnamomeum* (cinnamon fern), *Lycopus uniflorus* (northern water-horehound), and *Lysimachia terrestris* (swamp yellow-loosestrife). Many of the shrubs mentioned above may occur with greater cover on drier basin margins or other relatively higher ground in the wetland. Pioneer mosses often grow on the stems of buttonbush near the water line.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community type is widespread in the state but apparently most abundant in central and southern New Hampshire. Good examples can be found at Stratham Hill Park (Stratham), along the Blackwater River (Salisbury), and on Beaver Brook Association land (Hollis).

SOURCES: NHB field surveys.

SANDY POND SHORE, CLOSED - BASIN, AND SAND DUNE SETTINGS

The following communities occur in sand plain settings within pond shores, closed-basins, and interdunal swales. They are distinguished from typical limnogenous wetlands on the basis of their unusual geomorphic settings, floristic composition, and more broadly fluctuating water levels. Vertical water fluctuations (due to precipitation, evapotranspiration, and groundwater level changes) characterize the hydrology in closed-basin marshes and interdunal swales (e.g., no limnogenous influence). Soils are seasonally to permanently flooded, and comprised of fine mineral or 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 - 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 species composition is more diverse than ***highbush blueberry - winterberry shrub thickets***.

Soils are variable, consisting of sand or sand and gravel, inter-bedded sand and peat turf, or sandy muck on open pond shore beach ridge or upland edge. They have shallow hemic O horizons (0–13 cm), variable A horizons (0–55 cm), with sand and gravel deposits to depths of over 1 m. One location within an example of this community has over 1.3 m of peat at the surface.

CHARACTERISTIC VEGETATION: Diagnostic species occurring with high frequency and/or abundance and that are absent or infrequent in dense ***highbush blueberry - winterberry shrub thickets*** include *Myrica gale* (sweet gale), *Alnus incana* ssp. *rugosa* (speckled alder), *A. serrulata* (smooth alder), *Clethra alnifolia* (sweet pepperbush), *Spiraea tomentosa* (rosy meadowsweet), *Viburnum nudum* var. *cassinoides* (withe-rod), *V. dentatum* var. *lucidum* (smooth arrowwood), *Vaccinium macrocarpon* (large cranberry), and *Osmunda regalis* var. *spectabilis* (royal fern). Other, less frequent species include *Solidago rugosa* (wrinkle-leaved goldenrod), *Symphyotrichum racemosum* (small white American-aster), *Euthamia graminifolia* (common grass-leaved-goldenrod), *Onoclea sensibilis* (sensitive fern), *Panicum virgatum* (switch panicgrass), *Carex stricta* var. *strictior* (small tussock sedge), and *C. scoparia* (pointed broom sedge). Some of these less frequent species are also found in adjacent (lower) zones occupied by the ***twig-rush sandy turf pond shore*** community.

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 is a structurally diverse community that occurs on sandy lake shores in south-central New Hampshire. Robust and stress-tolerant species such as *Cladium mariscoides* (twig-rush), *Euthamia* spp. (grass-leaved-goldenrods), *Carex stricta* (tussock sedge), *C. lasiocarpa* (wire sedge), and *Calamagrostis canadensis* (bluejoint) grow on sandy, organic turf mats between shrub communities and open water or sand beach. Wave and ice action are prominent disturbance forces here, but they are less severe than in ***bulblet umbrella sedge open sandy pond shore*** and ***water lobelia aquatic sandy pond shore*** communities, which occur slightly lower on the shoreline and have much lower percent covers of vegetation. This community is similar to ***meadow beauty sand plain marsh***, but contains more robust, rhizomatous, stress-tolerant graminoids, has only a sparse *Sphagnum* presence, and is much more compositionally and structurally diverse. Numerous species of coastal plain distribution are found in this community.

The sandy peat mats have drastically diminished in size at Ossipee Lake where the larger of two examples occurs for this very rare community type in New Hampshire. The primary cause for this loss is likely the result of water levels being maintained at a higher level over the past several decades, driving wave action higher onto the shore. The few sandy peat mats that remain today occur adjacent to shrub communities and mostly lack twig-rush. These remnant patches formerly occupied less exposed portions of the sandy peat mats. In the past, twig-rush was abundant on the outer portions of these mats (now eroded away), here one of the few species tolerant of moderate levels of wave action.

Near the surface, soils consist of alternating layers of sandy peat mats and sand. Sand typically dominates below 50 cm, but in some cases is interbedded with organic layers to a depth of over 1 m. This deeper layering of sand, muck, and peat attests to the dynamic nature of the environment this community occurs in.

CHARACTERISTIC VEGETATION: Species common in this community are twig-rush, *Euthamia graminifolia* (common grass-leaved-goldenrod), the state-rare *E. caroliniana* (coastal plain grass-leaved-goldenrod)*, tussock sedge, wire sedge, bluejoint, and *Vaccinium macrocarpon* (large cranberry). Species frequently found in low abundance include *Viola lanceolata* (lance-leaved violet), *Galium tinctorium* (stiff three-petaled bedstraw), *Bidens frondosa* (Devil's beggar-ticks), *Lycopus uniflorus* (northern water-horehound), *Sagittaria latifolia* (common arrowhead), *Panicum virgatum* (switch panicgrass), *Muhlenbergia uniflora* (bog muhly), *Glyceria canadensis* (rattlesnake mannagrass), *Schoenoplectus pungens* (three-square bulrush), *Dulichium arundinaceum* (three-way sedge), *Eleocharis tenuis* (slender spikesedge), *Cyperus dentatus* (bulblet umbrella sedge), *Spiraea tomentosa* (rosy meadowsweet), and *Myrica gale* (sweet gale). Peat mosses (*Sphagnum* spp.) are occasional.

Lycopodiella appressa (appressed bog-clubmoss)* and *Proserpinaca pectinata* (comb-leaved mermaid-weed)* are two rare species known from this community at Ossipee Lake. At Lake Massasecum, the globally rare *Sclerolepis uniflora* (sclerolepis)* washes into this community from deeper water habitats.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Occurs on sandy shores of a few lakes in south-central New Hampshire. A remant example can be found at Ossipee Lake (Ossipee).

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. It is often discontinuous along and interspersed with 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, contains a greater prominence of ruderals, and lacks the robust graminoids of the twig-rush community. Short, clumped graminoids and rhizomatous forbs and graminoids dominate, along with numerous native ruderals.

CHARACTERISTIC VEGETATION: *Cyperus dentatus* (bulblet umbrella sedge), *Juncus pelocarpus* (brown-fruited rush) (rhizomatous), *Viola lanceolata* (lance-leaved violet), and *Bidens frondosa* (Devil's beggar-ticks) are nearly constant and vary from low to moderate abundance. Other frequent species include *Symphyotrichum racemosum* (small white American-aster), *Euthamia caroliniana* (coastal plain grass-leaved-goldenrod)*, *E. graminifolia* (common grass-leaved-goldenrod), *Gratiola aurea* (golden hedge-hyssop), *Triadenum virginicum* (Virginia marsh-St. John's-wort), *Eriocaulon aquaticum* (seven-angled pipewort), *Panicum* spp. (panicgrasses; seven species; annuals and perennials), *Agrostis scabra* (rough bentgrass), *Carex scoparia* (pointed broom sedge), and *Eleocharis tenuis* (slender spikesedge). Frequent annuals include *Agalinis paupercula* (small-flowered agalinis), *Bidens discoidea* (small beggar-ticks), *Erechtites hieraciifolius* (American burnweed), and sometimes, on wetter or less exposed sections, *Eleocharis acicularis* (needle spikesedge).

One basin contains the rare coastal plain species *Scleria reticularis* (netted nutsedge)* (disjunct from southeastern Massachusetts), and other rare species including *Euthamia caroliniana* (coastal plain grass-leaved-goldenrod)* and *Lindernia dubia* var. *anagallidea* (unpretentious yellow-seeded false pimpernel)*.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Occurs on both free-flowing lakes and those with artificially elevated water levels (e.g., Lake Massabesic, Manchester) in central and southern New Hampshire.

SOURCES: Sperduto 1994b; Sperduto 2000c.

• Water lobelia aquatic sandy pond shore (S2)

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-forming, 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 variants below.

VARIANTS: Two discernable variants are recognized, although some overlap is evident between them:

1. **Pondweed - pickerelweed variant**: This variant is characterized primarily by floating-leaved and aerenchymatous aquatics, including *Potamogeton epihydrus* (ribbon-leaved pondweed), *P. natans* (floating pondweed), *Pontederia cordata* (pickerelweed), and *Sparganium americanum* (American 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 variant has a lower frequency and abundance of floating-leaved aquatics and much higher frequency and abundance of rosette stress-tolerant

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* (seven-angled pipewort) (sparse to abundant), *Lobelia dortmanna* (water lobelia), *Isoetes tuckermanii* (Tuckerman's quillwort) and other *Isoetes*, *Schoenoplectus pungens* (three-square bulrush), *Utricularia gibba* (creeping bladderwort), and submersed aquatic forms of *Sagittaria graminea* (grass-leaved arrowhead), *Gratiola aurea* (golden hedge-hyssop), *Juncus pelocarpus* (brown-fruited rush), *Eleocharis acicularis* (needle spikesedge), and American bur-reed.

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.

• Montane sandy pond shore (S1)

GENERAL DESCRIPTION: This community occurs in narrow, peaty sand zones along sand or gravel pond and lake shores in the mountains and northern New Hampshire. Low nutrient levels, fluctuating water, and high disturbance create stressful environmental conditions. Wave-wracked shorelines often support a mix of short, stress-tolerant marsh and fen plants.

CHARACTERISTIC VEGETATION: Typical species include *Euthamia graminifolia* (common grass-leaved-goldenrod), *Drosera intermedia* (spatulate-leaved sundew), *Juncus* spp. (rushes), *Calamagrostis pickeringii* (Pickering's reed grass), *C. canadensis* (bluejoint), *Agrostis scabra* (rough bentgrass), *Carex echinata* (star sedge), *C. lenticularis* (lake shore sedge), *C. cryptolepis* (northeastern sedge), *Lycopodiella appressa* (appressed bog-clubmoss)*, and a thin layer of disturbance-tolerant peat mosses. Coastal plain plants are absent.

CLASSIFICATION CONFIDENCE: 2–3

DISTRIBUTION: This community occurs in the mountains and northern New Hampshire. Good examples occur at Gentian Pond (Success), Greeley Ponds (Livermore), Umbagog Lake (Errol), and Lily Pond (Livermore).

SOURCES: Sperduto et al. 2000a.

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. *Spiraea alba* var. *latifolia* (meadowsweet) dominates, with lesser amounts of *Carex stricta* (tussock sedge) and *Scirpus cyperinus* (woolly bulrush). The vegetation is taller than other herbaceous basin marsh types, and the composition is reminiscent of a fen. The growth of peat mosses is prolific during wet periods, which can last for years, but decomposition during drawdown periods precludes the build-up of organic matter. Robust perennial graminoid and medium shrub associates vary among examples but consist almost entirely of common, widespread wetland species with affinities to seasonally flooded poor fens and alluvial meadow marshes.

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: Meadowsweet is frequent and often a dominant; *Sphagnum* moss is abundant (mostly *Sphagnum cuspidatum*). Robust, cespitose (tussock-forming), and rhizomatous perennial graminoids are constant as groups. Rhizomatous species include frequent *Dulichium arundinaceum* (three-way sedge) (aerenchymatous) and tussock sedge, and occasional *Carex lasiocarpa* (wire sedge) and *C. utriculata* (swollen-beaked sedge). Cespitose species include *Glyceria canadensis* (rattlesnake mannagrass), *Calamagrostis canadensis* (bluejoint), and woolly bulrush. *Vaccinium macrocarpon* (large cranberry) and *Chamaedaphne calyculata* (leatherleaf) are the only other occasional shrubs. *Lysimachia terrestris* (swamp yellow-loosestrife) is a near constant in low abundance, but other forbs are sparse and mostly represent spill-over from adjacent zones. ***Three-way sedge - mannagrass mudflat marsh*** shares some species with this community, but has much less *Sphagnum* moss and meadowsweet, very few tussock-forming graminoids, and more short graminoids and forbs.

One occurrence of this community forms an unusual association for the state. It consists of a dense two-acre stand of solid three-way sedge and *Sphagnum cuspidatum* to the near exclusion of all other vegetation, with a patch of *Glyceria acutiflora* (sharp-flowered mannagrass)* 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 that forms in shallow basins with sandy bottoms. It is dominated by short rhizomatous sedges, forbs, and short clumped graminoids, with an abundance of *Sphagnum cuspidatum*. Many of the species characteristic of this type have coastal plain affinities.

Ninety-five percent of the water input at New Hampshire's only known site for this community comes in the form of precipitation, with the remainder from groundwater inflow. Drawdowns 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. Soils are shallow sandy muck (10–20 cm) over sand.

This community is somewhat similar to ***twig-rush sandy turf pond shore*** and ***bulblet umbrella sedge open sandy pond shore***. However, it differs by a greater abundance of short rhizomatous and clumped sedges, and fewer ruderals and tall graminoids. All three communities are rare and under threat in New Hampshire. Another similar community, the ***three-way sedge - mannagrass mudflat marsh***, occupies approximately the same topographic position as this community (both begin ca. 0.75 m below the upland transition), but tends to have more organic matter accumulation, perhaps driven by less dramatically fluctuating water levels.

CHARACTERISTIC VEGETATION: Dominant species include *Eleocharis tenuis* (slender spikesedge), *Rhexia virginica* (meadow beauty), *Glyceria canadensis* (rattlesnake mannagrass), and *Sphagnum cuspidatum*. Frequent and locally abundant species include *Dichanthelium acuminatum* ssp. *spretum* (spurned hairy

rosette-panicgrass), *Muhlenbergia uniflora* (bog muhly), *Juncus pelocarpus* (brown-fruited rush), *Cyperus dentatus* (bulblet umbrella sedge), *Gratiola aurea* (golden hedge-hyssop), *Viola lanceolata* (lance-leaved violet), *Hypericum boreale* (northern St. John's-wort), *Xyris difformis* (bog yellow-eyed-grass), and *Eriocaulon aquaticum* (seven-angled 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 - mannagrass mudflat marsh (S2S3)

GENERAL DESCRIPTION: This is a densely vegetated, semi-permanently flooded "mudflat" community dominated by short forbs and graminoids (<0.65 m). Periodic water level drawdowns produce mudflat conditions with dense vegetation. In New Hampshire, it is restricted to mucky, closed sand plain basins in central and southern parts of the state.

This community 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 ***spikesedge - floating-leaved aquatic mudflat marshes***. 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***, ***twig-rush sandy turf pond shore***, and ***bulblet umbrella sedge open sandy pond shore*** communities. The community is commonly found just above the wetter ***spikesedge - floating-leaved aquatic mudflat marsh*** community.

This community occupies approximately the same topographic position as ***meadow beauty sand plain marsh*** (both begin ca. 0.75 m below the upland transition), but tends to have more organic matter production and accumulation, perhaps driven by less dramatically fluctuating water levels.

Soils have 20–110 cm (average=57 cm) of O horizon with a muck A horizon over sand, gravel, or slightly silty-gravelly sand. Moderate to deep muck soils are typical, forming mudflat conditions during draw-down periods.

CHARACTERISTIC VEGETATION: Frequent characteristic species include the aerenchymatous (spongy-tissued) *Dulichium arundinaceum* (three-way sedge) (usually a dominant); floating-stemmed species *Glyceria borealis* (northern mannagrass) and *Torreyochloa pallida* (false manna grass); short rhizomatous graminoids including *Eleocharis palustris* (common spikesedge), *E. flavescens* var. *olivacea* (yellow spikesedge), and *Juncus pelocarpus* (brown-fruited rush); and rhizomatous forbs including *Hypericum boreale* (northern St. John's-wort), *Triadenum virginicum* (Virginia marsh-St. John's-wort), *Viola lanceolata* (lance-leaved violet), and *Lysimachia terrestris* (swamp yellow-loosestrife). Tall graminoids are occasional and in moderately low abundance, including *Carex vesicaria* (lesser bladder sedge) and *C. utriculata* (swollen-beaked sedge). *Sphagnum* moss is occasional and in low abundance. Mudflat annuals are frequent as a group and occasionally abundant, but inconsistent as to species. These include *Eleocharis obtusa* (blunt spikesedge), *Schoenoplectus smithii* (Smith's bulrush), *Lindernia dubia* (yellow-seeded false pimpernel), *Bidens connata* (purple-stemmed beggar-ticks), *B. frondosa* (Devil's beggar-ticks), and *Erechtites hieraciifolius* (American burnweed).

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 ***spikesedge - floating-leaved aquatic mudflat marshes***.

SOURCES: Sperduto 1994b; Sperduto 2000c.

• Spikesedge - floating-leaved aquatic mudflat marsh (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 - mannagrass mudflat marshes***. During draw-down periods, short rhizomatous graminoids and forbs and mudflat annuals emerge along with aerenchymatous species and "stranded" floating-leaved and submerged aquatic species. This community occurs in wetter settings than ***three-way sedge - mannagrass mudflat marshes***, and also 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* var. *olivacea* (yellow spikesedge), *E. palustris* (common spikesedge), *E. acicularis* (needle spikesedge), *Juncus pelocarpus* (brown-fruited rush), *Schoenoplectus torreyi* (Torrey's bulrush), *Hypericum boreale* (northern St. John's-wort), *Gratiola aurea* (golden hedge-hyssop), and *Persicaria hydropiperoides* (false water-pepper smartweed). The floating-stemmed graminoid *Glyceria borealis* (northern mannagrass) is occasional. Characteristic and frequent mudflat annuals include *Eleocharis obtusa* (blunt spikesedge) and *Schoenoplectus smithii* (Smith's bulrush). *Panicum tuckermannii* (Tuckermann's panicgrass), *Coleataenia longifolia* (redtop-panicgrass), *Bidens connata* (purple-stemmed beggar-ticks), *B. discoidea* (small beggar-ticks), *Eriocaulon aquaticum* (seven-angled pipewort), *Sparganium americanum* (American bur-reed), and *Erechtites hieraciifolius* (American burnweed) are occasional. Floating-leaved aquatics include *Nuphar variegata* (bullhead pond-lily), *Potamogeton oakesianus* (Oakes' pondweed), and *P. bicupulatus* (snail-seed pondweed). Other aquatics include *Myriophyllum humile* (low water-milfoil) and *Utricularia radiata* (floating bladderwort). The rare *Eleocharis ovata* (ovoid spikesedge)* has been documented in this community.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community has only been documented from closed-basins on sand plains in the lower Merrimack River Valley region. Good examples occur in Hollis and Litchfield.

SOURCES: Sperduto 1994b; Sperduto 2000c.

• Sharp-flowered mannagrass 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 mannagrass)*, a species at the northern edge of its range. Soils consist of 10–35 cm of well-decomposed peat above a shallow sandy muck layer over deep sand (histic and mineral histic epipedons).

CHARACTERISTIC VEGETATION: *Sphagnum* spp. (including *S. cuspidatum*) vary from being present in low abundance to being codominant with sharp-flowered mannagrass*. Drawdown periods produce habitat for mudflat ruderals such as *Schoenoplectus smithii* (Smith's bulrush), *Persicaria pensylvanica* (Pennsylvania smartweed), *Bidens cernua* (nodding beggar-ticks), *B. frondosa* (Devil's beggar-ticks), *B. connata* (purple-stemmed beggar-ticks), *Erechtites hieraciifolius* (American burnweed), and *Panicum dichotomiflorum* (fall panicgrass), and for seedling establishment of sharp-flowered mannagrass*. Other vegetation is sparse but includes *Callitriche heterophylla* (greater water-starwort), *Potamogeton oakesianus* (Oakes' pondweed), *Nuphar variegata* (bullhead pond-lily), *Glyceria canadensis* (rattlesnake mannagrass), and *Panicum tuckermannii* (Tuckermann's panicgrass).

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: This is a rare community type found only in the White Mountains and North Country regions. It is broadly defined with considerable variation in plant species composition and cover both within and between examples, particularly in wetter basin zones. Some observed vegetation patterns include royal fern - blue iris marsh; *Thelypteris palustris* var. *pubescens* (marsh fern) - *Carex lurida* (sallow sedge) marsh; *Onoclea sensibilis* (sensitive fern) - *Glyceria striata* (fowl mannagrass) - moss marsh; and *Callitriche heterophylla* (greater water-starwort) - moss mudflat.

Distinguishing characteristics of this community are the topographic association with nearly-closed basins, broadly fluctuating water levels (up to two meters or more between spring and late summer), and the absence of coastal plain species found in other basin marsh communities further south. They tend to have larger watersheds than their more southern counterparts as well. ***Montane sandy basin marshes*** are primarily found at the interface of mountain slopes and mixed outwash deposits, such as those in 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).

Soil at one site (one of the two sites with steep side-slopes – see below) 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). The B horizon consists of coarse, very stony sandy gravel.

CHARACTERISTIC VEGETATION: A variety of common, broadly-distributed marsh plants are characteristic. Some of these include royal fern, Canada rush, *Glyceria borealis* (northern mannagrass), water bulrush, meadowsweet, *Alnus incana* ssp. *rugosa* (speckled alder), blue iris, *Torreyochloa pallida* (false mannagrass), *Juncus pelocarpus* (brown-fruited rush), and *Bidens frondosa* (Devil's beggar-ticks). Coastal plain species are notably absent.

Two of the known sites are distinct from other basin marshes in the state: they have steep side-slopes several meters in width that support a mixture of wetland basin vegetation and upland forest species, apparently indicative of widely fluctuating water levels. These slopes have a sparse cover of shrubs and herbs including *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (common winterberry), *Maianthemum canadense* (Canada-mayflower), *Rubus pubescens* (dwarf raspberry), *Danthonia spicata* (poverty oatgrass), *Pteridium aquilinum* ssp. *latiusculum* (bracken fern), *Osmunda regalis* var. *spectabilis* (royal fern), and mosses. No mature trees grow in this zone.

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: This fresh water wetland community occurs in shallow depressions between sand dunes in a portion of the state's only remaining coastal sand dune system. These swales may be shrub or graminoid dominated and are likely very important to amphibians and other wildlife for breeding, food, and shelter. At one time, numerous swales likely existed as part of an extensive intact dune system that occurred in Seabrook and Hampton.

Soils are typically seasonally flooded. A thin surface organic layer lies above sandy soils.

CHARACTERISTIC VEGETATION: Dominants vary from swale to swale and include *Vaccinium macrocarpon* (large cranberry) swales and *Juncus balticus* ssp. *littoralis* (Baltic rush) swales. Marginal associates include *Aronia floribunda* (purple chokeberry), *Ilex verticillata* (common winterberry), *Toxicodendron radicans* (poison-ivy), and *Triadenum virginicum* (Virginia 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: NHB field surveys; Dunlop and Crow 1985.

OPEN PEATLANDS

Open peatland communities are separated into two major groups: 1) bogs and poor fens and 2) medium and rich fens. These terms refer to the relative nutrient availability to plants, which is closely linked to water pH in the system. The definitions of the terms “bog” and “fen” have been the subject of debate. From a long-term peatland-development perspective, 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 only to extremely acidic, heath shrub dominated peatlands with vegetation similar to raised, rain-fed bogs. All other open peatlands in New Hampshire are considered fens.

The vegetation of bogs and fens can shift at different rates depending on conditions. These wetlands may be quite stable over long periods, change only 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). Marsh and aquatic vegetation can become established where ericaceous shrubs once grew. However, water levels could change or peat build-up could resume as the basin continues to accumulate organic matter over the long-term. 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).

BOGS AND POOR FENS

Bogs and poor fens occur in saturated and very poorly drained settings such as level basins with outflows absent or limited. These settings remain saturated year-round. The only nutrient inputs are from precipitation, scant runoff from a small watershed, and sometimes pond or lake water.

Bog and poor fen communities are divided into three groups: 1) moss and moss-sedge carpets, 2) dwarf heath shrub bogs, and 3) tall shrub poor fens.

Moss and moss-sedge carpets

Poor fen moss carpets have a relatively flat surface and support vegetation of low stature. These communities share an abundance of bryophytes and a paucity of dwarfed heath shrubs. Peat mosses, liverworts, and occasionally other mosses form extensive carpets on the surface of floating or loosely

consolidated peat mats, in wet pool areas within firmer mats, or in weakly mineral-enriched moats adjacent to uplands. Heath shrubs generally contribute less than 25% cover and are less than 0.5 m in height. Short sedges range from scattered to moderately abundant. Moss and moss-sedge carpets occur most often in peatlands with dwarf heath shrub bog communities. Two communities, ***bog rosemary - sedge fen*** and ***subalpine sloping fen***, are intermediate in plant composition and structure between moss-sedge carpets and dwarf heath shrub bogs.

• *Sphagnum rubellum* - small cranberry moss carpet (S3)

GENERAL DESCRIPTION: This community occurs on floating and grounded peat mats dominated by *Sphagnum rubellum* and a relatively sparse and dwarfed heath shrub layer (average shrub height is 0.29 m and cover is generally 5–20%). It is 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* (leatherleaf) is also always present. *Kalmia polifolia* (bog laurel), *K. angustifolia* (sheep laurel), *Andromeda polifolia* var. *glaucophylla* (bog rosemary), *Sarracenia purpurea* (purple pitcherplant), *Rhynchospora alba* (white beaksedge), and *Eriophorum virginicum* (tawny cottonsedge) are often present. *Eriophorum vaginatum* ssp. *spissum* (tussock cottonsedge) is occasional. Trees are absent, or sparse and stunted. The rare *Gaylussacia bigeloviana* (dwarf huckleberry)* occurs in some examples within ca. 30 miles of the coast.

VARIANTS: Two variants are described.

1. **Typic variant**: As described above.
2. ***Sphagnum magellanicum* variant**: This variant is characterized by abundant *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.

• Liverwort - horned bladderwort fen (S3)

GENERAL DESCRIPTION: This is a wet, oligotrophic community dominated by low, turfy mats of the leafy liverwort *Cladopodiella fluitans*, which turns black and looks like mud from a distance. It 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 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. It generally occurs in association with floating or grounded peat mats of pond-border or lake-fill kettle holes.

CHARACTERISTIC VEGETATION: *Cladopodiella fluitans*, *Sphagnum cuspidatum*, *Utricularia cornuta* (horned bladderwort), *Rhynchospora alba* (white beaksedge), 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 10% cover. The most frequent shrubs are *Vaccinium oxycoccos* (small cranberry), *Andromeda polifolia* var. *glaucophylla* (bog rosemary), and *Chamaedaphne calyculata* (leatherleaf). Trees and tall shrubs are always absent. Other species found in this community, but that also occur in other oligotrophic dwarf shrub peatland communities include *Sphagnum rubellum*, *S. magellanicum*, *Sarracenia purpurea* (purple pitcherplant), and *Drosera rotundifolia* (round-leaved sundew). North of the White Mountains, *Carex exilis* (meager sedge)* may be abundant in this community, especially in the wet "flarks" of some patterned fens.

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.

• Large cranberry - short sedge moss lawn (S3)

GENERAL DESCRIPTION: This widespread natural community forms on floating mats or in moat areas adjacent to uplands. It is characterized by loosely consolidated lawns, carpets, or pools of *Sphagnum cuspidatum* or *S. torreyanum* along with *Vaccinium macrocarpon* (large cranberry), a sparse dwarf shrub layer (<0.5 m), 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) in a number of ways. These differences include abundant aquatic peat mosses; a relatively sparse, dwarf shrub layer; a higher frequency of "bog" plants such as *Eriophorum virginicum* (tawny cottonsedge) and *Sarracenia purpurea* (purple pitcherplant); a higher frequency of short sedges (*Carex*, *Dulichium*, and *Rhynchospora*); a lower frequency of robust *Carex* species; and the absence of *Sphagnum lescurii*.

CHARACTERISTIC VEGETATION: Some combination of *Sphagnum torreyanum*, *S. cuspidatum*, and *S. pulchrum* dominate the moss layer. Large cranberry, *Dulichium arundinaceum* (three-way sedge), *Carex canescens* (hoary sedge), and sweet gale often occur in low to moderate abundance. *Rhynchospora alba* (white beaksedge), purple pitcherplant, tawny cottonsedge, *Carex limosa* (quagmire sedge), *Lysimachia terrestris* (swamp yellow-loosestrife), *Triadenum virginicum* (Virginia marsh-St. John's-wort), and *Juncus pelocarpus* (brown-fruited rush) are occasional to frequent. *Chamaedaphne calyculata* (leatherleaf) is frequent and sometimes abundant, but dwarfed. Robust *Carex* species [*Carex lasiocarpa* (wire sedge), *C. utriculata* (swollen-beaked 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 beaksedge 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* (button sedge)* and *Sphagnum cuspidatum*. 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. Brown-fruited rush, spatulate-leaved sundew, purple pitcherplant, and tawny cottonsedge are occasional. *Scheuchzeria palustris* (pod-grass), wire sedge, swollen-beaked sedge, few-seeded sedge, and 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 sweet gale, *Sphagnum affine*, and *S. papillosum. Vaccinium oxycoccos* (small cranberry), quagmire sedge, *Andromeda polifolia* var. *glaucophylla* (bog rosemary), and 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.

• Bog rosemary - sedge fen (S3)

GENERAL DESCRIPTION: This is a weakly minerotrophic fen community dominated by a mixture of dwarf shrubs, *Carex* sedge species, and several peat mosses. Trees and tall shrubs are sparse or absent. Shrub stature is somewhat low with an average height of 0.49 m. Average pH is 4.1. 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* (leatherleaf) 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* (swollen-beaked sedge) by having an abundance of *Sphagnum fallax*, *S. angustifolium*, and *S. magellanicum*, and some combination of *Andromeda polifolia* var. *glaucophylla* (bog rosemary), *Kalmia polifolia* (bog laurel), *Vaccinium oxycoccos* (small cranberry), and *Maianthemum trifolium* (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.

• Montane level fen/bog (S2)

GENERAL DESCRIPTION: This community occurs in small bedrock depressions in exposed montane settings. It lacks arctic - alpine species found in high-elevation bogs (above 3,500 ft.) and many of the species with a more southern distribution that reach north into south - central New Hampshire in lower elevation peatlands. Species composition and structure vary depending on water level, nutrient status, mat depth and microtopography, and other factors.

Organic soils range from thin mats over bedrock to deeper peats.

CHARACTERISTIC VEGETATION: Common shrubs can include *Chamaedaphne calyculata* (leatherleaf), *Rhododendron canadense* (rhodora), *R. groenlandicum* (Labrador tea), *Kalmia angustifolia* (sheep laurel), *Ilex mucronata* (mountain holly), *Aronia* spp. (chokeberries), *Vaccinium vitis-idaea* ssp. *minus* (mountain cranberry), *V. myrtilloides* (velvet-leaved blueberry), and *Gaultheria hispidula* (creeping spicy-wintergreen). Characteristic herbs are *Eriophorum* spp. (cottonsedges), *Rhynchospora* spp. (beaksedges), *Carex trisperma* (three-seeded sedge), *C. canescens* (hoary sedge), *Drosera rotundifolia* (round-leaved sundew), *Maianthemum trifolium* (three-leaved false Solomon's-seal), and *Osmundastrum cinnamomeum* (cinnamon fern). *Sphagnum* (peat moss) is frequent. When *Picea rubens* (red spruce) and other tree species are present, their cover is typically sparse and restricted to peatland edges.

CLASSIFICATION CONFIDENCE: 2–3

DISTRIBUTION: This community can be found in montane settings throughout the state. Good examples occur on Mt. Monadnock (Jaffrey) and Cardigan Mtn. (Orange).

SOURCES: Nichols 2002.

• Subalpine sloping fen (S1)

GENERAL DESCRIPTION: This is a steeply-sloped (5–30°) peatland that occurs along the brow of a ***montane - subalpine circumneutral cliff***. Wetlands are unusual in such steep settings, but they are occasionally made possible by a rare combination of surface runoff, seepage, cloud-intercept, cold temperatures, and low evaporation. The species composition of this fen community is similar to other alpine/subalpine peatlands, but it is dominated by *Calamagrostis pickeringii* (Pickering's reed grass), *Geum peckii* (White Mountain avens)*, and pioneer peat mosses. Soils consist of a shallow peat (1–35 cm) over bedrock. In New Hampshire's only documented example, portions of the peat mat periodically supersaturate and slide over the edge.

CHARACTERISTIC VEGETATION: This community is floristically similar to ***alpine/subalpine bog*** but differs by having an abundance of Pickering's reed grass, White Mountain avens*, and *Sphagnum compactum*. *Sphagnum compactum* is a pioneer peat moss species that grows well on seepy, exposed bedrock or sand. *Trichophorum cespitosum* (tufted clubsedge), *Sphagnum russowii*, *S. capillifolium*, and *S. girgensohnii* are abundant, along with various shrubs including *Kalmia angustifolia* (sheep laurel), *Rhododendron 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. 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 west slope of Franconia Ridge).

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

Dwarf heath shrub bogs

Dwarf heath shrub bog communities have vegetation of low to moderate stature, and are distinguished from moss and moss-sedge carpet types by a denser cover of dwarf heath shrubs. Total shrub cover generally exceeds 25%, and the shrubs are usually dwarf (less than 0.5 m tall) or of medium height (up to 0.75 m tall). Tall shrubs are sparse or absent. *Picea mariana* (black spruce) or *Larix laricina* (American larch) may be present, but with a lower stature and abundance compared to those occurring in wooded fens. Surface peat is poorly to moderately decomposed, and very to extremely acidic (pH 4.1 or lower).

Leatherleaf - sheep laurel shrub bogs and ***leatherleaf - black spruce bogs*** are level, and located in low and montane settings below 2,900 ft. elevation. ***Alpine/subalpine bogs*** and ***wooded subalpine bog/heath snowbanks*** are either level or sloping, and restricted to higher elevations. On sloping ground in these settings, the cold, wet climate and low evapotranspiration combine to allow peat to accumulate. Degree of wetness appears to be a more important determinant of species composition than slope. ***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.

In parts of the White Mountains alpine/subalpine peatlands 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 4,000 ft. elevation on flat to gently sloping ridgetops of the Mahoosuc, Carter-Moriah, and Baldface Ranges. Smaller examples are found in several other scattered locations.

• Leatherleaf - sheep laurel shrub bog (S2S3)

GENERAL DESCRIPTION: These bogs and poor fens are oligotrophic to weakly minerotrophic and dominated by a dense cover of dwarf- to medium-height heath shrubs. Total diversity is low and there is 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* (leatherleaf) 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 peat mosses include *Sphagnum magellanicum* and *S. rubellum*, while *S. angustifolium* is occasional. *Polytrichum strictum* is common on hummocks and *Carex billingsii* (Billings' sedge) is occasional. This community has a higher constancy of *Sphagnum capillifolium* and apparent lower frequency of *Picea mariana* (black spruce) than the ***leatherleaf - 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**: 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**: 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. It 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 pHs are the lowest recorded among lowland peatlands in the state (below 1,000 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 shrub variant is rare and only occurs at a few sites in the state, including Rochester Heath Bog (Rochester).

SOURCES: Sperduto et al. 2000a.

• Leatherleaf - black spruce bog (S3)

GENERAL DESCRIPTION: This community is an oligotrophic dwarf heath bog or very poor fen that occurs throughout the state. It closely resembles the ***leatherleaf - sheep laurel shrub bog*** community, but also has scattered and stunted *Picea mariana* (black spruce) and *Larix laricina* (American larch). These trees typically have a cover of 1–10% and a height of 1–6 m, although taller individuals often exist. There are essentially no tall shrubs associated with the stunted trees. There is a significant component of dwarf heath species such as *Chamaedaphne calyculata* (leatherleaf), *Rhododendron groenlandicum* (Labrador tea), *Kalmia angustifolia* (sheep laurel), *K. polifolia* (bog laurel), and *Vaccinium oxycoccos* (small cranberry). Peat mats are grounded, and *Sphagnum* moss hummocks are usually very well developed.

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. This community is structurally similar to "muskeg" habitats of the boreal forest region in northern climates.

CHARACTERISTIC VEGETATION: Black spruce and/or larch dominate the stunted tree canopy. Leatherleaf, sheep laurel, small cranberry, and bog laurel are characteristic of the dwarf heath layer. *Eriophorum vaginatum* ssp. *spissum* (tussock cottonsedge), *E. virginicum* (tawny cottonsedge), *Maianthemum trifolium* (three-leaved false Solomon's-seal), and *Carex billingsii* (Billings' sedge) are frequent. 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 ***leatherleaf - sheep laurel shrub bogs***.

VARIANTS: Two reasonably distinct variants are described:

1. ***Sphagnum rubellum - S. angustifolium* 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 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* variant**: This variant is most common in northern New Hampshire and is distinguished by the presence of 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 3.9.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community occurs throughout the state. Good examples can be found at South Bay Bog (Clarksville), Trask Swamp (Alton), Hubbard Pond (Rindge), Loverens Mill (Antrim), northwest of Umbagog Lake (Errol), and near Duncan Lake (Ossipee).

SOURCES: Sperduto et al. 2000a.

• Alpine/subalpine bog (S1)

GENERAL DESCRIPTION: This *Sphagnum* (peat moss) dominated peatland community occurs on mostly level to sloping terrain, generally above 3,500 ft. elevation. 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 0–8º, but occasionally as steep as 35º.

CHARACTERISTIC VEGETATION: This community is distinguished from lowland peatlands by the presence of subalpine plants including *Empetrum nigrum* (black crowberry), *Vaccinium uliginosum* (alpine blueberry), *Trichophorum cespitosum* (tufted clubsedge), and *Rubus chamaemorus* (baked apple berry)*. Saturated conditions are indicated by the presence of *Vaccinium oxycoccos* (small cranberry), *Eriophorum vaginatum* ssp. *spissum* (tussock cottonsedge), and an abundance and high constancy of *Sphagnum* spp. (peat mosses). *Sphagnum fuscum* and *S. capillifolium* are the most common species; *S. rubellum*, *S. russowii*, and *S. lescurii* may also be present. *Rhododendron groenlandicum* (Labrador tea) is nearly constant and other heath shrubs are frequent, including *Chamaedaphne calyculata* (leatherleaf), *Kalmia angustifolia* (sheep laurel), and *K. polifolia* (bog laurel). Sheep laurel is not abundant, typically <10% cover. Leatherleaf is usually >10% cover in contrast to <10% in ***wooded subalpine bog/heath snowbank***. *Rhododendron canadense* (rhodora) and *Picea mariana* (black spruce) are more frequent in lower elevation examples. *Drosera rotundifolia* (round-leaved sundew) is occasional. The lichens *Cladina rangiferina* and *Cetraria islandica* are occasional and sometimes abundant.

VARIANTS: Two variants are recognized:

1. **Baked apple berry - alpine blueberry variant**: This variant differs from the next by a higher frequency of baked apple berry*, alpine blueberry, and tufted clubsedge. *Vaccinium vitis-idaea* (mountain cranberry) is occasional. Rhodora is notably absent. This variant can occur at higher elevations (up to ca. 4,900 ft.) than the one described below.
2. **Rhodora - shrub heath variant**: This variant tends to lack tufted clubsedge and baked apple berry*, has less alpine blueberry, and often has a denser cover of dwarf shrubs. Black crowberry is occasional, while rhodora is frequent. Black spruce is more frequent and abundant compared to the preceding variant. This variant occurs at a maximum elevation of ca. 3,700 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 3,500 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: These peatlands are found in subalpine settings where deep snows accumulate (e.g., on lee slopes of peaks or near krummholz margins), on borders of bogs (drier parts away from the center), and on slopes where *Sphagnum* moss grows and peat accumulates. The community is intermediate

between wet bogs and heath - krummholz communities.

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 0–8º, but occasionally as steep as 35º.

This community differs from ***alpine/subalpine bogs*** by having a generally greater frequency of stunted trees (black spruce and balsam fir <2 m in height) and heath shrubs. The shrub layer is typically 25–30 cm high, slightly higher than in ***alpine/subalpine bogs***. This community is also distinguished from these bogs by an absence of plants that are typically restricted to saturated conditions, such as *Vaccinium oxycoccos* (small cranberry), *Eriophorum vaginatum* ssp. *spissum* (tussock cottonsedge), and *Kalmia polifolia* (bog laurel). Sedges are absent and peat moss is often but not always present.

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 black spruce in abundance, and often the presence of bog-indicator species such as peat moss and leatherleaf.

CHARACTERISTIC VEGETATION: Characteristic species include *Rhododendron groenlandicum* (Labrador tea), *Kalmia angustifolia* (sheep laurel), *Vaccinium vitis-idaea* (mountain cranberry), *V. uliginosum* (alpine blueberry), *Chamaedaphne calyculata* (leatherleaf), *Picea mariana* (black spruce), and *Abies balsamea* (balsam fir). Labrador tea is the most common shrub; leatherleaf is occasional but not abundant (<10% cover). Mosses (including peat mosses) and lichens are occasional or locally abundant. *Cladina rangiferina* and *Cetraria islandica* are infrequent.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community occurs in the White Mountains, generally above 2,900 ft. Good examples are found on Mt. Success, Eagle Crag, Imp Mtn., Mt. Jackson, Mt. Moriah, and on the lee slope of the summit of Mt. Hight.

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

`Tall shrub poor fens`

Tall and medium-height shrubs, along with scattered trees, dominate these wooded fens. In contrast to dwarf heath shrub bogs, tall shrubs comprise at least 15% cover and often form dense thickets. Trees form a sparse but distinct overstory. Both tall shrub poor fen communities are more acidic and nutrient-poor than the tall shrub fens associated with medium and rich fens.

• Highbush blueberry - mountain holly wooded fen (S3S4)

GENERAL DESCRIPTION: This is a somewhat nutrient-poor community that is characterized by a mixture of northern and more southern or coastal species. It occurs most commonly as a border thicket around more open dwarf heath peatlands, including kettle hole bogs, and less commonly over large areas of perched basins.

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: The community is characterized by a mixture of tall and medium height heath shrubs, and usually a sparse canopy of *Picea mariana* (black spruce), *Larix laricina* (American larch), and sometimes *Pinus strobus* (white pine) or *P. rigida* (pitch pine). Tall shrubs average ca. 15% cover (range 1–30%) and usually include *Vaccinium corymbosum* (highbush blueberry), *Ilex mucronata* (mountain holly), *Lyonia ligustrina* (maleberry), and *Aronia melanocarpa* (black chokeberry). *Ilex verticillata* (common winterberry) and forbs indicative of more minerotrophic conditions are generally not

present. Dwarf and medium-height shrubs are typically more abundant (average 34% cover) than tall shrubs and include *Chamaedaphne calyculata* (leatherleaf), *Kalmia angustifolia* (sheep laurel), *Gaylussacia baccata* (black huckleberry), and occasionally *K. polifolia* (bog laurel). *Woodwardia virginica* (Virginia chain fern) and *Carex billingsii* (Billings' sedge) are occasional. *Sphagnum magellanicum* is dominant, while *S. rubellum* is characteristic but less frequent and abundant than in ***Sphagnum rubellum - small cranberry moss carpets*** that lack tall shrubs. *Sphagnum bartlettianum*, a species with coastal and southern distributional tendencies, occurs in some examples.

VARIANTS: Two variants are apparent:

1. **Rhodora - mountain holly - *Sphagnum russowii* variant**: This variant is characterized by a high frequency and abundance of *Rhododendron canadense* (rhodora) and *Sphagnum russowii* with little or no highbush blueberry. The most frequent tall shrub species are mountain holly and *Viburnum nudum* var. *cassinoides* (withe-rod). 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 other variant, and *S. angustifolium* is occasional to sometimes abundant.
2. **Highbush blueberry - huckleberry - large cranberry variant**: This variant has a high frequency and abundance of highbush blueberry and black huckleberry; *Vaccinium macrocarpon* (large cranberry) occurs in low abundance. Rhodora and 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 1,300 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.

• Mountain holly - black spruce wooded fen (S3)

GENERAL DESCRIPTION: This oligotrophic community is restricted to northern New Hampshire, and typically forms border thickets around dwarf heath shrub bogs in lake-fill peatlands or occupies more extensive areas in broad peatland basins. Mountain holly, withe-rod, and shorter dwarf heath shrubs are the most abundant species, with variable amounts of black spruce and larch forming a scattered tree layer.

Peat is usually moderately well decomposed in the upper 0.5 m. Hummock-hollow topography is moderately well developed.

CHARACTERISTIC VEGETATION: *Picea mariana* (black spruce) and *Larix laricina* (American larch) form a sparse canopy over a tall shrub layer dominated by *Ilex mucronata* (mountain holly) and *Viburnum nudum* var. *cassinoides* (withe-rod). Short heath shrubs are abundant, and include species such as *Kalmia angustifolia* (sheep laurel), *Rhododendron canadense* (rhodora), *R. groenlandicum* (Labrador tea), *Chamaedaphne calyculata* (leatherleaf), and *Kalmia polifolia* (bog laurel). Floristically, it is otherwise similar to the ***highbush blueberry - mountain holly wooded fen***, but lacks southern species such as *Vaccinium corymbosum* (highbush blueberry), *Lyonia ligustrina* (maleberry), *Gaylussacia baccata* (black huckleberry), and *Woodwardia virginica* (Virginia chain fern).

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Found in northern New Hampshire, generally north of the White Mountains.

SOURCES: Sperduto et al. 2000a.

MEDIUM AND RICH FENS

Medium and rich fens are mineral and oxygen-enriched peatlands. Sedges, forbs, and shrubs other than those in the heath family (Ericaceae) are more abundant in medium and rich fens than in bogs and poor fens, although heaths and peat mosses may still be prominent in the latter.

Medium and rich fen communities are divided into four groups: 1) level sedge, shrub, and shrub-sedge fens, 2) sloping graminoid and shrub fens, 3) level to sloping wooded fens, and 4) marshy communities of peatland margins.

Level sedge, shrub, and shrub-sedge fens

This group consists of three medium fen communities that occur in level basins drained by a stream. Each community is dominated by a combination of robust sedges and medium-height shrubs (up to 1 m). Tall shrubs and trees are absent or sparse (less than 5% cover). Internal streams or ponds are sometimes present within the peatland.

• Sweet gale - meadowsweet - tussock sedge fen (S4)

GENERAL DESCRIPTION: This community 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).

CHARACTERISTIC VEGETATION: *Myrica gale* (sweet gale), *Spiraea alba* var. *latifolia* (meadowsweet), and *Carex stricta* (tussock sedge) are diagnostic and usually present in some combination. Tall shrubs are sparse (<5%) or absent. Sweet gale and *Chamaedaphne calyculata* (leatherleaf) are robust (average height 0.90 m), nearly constant, and abundant.

The herb layer is moderately well developed and typically contributes 5–25% cover. It consists of several herbaceous species, each of which is only present in low abundance, including *Calamagrostis canadensis* (bluejoint), *Carex lasiocarpa* (wire sedge), *C. utriculata* (swollen-beaked sedge), *C. canescens* (hoary sedge), *Typha latifolia* (broad-leaved cattail), *Lysimachia terrestris* (swamp yellow-loosestrife), and *Triadenum virginicum* (Virginia marsh-St. John's-wort). *Sphagnum fimbriatum* and *S. henryense* are frequent; *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.

• Wire 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 moderate sized (average height 0.2 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* (wire sedge) is abundant and mixes with variable amounts of *Myrica gale* (sweet gale), *Carex utriculata* (swollen-beaked sedge; frequent), and *C. oligosperma* (few-seeded sedge; occasional). At least one of the three sedge species is always present. *Chamaedaphne calyculata* (leatherleaf) is occasional; tall shrubs and trees are sparse or absent. Forbs indicative of intermediate nutrient status are usually present in low abundance, including *Lysimachia terrestris* (swamp yellow-loosestrife), *Triadenum virginicum* (Virginia marsh-St. John's-wort), and *Sagittaria latifolia* (common arrowhead). *Vaccinium macrocarpon* (large cranberry) can be common but is not always present. *Spiraea alba* var. *latifolia* (meadowsweet), *Calamagrostis canadensis* (bluejoint), and *Typha latifolia* (broad-leaved cattail) may be present, particularly when *Vaccinium macrocarpon* (large cranberry) is absent. *Peltandra virginica* (green arrow-arum) is occasional. *Sphagnum* spp. (peat mosses) are occasionally absent but usually form a sparse to moderate cover that may include *S. lescurii* (frequent) and *S. torreyanum* (occasional). *Sphagnum cuspidatum*, *S. fimbriatum*, and *S. affine* are uncommon.

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), on the Bearcamp River delta (Ossipee), at Berry Pond (Moultonborough/Sandwich), along the Powwow River (Kingston), and at World End Pond (Salem).

SOURCES: Sperduto et al. 2000a.

• Water willow - *Sphagnum* fen (S3)

GENERAL DESCRIPTION: This community occurs in wet minerotrophic settings along the edge of peat mats, typically adjacent to pond edges, as well as in moat settings. 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 height of medium shrubs is 0.95 m.

CHARACTERISTIC VEGETATION: Dominated by *Decodon verticillatus* (water willow) and minerotrophic *Sphagnum* species including *S. recurvum*, *S. flexuosum*, *S. fimbriatum*, and occasionally *S. papillosum*. Both *Sphagnum recurvum* and water willow have southern or coastal affinities, restricting the distribution of this community. Other frequent species include *Chamaedaphne calyculata* (leatherleaf), *Myrica gale* (sweet gale), *Carex canescens* (hoary sedge), *Lysimachia terrestris* (swamp yellow-loosestrife), and *Triadenum virginicum* (Virginia marsh-St. John's-wort). *Vaccinium corymbosum* (highbush blueberry) may occur in low abundance.

CLASSIFICATION CONFIDENCE: 2

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.

Sloping graminoid and shrub fens

This group consists of sloping medium or rich fen communities in active groundwater seepage areas of northern New Hampshire. Sedges, grasses, or shrubs dominate. Slopes are typically gentle, but occasionally as steep as 10º. A stream may drain sloping graminoid and shrub fens, but internal streams or adjacent ponds are unusual. Sloping fen communities are low in stature, dominated by herbaceous plants or medium-height shrubs (less than 1 m tall), and moderately acidic to near neutral (pH above 5.3). Tall

shrubs and trees are absent or sparse.

• Montane sloping fen (S1)

GENERAL DESCRIPTION: This graminoid or graminoid and shrub dominated community is weakly to moderately minerotrophic. It forms nearly level to demonstrably sloping soligenous peat mats in the White Mountains above 2,400 ft. elevation and below subalpine zones. This type of fen is the only known peatland in the state or region that is dominated by a grass. It is characterized by a prominence of *Calamagrostis pickeringii* (Pickering's reed 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* (common winterberry), and *Gaylussacia baccata* (black huckleberry). This community occurs in mosaics with ***montane alder - heath shrub thickets*** and ***montane heath woodlands***.

Slopes are frequently up to 10º, with a maximum of about 20º. Soils are characterized by shallow organics over hydric, cryic, silty gravels. The pH ranges between 4.2–6.2 and averages 5.3. Hummock and hollow topography is moderately to poorly developed. Climate, hydrologic conditions, and soil features are the primary factors contributing to the development of this soligenous peatland community.

CHARACTERISTIC VEGETATION: Pickering's reed grass is one of the dominant herbs, typically contributing 5% cover or more (up to 25%). *Sphagnum* moss is abundant 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* (star sedge), *C. pauciflora* (few-flowered sedge), *C. michauxiana* (Michaux's sedge), Wiegand's sedge*, *C. oligosperma* (few-seeded sedge), *C. brunnescens* (brownish sedge), *Eriophorum virginicum* (tawny cottonsedge), *Solidago uliginosa* (bog goldenrod), *Eurybia radula* (rough wood-aster), *Chamaepericlymenum canadense* (bunchberry), *Coptis trifolia* (three-leaved goldthread), *Veratrum viride* (American false hellebore), *Thalictrum pubescens* (tall meadow-rue), *Sarracenia purpurea* (purple pitcherplant), *Platanthera dilatata* (white northern bog-orchid), *P. clavellata* (little club-spur bog-orchid), *Houstonia caerulea* (little bluet), *Drosera rotundifolia* (round-leaved sundew), and *Maianthemum trifolium* (three-leaved false Solomon's-seal). Common shrubs include *Chamaedaphne calyculata* (leatherleaf), *Kalmia polifolia* (bog laurel), *Rhododendron groenlandicum* (Labrador tea), *R. canadense* (rhodora), *Ilex mucronata* (mountain holly), *Viburnum nudum* var. *cassinoides* (withe-rod), *Vaccinium oxycoccos* (small cranberry), *V. myrtilloides* (velvet-leaved blueberry), and *Aronia melanocarpa* (black chokeberry). *Sphagnum* mosses are abundant, and include *S. subtile, S. angustifolium*, and *S. girgensohnii* (detailed surveys not undertaken). Other occasional species include *Carex trisperma* (three-seeded sedge), *Juncus brevicaudatus* (short-tailed rush), *Rubus dalibarda* (dewdrop), *Alnus incana* ssp. *rugosa* (speckled alder), *Kalmia angustifolia* (sheep laurel), and *Amelanchier bartramiana* (mountain shadbush). Scattered trees include *Larix laricina* (American larch), *Picea mariana* (black spruce), and *P. rubens* (red spruce). *Carex exilis* (meager sedge)*, a rare plant in NH and otherwise not known from the White Mountains, was frequent in one fen.

CLASSIFICATION CONFIDENCE: 1–2

DISTRIBUTION: Restricted to a few scattered localities in the White Mountains above 2,400 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.

• Calcareous sedge - moss fen (S2)

GENERAL DESCRIPTION: ***Calcareous sedge - moss fens*** occur in northern New Hampshire in a variety of ground-water influenced hydrological settings (disturbed and natural) where seepage often is prominent year-round 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 prominent seepage, (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 and remain open. 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 sedge - moss 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-green sedge), *C. hystericina* (porcupine sedge), *Eriophorum virginicum* (tawny cottonsedge), *Eleocharis tenuis* (slender spikesedge), *Trichophorum alpinum* (alpine clubsedge), *Scirpus microcarpus* (barber-pole bulrush), *Equisetum fluviatile* (river horsetail), *Drosera rotundifolia* (round-leaved sundew), *Geum rivale* (water avens), *Platanthera huronensis* (Lake Huron green bog-orchid), *P. psycodes* (lesser purple fringed bog-orchid), *P. dilatata* (white northern bog-orchid), *Packera schweinitziana* (New England groundsel), *Typha latifolia* (broad-leaved cattail), and *Thuja occidentalis* (northern white cedar). Other species frequent in calcareous fens that may also occur in other habitats include *Eutrochium maculatum* (spotted Joe-Pye weed), *Fragaria virginiana* (common strawberry), *Hydrocotyle americana* (American marsh-pennywort), *Glyceria striata* (fowl mannagrass), *Juncus tenuis* (path rush), *J. nodosus* (knotted rush), *Equisetum arvense* (field horsetail), *Thelypteris palustris* var. *pubescens* (marsh fern), *Salix lucida* (shinning willow), *S. discolor* (pussy willow), and *S. bebbiana* (long-beaked willow).

Rare plants occurring in calcareous fens include *Spiranthes romanzoffiana* (hooded ladies'-tresses), *Cypripedium reginae* (showy lady's-slipper)*, *Lobelia kalmii* (brook lobelia)*, *Petasites frigidus* var. *palmatus* (northern sweet-coltsfoot)*, *Carex bebbii* (Bebb's sedge), *C. castanea* (chestnut sedge)*, *Carex aurea* (golden-fruited sedge)*, *Eleocharis quinqueflora* ssp. *fernaldii* (few-flowered spikesedge)*, *Equisetum variegatum* (variegated scouring-rush), *E. palustre* (marsh horsetail)*, and *E. pratense* (meadow horsetail).

Bryophytes often found in calcareous fens include *Sphagnum warnstorfii*, *Aulocomnium palustre*, *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 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. **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 northern white cedar swamps.
3. **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 drainage marshes behind old beaver impoundments in regions with calcareous substrates. Few examples are known, but these wetlands clearly have a different long- and short-term disturbance regime. Orchids appear to be sparse, and certain graminoids may be more prominent than in the above variants, including *Carex utriculata* (swollen-beaked sedge), Bebb's sedge, *Calamagrostis canadensis* (bluejoint), and the rare few-flowered spikesedge*, but calciphiles are also present, distinguishing this variant from typical beaver meadows. Presumably, this variant is 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.

• Northern white cedar circumneutral string (S1)

GENERAL DESCRIPTION: Circumneutral strings 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 vary 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* (leatherleaf), *Rhododendron groenlandicum* (Labrador tea), *Andromeda polifolia* var. *glaucophylla* (bog rosemary), and *Salix pedicellaris* (bog willow). Scattered northern white cedar, *Picea mariana* (black spruce), *Larix laricina* (American larch), and *Acer rubrum* (red maple) reach heights of 5–7 m in the tall shrub layer. The poorly developed herb layer supports *Carex exilis* (meager sedge)* and less frequently *C. billingsii* (Billings' sedge), *Trichophorum alpinum* (alpine clubsedge), *Muhlenbergia glomerata* (spike muhly), *Drosera rotundifolia* (round-leaved sundew), *Sarracenia purpurea* (purple pitcherplant), *Menyanthes trifoliata* (buck-bean), *Eurybia radula* (rough wood-aster), *Solidago uliginosa* (bog goldenrod), *Osmunda regalis* var. *spectabilis* (royal fern), and few others. 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. ***Northern white cedar circumneutral strings*** occur only at the Umbagog Lake site.

SOURCES: Sperduto et al. 2000a.

• Circumneutral - calcareous flark (S1)

GENERAL DESCRIPTION: ***Circumneutral - calcareous flarks*** are characterized by saturated to flooded hollows (flarks) lying approximately parallel to low peat ridges (strings or ribs) in patterned fens. Slow groundwater movement through the gently sloping wetland causes the patterned or "ribbed" fen topography.

The flarks range from a few meters to more than 25 m wide, with pHs 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* (meager sedge)*, *C. livida* (livid sedge)*, *C. tenuiflora* (sparse-flowered sedge)*, *Eriophorum viridicarinatum* (green-keeled cottonsedge), *Rhynchospora alba* (white beaksedge), *Trichophorum alpinum* (alpine clubsedge), *Muhlenbergia glomerata* (spike muhly), *Juncus stygius* ssp. *americanus* (moor rush)*, *Menyanthes trifoliata* (buck-bean), *Utricularia minor* (lesser bladderwort), *Sarracenia purpurea* (purple pitcherplant), *Drosera intermedia* (spatulate-leaved sundew), *Solidago uliginosa* (bog goldenrod), and *Andromeda polifolia* var. *glaucophylla* (bog rosemary).

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. ***Circumneutral - calcareous flarks*** occur only at the Umbagog Lake site.

SOURCES: Sperduto et al. 2000a.

`Level to sloping wooded fens`

This group of communities consists of tall shrubs and/or medium-height shrub-dominated fens in level or sloped settings. They typically occur closer to the upland border than level shrub and shrub-sedge fens and sloping sedge, graminoid, and shrub fen communities. Each of the communities has a moderate to dense cover of tall and medium-height shrubs and a scattered tree layer. Wooded tall shrub fens often occupy the upland border zone of open peatlands, or are the dominant type in peat-filled basins without ponds.

• Winterberry - cinnamon fern wooded fen (S4)

GENERAL DESCRIPTION: This community typically occurs as a broad to narrow zone around the perimeter of small peatlands, or along sluggish stream borders. Occasionally it 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* (common winterberry) and *Osmundastrum cinnamomeum* (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 (hummocks average 0.22 m in height; maximum average 0.44 m). Medium shrub height averages 0.85 m. Peat depths are often less than 1 m.

CHARACTERISTIC VEGETATION: Characteristic tall shrubs include common winterberry, *Vaccinium corymbosum* (highbush blueberry), *Lyonia ligustrina* (maleberry), *Ilex mucronata* (mountain holly), *Alnus incana* ssp. *rugosa* (speckled alder), and *Aronia melanocarpa* (black chokeberry). *Decodon verticillatus* (water willow) is occasionally abundant, and *Chamaedaphne calyculata* (leatherleaf), *Kalmia angustifolia* (sheep laurel), and *Gaylussacia baccata* (black huckleberry) are common. 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 diagnostic (but in low abundance). These include cinnamon fern, *Carex canescens* (hoary sedge), *C. stricta* (tussock sedge; occasionally abundant), *Lysimachia terrestris* (swamp yellow-loosestrife), *Triadenum virginicum* (Virginia marsh-St. John's-wort), and *Lycopus uniflorus* (northern water-horehound). *Calla palustris* (wild calla), *Iris versicolor* (blue iris), and *Typha latifolia* (broad-leaved cattail) are occasional in wet hollows. *Oclemena nemoralis* (bog nodding-aster) and *O. x blakei* (Blake's nodding-aster) are infrequent. *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*, *S. affine*, and *Aulocomnium palustre* are occasional.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: This community occurs below 1,500 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 characterized by medium and 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* (common winterberry). Other coastal or southern species include *Woodwardia virginica* (Virginia chain fern), *Rhododendron viscosum* (clammy azalea), *Carex seorsa* (weak stellate sedge)*, *Toxicodendron vernix* (poison-sumac), *Gaylussacia frondosa* (blue huckleberry), *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.

• 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) such as *Myrica gale* (sweet gale) and *Spiraea alba* var. *latifolia* (meadowsweet), with a sparse to moderate cover of tall shrubs. The community is found along upland borders of acidic fens, along sluggish stream borders, and sometimes as the dominant fen community in basins that are influenced by upland runoff. It occurs primarily in central and southern parts of New Hampshire, but also occasionally further north.

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: Sweet gale and meadowsweet are diagnostic in combination with tall shrubs, including various combinations of *Vaccinium corymbosum* (highbush blueberry), *Lyonia ligustrina* (maleberry), *Aronia melanocarpa* (black chokeberry), *Ilex verticillata* (common winterberry), and *Alnus incana* ssp. *rugosa* (speckled alder). *Chamaedaphne calyculata* (leatherleaf) 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* (swollen-beaked 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 (below 1,500 ft.) in central and southern New Hampshire, but it does occur occasionally in the northern part of the state.

SOURCES: Sperduto et al. 2000a.

• Alder - lake sedge intermediate fen (S2S3)

GENERAL DESCRIPTION: This is a minerotrophic fen community dominated by medium-height and tall shrubs and robust herbaceous species. It occurs where there is some groundwater seepage influence. The prominence of shrubs, deeper organic soil, and greater abundance of peat moss separates it from ***herbaceous seepage marshes***; the abundance of herbs (25–90% cover) distinguishes it from other fen communities; and the absence or low cover of trees in the overstory (<25%) differentiates it structurally from seepage swamps.

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 and pronounced. Measured pH ranges from 4.4 to 5.7.

CHARACTERISTIC VEGETATION: The tall shrub layer varies from 5 to 40% cover, with *Alnus incana* ssp. *rugosa* (speckled alder) usually being the most abundant species. Others include *Ilex verticillata* (common winterberry), *Lyonia ligustrina* (maleberry), *Viburnum nudum* var. *cassinoides* (withe-rod), and *Vaccinium corymbosum* (highbush blueberry). Medium shrubs are usually abundant (5–50% cover). Frequent species include *Chamaedaphne calyculata* (leatherleaf), *Myrica gale* (sweet gale), *Rhododendron canadense* (rhodora), *Spiraea alba* var. *latifolia* (meadowsweet), *Kalmia angustifolia* (sheep laurel), *K. polifolia* (bog laurel), and *Andromeda polifolia* var. *glaucophylla* (bog rosemary).

Robust herbs are abundant (25–90%). Frequent and abundant species include *Carex lacustris* (lake sedge), *Symplocarpus foetidus* (skunk-cabbage), *Osmunda regalis* var. *spectabilis* (royal fern), and *Osmundastrum cinnamomeum* (cinnamon fern). Less frequent herbs include *Carex utriculata* (swollen-beaked sedge), *C. oligosperma* (few-seeded sedge), *Calamagrostis canadensis* (bluejoint), *Calla palustris* (wild calla),

Lysimachia terrestris (swamp yellow-loosestrife), *Triadenum virginicum* (Virginia marsh-St. John's-wort), and *Maianthemum trifolium* (three-leaved false Solomon's-seal). Peat mosses are common to abundant (20–80% cover) and include *Sphagnum fallax*, *S. magellanicum*, *S. angustifolium*, and *S. flexuosum*.

Trees may include *Larix laricina* (American larch), *Picea mariana* (black spruce), *Acer rubrum* (red maple), and *Betula populifolia* (gray birch). The rare *Betula pumila* (bog birch)* sometimes occurs in this community.

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.

• Alder wooded fen (S3S4)

GENERAL DESCRIPTION: This "boggy alder swamp" is dominated by *Alnus incana* ssp. *rugosa* (speckled alder), various other shrub associates and sometimes scattered conifers. It occurs in open headwater basins, in somewhat seepy subacid fens, and along small low-energy streams (e.g., first and second order streams), all of which are lower-energy settings relative to other alder-dominated communities. It has fewer heath shrubs [e.g., *Rhododendron canadense* (rhodora) and *Rhododendron groenlandicum* (Labrador tea)] than similar ***montane alder - heath shrub thicket*** communities described from the White Mountains. Shallow to deep muck or peat soils are typical.

CHARACTERISTIC VEGETATION: Speckled alder dominates. Other characteristic shrubs found in lower abundance include *Swida sericea* (red-osier dogwood), *Ilex mucronata* (mountain holly), *Lonicera villosa* (mountain honeysuckle), *Spiraea alba* var. *latifolia* (meadowsweet), *S. tomentosa* (rosy meadowsweet), *Viburnum nudum* var. *cassinoides* (withe-rod), *Ribes triste* (swamp red currant), and *R. glandulosum* (skunk currant). Herbs and dwarf shrubs are common including *Carex trisperma* (three-seeded sedge), *C. canescens* (hoary sedge), *C. echinata* (star sedge), *Dryopteris cristata* (crested wood fern), *D. carthusiana* (spinulose wood fern), *Gymnocarpium dryopteris* (northern oak fern), *Maianthemum trifolium* (three-leaved false Solomon's-seal), *Rubus pubescens* (dwarf raspberry), 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.

• Montane alder - heath shrub thicket (S1)

GENERAL DESCRIPTION: This community is dominated by tall shrubs, though scattered trees are usually present. It is restricted to flat ridges and slopes near the transition to heath - krummholz communities and in certain high elevation valleys in the White Mountains. It may be expected in other parts of northern New Hampshire, though the similar ***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 in the related ***montane sloping fen*** community. Near-surface water pH is 5.0. Hummock and hollow topography is moderately developed.

This community differs from 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 ***alder wooded fens*** by having more abundant heaths and other northern shrubs.

CHARACTERISTIC VEGETATION: Characteristic shrubs include *Alnus incana* ssp. *rugosa* (speckled alder), *Rhododendron canadense* (rhodora), *Ilex mucronata* (mountain holly), and *Viburnum nudum* var. *cassinoides* (withe-rod). Other common woody species include *Rhododendron groenlandicum* (Labrador tea), *Vaccinium myrtilloides* (velvet-leaved blueberry), *Gaultheria hispidula* (creeping spicy-wintergreen), *Larix laricina* (American larch), and *Picea mariana* (black spruce). Scattered herbaceous vascular plants found in small openings include *Carex trisperma* (three-seeded sedge), *C. intumescens* (greater bladder sedge), *Eriophorum virginicum* (tawny cottonsedge), *Calamagrostis pickeringii* (Pickering's reed grass), *Glyceria melicaria* (northeastern mannagrass), *Thalictrum pubescens* (tall meadow-rue), *Doellingeria umbellata* (tall white-aster), *Chelone glabra* (white turtlehead), and *Drosera rotundifolia* (round-leaved sundew). *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 2,400 ft. and, at a few sites, near the transition to heath - krummholz.

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

Marshy communities of peatland margins

These peatland communities occur adjacent to sheltered pond and lake borders, stagnant streams, or upland habitats with a minerotrophic influence from upland runoff or open water. They may be transitional to aquatic beds, marshes, shrub thickets, or upland habitats. Some peatland types described elsewhere may also occur along pond or upland borders, but they do not contain an abundance of emergent or aquatic marsh species as is indicative of the two types described here.

• Floating marshy peat mat (S3S4)

GENERAL DESCRIPTION: This community consists of thin, flat, loosely consolidated peat and vegetation along calm margins of lakes, ponds, and slow-moving streams. They are transitional between aquatic bed or emergent marsh communities in deeper water and open peatlands on thicker, more consolidated peat landward. This community occurs statewide, usually at the edges of open waterbodies.

The depth of the floating peat mat ranges from a few to more than 50 cm, and measured pH ranges from 4.4–5.7. The pH values are influenced by proximity to open water. The mat surface is flat with occasional, very low micro-relief. Width ranges from less than a meter to several meters wide.

CHARACTERISTIC VEGETATION: Species composition is variable, but often includes *Nymphaea odorata* (white water-lily), *Nuphar variegata* (bullhead pond-lily), *Eriophorum viridicarinatum* (green-keeled cottonsedge), *Eleocharis flavescens* var. *olivacea* (yellow spikesedge), *E. palustris* (common spikesedge), *Rhynchospora alba* (white beaksedge), *Dulichium arundinaceum* (three-way sedge), *Juncus pelocarpus* (brown-fruited rush), *Triadenum virginicum* (Virginia marsh-St. John's-wort), *Hypericum boreale* (northern St. John's-wort), *Drosera intermedia* (spatulate-leaved sundew), *Utricularia* spp. (bladderworts), *Pontederia cordata* (pickerelweed), *Iris versicolor* (blue iris), and other forbs and graminoids. Shrubs are both sparse and stunted, or completely absent.

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: This community probably occurs throughout New Hampshire, at the edges of open waterbodies. Good examples 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 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 from them by having a greater prominence of 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 and variable in composition, with a number of minerotrophic indicator species. Temporarily to seasonally flooded moat zones support most of the shrub and marsh species present. Emergent or aquatic species generally absent from other peatland types include *Sparganium americanum* (American bur-reed), *Calamagrostis canadensis* (bluejoint), *Glyceria* spp. (mannagrasses), *Scirpus cyperinus* (woolly bulrush), *Eleocharis palustris* (common spikesedge), *Juncus canadensis* (Canada rush), and *J. effusus* ssp. *solutus* (loosened soft rush). In semi-permanently flooded moat zones, several aquatic species may be present, including *Potamogeton* spp. (pondweeds), *Brasenia schreberi* (water-shield), *Utricularia vulgaris* ssp. *macrorhiza* (greater bladderwort), *Nuphar variegata* (bullhead pond-lily), and *Nymphaea odorata* (white water-lily).

Other characteristic species that are also occasional in other peatland communities include *Peltandra virginica* (green arrow-arum), *Triadenum virginicum* (Virginia marsh-St. John's-wort), *Lycopus uniflorus* (northern water-horehound), *Lysimachia terrestris* (swamp yellow-loosestrife), *Dulichium arundinaceum* (three-way sedge), *Carex canescens* (hoary sedge), and *C. lasiocarpa* (wire sedge). Shrubs may include *Cephalanthus occidentalis* (buttonbush), *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (common winterberry), *Decodon verticillatus* (water willow), *Chamaedaphne calyculata* (leatherleaf), *Spiraea alba* var. *latifolia* (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 Nye Meadow (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 fresh water 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 fresh water flow (Cowardin et al. 1979).

Surface water salinity fluctuates widely according to seasonal variation in fresh water 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. Fresh water marshes occur where salinity levels are 0.5 ppt or less during the period of annual low fresh water flow.

Salt marshes are the dominant natural communities in estuarine ecosystems. In New Hampshire, salt marshes grow atop fibrous marine peat, which has very little mineral content due to the weather-resistant bedrock found along the North Atlantic coast. These salt marshes are referred to as the New England Type (Johnson 1925). The organic soils of the New England Type distinguish them from other salt marshes to the north and south along the east coast of North America (Reimold 1977), which have mineral soils.

New Hampshire salt marshes are estimated to be around 4,000 years old. Their origin dates to the point when the rate of sea level rise slowed sufficiently to allow for the establishment and growth of salt marshes (Redfield 1972). As salt marshes expanded, they replaced brackish marshes and uplands landward and accreting intertidal flats seaward. Their current extent is dictated by tidal amplitude. 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 saltmarsh 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 abilities of individual plant species to tolerate the combination of stresses dictate which plant species grow where. For example, *Spartina alterniflora* (smooth cordgrass) dominates the physically stressful low marsh due to its ability to oxygenate its roots and rhizosphere. *Spartina patens* (saltmeadow cordgrass), sensitive to tidal flooding, competitively excludes smooth cordgrass from the high marsh. Along the upland edge of the marsh, saltmeadow cordgrass is itself competitively excluded by *Juncus gerardii* (saltmarsh 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 saltmeadow cordgrass and *Distichlis spicata* (saltgrass) for hay, pasture, and mulch. New Hampshire's salt marshes were also ditched in an effort to reduce salt marsh mosquito populations (*Aedes sollicitans* and other species). 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 *Stuckenia pectinata* (Sago false 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 fresh water runoff. Recent mitigation efforts have helped to begin the restoration process for these degraded salt marshes.

Typha angustifolia (narrow-leaved cattail) is a species considered non-native in recently published floras and plant atlases (Haines 2011; Kartesz 2011). However, there is mounting evidence indicating this taxon occurred on the Northeast coast prior to European settlement and has since spread in a way similar to the native *Typha latifolia* (broad-leaved cattail), as a result of its invasive nature and human disturbance (Distler 2010; Farrell et al. 2010; Pederson et al. 2005; Rippke et al. 2010; Shih and Finkelstein 2008). Similarly, even though *Agrostis stolonifera* (creeping bentgrass) is often considered non-native in North American (Haines 2011), Harvey (2007) believes some northern salt marsh populations may be native. Because narrow-leaved cattail and creeping bentgrass may be native in esturaine habitat in the northeastern U.S., they are here considered to be native.

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 communities***, upper reaches of ***intertidal rocky shore***, ***high salt marsh***, ***brackish marsh***, high marsh ***salt pannes and pools***, ***high brackish 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 ***salt pannes and pools***, ***low brackish riverbank marsh***, ***intertidal flat***, and ***intertidal rocky shore*** natural communities. The lower intertidal is the irregularly exposed zone (substrate exposed less than daily) occurring between the mean low tide and very low spring tide, which supports the lower reaches of the ***intertidal flat*** and ***intertidal rocky shore*** natural communities.

• Low salt marsh (S3)

GENERAL DESCRIPTION: This community is dominated by *Spartina alterniflora* (smooth cordgrass) and occurs between mean sea level and mean high tide in areas protected from high-energy wave action. They form along the coast in protected bays, along rivers, and behind rocky spits, barrier beaches, and sand bars. ***Low salt marshes*** grade into ***intertidal flats*** and subtidal communities seaward and ***high salt marshes***

landward. ***Salt pannes and pools*** can be found in this community but are more common in the ***high salt marsh***. ***Low salt marshes*** are often restricted to a narrow fringe along ditches, creeks, rivers, and bays where poly- to euhaline conditions limit competition. Smooth cordgrass can reach heights of ca. 3–6 ft. in these bands. Where slopes are gentler, smooth cordgrass may cover broader areas. While this is a distinct, narrowly-defined natural community, it does share similarities with the ***low brackish riverbank marsh*** described later in this section.

Soils are typically organic materials 16 to 50" thick overlying sandy or silty materials (Terric Sulfihemists). Soil water salinity roughly corresponds to polyhaline levels (18–30 ppt).

CHARACTERISTIC VEGETATION: Smooth cordgrass dominates the physically stressful low salt marsh. Associated vascular halophytes occur in low abundance and may include *Salicornia depressa* (common glasswort), *Atriplex prostrata* (halberd-leaved orache), *A. glabriuscula* (bracted orache), *Eleocharis parvula* (little-headed spikesedge)*, *Suaeda* spp. (sea-blites), and *Spergularia marina* (saltmarsh sand-spurry). Macroalgae (seaweed) include *Ascophyllum nodosum* and *Fucus* spp. (rockweeds), among others.

VARIANTS: This community occurs in two distinct settings, forming two variants. The typic variant is more common than the mineral soil variant in New Hampshire.

1. **Typic variant**: As described above. This variant occurs in organic soils, typically as a narrow fringe at the seaward edge of high marsh.
2. **Mineral soil variant**: This variant occurs as linear strands of *Spartina alterniflora* (smooth cordgrass) in moderate to high-energy settings. Mineral soils are coarse (often gravel or cobble) with a shallow (or absent) organic layer. Frequently occurs together with the shallow peat variant of ***high salt marsh***.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Restricted to sheltered areas near 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: This community, dominated by *Spartina patens* (saltmeadow cordgrass), accounts for more than 90% of the total salt marsh habitat in New Hampshire. Along with ***low salt marshes***, this community occurs along the coast behind rocky spits, barrier beaches, and sand bars and along bays and rivers where it is protected from high-energy wave action. The transition between this community 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. The upper edge of this community supports an increased diversity of plant species.

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. ***Salt pannes and pools*** are common on the marsh surface.

Soils are generally organic materials thicker than 50" over sand, silt, or bedrock (Typic Sulfihemists). Organic soils 16 to 50" thick occur along stream and river mouths entering the Great Bay complex and the narrow margins around the bay (Terric Sulfihemists over silt). Thinner soils (<16”) underlie ***high salt 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 (Sulfaquents). Salt marsh soil water salinity roughly corresponds to polyhaline levels (18–30 ppt).

CHARACTERISTIC VEGETATION: Saltmeadow cordgrass is typically dominant in this community. Other

common plants include *Spartina alterniflora* (smooth cordgrass; short form), *Distichlis spicata* (saltgrass), and *Juncus gerardii* (saltmarsh rush). Saltgrass often forms pure stands in wetter, more poorly drained areas, or mixes with saltmeadow cordgrass, growing at similar elevations on the high marsh. Saltmarsh rush often dominates landward of saltmeadow cordgrass 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 community. This zone has the highest species richness in the marsh and includes *Solidago sempervirens* (seaside goldenrod), *Symphyotrichum novi-belgii* (New York American-aster), *Panicum virgatum* (switch panicgrass), *Anthoxanthum nitens* (vanilla sweet grass), *Festuca rubra* ssp. *pruinosa* (frosty red fescue), *Elymus virginicus* (common eastern wild-rye), *E. repens* (creeping wild-rye), *Spartina pectinata* (prairie cordgrass), *Carex hormathodes* (marsh straw sedge), *Juncus balticus* ssp. *littoralis* (Baltic rush), *Teucrium canadense* (American germander), *Sanguisorba canadensis* (Canada burnet), and *Ligusticum scothicum* (Scotch lovage).

Less frequent species in this community are *Polygonum ramosissimum* ssp. *ramosissimum* (yellow-flowered knotweed), *P. ramosissimum* ssp. *prolificum* (prolific yellow-flowered knotweed)*, *Argentina egedii* ssp. *groenlandica* (coastal silverweed), *Symphyotrichum tenuifolium* (perennial saltmarsh American-aster)*, and *S. subulatum* (annual saltmarsh American-aster).

Plants often found on low natural levees include *Suaeda* spp. (sea-blites), *Puccinellia maritima* (seaside alkali grass), and *Atriplex prostrata* (halberd-leaved orache). Along larger marsh creeks, levees several meters wide typically rise 2–6" above the marsh. Areas along the upper edge of this community that are influenced by fresh water streams, ephemeral channeled runoff, or groundwater discharge often support ***brackish marsh***.

VARIANTS: This community occurs in two distinct settings, forming two variants. The typic variant is more common than the shallow peat variant in New Hampshire.

1. **Typic variant**: As described above. This variant occurs in deeper organic soils in estuarine settings.
2. **Shallow peat variant**: This variant occurs as isolated patches or linear strands of *Spartina patens* (saltmeadow cordgrass) and other species in moderate to high-energy settings. Peat depth is shallow, often only a few inches deep above bedrock, gravel, or cobble. This variant frequently occurs together with the mineral soil variant of ***low salt marsh***.

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: These marshes occasionally occur along the upper margins of ***high salt marshes*** and ***high brackish riverbank marshes*** where sufficient fresh water runoff or groundwater discharge flows onto the marsh surface. They are flooded by salt water only during spring tides and storm surges. These conditions support several species most often found in fresh or salt marshes but that are also tolerant of brackish conditions and able to successfully compete in this environment. ***High and low brackish riverbank marshes*** are two similar communities but they are tidally flooded more frequently than by spring tides alone.

Sulfihemist soils with low surface salt content likely underlie most examples (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 a variable mix of herbaceous species including *Carex paleacea* (chaffy sedge), *Bolboschoenus robustus* (sea-coast tuber-bulrush), *Agrostis stolonifera* (creeping bentgrass), *Festuca rubra* ssp. *pruinosa* (frosty red fescue), *Spartina pectinata* (prairie cordgrass), *S. patens* (saltmeadow cordgrass), *Juncus gerardii* (saltmarsh rush), *Solidago sempervirens* (seaside goldenrod), and *Symphyotrichum novi-belgii* (New York American-aster). *Eleocharis parvula* (little-headed spikesedge)* and *E. uniglumis* (one-glumed spikesedge)* are rare species that can be found in both variants.

Some ***brackish marshes*** are dominated by *Typha angustifolia* (narrow-leaved cattail), particularly in coves or other protected areas with restricted spring-tide "sheet flow" (bi-monthly or less frequent tidal flooding events) and with significant fresh water input. It is unclear if narrow-leaved cattail is native here or not, although there is a growing body of evidence indicating this taxon occurred on the Northeast coast prior to European settlement (see discussion under "Estuarine Communities" introduction).

VARIANTS: Two variants with reasonably distinct plant associations are distributed along gradients of hydrology and salinity.

1. **Short graminoid variant**: This variant supports a greater diversity of plants and is generally flooded less frequently than the other ***brackish marsh*** variant. It is higher in elevation, receives more fresh water input, and experiences less frequent tidal flooding than the ***high salt marsh***. It is characterized by a mix of graminoids including creeping bentgrass, frosty red fescue, saltmeadow cordgrass, and saltmarsh rush. One or more of these species may be locally dominant. In wetter settings, chaffy sedge may be more frequent and sub-dominant.

   Other common graminoids and forbs include New York American-aster, seaside goldenrod, prairie cordgrass, and sea-coast tuber-bulrush. Less constant and frequent plants include *Polygonum ramosissimum* ssp. *ramosissimum* (yellow-flowered knotweed), *Triglochin maritima* (saltmarsh arrow-grass), *Argentina egedii* ssp. *groenlandica* (coastal silverweed), *Ranunculus sceleratus* (cursed crowfoot), *Acorus calamus* (single-veined sweetflag), narrow-leaved cattail, *Sanguisorba canadensis* (Canada burnet), *Amaranthus cannabinus* (salt marsh water-hemp), *Juncus balticus* ssp. *littoralis* (Baltic rush), *Schoenoplectus pungens* (three-square bulrush), *Carex hormathodes* (marsh straw sedge), *Distichlis spicata* (saltgrass), *Panicum virgatum* (switch panicgrass), *Anthoxanthum nitens* (vanilla sweet grass), and *Elymus virginicus* (common eastern wild-rye). The state-threatened *Iris prismatica* (slender blue iris)* occurs in this 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 ***salt pannes and pools*** description).

2. **Tall graminoid - 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 fresh water input. Species that may dominate or co-dominate include narrow-leaved cattail, three-square bulrush, sea-coast tuber-bulrush, *Schoenoplectus tabernaemontani* (soft-stemmed bulrush), Baltic rush, prairie cordgrass, *Phragmites americanus* (American reed)*, as well as the invasives *P. australis* (common reed) and *Lythrum salicaria* (purple loosestrife). Less frequent are *Solidago sempervirens* (seaside goldenrod), *Symphyotrichum novi-belgii* (New York American-aster), *Amaranthus cannabinus* (salt marsh water-hemp), *Eleocharis flavescens* var. *olivacea* (yellow spikesedge), chaffy sedge, *Spartina patens* (saltmeadow cordgrass), frosty red fescue, *Thelypteris palustris* var. *pubescens* (marsh fern), and several other brackish marsh species. In one example, *Typha x glauca* (glaucous cattail; *T. angustifolia* x *T. latifolia*) is the dominant cattail species in the ***brackish marsh***.

   Some examples of narrow-leaved cattail dominated ***brackish marsh*** grade into a cattail dominated

high brackish 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 riverbank 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. They form fine-scale natural communities (less than 1 m^2 to over 100 m^2) within both saline and brackish marshes. Species composition varies with salinity, hardness of substrate, elevation, soil oxygen, hydroperiod, and other factors. ***Low salt marsh*** pannes and pools are regularly flooded and often unvegetated with a soft, silty mud substrate. Irregularly flooded ***high salt 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* (saltmeadow cordgrass) and other high marsh vegetation from ice erosion or smothering by stranded mats of *Spartina alterniflora* (smooth cordgrass) (Bertness 1992) and other flood-deposited plant litter or trash. Other processes account for the formation of "pond holes" or deep pools (Redfield 1972).

From the time the first European settlers arrived on the coast until recently, pannes were routinely drained to increase the productivity of saltmeadow cordgrass and *Distichlis spicata* (saltgrass) 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 populations (*Aedes sollicitans* and other species).

VARIANTS: Several panne and pool variants are described below, including five in salt marshes and three in brackish marshes.

Salt marsh variants:

1. **Low salt marsh panne variant**: Pannes in the ***low salt marsh*** typically lack vegetation. Species that may be present in low cover include *Spartina alterniflora* (smooth cordgrass), and marine algae such as *Ascophyllum nodosum* (knotted wrack), and *Fucus* spp. (rockweeds). The substrate in low salt marsh pannes is usually soft, silty mud.
2. **Forb panne variant**: Very shallow, briefly flooded, moderately vegetated ***high salt marsh*** forb pannes are typically dominated by *Triglochin maritima* (saltmarsh arrow-grass). Other common species include *Juncus gerardii* (saltmarsh rush), saltgrass, saltmeadow cordgrass, and the short form of smooth cordgrass. Less frequent are *Plantago maritima* ssp. *juncoides* (seaside plantain), *Limonium carolinianum* (Carolina sea-lavender), *Atriplex prostrata* (halberd-leaved orach), *Lysimachia maritima* (sea-milkwort), *Argentina egedii* ssp. *groenlandica* (coastal silverweed), and *Puccinellia maritima* (seaside alkali grass). Lower portions of the panne where evaporation and poor drainage create high salinity levels may remain unvegetated or support the succulent *Salicornia depressa* (common glasswort). Forb pannes also provide habitat for the state-threatened *Agalinis maritima* (saltmarsh agalinis)* and *Salicornia bigelovii* (dwarf glasswort)*, and the state-

endangered *Puccinellia pumila* (tundra alkali grass)*. *Pluchea odorata* var. *succulenta* (sweet-scented camphorweed)*, a state-endangered species, may be found in this habitat and in brackish marsh communities.

3. **Smooth cordgrass (short form) panne variant**: 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 smooth cordgrass (Howes et al. 1986). Smooth cordgrass 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 cordgrass usually decreases (Redfield 1972). Species occurring in low abundance include common glasswort, halberd-leaved orach, and a 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 cordgrass are occasionally formed from mini-levees trapping water along ditch margins (Shea et al. 1975).

4. **Salt marsh mosquito panne variant**: These sparsely-vegetated pannes occur on the upper half of the ***high salt marsh***. They are generally deeper than both the forb and smooth cordgrass (short form) 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 species) 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.

5. **Widgeon-grass - marsh minnow pool variant**: 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 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, habitat commonly supporting *Bolboschoenus maritimus* ssp. *paludosus* (saltmarsh tuber-bulrush). The margin may also be steep and deep, without emergent vegetation. Purple sulfur-bacteria often cover much of the stagnant water surface. The state-threatened *Stuckenia pectinata* (Sago false 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 variants: These variants occur in ***brackish marshes*** (short graminoid variant).

1. **Mixed graminoid - forb panne variant**: These shallow depressions are ponded only for short periods and are characterized by a variable mix of graminoids and forbs. Frequent herbs include *Schoenoplectus pungens* (three-square bulrush), *Bolboschoenus robustus* (sea-coast tuber-bulrush), *Eleocharis uniglumis* (one-glumed spikesedge)*, *E. parvula* (little-headed spikesedge)*, *Agrostis stolonifera* (creeping bentgrass), and saltmarsh arrow-grass. Less frequent are *Symphyotrichum*

novi-belgii (New York American-aster), coastal silverweed, *Festuca rubra* ssp. *pruinosa* (frosty red fescue), saltmeadow cordgrass, and saltmarsh rush.

2. **Sparsely vegetated panne variant**: 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 creeping bentgrass, *Elymus virginicus* (common eastern wild-rye), smooth cordgrass, *Carex paleacea* (chaffy sedge), New York American-aster, *Solidago sempervirens* (seaside goldenrod), and *Plantago intermedia* (many-seeded plantain).
3. **Narrow-leaved cattail panne variant**: This panne variant is dominated by *Typha angustifolia* (narrow-leaved cattail). It is unclear if narrow-leaved cattail is native here or not, although there is a growing body of evidence indicating this taxon occurred on the Northeast coast prior to European settlement (see discussion under "Estuarine Communities" introduction).

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.

• Marsh elder shrubland (S1)

GENERAL DESCRIPTION: This rare community is dominated by *Iva frutescens* (marsh elder)*, one of only two woody species that grows in New Hampshire's salt marshes. This salt shrub community, located between ***high salt marsh*** and upland habitats, occurs at just a few sites in the state. It is more common south of New Hampshire. Soil salinities are lower and peat depths are thinner compared to soils in the ***high salt marsh***.

CHARACTERISTIC VEGETATION: Common associates of the dominant marsh elder* include *Distichlis spicata* (saltgrass), *Spartina patens* (saltmeadow cordgrass), *Elymus repens* (creeping wild-rye), *Agrostis stolonifera* (creeping bentgrass), *Phragmites americanus* (American reed)*, *Juncus gerardii* (saltmarsh rush), *Symphyotrichum novi-belgii* (New York American-aster), and *Solidago sempervirens* (seaside goldenrod). Less frequent are *Juncus balticus* ssp. *littoralis* (Baltic rush), *Cuscuta gronovii* (common dodder), *Limonium carolinianum* (Carolina sea-lavender), and *Anthoxanthum nitens* (vanilla sweet grass).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: A good example of this community can be seen at Sandy Point on the south shore of Great Bay at the Great Bay Discovery Center (Stratham).

SOURCES: NHB field surveys.

• Low brackish riverbank marsh (S1S2)

GENERAL DESCRIPTION: Brackish riverbanks are flooded by seawater diluted by fresh water flowing down from the watershed above. ***Low brackish riverbank marshes*** typically occur in zones between mean sea level and mean high tide along moderate to steep brackish river- and stream-banks. The hydroperiod (duration and frequency of tidal flooding) 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 is a narrowly defined tidal community, but it may grade into ***intertidal flats*** and **subtidal systems** toward the channel and ***high brackish riverbank marsh*** (which it is nearly always found in association with) landward. It often occurs as a narrow band, but where slopes are gentler the marsh may cover broader areas. Several rare plants are restricted to brackish riverbank marshes in New Hampshire.

Sulfihemist soils with low surface salt content likely underlie this community (Breeding et al. 1974). Substrates of smaller brooks near the upper reaches of 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 cordgrass) typically dominates this low marsh community. As salinity decreases, *Bolboschoenus robustus* (sea-coast tuber-bulrush) and *Typha angustifolia* (narrow-leaved cattail) may become more prominent and dominate in some examples. Associated vascular plants in low abundance may include *Amaranthus cannabinus* (salt marsh water-hemp), *Atriplex prostrata* (halberd-leaved orach), *Salicornia depressa* (common glasswort), *Limonium carolinianum* (Carolina sea-lavender), *Eleocharis parvula* (little-headed spikesedge)*, *E. uniglumis* (one-glumed spikesedge)*, *Schoenoplectus pungens* (three-square bulrush), and *Bolboschoenus maritimus* ssp. *paludosus* (saltmarsh tuber-bulrush). Rare plants that occur here and distinguish this community from ***low salt marsh*** include *Limosella australis* (Atlantic mudwort)*, *Lilaeopsis chinensis* (eastern grasswort)*, *Crassula aquatica* (pygmy-weed)*, and *Samolus valerandi* ssp. *parviflorus* (seaside brookweed)*. These rare species can also occur in the ***high brackish riverbank marsh***, and 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 riverbank marsh (S1S2)

GENERAL DESCRIPTION: Brackish riverbanks are flooded by seawater diluted by fresh water flowing down from the watershed above. ***High brackish riverbank marshes*** typically occur as narrow zones flooded less than daily along moderate to steep brackish river- and stream-banks. The transition between high and ***low brackish riverbank marshes*** occur approximately at the mean high water mark; from here this community 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 salt water, causing the salinity to fluctuate widely with the tides.

This community may grade into ***low brackish riverbank marsh***, ***intertidal flats***, and subtidal communities toward the channel. Fresh water wetlands or upland communities are found landward. This community supports 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 riverbank marshes in New Hampshire. This is a narrowly defined tidal community nearly always found in association with ***low brackish riverbank marsh***, and often as a fairly narrow zone. Where slopes are gentler however, the marsh may cover broader areas.

Substrates are generally sulfihemist soils with low surface salt content (Breeding et al. 1974). Substrates of smaller brooks near the upper reaches of tidal influence are often composed of gravelly or cobbly material. Soil water salinity generally ranges 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 *Symphyotrichum novi-belgii* (New York American-aster), *Solidago sempervirens* (seaside goldenrod), *Typha angustifolia* (narrow-leaved cattail), *Spartina patens* (saltmeadow cordgrass), *S. pectinata* (prairie cordgrass), *Agrostis stolonifera* (creeping bentgrass), *Bolboschoenus robustus* (sea-coast tuber-bulrush), *Schoenoplectus pungens* (three-square bulrush), *Carex paleacea* (chaffy sedge), and *Juncus gerardii* (saltmarsh rush). One or more of these species may be locally dominant.

Less frequent species include *Atriplex prostrata* (halberd-leaved orach), *Argentina egedii* ssp. *groenlandica* (coastal silverweed), *Sium suave* (water-parsnip), *Calystegia sepium* (hedge false bindweed), *Rumex crispus* (curly dock), *Plantago intermedia* (many-seeded plantain), *Amaranthus cannabinus* (salt marsh water-hemp), *Lythrum salicaria* (purple loosestrife), *Spergularia marina* (saltmarsh sand-spurry), *Cyperus filicinus* (beach umbrella sedge), *Carex hormathodes* (marsh straw sedge), *Juncus balticus* ssp. *littoralis* (Baltic rush), *Distichlis spicata* (saltgrass), *Spartina alterniflora* (smooth cordgrass), *Elymus virginicus* (common eastern wild-rye), *Poa pratensis* (Kentucky blue grass), *Panicum virgatum* (switch panicgrass), *Anthoxanthum nitens* (vanilla sweet grass), and *Toxicodendron radicans* (poison-ivy).

Rare plants that occur here and distinguish this community from ***high salt marshes*** that have an equivalent flood regime include *Limosella australis* (Atlantic mudwort)*, *Lilaeopsis chinensis* (eastern grasswort)*, *Crassula aquatica* (pygmy-weed)*, and *Samolus valerandi* ssp. *parviflorus* (seaside brookweed)*. These rare species can also occur in the ***low brackish riverbank marsh***. 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 meadow marsh (S1)

GENERAL DESCRIPTION: This community is part of the single viable coastal salt pond marsh system occurring in New Hampshire at Odiorne Point State Park. The ocean shapes the marsh's nature by periodic intrusion of salt water over the narrow sand and cobble berm. This semi-permanently saturated to seasonally flooded community lies adjacent to the ***coastal salt pond emergent marsh*** found on lower ground. In the spring the meadow marsh is typically flooded, but during most of the growing season the water table remains at or below the surface except after heavy precipitation events.

Soils consist of a thin O horizon overlying gravelly loam. Scattered outcrops are exposed in the marsh. Soil water salinity generally ranges from 0.5–18 ppt (oligo- to mesohaline). Salinity levels fluctuate seasonally and between years in response to fresh water input, evaporation, and periodic infusion with salt water during storm events.

CHARACTERISTIC VEGETATION: Characteristic species include *Symphyotrichum novi-belgii* (New York American-aster), *Solidago sempervirens* (seaside goldenrod), *Spartina pectinata* (prairie cordgrass), and *Agrostis stolonifera* (creeping bentgrass). Associated species are *Triadenum virginicum* (Virginia marsh-St. John's-wort), *Iris versicolor* (blue iris), *Bidens connata* (purple-stemmed beggar-ticks), *B. frondosa* (Devil's beggar-ticks), *Chenopodium rubrum* (red goosefoot)*, *Lycopus uniflorus* (northern water-horehound), *Lysimachia terrestris* (swamp yellow-loosestrife), *Lythrum salicaria* (purple loosestrife), *L. hyssopifolia* (hyssop-leaved loosestrife), *Hypericum boreale* (northern St. John's-wort), *Scirpus cyperinus* (woolly bulrush), *Carex hormathodes* (marsh straw sedge), *Juncus canadensis* (Canada rush), and *Thelypteris*

palustris var. *pubescens* (marsh fern).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Restricted to the coastal zone. The only known viable example occurs at Odiorne Point State Park in Rye (Gulf of Maine Coastal Lowland subsection).

SOURCES: NHB field surveys; Straus 1992.

• Coastal salt pond emergent marsh (S1)

GENERAL DESCRIPTION: This community is part of the single viable coastal salt pond marsh system occurring in New Hampshire at Odiorne Point State Park. The ocean shapes the marsh's nature by periodic intrusion of salt water over the narrow sand and cobble berm. Situated between the flat and meadow marsh communities, the ***coastal salt pond emergent marsh*** is saturated to semi-permanently flooded with seasonably variable water levels. Water levels in shallower portions of the emergent marsh are several inches deep early in the growing season, though the soil surface may be exposed mid to late season. Deeper sections of the emergent marsh have 1–2 ft. or more of standing water. Soils in this area are exposed only during extended dry periods. Species composition in a given area depends on factors such as salinity, water depth, and amplitude of water-level fluctuations.

Soils consist of a thick O horizon overlying gravelly loam. Scattered outcrops are exposed in the marsh. Soil water salinity generally ranges from 0.5–18 ppt (oligo- to mesohaline). Salinity levels fluctuate seasonally and between years in response to fresh water input, evaporation, and periodic infusion with salt water during storm events.

CHARACTERISTIC VEGETATION: Characteristic perennial emergent species, typically spongy-tissued (aerenchymatous), are *Typha angustifolia* (narrow-leaved cattail), *Schoenoplectus tabernaemontani* (soft-stemmed bulrush), *S. pungens* (three-square bulrush), *Bolboschoenus maritimus* ssp. *paludosus* (saltmarsh tuber-bulrush), and *Sparganium* sp. (bur-reed). Other plant taxa include *Hypericum boreale* (northern St. John's-wort), *Triadenum virginicum* (Virginia marsh-St. John's-wort), *Scutellaria galericulata* (hooded skullcap), *Lysimachia terrestris* (swamp yellow-loosestrife), *Lythrum salicaria* (purple loosestrife), *Solanum dulcamara* (climbing nightshade), *Phragmites australis* (common reed), *Juncus canadensis* (Canada rush), and *Thelypteris palustris* var. *pubescens* (marsh fern). Floating aquatic species intermixed with the dominant emergent vegetation include *Lemna minor* (common duckweed) and *Nymphaea odorata* (white water-lily).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Restricted to the coastal zone. The only known viable example occurs at Odiorne Point State Park in Rye (Gulf of Maine Coastal Lowland subsection).

SOURCES: NHB field surveys; Straus 1992.

• Coastal salt pond flat (S1)

GENERAL DESCRIPTION: This community is part of the single viable coastal salt pond marsh system occurring in New Hampshire at Odiorne Point State Park. The ocean shapes the marsh's nature by periodic intrusion of salt water over the narrow sand and cobble berm. The ***coastal salt pond flat*** occurs adjacent to the ***coastal salt pond emergent marsh*** but in lower-lying wetter areas that are seasonally to semi-permanently flooded. The community is vegetated by scattered rhizomatous perennials near the emergent marsh and by annuals that emerge from the seedbank as lower normally inundated areas are exposed during extended periods of drought.

Soils consist of well decomposed organics or a thick O horizon overlying gravelly loam. Scattered outcrops are exposed in the flat. Soil water salinity generally ranges from 0.5–18 ppt (oligo- to mesohaline). Salinity levels fluctuate seasonally and between years in response to fresh water input, evaporation, and periodic infusion with salt water during storm events.

CHARACTERISTIC VEGETATION: Characteristic species are *Eleocharis parvula* (little-headed spikesedge)*, *E. uniglumis* (one-glumed spikesedge)*, and *E. flavescens* var. *olivacea* (yellow spikesedge). *Schoenoplectus pungens* (three-square bulrush) and *Bolboschoenus maritimus* ssp. *paludosus* (saltmarsh tuber-bulrush) occur in low cover. Because the low flat is often ponded, aquatic species such as *Lemna minor* (common duckweed) that are tolerant of brackish conditions and drawdown are present. *Zannichellia palustris* (horned-pondweed)*, a rare aquatic species in the state, was listed in this community by Straus (1973).

CLASSIFICATION CONFIDENCE: 2

DISTRIBUTION: Restricted to the coastal zone. The only known viable example occurs at Odiorne Point State Park in Rye (Gulf of Maine Coastal Lowland subsection).

SOURCES: NHB field surveys; Straus 1992.

• Brackish water pool (S2)

GENERAL DESCRIPTION: Brackish pools occur on the Isles of Shoals, in small depressions within ***maritime rocky barrens***. They typically range from a few to several square meters in size. Depending on salinity, fresh and/or brackish water graminoids and forbs occur within and along the margins of these pools. Salinity fluctuates as a result of salt inputs from storm waves and salt spray, fresh water precipitation, and evaporation.

The substrate consists of various types of bedrock.

CHARACTERISTIC VEGETATION: Fresh water species include *Lysimachia arvensis* (scarlet pimpernel), *Epilobium ciliatum* (fringed willow-herb), *Iris versicolor* (blue iris), *Lemna minor* (common duckweed), *Lycopus uniflorus* (northern water-horehound), *Lythrum salicaria* (purple loosestrife), *Persicaria hydropiper* (water-pepper smartweed), *P. pensylvanica* (Pennsylvania smartweed), *P. punctata* (dotted smartweed), *Portulaca oleracea* (common purslane), *Ranunculus sceleratus* (cursed crowfoot), *Scutellaria galericulata* (hooded skullcap), *Typha latifolia* (broad-leaved cattail), and *Hordeum jubatum* (fox-tail barley). Species present that are often associated with brackish conditions include *Argentina egedii* ssp. *groenlandica* (coastal silverweed), *Lythrum hyssopifolia* (hyssop-leaved loosestrife), *Plantago maritima* ssp. *juncoides* (seaside plantain), *Spergularia marina* (saltmarsh sand-spurry), *Solidago sempervirens* (seaside goldenrod), *Symphyotrichum novi-belgii* (New York American-aster), *S. subulatum* (small salt marsh aster), *Typha angustifolia* (narrow-leaved cattail), *Bolboschoenus robustus* (sea-coast tuber-bulrush), *Schoenoplectus pungens* (three-square bulrush), *Eleocharis uniglumis* (one-glumed spikesedge)*, *Carex hormathodes* (marsh straw sedge), *Juncus bufonius* (toad rush), *J. gerardii* (saltmarsh rush), *J. pelocarpus* (brown-fruited rush), and *Agrostis stolonifera* (creeping bentgrass).

CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: This community is known from the Isles of Shoals (Rye) in the Coastal Lowland subsection.

SOURCES: NHB field surveys.

• Coastal shoreline strand/swale (S2)

GENERAL DESCRIPTION: This is a sparsely vegetated upper intertidal community found along protected

estuarine shorelines or backdune sandy depressions and channels bordering salt marshes. Flooded less than daily, 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 intermixed at times with scattered bedrock including those of the Rye Formation. Dead plant stems and other detritus often cover much of the substrate surface.

CHARACTERISTIC VEGETATION: A sparse cover (typically <25%) of halophytic herbs consists of *Spergularia marina* (saltmarsh sand-spurry), *Salicornia depressa* (common glasswort), *Suaeda linearis* (annual sea-blite), *Limonium carolinianum* (Carolina sea-lavender), and *Puccinellia maritima* (seaside alkali grass). Infrequent species include other *Suaeda* spp. (sea-blites) and *Atriplex prostrata* (halberd-leaved orach). *Distichlis spicata* (saltgrass) and *Spartina patens* (saltmeadow cordgrass) may be present in sandy areas. Vascular plants that can be found along the upland border include *Cakile edentula* (American sea-rocket), *Chenopodium rubrum* (red goosefoot)*, and *Polygonum* spp. (knotweeds). Rare species documented in this community are *Honckenya peploides* ssp. *robusta* (seaside-sandwort)* and *Salicornia bigelovii* (dwarf glasswort)*.

This upper intertidal community is distinguished from ***intertidal flats*** and lower elevations of ***intertidal rocky shores*** by the presence of vascular plants, substrate, the 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 community occurs in the intertidal zone on a substrate of exposed bedrock or coarse boulders and rubble. They are most abundant on the open coast, but are also found intermittently along estuarine rivers and around protected embayments. Vascular plants are absent in the upper intertidal portions of this community, but cyanobacteria (or "blue-green algae") and lichens may be present. More commonly, inundated parts of intertidal rocky shores support a great diversity of marine algae. In the Great Bay Estuary, seaweed species dominance shifts from green to red (or brown) algae with increases in salinity levels. Great Bay also supports disjunct populations of several seaweed species typically found in warmer climates. The rocky substrate also provides solid purchase for barnacles, periwinkles, and mussels. Tidepools are conspicuous ephemeral features of intertidal rocky shores, harboring a large number of marine species.

CHARACTERISTIC VEGETATION: Vascular plants are absent. In the supralittoral and high littoral zones, non-vascular species include cyanobacteria or "blue-green algae" and lichens. Commonly seen macroalgae in lower intertidal zones include the rockweeds *Ascophyllum nodosum, Fucus* spp., and many other species (Borror 1994).

VARIANTS: Two variants of this community occur, distinguished by setting and algae types.

1. **Maritime variant**: This variant primarily occurs in high-energy settings along the rocky maritime coastline and at the Isles of Shoals, and is the more common of the two variants.
2. **Estuarine variant**: This variant primarily occurs along the shores of estuaries like Great Bay and contains algae species not found in the other variant. While tidal currents are sometimes strong and wave action can be significant, settings are typically lower-energy compared to the other variant.

CLASSIFICATION CONFIDENCE: 3

DISTRIBUTION: This community is restricted to the Isles of Shoals (Rye), Odiorne Point State Park (Rye), and other exposed maritime shores in the Coastal Lowland subsection.

SOURCES: NHB field surveys; Borror 1994; Short 1992.

• Intertidal flat (S3)

GENERAL DESCRIPTION: Intertidal sand and mudflats are gently sloping, sparsely vegetated areas that occur between ***low salt marsh*** or ***low brackish riverbank marsh*** 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 in bays and rivers, or along the coast behind landforms such as rocky spits, barrier beaches, and sand bars (all of which contribute sediments to the formation of this community).

A variety of primary foods (microalgae, phytoplankton, and detritus) supports a high level of productivity in this community. Benthic diatoms and other microalgae occurring in this environment are important contributors to the primary productivity of the estuarine system (Sickley 1989). Characteristic invertebrates found in New Hampshire's intertidal mudflats include marine 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 substrate, exposed completely during particularly low spring tides, is composed of sand, silt, and clay rich in organic matter. Muds, comprised of silt and clay particles, 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. Tide and wave driven ice action during winter months can also influence sediment accretion, erosion, and transport.

Surface water salinity fluctuates widely according to seasonal variation in fresh water 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 fresh water 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.

CHARACTERISTIC VEGETATION: Vascular plants are sparse to (more typically) absent. Brackish flats may support populations of *Eleocharis parvula* (little-headed spikesedge)* and *Limosella australis* (Atlantic mudwort)*. Although macroalgae is typically uncommon across the exposed substrate, New Hampshire's ***intertidal flats*** are overall rich in seaweed species (n=169).

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.

SOURCES: NHB field surveys; Normandeau Associates 1973; Whitlatch 1982; Sickley 1989; Mathieson and Penniman 1991; Short 1992.

SUBTIDAL COMMUNITIES

Subtidal areas are continuously submerged, below the reach of the lowest spring tides. They contain important habitat for oyster, eelgrass, and flounder populations, provide refuge for fish and invertebrates that retreat from exposed intertidal flats and estuarine marshes at low tide, and serve as spawning and nursery areas for numerous species of aquatic animals.

More than a few subtidal communities exist, although only the one supporting vascular plants is described below. As more data are collected, other subtidal communities characterized by algae, invertebrates, and other organisms will be described (similar circumstance for marine subtidal habitats).

• Eelgrass bed (S1)

GENERAL DESCRIPTION: This community occurs in shallow estuarine waters dominated by *Zostera marina* (eelgrass). This ribbon-like, rooted vascular plant covers nearly half of the bottom of Great Bay (2,585 acres). ***Eelgrass beds*** trap sediments, dissolved nutrients, and larval organisms flowing through the community and are an important contributor to ecosystem health and productivity. They serve as breeding, nursery, and feeding areas for many species of fish, mollusks, crustaceans, and other 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 20 ft. where water transparency is high.

Substrate is sand or mud comprised of silt and clay particles. Eelgrass is a sensitive indicator of nitrogen loadings and is used to monitor overall ecosystem health.

CHARACTERISTIC VEGETATION: This shallow subtidal community is dominated by eelgrass. Associated species include a diverse array of rooted, epiphytic, and suspended marine algae.

CLASSIFICATION CONFIDENCE: 1

DISTRIBUTION: Restricted to the Great Bay estuarine complex in the coastal zone. Good examples occur in certain shallow subtidal areas of Great Bay.

SOURCES: Thayer et al. 1975; Short and Short 1984; Dennison and Albert 1986; Costa 1988; Short 1992.

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GLOSSARY

Ablation till: Loose, permeable *glacial till* deposited from material in and on a glacier during its final melting (as opposed to compact *basal till* from material deposited under the ice). Ablation till often forms a more rolling, choppy landscape than *basal till*.

Acidic: Used to describe water or soil with a *pH* less than 7.0. Although bedrock technically does not have a *pH*, the term "acidic" can also refer to bedrock with a total *silica* content greater than ~65 percent, typically due to an abundance of *quartz*, *feldspar*, and mica. Acidic bedrock typically has low concentrations of *base cations* and yields nutrient-*poor* acidic soils with low pHs upon *weathering*. *Granite* is one example of an acidic rock. Compare *alkaline* or *basic*, *calcareous*, *circumneutral*, *intermediate*, *mafic*, and *subacid*.

Acidophile: A plant species that grows best in *acidic* soils (= *calcifuge*).

Adventitious: Growing in or from an unusual place, such as roots growing above ground, or roots that sprout from leaves.

Aerenchyma: Spongy tissue in aquatic and emergent plants that allows for the circulation of air and provides buoyancy.

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 usually found under the A horizon.

Alkaline: Used to describe water or soils with a *pH* greater than 7 (synonymous with *basic*). Compare *acidic*, *calcareous*, *circumneutral*, *intermediate*, *mafic*, and *subacid*.

Alleghenian: A term 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 into the central Appalachian Mountains. Representative species include red spruce, yellow birch, heart-leaved paper birch, white pine, and hemlock.

Alluvium: *Sand*, *silt*, and/or *clay* sediments deposited by moving water on land surfaces.

Alpine: Refers to a largely treeless zone (also called *tundra*) 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, alpine areas are restricted to largely treeless high-elevation peaks and ravines of the White Mountains above 4,900 ft. and occasionally on lower summits and ridges, a few scattered high elevation monadnocks in central and southern New Hampshire, and several lower elevation cold microhabitats. Many of these plants are disjunct from arctic centers of distribution in northern Canada. Compare *subalpine*.

Anions: Negatively charged *ions*.

Arboreal: Pertaining to trees; living in or among trees.

Backdune: In a coastal sand *dune* system, the *dune* that is farthest from the sea and least directly influenced by wave action and salt water. Compare *foredune*.

Bankfull discharge: The highest water level a river 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 the more rolling or choppy landscapes formed by *ablation till*.

Basalt: A fine-grained *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. Also loosely applied to an *igneous rock* that contains a relatively low amount of *silica* (45–52 percent) and a relatively high amount of *base cations* (although rocks do not technically have a *pH*). 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 occurs due to decomposition of roots or precipitation of organic coatings on mineral surfaces rather than by physical mixing of the soil.

Biodiversity: The variety and variability of all living things. In its simplest and broadest terms, biodiversity refers to the full suite of life on Earth. More narrowly defined, it refers to a given area's full range of individual species and genetic diversity.

Biome: Large regional or continental-scale biotic ecosystems. Each has distinctive composition of life forms and species that are adapted to the environment. They often correspond closely to the major climatic regions of the world, such as boreal forest biome, eastern deciduous forest biome, and desert biome.

Bog: Bogs are defined in both a narrow sense and a broad sense. The narrow hydrologic definition is an *ombrotrophic* peatland whose only source of water is precipitation; the less restrictive definition (used in this manual) is a nutrient-*poor*, *oligotrophic* peatland with superacid conditions (pHs <4.0). Bogs may receive minor inputs of *minerotrophic* water in the latter definition, but they remain floristically and trophically similar to strictly defined bogs. Compare *fen* and *peatland*.

Boreal: Applied to a climate zone with short, warm summers and snowy winters. Also can refer 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]

Bryophytes: Non-vascular, non-seedbearing plants, including mosses and liverworts.

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" (see *basic*, *intermediate*, and *circumneutral* as alternative terms). Calcareous soil generally has a circumneutral *pH* (in the 6s and 7s). Compare *acidic*, *basic*, *circumneutral*, *intermediate*, and *mafic*.

Calcifuge: See *acidophile*.

Calciphile (calciphyte, 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 a *pH* 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*.

Cirque: Steep-walled, U-shaped ravines carved by *alpine* glaciers at high elevations in the mountains.

Clay: A fine-grained, slow-draining mineral soil. The minerals that compose clay exhibit plasticity and harden when dried. Clays are typically associated with low-energy depositional environments such as large lakes. Compare *sand* and *silt*.

Clonal growth: Plant reproduction by vegetative means such as spreading root systems.

Coastal plain: A 10-mile to more than 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).

Composite: A plant in the aster family (Asteraceae).

Cosmopolitan distribution: Present over extensive areas of the globe, applicable to species 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]

Delta: Flat, often fan-shaped landscape feature comprised of alluvial sediments deposited at the mouth of a

river or stream.

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. Compare *monomictic*.

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 *groundwater* reservoirs to the surface of the ground or to the 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 U.S. Department of Agriculture that reflect the average, long-term water budget for a soil as affected by landscape position, *groundwater* fluctuations, and soil texture.

Drumlin: Elliptical hill formed from *till* by the movement of a glacier; typically with a steep face opposite the glacier's direction of travel. In New Hampshire, they are most common in central and southern portions of the state. The bases of drumlins are often characterized by compact *basal till*.

Dune: Low hill composed of *sand*. Also see *backdune* and *foredune*.

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). See "Glossary Bibliography" numbers "[1, 2, and 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. Also see *Spodosols*.

Endemic: Refers to species that are restricted to a particular geographic region. Robbins' cinquefoil (*Potentilla robbinsiana*), 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. Compare *Histosols*, *Inceptisols*, and *Spodosols.*

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. They usually form along the margins of a thinning glacier or along the pathways of drainage channels through the inside of a glacier. Subsidence of turbulent meltwater dumps the former streambed material in place, in the shape of the former channel.

Estuarine: Referring to an *estuary*.

Estuary: A coastal body of deeper water and its adjacent wetland, semi-enclosed by land and with access to the sea, where ocean water is at least occasionally diluted by fresh water; also refers to other ecosystems which are directly influenced the brackish tidal waters.

Eutrophic: Term applied to either upland soil or fresh water with high nutrient levels, resulting in very high *productivity* systems. Compare *oligotrophic*, *submesotrophic*, *mesotrophic* and *permesotrophic*.

Evapotranspiration: A collective term for the sum of water lost through evaporation from soils and bodies of water and transpiration through plants, usually expressed in comparison to rainfall amounts; an output from the water budget system.

Facultative: A U.S. Fish and Wildlife Service wetland indicator status category defined as "equally likely to occur in wetlands (estimated probability 34–66%) or non-wetlands." Compare *obligate wetland*, *facultative wetland*, *facultative upland*, and *obligate upland.*

Facultative upland: A U.S. Fish and Wildlife Service wetland indicator status category defined as "usually occur in non-wetlands (estimated probability 67–99%), but occasionally found in wetlands (estimated probability 1–33%)." Compare *obligate wetland*, *facultative wetland*, *facultative*, and *obligate upland*.

Facultative wetland: A U.S. Fish and Wildlife Service wetland indicator status category defined as "usually occurs in wetlands (estimated probability 67–99%), but occasionally found in non-wetlands (estimated probability 1–33%)." Compare *obligate wetland*, *facultative*, *facultative upland*, and *obligate upland*.

Feldspar: The most common group of rock-forming minerals in the Earth's crust, usually found in *igneous rocks* such as *granite*, but present in *metamorphic* and *sedimentary rocks* as well. Feldspar crystals tend to be blocky, and white or pink in color.

Felsenmeer: A German word meaning "sea of rocks," applied to extensive fields of large, angular, frost-cracked boulders found in *alpine* and arctic environments.

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: Applied to 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. Compare *forb*.

Foredune: In a coastal sand *dune* system, the *dune* nearest to the sea and the one most influenced by wave action and salt water.[1] Compare *backdune* and *interdune*.

Forest: Applied in classification to communities with more than 60% cover by trees that are >2 m in height.

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 5˚F greater than those in winter. Compare *cryic* and *mesic*.[1]

Gabbro: A coarsely crystalline *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*).

Glacial refugium: An ice-free geographic location that vegetation survives in during a glacial period (plural = refugia).

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 at least 10% *quartz*, 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 wetland 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.

Headwall: The steepest, upper part of a *cirque*, often consisting of open rock slabs.

Heath shrubs: Species in the family Ericaceae, including blueberries, cranberries, and crowberries. Heath shrubs, sometimes just called heaths, most commonly occur in *acidic*, nutrient-poor environments. See *ericaceous*.

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 *Entisols*, *Inceptisols*, and *Spodosols.*

Hollow: A generally small, variably sized topographic depression (generally <1 to several feet 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*.

Humus: An upper soil *horizon* consisting of dark, well-decomposed organic material, resulting from the activity of biological organisms in the soil.

Hydrogeomorphic: Applied to 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* and *xeric*.

Ice-contact deposits: Variously sorted and *stratified* deposits formed from meltwater deposits in or at the edge of a thinning glacier (includes *kames*, *eskers*, and other undifferentiated deposits). Compare *outwash*, *talus*, and *till*.

Igneous rock: Rock formed by the cooling and solidification of molten material. Compare *metamorphic rock* and *sedimentary rock.*

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 *Entisols*, *Histosols*, and *Spodosols.*

Interdune: In a coastal sand *dune* system, dunes lying between the *foredune* and the *backdune*.

Intermediate: Applied to *igneous rocks* that contain intermediate amounts of *silica* (50–60 percent), but generally less than 10 percent *quartz*. Intermediate rocks, such as *syenite* and *diorite*, may produce *circumneutral* to *acidic* soils. Compare *acidic*, *alkaline*, *basic*, *calcareous*, *circumneutral*, and *mafic*. Also used in this book to refer to wetlands of intermediate nutrient status; in other words, 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.

Isostatic rebound: Rise in ground level associated with a landscape that has been depressed by the weight of a glacier.

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.

Kettle hole: A depression formed from the melting of an ice block stranded in surrounding *glacial drift*.

Krummholz: Gnarled, stunted, and shrub-like conifer forest characteristic of timberline, generally less than 2 m in height.

Lacustrine: Referring to fresh water lakes and ponds.

Lagg: *Minerotrophic*, often moat-like, shallow water zone around the margin of a *peatland*, characterized variously by sedges, *forbs*, or tall shrubs, in combination with areas of open water. 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 in the quiet-water environments at the bottom of lakes.

Levee: An elevated ridge of sediments formed parallel to a river by floodwaters, usually consisting of coarser sediments which settle due to the decreased water velocity away from the main *river channel* (finer particles are carried farther from the river).

Liana: A woody plant with a vine-like habit. Compare *vine*.

Lignin: A chemical compound found in the cell walls of all vascular plants, most notably as the fiber-like carbon polymer that gives strength to wood and allows trees to grow tall. Lignin is one of the most abundant materials on Earth.

Limestone: A *sedimentary calcareous* rock primarily composed of calcium carbonate. Produces calcium rich soils with high *pH* and nutrient availability.

Limiting nutrient: The nutrient that controls or limits the growth and *productivity* of plants, such that adding the nutrient would result in increased growth of some or all of the plants in a community.

Limnogenous: Pertaining to lakes and other fresh waterbodies. Referring to *peatland* hydrology; limnogenous *peatlands* form adjacent to surface waterbodies. Compare *soligenous* and *topogenous*.

Loam: Soil composed of even concentrations of *sand*, *silt*, and *clay*. Loam soils retain nutrients and water easily, yet also have good infiltration and *drainage*. Loam is considered ideal for gardening and agriculture.

Lodgement till: See *basal till*.

Mafic: Applied to minerals high in iron or magnesium (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: Applied to moist, well drained soils, intermediate between *xeric* and *hydric* soils. 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: Fresh water 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. Compare *oligotrophic*, *submesotrophic*, *permesotrophic*, and *eutrophic*.

Metamorphic rock: Rock formed from recrystalization (without melting) of pre-existing rock (*igneous* or *sedimentary*) by high temperature and pressure. Compare *igneous rock* and *sedimentary rock*.

Microtopography: Small variations in the height and roughness of the ground surface, roughly at the scale of an individual organism; microrelief.

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 most nutrients that plants need to grow.

Minerotrophic: Refers to water or soils that have been enriched or contain nutrients important for plant growth; usually used in a relative or comparative sense. Compare *oligotrophic* and *ombrotrophic*.

Monomictic: A fresh water body that experiences vertical mixing once a year. Compare *dimictic*.

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: A type of wetland soil composed of dark-colored, fine, well-decomposed and unrecognizable organic material generally with a higher mineral sediment content than *peat*. Compare *peat*.

Natural community: Recurring assemblages of species found in a particular physical environment. 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: A species not indigenous to a particular area; alien or exotic. Invasive species are a subset of non-native species whose introduction to an ecosystem causes environmental harm.

nor’easter: Low-pressure storm system in which the strongest winds blow onshore from the northeast. They can originate any time of year along the east coast of North America as a result of converging (cold) polar and (warmer) Gulf Stream air masses, but can be most intense during the winter season.

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. Layer can be thick when conditions are very

wet and/or very cold and *acidic*.

Obligate upland: A U.S. Fish and Wildlife Service wetland indicator status category defined as "almost always occurs in non-wetlands (estimated probability >99%) under natural conditions." Compare *obligate wetland*, *facultative wetland*, *facultative*, and *facultative upland*.

Obligate wetland: A U.S. Fish and Wildlife Service wetland indicator status category defined as "almost always occurs in wetlands (estimated probability >99%) under natural conditions." Compare *facultative wetland*, *facultative*, *facultative upland*, and *obligate upland*.

Oligotrophic: Nutrient-poor waters or soils with low primary *productivity*. Compare *submesotrophic*, *mesotrophic*, *permesotrophic*, and *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 deposits that have been transported, reworked, sorted, and stratified by glacial meltwaters beyond the margin of the glacier. Compare *ice-contact deposits*, *scree*, *talus*, and *till*.

Oxbow: U-shaped portion of a *river channel*, occasionally abandoned as a river changes its course, leaving a depression in the *terrace*. Oxbow ponds can develop in these 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.

Parent material: The original geologic material from which a soil is derived, usually referring to underlying sediment deposits or bedrock.

Peat: Coarse, unconsolidated, largely undecomposed accumulations of organic matter formed under *hydric* conditions or excess moisture.

Peatland: Any graminoid, shrub, *forest*, or moss-dominated wetland formed on *peat* deposits. Compare *muck*.

Permesotrophic: Intermediate between *mesotrophic* and *eutrophic* (moderate-high *productivity*). Compare *oligotrophic*, *submesotrophic*, *mesotrophic* and *eutrophic*.

pH: A measure of acidity or alkalinity, with values ranging from 0 to 14. Values below 7 are *acidic*, values above 7 are *alkaline* (or *basic*), and a *pH* of 7 is neutral. The *pH* of a solution can be calculated using the following equation, where $[H^+]$ represents the concentration of hydrogen *ions* in moles per liter: $pH = \log_{10}(1/[H^+])$. Because this equation defines a logarithmic scale, each unit pf *pH* represents a ten-fold change in acidity (a *pH* of 6, for example, is ten times more *acidic* than a *pH* of 7). 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*, shrubland, and *herbaceous*).

Phytogeography: The study of the geography of plants, particularly their distribution at different taxonomic levels.[1]

Pit: See *hollow*.

Point bar: A low, crescent-shaped ridge of *sand* or gravel deposited in settings where flow velocities are low to moderate, such as along the inside bends of river meanders and at the downstream ends of islands.

Polychaete: A class of segmented worms, generally marine.

Poor: Infertile soils that have lower *exchange capacity, base-saturation, pH*, and/or nitrogen availability than *intermediate* or *rich* soils. Corresponds to *oligotrophic* (low) and *submesotrophic* (moderate-low) *productivity*/nutrient regime categories. Compare *intermediate* and *rich*.

Productivity: The biomass of vegetation generated over time in a given area (the total of which is called "gross primary productivity"), usually measured as above-ground biomass. Productivity varies greatly at both regional and local scales.

Propagules: Parts of a plant, such as seeds, buds, *rhizomes*, or spores, which aid in dispersal and allow it to reproduce.

Quartz: The second most common mineral in the Earth's crust; a primary component of *granite*.

Recharge: Movement of water from the surface into *groundwater* reservoirs.

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 *natural community* to absorb an external disturbance without resulting in major changes to such key characteristics (e.g., nutrient cycling, species composition, and diversity).

Rhizome: A horizontal, underground portion of plant stem with shoots above and roots below serving as a reproductive structure; not a true root. Also see *clonal growth*.

Rhyolite: A fine-grained to glassy *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* (moderate-high) or, less commonly, the *mesotrophic* (moderate) nutrient regime categories. *Calciphiles* (*calcicoles* or *calciphytes*) are characteristic indicators of rich soils. Compare *poor*.

Rill: A small stream or rivulet, usually fast-flowing and narrow.

Riparian: Term applied to the lands adjacent to and directly influenced by rivers and streams. *River channel* and *floodplain* environments are collectively called the riparian zone.

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 panne: A natural depression within a salt marsh inundated for longer periods than the surrounding marsh; a deposit of salt upon evaporation of the water.[4]

Sand: The largest size class of particles that make up soil. Sand is gritty to the touch and individual grains are visible to the naked eye. Compare *clay* and *silt*.

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*, and *till*.

Sedimentary rock: Rock formed by consolidation of sediments deposited by wind or water. Compare *igneous rock* and *metamorphic rock*.

Seepage: Lateral water flow through soil; transports nutrients to and through wetlands from soil and bedrock source areas. The water may emerge at the land surface where hydraulic pressure and 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: Small *seepage* water emergence zones on sloped uplands.

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. Also see *serpentinite*.

Serpentinite: *Metamorphic rocks* formed from *ultramafic parent material*, composed primarily of minerals of the *serpentine* group. Often (inaccurately) referred to as *serpentine* rock. Also see *serpentine* and *ultramafic*.

Silica: Silicon dioxide (SiO_2). Silica commonly occurs as *sand* or *quartz*, and is a primary mineral component of *granite*.

Siliceous: Containing *silica* or high concentrations of *silica*; *granite* is a siliceous rock type.

Silt: A soil particle intermediate in size between *sand* and *clay*. Silt is smooth and slippery when wet.

Softwater: Water that lacks dissolved minerals, especially calcium.

Soil development: The process of physical and chemical alteration of *parent material* into soil 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. Also see the definitions of individual *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 *Entisols, Histosols,* and *Inceptisols.*

Stratified drift: Sediments that have been sorted (by particle size) and stratified into layers by moving glacial meltwaters away from the glacial margin.

Subacid: Used to describe water or soil with a *pH* from 5.0 to 5.9.

Subalpine: Vegetation zone intermediate between high-elevation spruce - fir forests and *alpine tundra*, characterized by stunted spruce and fir trees (see *krummholz*) and a more limited number of *alpine* species than in higher elevation regions. In New Hampshire, the subalpine zone generally occurs between 3,000–4,900 ft. on exposed ridges and summits with thin soils. Some subalpine areas have been expanded by fires. Compare *alpine*.

Submesotrophic: Moderate-low *productivity*; intermediate between *mesotrophic* and *oligotrophic*. Compare *oligotrophic*, *mesotrophic*, *permesotrophic*, and *eutrophic*.

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, mostly stones (3–24" diameter) and boulders (>24") accumulated at the base of a cliff or slope formerly consisting of a cliff. Compare *scree, till,* and *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 relatively flat features along a stream valley.[1,4] Terraces can fall within the active *floodplain* and be flooded at some interval or may no longer flood due to downcutting of *river channels* and lower river volumes. Ancient *floodplain* terraces (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, silt, sand,* gravel, and rock fragments intermingled in any proportion. Compare *ice-contact deposits, scree, talus,* and *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*. Also see nutrient regime and *productivity* classes under *oligotrophic, submesotrophic, mesotrophic, permesotrophic,* and *eutrophic*.

Tundra: Low-growing vegetation type characteristic of Arctic regions. *Alpine* vegetation is often referred to as tundra due to its similarity to Arctic tundra. Also see *alpine* and *subalpine*.

Tussock: A compact tuft or clump of grass or sedge.

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 (see *serpentine*). Ultramafic rocks are *igneous rocks* composed of *mafic* minerals – primarily pyroxene and/or olivine. They are commonly partially metamorphosed to *serpentinite*. Also see *serpentine* and *serpentinite*.

Understory: Vegetation growing beneath a community's tallest woody plant stratum. The understory for a *woodland* or *forest* may include the shrub and herb layers; for medium to tall shrublands, just the herb layer.

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 similar, 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.

Vine: An *herbaceous* plant not fully supporting itself; stem trails along ground or climbs on other vegetation. Compare *liana*.

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 forms more available to plants.

Woodland: Applied in the classification to wooded communities with 25–60% cover by trees.

Xeric: Characterized by a lack of moisture. Compare *mesic* and *hydric*.

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APPENDIX 1. Explanation of Global and Subnational Rank Codes

Rank codes describe the degree of risk of a species, natural community, or natural community system to extinction/elimination or extirpation, either throughout its range (global or "G" rank) or within a subnational unit such as a state (subnational or "S" rank). Risk of extinction or extirpation for a sub-species or variety is indicated with a taxon ("T") rank. For example, a G5T1 rank indicates that the sub-species is critically imperiled (T1) while the species is secure (G5). **Extinction or elimination risk** indicates the likelihood that a species (extinction) or community/system (elimination) will totally vanish or die out globally. **Extirpation risk** indicates the likelihood that a species or community/system will vanish or die out at the state level but still exist elsewhere globally.

Code	Examples		Description
1	G1	S1	**Critically imperiled:** At very high risk of extinction/elimination or extirpation due to very restricted range, very few populations or occurrences (e.g., one to five occurrences), very steep declines, very severe threats, or other factors.
2	G2	S2	**Imperiled:** At high risk of extinction/elimination or extirpation due to restricted range, few populations or occurrences (e.g., six to 20), steep declines, severe threats, or other factors.
3	G3	S3	**Vulnerable:** At moderate risk of extinction/elimination or extirpation due to a fairly restricted range, relatively few populations or occurrences (e.g., 21 to 80), recent and widespread declines, threats, or other factors.
4	G4	S4	**Apparently secure:** At fairly low risk of extinction/elimination or extirpation due to an extensive range and/or many populations or occurrences (e.g., >80), but with possible cause for some concern as a result of local recent declines, threats, or other factors.
5	G5	S5	**Secure:** At very low risk of extinction/elimination or extirpation due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.
U	GU	SU	**Unrankable:** Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. NOTE: When the range of uncertainty is three consecutive ranks or less, a range rank (e.g., G2G3) should be used to delineate the limits or range of uncertainty.
H	GH	SH	**Possibly extinct/eliminated or extirpated:** Known from only historical occurrences but still some hope of rediscovery. Examples of evidence include (1) that a species has not been documented in the last 20 years (40+ years for community/system) despite some searching and/or some evidence of significant habitat loss or degradation; (2) that a species or community/system has been searched for unsuccessfully, but not thoroughly enough to presume that it is extinct/eliminated or extirpated.
X	GX	SX	**Presumed extinct or extirpated (species):** Not located despite intensive searches and virtually no likelihood of rediscovery. **Presumed eliminated or extirpated (communities and systems):** Eliminated or extirpated due to loss of key dominant and characteristic taxa and/or eradication of the sites and ecological processes on which the type depends.

APPENDIX 2. Key to Natural Communities

Introduction

Natural communities are defined as recurring assemblages of species found in particular physical environments. Classifying natural communities enables ecologists, land managers, and others to communicate effectively and to make management decisions regarding ecological systems.

Based on more than 20 years of ecological research, the New Hampshire Natural Heritage Bureau (NHB) developed a classification of all the known natural communities in the state (does not include most communities in subtidal, deep fresh water, or subterranean habitats). This work was published as *Natural Communities of New Hampshire* (Sperduto and Nichols) in 2004, and an updated second edition will be available on the NHB website in 2011.

Each natural community type is distinguished by three characteristics: (1) a distinct plant species composition; (2) a consistent physical structure (such as forest, shrubland, or grassland); and (3) a specific combination of physical conditions (such as nutrients, drainage, and climate) and disturbance regime (such as fire, wind, and flooding). 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.

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

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

Important notes about the key

1. It may be important to consult the more detailed community descriptions available in the current edition of *Natural Communities of New Hampshire* to confirm a community determination or to decide between two or more types. Any given example in the field may not conform or "fit" cleanly into the concept of a single community type, since descriptions are based on information from a limited number of samples. Community types are essentially idealized descriptions of segments of the continuous gradient of vegetation and environmental conditions that exist on the ground. It is often preferable to think of any one example as *approximating* one natural community type or even more than one type, rather than inappropriately "forcing" it into one community or another.

2. For forested communities, this key is designed for use in relatively mature and undisturbed community examples of at least one acre in size. Either early successional occurrences or those significantly disturbed or manipulated by humans may be difficult to key out based solely on current vegetation. In such instances, a community determination should include particular attention to late-successional tree species in the understory and/or a combination of soil drainage, mineralogy, and texture characteristics and features of adjacent undisturbed communities. Ideally, the vegetation being considered should be reasonably homogeneous, with no major internal features that would not be considered representative (inclusions of small patch communities, variation in seral stage, etc.).

3. Keying out examples transitional between the communities should be avoided. Transitional areas share certain characteristics that help identify them. Their width is typically much narrower than the communities on either side of the transition. These areas usually support species common to both communities and vegetation structure may be intermediate. Transitional areas are often associated with abrupt physical gradients associated with hydrology, nutrients, elevation, slope, aspect, etc.

4. Forest community types are not synonymous with tree canopy cover types as used by SAF or other groups. Although there is a reliance on tree canopy species in certain sections of the key, and to some extent in the naming of the community types, they are *not* simply cover types. When trees are used for names, they generally reflect mid- to late-successional composition, but understory species have also been considered in differentiating and describing the types. Overstory composition may correlate closely with a single natural community type, but this is not always the case. For instance, a white pine cover type could correspond to one of several community types. On the other hand, some cover types may be specific to a community but not be the only cover type possible for that community.

5. Species composition and relative abundance are used in various combinations to differentiate communities. The relative abundance of a species or group of species can be an important determinant of a community type, but this is not always the case. Two types of species are particularly important for identifying natural community type: differential and characteristic species.

   Differential species are those used to distinguish between two community types or groups of communities. A particular species may occur in many community types, but it is used as a *differential* species only when it has diagnostic value for deciding between two *particular* community types or groups of communities. For instance, white ash and basswood are among the differential species used to distinguish acidic northern hardwood forests from enriched northern hardwood forest (they are only present in the latter), but they have relatively little diagnostic value when differentiating among the several types of enriched northern hardwood forests. In some cases, differential species may only be present in low abundance (e.g., <1% cover), but still have a diagnostic value.

   Characteristic species are those that often occur in a particular community, and collectively help characterize the type; however, they are not always useful as differential species, since they can often occur in many community types.

KEY TO THE NATURAL COMMUNITIES OF NEW HAMPSHIRE

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

Key to Upland Natural Communities

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

Key to Wetland Natural Communities

KEY TO UPLAND NATURAL COMMUNITIES

1a. Tree canopy cover generally >25% (forests and woodlands; includes examples of rocky ridge communities with sparse woodland vegetation) **2**

1b. Tree canopy cover generally <25% cover, or less than 6 ft. tall (includes barrens with a sparse cover of shrubs or herbaceous species)……. **45**

2a. Forests on enriched sites dominated by hardwood species such as sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*), or hickories (*Carya* spp.); yellow birch (*Betula alleghaniensis*) and American beech (*Fagus grandifolia*) may be present but are not dominant; conifers such as white pine (*Pinus strobus*), hemlock (*Tsuga canadensis*), and red spruce (*Picea rubens*) are generally sparse or absent; enriched-site indicators include basswood (*Tilia americana*), Christmas fern (*Polystichum acrostichoides*), blunt-lobed hepatica (*Anemone americana*), baneberries (*Actaea* spp.), and wide-leaved sedges (*Carex* spp.) **3**

2b. Forests on rocky ridges, till, sand or other fluvial soils without notable nutrient enrichment (rich site indicators in 2a absent); dominant species can include white oak (*Quercus alba*), white pine (*Pinus strobus*), hemlock (*Tsuga canadensis*), American beech (*Fagus grandifolia*), yellow birch (*Betula alleghaniensis*), red spruce (*Picea rubens*), or balsam fir (*Abies balsamea*) **8**

3a. Enriched hardwood forests with few or no oak species on mesic loamy soils; sugar maple (*Acer saccharum*) dominates; generally not on talus **4**

3b. Enriched forests or woodlands with oaks on dry or dry-mesic, often rocky, soils **5**

4a *One or more of the following rich mesic forest differential species is present* (absent in semi-rich mesic forests): blue cohosh (*Caulophyllum thalictroides*), ostrich fern (*Matteuccia struthiopteris* ssp. *pensylvanica*), maidenhair fern (*Adiantum pedatum*), bland sweet-cicely (*Osmorhiza claytonii*), Dutchman's-breeches (*Dicentra cucullaria*), silvery false spleenwort (*Deparia acrostichoides*), or Goldie's wood fern (*Dryopteris goldiana*); usually a broad (but variable) diversity of enriched site species are also present, including some listed for alternate choice; sugar maple (*Acer saccharum*) is dominant, with American beech (*Fagus grandifolia*) infrequent or absent ..... ***Rich mesic forest***

4b. The enriched-site indicator species listed in the alternate choice absent or essentially so; species indicative of only moderately enriched conditions are present, including baneberries (*Actaea* spp.), foam-flower (*Tiarella cordifolia*), wood nettle (*Laportea canadensis*), round-leaved violet (*Viola rotundifolia*), Jack-in-the-pulpit (*Arisaema triphyllum*), axillary goldenrod (*Solidago caesia*), Christmas fern (*Polystichum acrostichoides*), alternate-leaved dogwood (*Swida alternifolia*), basswood (*Tilia americana*), white ash (*Fraxinus americana*), red elderberry (*Sambucus racemosa*), millet grass (*Milium effusum* ssp. *cisatlanticum*), ironwood (*Ostrya virginiana*), and Braun's holly fern (*Polystichum braunii*); diversity and abundance of these enriched-site species is generally low compared to that of the alternate choice; sugar maple (*Acer saccharum*) dominates, although American beech (*Fagus grandifolia*) may be co-dominant, and yellow birch (*Betula alleghaniensis*) may be present; forests of till, talus, and river terrace-flat landscape positions ..... ***Semi-rich mesic sugar maple forest***

5a. Semi-rich forest with herbaceous layer dominated by dense "lawn" of Pennsylvania sedge (*Carex pensylvanica*) on open ridges and upper slopes of hills and low mountains; rich site indicators include Michaux's sandplant (*Minuartia michauxii*)*, rusty cliff fern (*Woodsia ilvensis*), and blunt-lobed hepatica (*Anemone americana*)..... ..... ***Red oak - ironwood - Pennsylvania sedge woodland***

5b. Rich or semi-rich forests in which Pennsylvania sedge (*Carex pensylvanica*) may be present, but does not form the extensive "grassy lawns" characteristic of the alternate choice **6**

6a. Rich rocky woodlands with one or more of the following herbaceous indicator species: ebony spleenwort (*Asplenium platyneuron*), early small-flowered-saxifrage (*Micranthes virginiensis*), broad-leaved sedge (*Carex platyphylla*), blackseed mountain rice (*Piptatherum racemosum*), sicklepod rockcress (*Boechera canadensis*)*, and smooth rockcress (*Boechera laevigata*)* **7**

6b. Semi-rich rocky woods lacking indicator species listed in alternate choice; red oak (*Quercus rubra*), sugar maple (*Acer saccharum*), and white ash (*Fraxinus americana*) dominate the canopy; typical semi-rich herbs include Christmas fern (*Polystichum acrostichoides*), hairy Solomon's-seal (*Polygonatum pubescens*), red baneberry (*Actaea rubra*), eastern woodland sedge (*Carex blanda*), pointed-leaved tick-trefoil (*Hylodesmum glutinosum*), and round-leaved violet (*Viola rotundifolia*) ..... ***Semi-rich oak - sugar maple forest***

7a. Forests or woodlands dominated by Appalachian species such as white oak (*Quercus alba*), shagbark hickory (*Carya ovata*), pignut hickory (*Carya glabra*), and flowering dogwood (*Benthamidia florida*); only found in southern third of the state ..... ***Rich Appalachian oak rocky woods***

7b. Forests or woodlands dominated by red oak (*Quercus rubra*) and sugar maple (*Acer saccharum*), with basswood (*Tilia americana*) and white ash (*Fraxinus americana*); lacking Appalachian species listed in the alternate choice; found primarily south of the White Mountains ..... ***Rich red oak rocky woods***

8a. Forests and woodlands with an abundance of Appalachian oak and/or other southern species, including white oak (*Quercus alba*), black oak (*Quercus velutina*), chestnut oak (*Quercus montana*), pitch pine (*Pinus rigida*), eastern red cedar (*Juniperus virginiana*), shagbark hickory (*Carya ovata*), flowering dogwood (*Benthamidia florida*), sassafras (*Sassafras albidum*), and mountain laurel (*Kalmia latifolia*); communities mainly limited to less than 1,000 ft. elevation in southern NH, with some disjunct examples in south-central NH on steep, south-facing hills **9**

8b. Forests and woodlands lacking Appalachian indicator species listed in alternate choice **20**

9a. Forests or woodlands lacking Appalachian oak species; canopy dominated by a mix of pitch pine (*Pinus rigida*), white pine (*Pinus strobus*), red pine (*Pinus resinosa*), and red oak (*Quercus rubra*); known primarily from the Ossipee Pine Barrens region ..... ***Mixed pine - red oak woodland***

9b. Appalachian oak species present and typically dominant or co-dominant **10**

10a. Coastal woodlands on bedrock or sand that are influenced by maritime climate and salt spray **11**

10b. Forests or woodlands away from direct maritime influences **12**

11a. Woodlands on coastal rocky promontories; dominant trees are eastern red cedar (*Juniperus virginiana*) and black oak (*Quercus velutina*), with frequent black cherry (*Prunus serotina*) ..... ***Coastal rocky headland***

11b. Dense woodlands or wooded thickets in protected hollows of dune systems; dominant species include black cherry (*Prunus serotina*), dwarf shadbush (*Amelanchier spicata*), quaking aspen (*Populus tremuloides*), red maple (*Acer rubrum*), and occasionally pitch pine (*Pinus rigida*) ..... ***Maritime wooded dune***

12a. Forests with mountain laurel (*Kalmia latifolia*) abundant in the understory ..... ***Oak - mountain laurel forest***

12b. Mountain laurel (*Kalmia latifolia*) is sparse or absent in the understory **13**

13a. Forest or woodland ridgetops and sideslopes distinguished by the dominance or co-dominance of chestnut oak (*Quercus montana*) ..... ***Chestnut oak forest/woodland***

13b. Chestnut oak (*Quercus montana*) may be present, but is not dominant or co-dominant **14**

14a. Woodland or sparse woodland on talus with Appalachian species such as shagbark hickory (*Carya ovata*), bitternut hickory (*Carya cordiformis*), white oak (*Quercus alba*), black oak (*Quercus velutina*), chestnut oak (*Quercus montana*) and mountain laurel (*Kalmia latifolia*); other species typical of talus include black birch (*Betula lenta*), rock polypody (*Polypodium virginianum*), gooseberries and currants (*Ribes* spp.) and vines such as fringed bindweed (*Fallopia cilinodis*), Virginia-creeper (*Parthenocissus quinquefolia*), and poison-ivy (*Toxicodendron radicans*); only known from low elevations (<500 ft.) of southern and coastal NH ..... ***Appalachian wooded talus***

14b. Communities not on talus slopes; lacking abundance of talus indicators listed in the alternate choice **15**

15a. Communities on rocky ridges; woodlands or sparse woodlands with extensive exposures of bedrock **16**

15b. Forests or woodlands on till soils or lowland sand plain settings **17**

16a. Rocky ridge dominated by pitch pine (*Pinus rigida*) ..... ***Pitch pine rocky ridge***

16b. Rocky ridge woodland with red oak (*Quercus rubra*), white pine (*Pinus strobus*), and Appalachian oaks such as white oak (*Quercus alba*) and black oak (*Quercus velutina*); pitch pine (*Pinus rigida*) may be present, but is not dominant ..... ***Appalachian oak - pine rocky ridge***

17a. Forests or woodlands on sand plain deposits with pitch pine (*Pinus rigida*) as a dominant or co-dominant **18**

17b. Forests or woodlands on till soils dominated by Appalachian oaks **19**

18a. Pitch pine (*Pinus rigida*) is dominant in a discontinuous canopy over a well-developed tall shrub layer of scrub oak (*Quercus ilicifolia*); other canopy species are sparse or absent; absence of fire may result in examples with increased canopy closure and regeneration of white pine (*Pinus strobus*) and early successional hardwoods ..... ***Pitch pine - scrub oak woodland***

18b. Pitch pine (*Pinus rigida*) is co-dominant with Appalachian oak species such as white oak (*Quercus alba*), scarlet oak (*Quercus coccinea*), and black oak (*Quercus velutina*), as well as white pine (*Pinus strobus*); known only from the lower Merrimack River valley and coastal region..... ***Pitch pine - Appalachian oak - heath forest***

19a. Dry forests dominated by Appalachian oaks (e.g., *Quercus alba, Q. velutina, Q. coccinea,* and *Q. montana*) on shallow-to-bedrock or otherwise coarse, dry soils; heath layer with blueberries and huckleberries is typical as well as other dry-site species such as whorled yellow-loosestrife (*Lysimachia quadrifolia*), Blue Ridge sedge (*Carex lucorum*), and wavy hair grass (*Deschampsia flexuosa*); hickories (*Carya* spp.) present in some examples ..... ***Dry Appalachian oak forest***

19b. Mesic and dry-mesic forests with a more diverse tree canopy including red oak (*Quercus rubra*), white pine (*Pinus strobus*), black oak (*Quercus velutina*), red maple (*Acer rubrum*), and sometimes black birch (*Betula lenta*); other birches, hickories, hemlock, and American beech may also be present; heath shrub layer is absent or sparse, and herb species more indicative of dry sites listed in the alternate choice absent or in low abundance; common herbs and shrubs include partridge-berry (*Mitchella repens*), eastern spicy-wintergreen (*Gaultheria procumbens*), wild sarsaparilla (*Aralia nudicaulis*), Canada-mayflower (*Maianthemum canadense*), and clubmosses such as flat-branched tree-clubmoss (*Dendrolycopodium obscurum*), Hickey's tree-clubmoss (*Dendrolycopodium hickeyi*), and southern ground-cedar (*Diphasiastrum digitatum*) ..... ***Mesic Appalachian oak - hickory forest***

20a. Forests, woodlands, or rocky ridges dominated by northern conifers; forests typically dominated by red spruce (*Picea rubens*) and/or balsam fir (*Abies balsamea*); paper birch (*Betula papyrifera*) and/or heart-leaved paper birch (*Betula cordifolia*) are frequent successional associates; black spruce (*Picea mariana*) may occur in some communities; includes rocky ridges and woodlands dominated by red pine (*Pinus resinosa*), Jack pine (*Pinus banksiana*)*, or northern white cedar (*Thuja occidentalis*), as well as rocky ridges with white pine (*Pinus strobus*) and red oak (*Quercus rubra*) between 1,000 and 2,000 ft. elevation..... **21**

20b. Hardwoods, white pine (*Pinus strobus*), or hemlock (*Tsuga canadensis*) are dominant; when present, spruce and fir are at most co-dominant along with the northern hardwoods yellow birch (*Betula alleghaniensis*), American beech (*Fagus grandifolia*), and sugar maple (*Acer saccharum*)..... **34**

21a. Communities with red spruce (*Picea rubens*) and/or balsam fir (*Abies balsamea*) as dominant or co-dominant; paper birch (*Betula papyrifera*) and/or heart-leaved paper birch (*Betula cordifolia*) are frequent successional associates; black spruce (*Picea mariana*) may occur in some communities **22**

21b. Rocky ridges and woodlands dominated by red pine (*Pinus resinosa*), Jack pine (*Pinus banksiana*)*, northern white cedar (*Thuja occidentalis*), or red oak (*Quercus rubra*) and/or white pine (*Pinus strobus*)..... **30**

22a. Communities with woodland to sparse woodland structure on rocky ridge settings..... **23**

22b. Forests or woodlands on till soils or accumulations of talus..... **24**

23a. Community with fairly dense stratum of medium height to tall shrubs such as mountain holly (*Ilex mucronata*), rhodora (*Rhododendron canadense*), Labrador tea (*R. groenlandicum*), sheep laurel (*Kalmia angustifolia*), and withe-rod (*Viburnum nudum* var. *cassinoides*) interspersed with short- to moderate-height red spruce (*Picea rubens*), black spruce (*Picea mariana*), and/or balsam fir (*Abies balsamea*) trees; typically found between 2,500 and 4,000 ft. elevations in the White Mtns. and scattered other peaks; in mesic to wet-mesic settings, such as flat ridgetops or protected concavities, with shallow moist organic layer over bedrock..... ***Montane heath woodland***

23b. Community with canopy characterized by red spruce (*Picea rubens*); rocky openings characterized by the presence of heath shrubs and three-toothed cinquefoil (*Sibbaldiopsis tridentata*); generally occurs between 1,700 and 3,000 ft. elevation..... ***Red spruce - heath - cinquefoil rocky ridge***

24a. Woodlands on large block talus at base of slopes, in deep ravines, or on north aspects; black spruce (*Picea mariana*) and red spruce (*Picea rubens*) present, with lush carpets of mosses, liverworts, and rock polypody (*Polypodium virginianum*) on talus boulders… ..... ***Spruce - moss wooded talus***

24b. Forests on till soils or talus, lacking abundance of rock polypody (*Polypodium virginianum*)..... **25**

25a. Hemlock (*Tsuga canadensis*) and/or yellow birch (*Betula alleghaniensis*) are dominant or co-dominant with red spruce (*Picea rubens*) **26**

25b. Red spruce (*Picea rubens*) and/or balsam fir (*Abies balsamea*) are dominant or co-dominant; black spruce (*Picea mariana*) is co-dominant in some communities; yellow birch (*Betula alleghaniensis*), if present, may be frequent, but is not dominant or co-dominant **27**

26a. Various combinations of sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), and yellow birch (*Betula alleghaniensis*), mixed with a usually subdominant component of red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*); hemlock (*Tsuga canadensis*) is absent; found primarily on upland till soils above 2,000 ft. elevation …… ……..…….....***Northern hardwood - spruce - fir forest***

26b. Hemlock (*Tsuga canadensis*) and red spruce (*Picea rubens*) present in abundance with or without mixtures of northern hardwoods (maples and birches); found on upland till soils, and sloping and flat areas of river and kame terrace soils; white and red pine and other conifers are occasional on river and kame terrace soils..... ……..***Hemlock - spruce - northern hardwood forest***

27a. Spruce and spruce-fir forests in valley bottom settings, mostly at lower elevations (usually 1,000–2,500 ft.) north of the White Mtns., occasionally at higher elevations in valley bottoms in the White Mtns.; soils are typically somewhat poorly to moderately well drained……..**28**

27b. Well drained fir and spruce-fir forests on mountain side slopes and summits at high elevations (usually 2,500-4,500 ft.), and occasionally on rocky slopes at lower elevation……..**29**

28a. Forests dominated by red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*) on moist lowland sites (typically somewhat poorly to moderately well drained); black spruce (*Picea mariana*) is absent or present in low abundance …. ……***Lowland spruce - fir forest***

28b. Black spruce (*Picea mariana*) is a dominant or co-dominant canopy tree along with red spruce (*Picea rubens*); balsam fir (*Abies balsamea*) is less abundant or locally absent; on somewhat poorly to moderately well drained, silty soils in high-elevation mountain valley bottoms of the upper East Branch Pemigewasset River valley in the White Mtns. and in extreme northern NH……..***Montane black spruce - red spruce forest***

29a. Balsam fir (*Abies balsamea*) dominates; trees generally less than 30 ft. in height; usually 3,500–4,500 ft. elevation, or lower in exposed settings and higher in protected ravine settings; red spruce (*Picea rubens*), yellow birch (*Betula alleghaniensis*), and paper birch (*Betula papyrifera*) absent or in relatively low abundance; heart-leaved paper birch (*Betula cordifolia*) and showy mountain-ash (*Sorbus decora*) are the only prominent hardwoods); morphs to a short, scrubby woodland that transitions to krummholz (<6 ft. tall).....***High-elevation balsam fir forest***

29b. Red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*) are among dominants; heart-leaved paper birch (*Betula cordifolia*), paper birch (*Betula papyrifera*), yellow birch (*Betula alleghaniensis*), American mountain-ash (*Sorbus americana*), and showy mountain-ash (*Sorbus decora*) may be common; generally at elevations between 2,500 and 3,500 ft…….***High-elevation spruce - fir forest***

30a Rocky ridges or sandy woodlands dominated or co-dominated by red pine (*Pinus resinosa*), or rocky ridges dominated by red oak (*Quercus rubra*) and/or white pine (*Pinus strobus*)..... **31**

30b. Forests or woodlands dominated by northern white cedar (*Thuja occidentalis*) or rocky ridges dominated by Jack pine (*Pinus banksiana*)*..... **33**

31a. Rocky ridges dominated by red pine or by red oak (*Quercus rubra*) and/or white pine (*Pinus strobus*); may have a forest or woodland structure..... **32**

31a. Forests on sandy soil dominated by some combination of red pine and white pine (*Pinus strobus*); balsam fir (*Abies balsamea*) may be abundant in the understory..... ***Red pine - white pine forest***

32a. Red pine (*Pinus resinosa*) is the characteristic tree species; other species such as red oak (*Quercus rubra*), red spruce (*Picea rubens*), and white pine (*Pinus strobus*) may also be present, but red pine is dominant; generally occurs between 750 and 2,700 ft. elevation……..... ***Red pine rocky ridge***

32b. Woodland dominated by red oak (*Quercus rubra*) and sometimes white pine (*Pinus strobus*); red pine (*Pinus resinosa*) may be present, but is not dominant ..... ***Red oak - pine rocky ridge***

33a. Forests or woodlands dominated by northern white cedar (*Thuja occidentalis*); on ledgy slopes and mesic till uplands; only known north of the White Mtns ..... ***Northern white cedar forest/woodland***
33b. Rocky ridges dominated by Jack pine (*Pinus banksiana*)*; typically extensive ledges of unvegetated bedrock; only known in White Mtns. at elevations between 1,800 and 3,900 ft..... ***Jack pine rocky ridge***

34a. Communities on talus slopes, typically with woodland structure; characterized by presence of talus specialists such as mountain maple (*Acer spicatum*), gooseberries and currants (*Ribes* spp.), and vines such as fringed bindweed (*Fallopia cilinodis*), Virginia-creeper (*Parthenocissus quinquefolia*), and American bittersweet (*Celastrus scandens*) **35**
34b. Forests on till or sand soils; if on talus, lacking indicator species listed in the alternate choice **36**

35a. Talus woodland dominated by yellow birch (*Betula alleghaniensis*), paper birch (*Betula papyrifera*), and heart-leaved paper birch (*Betula cordifolia*), mountain maple (*Acer spicatum*), and mountain-ashes (*Sorbus* spp.); black birch (*Betula lenta*) and oaks (*Quercus* spp.) are absent ..... ***Birch - mountain maple wooded talus***
35b. Talus forests or woodlands that are characterized by red oak (*Quercus rubra*); black birch (*Betula lenta*) is frequent; high elevation species such as heart-leaved paper birch (*Betula cordifolia*) and mountain-ashes (*Sorbus* spp.) are absent…….. ..... ***Red oak - black birch wooded talus***

36a. Red spruce (*Picea rubens*) is a co-dominant or frequent component in the canopy **37**
36b. Red spruce (*Picea rubens*) is absent or sparse **38**

37a. Various combinations of sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), and yellow birch (*Betula alleghaniensis*), mixed with a significant but subdominant component of red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*); hemlock (*Tsuga canadensis*) is absent; found primarily on upland till soils above 2,000 ft. elevation ……..……. ***Northern hardwood - spruce - fir forest***
37b. Hemlock (*Tsuga canadensis*) and red spruce (*Picea rubens*) present in abundance with or without mixtures of northern hardwoods (maples and birches); found on upland till soils, and sloping and flat areas of river and kame terrace soils; white and red pine and other conifers are occasional on river and kame terrace soils..... ……..***Hemlock - spruce - northern hardwood forest***

38a. Forests with hemlock (*Tsuga canadensis*) present in modest or greater abundance (>5–10% of canopy or understory late successional species)……. **39**
38b. Forests in which hemlock (*Tsuga canadensis*) is sparse or in very low abundance; may be dominated by hardwoods or pine species…….. ..... **42**

39a. Community dominated by hemlock (*Tsuga canadensis*) or hemlock and white pine (*Pinus strobus*); hardwood species absent from the canopy or in very low abundance (<15%)..... **40**
39b. Community is dominated by a mix of hemlock (*Tsuga canadensis*) and other species, including American beech (*Fagus grandifolia*), red oak (*Quercus rubra*), white pine (*Pinus strobus*), and occasionally the northern hardwood species yellow birch (*Betula alleghaniensis*) and sugar maple (*Acer saccharum*)..... **41**

40a. Hemlock (*Tsuga canadensis*) co-dominant with white pine (*Pinus strobus*); black birch (*Betula lenta*) frequently present in the canopy……..……..***Hemlock - white pine forest***
40b. Hemlock (*Tsuga canadensis*) constitutes >75% of the canopy……***Hemlock forest***

41a. Hemlock (*Tsuga canadensis*) in abundance with northern hardwoods such as American beech (*Fagus grandifolia*), yellow birch (*Betula alleghaniensis*), and sugar maple (*Acer saccharum*); red oak (*Quercus rubra*) and/or white pine (*Pinus strobus*) typically present, but less so at higher elevations..... ***Hemlock - oak - northern hardwood forest***
41b. "Transition hardwood" forests, with only minor (or no) presence of sugar maple (*Acer saccharum*) and yellow birch (*Betula alleghaniensis*); hemlock (*Tsuga canadensis*), American beech (*Fagus grandifolia*), red oak (*Quercus rubra*), white pine (*Pinus strobus*), red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), black birch (*Betula lenta*), and black cherry (*Prunus serotina*) all may be present in various combinations; a very common community in southern and central NH below 1,400 ft. elevation……***Hemlock - beech - oak - pine forest***

42a. Hardwood forests dominated by American beech (*Fagus grandifolia*) or a combination of American beech, yellow birch (*Betula alleghaniensis*), and sugar maple (*Acer saccharum*); white pine (*Pinus strobus*) absent or in very low abundance……..……**43**

42b. Conifer or mixed forests dominated or co-dominated by white pine (*Pinus strobus*); canopy co-dominant may be red oak (*Quercus rubra*) or red pine (*Pinus resinosa*); on dry sandy or rocky soils **44**

43a. American beech (*Fagus grandifolia*) constitutes >75% of the canopy; low diversity and abundance of herbaceous understory plants……***Beech forest***
43b. American beech (*Fagus grandifolia*) constitutes <75% of the canopy; classic "northern hardwood" forest with American beech co-dominant with yellow birch (*Betula alleghaniensis*) and sugar maple (*Acer saccharum*) …… ……***Sugar maple - beech - yellow birch forest***

44a. Forest community on sand plain substrates dominated by a mix of white pine (*Pinus strobus*) and red pine (*Pinus resinosa*); balsam fir (*Abies balsamea*) can be frequent in the understory; known primarily from the Ossipee Pine Barrens region……...***Red pine - white pine forest***
44b. Forests characterized by a mix of red oak (*Quercus rubra*) and white pine (*Pinus strobus*) on bedrock, till, or sandy outwash settings; red pine (*Pinus resinosa*) and balsam fir (*Abies balsamea*) are sparse or absent ..... ……..***Dryred oak - white pine forest***

45a. Communities occur exclusively in coastal settings on sand or bedrock that is being directly influenced by ocean winds, salt spray, and storm surge……..... **46**
45b. Communities on bedrock, talus, till, or sand not directly influenced by maritime conditions **53**

46a. Communities occur on shifting sands between the ocean and estuarine or upland systems **47**
46b. Communities occur on exposed bedrock or accumulations of cobbles and other loose rock; many communities found on the Isles of Shoals, small rocky islands 6 miles off the NH coast..... **50**

47a. Open beaches between the extra-high tide line and the base of the foredune; vegetation is extremely sparse (<1%); all NH examples heavily impacted by human foot traffic .....***Maritime sandy beach***
47b. Communities on dune areas landward of open beaches **48**

48a. Shrublands in protected hollows of dune systems; dominated by the short to moderate height shrubs small bayberry (*Morella caroliniensis*) and beach plum (*Prunus maritima*) .....***Bayberry - beach plum maritime shrubland***
48b. Community characterized by herbaceous plants or low-growing, mat-forming shrubs on open dunes **49**

49a. Grasslands on open dunes or dune strands at upper edges of beaches; beach grass (*Ammophila breviligulata*)* is the dominant species, with seaside goldenrod (*Solidago sempervirens*) abundant; hairy hudsonia (*Hudsonia tomentosa*)* is occasional to absent …….....***Beach grass grassland***
49b. Interdunal areas dominated by extensive mats of hairy hudsonia (*Hudsonia tomentosa*)*; herbaceous species such as beach grass (*Ammophila breviligulata*)* and seaside goldenrod (*Solidago sempervirens*) are occasional, but collectively amount to only a sparse cover (<5%) ..... ***Hudsonia maritime shrubland***

50a. Community is dominated by shrubs (>25% cover) such as small bayberry (*Morella caroliniensis*), purple chokeberry (*Aronia floribunda*), black chokeberry (*Aronia melanocarpa*), Virginia rose (*Rosa virginiana*), and poison-ivy (*Toxicodendron radicans*).....…...***Maritime shrub thicket***
50b. Shrub cover is low to absent (usually <10%)..... **51**

51a. Substrate is dominated by cobble and other loose rock..... ***Maritime cobble beach***
51b. Substrate is primarily exposed bedrock..... **52**

52a. Herbaceous cover is generally <5%; typically adjacent to and landward of the ***intertidal rocky shore*** community ……. ……..…….....***Maritime rocky barren***
52b. Herbaceous cover somewhat low to high (>5% to occasionally over 60%); typically adjacent to and landward of the ***maritime rocky barren*** community ..... ***Maritime meadow***

53a. Communities in alpine or subalpine settings above 3,000 ft. elevation in the White Mtns; woody vegetation, when present, is stunted (<6 ft. tall); mat forming shrubs, graminoids, mosses, and lichens are the dominant life forms; alpine/subalpine-restricted species include alpine blueberry (*Vaccinium uliginosum*), mountain cranberry (*Vaccinium vitis-idaea*), Bigelow's sedge (*Carex bigelowii*)*, and crowberries (*Empetrum* spp.); alpine occurs above treeline around 4,900 ft.; subalpine occurs at lower elevations where exposure, shallow soils and sometimes fire history allow for the development of subalpine communities..... **54**

53b. Communities on bedrock or talus that are not in alpine or subalpine settings, generally below 3,000 ft..... **67**

54a. Community is characterized by presence of conifer species such as black spruce (*Picea mariana*), red spruce (*Picea rubens*), and/or balsam fir (*Abies balsamea*) in either krummholz form (<6ft.) or as stunted trees (10-20 ft tall)…… **55**

54b. Conifer species in general and krummholz in particular are absent; community may be dominated by herbaceous species or shrubs, or have little vascular vegetation at all **58**

55a. Community found at the base of large, open talus slopes and is influenced by ice-cooled air moving beneath the talus; sparse, stunted tree canopy (10-20 ft. tall) composed of black spruce (*Picea mariana*) and/or red spruce (*Picea rubens*), along with other species; well-developed low shrub layer among bare talus boulders includes Labrador tea (*Rhododendron groenlandicum*), sheep laurel (*Kalmia angustifolia*), black crowberry (*Empetrum nigrum*), mountain cranberry (*Vaccinium vitis-idaea*), and alpine blueberry (*Vaccinium uliginosum*); known from a few White Mtn. locations between 2,300–3,400 ft. elevation..... ***Subalpine cold-air talus shrubland***

55b. Community is characterized by the presence of krummholz (twisted, stunted trees generally <6 ft. in height) comprised of black spruce (*Picea mariana*), red spruce (*Picea rubens*) and/or balsam fir (*Abies balsamea*); on stabilized talus or other substrates…….. **56**

56a. Community consists of nearly pure krummholz (>60% cover); black spruce (*Picea mariana*), red spruce (*Picea rubens*), and/or balsam fir (*Abies balsamea*) are the primary krummholz-forming species, with heart-leaved paper birch (*Betula cordifolia*) frequent; elevation range is between 3,500 and 4,900 ft..... ***Black spruce - balsam fir krummholz***

56b. Heath-krummholz communities in which the cover of krummholz is between 20% and 60%, and is interspersed with dwarf heath and other low shrubs, including Labrador tea (*Rhododendron groenlandicum*), sheep laurel (*Kalmia angustifolia*), crowberries (*Empetrum* spp.), alpine blueberry (*Vaccinium uliginosum*), and mountain cranberry (*Vaccinium vitis-idaea*); usually has substantial areas of exposed bedrock, gravel, or talus (>25%)…….. ..... **57**

57a. Black spruce (*Picea mariana*) and balsam fir (*Abies balsamea*) are the characteristic krummholz species, although red spruce (*Picea rubens*) is occasional at the lower end of the elevation range; shrubs in alternate choice are typically absent; restricted to elevations in the White Mtns. between 3,500–4,900 ft..... ***Labrador tea heath - krummholz***

57b. Krummholz is typically comprised of red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*); black spruce (*Picea mariana*) krummholz is rare in this community; prominent heath shrubs present here but absent in the alternate choice include sheep laurel (*Kalmia angustifolia*), rhodora (*Rhododendron canadense*), and mountain holly (*Ilex mucronata*); generally found at elevations between 3,000–3,500 ft. including on peaks south of the White Mtns. ..... ***Sheep laurel - Labrador tea heath - krummholz***

58a. Community is sparsely vegetated, with either extensive areas of exposed bedrock in the subalpine zone or fields of frost-cracked boulders……..... **59**

58b. Community is not sparsely vegetated; vegetation is characterized by short graminoids, herbs, or shrubs **60**

59a. Lichens are primary vegetative form, growing on extensive fields of frost-cracked boulders; restricted to Presidential Range in the White Mtns…….. ***Felsenmeer barrens***

59b. Sparsely vegetated subalpine summits with less than 5–10% cover of vascular plants and several acres of exposed bedrock; vegetation is restricted to cracks and benches that retain thin soils ..... ***Subalpine rocky bald***

60a. Community is a shrub thicket dominated by green alder (*Alnus viridis* ssp. *crispa*), with other frequent species including meadowsweet (*Spiraea alba* var. *latifolia*); found in wet-mesic conditions of alpine ravines above 4,000 ft. elevation where snow accumulation can be substantial; known from ravines of the Presidential Range, including Tuckerman Ravine and the Great Gulf……..... …… ***Alpine ravine shrub thicket***

60b. Community is dominated by herbs or dwarf shrubs; tall shrubs such as green alder (*Alnus viridis* ssp. *crispa*) are absent…….. **61**

61a. Community is a dwarf-shrubland in subalpine settings (3,400–4,800 ft. elevation) in the White Mtns. outside the Presidential Range; alpine blueberry (*Vaccinium uliginosum*) and mountain cranberry (*Vaccinium vitis-idaea*) are dominant species, along with other dwarf shrubs such as red crowberry (*Empetrum atropurpureum*) and three-toothed cinquefoil (*Sibbaldiopsis tridentata*) ..... ***Subalpine dwarf shrubland***

61b. Alpine dwarf shrublands and meadows on gravel, sand, and rock substrates; communities restricted to higher elevations (4,900–5,800 ft., locally lower in alpine ravines) of the White Mtns., particularly the Presidential Range, Franconia Ridge, and Mt. Moosilauke…..... **62**

62a. Communities in wet-mesic settings that develop in late-melting snowbank areas, in seeps, and along rills and headwall gullies; diagnostic species include large-leaved goldenrod (*Solidago macrophylla*), bluejoint (*Calamagrostis canadensis*), White Mountain avens (*Geum peckii*)*, tufted clubsedge (*Trichophorum cespitosum*), alpine bistort (*Bistorta vivipara*)*, and Boott's rattlesnake-root (*Nabalus boottii*)*..... **63**

62b. Dry-mesic alpine tundra setting; diagnostic species listed in the alternate choice generally absent **64**

63a. Wet snowbanks and rills characterized by the presence of large-leaved goldenrod (*Solidago macrophylla*), wavy hair grass (*Deschampsia flexuosa*), and dwarf blueberry (*Vaccinium cespitosum*)*; other species characteristic of wet sites in the alpine zone include bluejoint (*Calamagrostis canadensis*), little bluet (*Houstonia caerulea*), and American false hellebore (*Veratrum viride*); known from ravines of the Presidential Range between 4,400–5,500 ft. in elevation (locally above the ravines in wet snowbank and rill settings)..... ***Alpine herbaceous snowbank/rill***

63b. Moist alpine tundra community restricted to Mount Washington, dominated by a mix of forbs, sedges, and heath shrubs; generally somewhat drier conditions than the alternate choice, and the diagnostic and wet-site species listed in the alternate choice are absent or rare; differential species (absent in **62a**) may include alpine bistort (*Bistorta vivipara*)*, Boott's rattlesnake-root (*Nabalus boottii*)*, scirpus-like sedge (*Carex scirpoidea*)*, and Scotch bellflower (*Campanula rotundifolia*)……..……...***Moist alpine herb - heath meadow***

64a. Diapensia (*Diapensia lapponica*)* is the dominant species (usually >5% cover); found primarily above 4,300 ft. elevation ……..... ***Diapensia shrubland***

64b. Community is dominated by a mix of Bigelow's sedge (*Carex bigelowii*)*, highland rush (*Juncus trifidus*), and dwarf heaths such as alpine blueberry (*Vaccinium uliginosum*) and mountain cranberry (*Vaccinium vitis-idaea*); diapensia (*Diapensia lapponica*)* is often present, but is not dominant **65**

65a. Bigelow's sedge (*Carex bigelowii*)* dominates to the near exclusion of other vascular plants, although scattered individuals of other species may be present; found primarily in the Presidential Range, although small patches occur on some outlying peaks ……. ***Bigelow's sedge meadow***

65b. Bigelow's sedge (*Carex bigelowii*)* may be frequent or co-dominant with other species, but is not the sole dominant.. **66**

66a. Well drained snowbank communities characterized by some combination of the species Labrador tea (*Rhododendron groenlandicum*), dwarf blueberry (*Vaccinium cespitosum*)*, black crowberry (*Empetrum nigrum*), wavy hair grass (*Deschampsia flexuosa*), starflower (*Lysimachia borealis*), *Spinulum annotinum* (common interrupted-clubmoss), bunchberry (*Chamaepericlymenum canadense*), and Canada-mayflower (*Maianthemum canadense*); restricted to Presidential Range and Franconia Ridge from 4,600–5,500 ft. elevation..……. ***Alpine heath snowbank***

66b. Alpine meadows in which the species listed in the alternate choice are absent or rare; dominant species are Bigelow's sedge (*Carex bigelowii*)*, highland rush (*Juncus trifidus*), alpine blueberry (*Vaccinium uliginosum*), mountain cranberry (*Vaccinium vitis-idaea*), and three-toothed cinquefoil (*Sibbaldiopsis tridentata*); community occurs between 4,800–5,600 ft. in the Presidential Range and as low as 4,600 ft. on Franconia Ridge and Mt. Moosilauke ….. ……..……. ***Sedge - rush - heath meadow***

67a. Communities on cliffs (exposed bedrock greater than three meters in height and 65 degrees in slope **68**

67b. Communities not on cliffs……..... **71**

68a. Cliff communities generally below 2,200 ft. in elevation **69**

68b. Cliff communities generally above 2,200 ft. in elevation **70**

69a. Cliff has species characteristic of acidic, nutrient-poor conditions; typical species include wavy hair grass (*Deschampsia flexuosa*), marginal wood fern (*Dryopteris marginalis*), rock polypody (*Polypodium virginianum*), Mackay's brittle fern (*Cystopteris tenuis*), and pink-corydalis (*Capnoides sempervirens*)..... ***Temperate acidic cliff***

69b. Cliff has species characteristic of circumneutral, mineral-enriched conditions; diagnostic species include slender rock-brake (*Cryptogramma stelleri*)*, Meyer's maidenhair spleenwort (*Asplenium trichomanes* ssp. *quadrivalens*), rusty cliff fern (*Woodsia ilvensis*), purple cliff-brake (*Pellaea atropurpurea*)*, and early saxifrage (*Saxifraga virginiensis*)..... ……..***Temperate circumneutral cliff***

70a. Cliff has species characteristic of acidic, mineral-poor conditions; typical species include wavy hair grass (*Deschampsia flexuosa*), three-toothed cinquefoil (*Sibbaldiopsis tridentata*), fragile fern (*Cystopteris fragilis*), *Solidago simplex* ssp. *randii* var. *monticola* (montane Rand's goldenrod), poverty oatgrass (*Danthonia spicata*), and pink-corydalis (*Capnoides sempervirens*).....***Montane - subalpine acidic cliff***

70b. Cliff has species characteristic of circumneutral to subacid, mineral-enriched conditions; diagnostic species include fragrant wood fern (*Dryopteris fragrans*)*, smooth cliff fern (*Woodsia glabella*)*, Scotch bellflower (*Campanula rotundifolia*), rusty cliff fern (*Woodsia ilvensis*), slender rock-brake (*Cryptogramma stelleri*)*, northern white cedar (*Thuja occidentalis*), and scirpus-like sedge (*Carex scirpoidea*)*, among several others..... ……..***Montane - subalpine circumneutral cliff***

71a. Rocky ridge community with species characteristic of circumneutral bedrock sites; diagnostic species include creeping juniper (*Juniperus horizontalis*)*, white flat-topped-goldenrod (*Oligoneuron album*)*, wild honeysuckle (*Lonicera dioica*), and one-flowered broom-rape (*Orobanche uniflora*)…….…….***Circumneutral rocky ridge***

71b. Communities on landslides and talus slopes, not rocky ridges **72**

72a. Talus slopes and landslide scars at mid to high elevations in the White Mtns. (mostly above 2,200 ft., occasionally to 1,500 ft.); red spruce (*Picea rubens*), birches (*Betula* spp.), and mountain-ashes (*Sorbus* spp.) in vicinity; oaks (*Quercus* spp.) and black birch (*Betula lenta*) absent.....**73**

72b. Talus barrens at low to mid elevations in southern and central NH (below 2,200 ft.); vascular plant cover is very low (generally <5%); substrate consists of boulders and large rocks; lichens are primary vegetation form; red spruce (*Picea rubens*) and mountain-ashes (*Sorbus* spp.) absent or sparse from surrounding communities; oaks (*Quercus* spp.) and black birch (*Betula lenta*) present or in vicinity..... ***Temperate lichen talus barren***

73a. Community occurs as a linear track down a steep mountain slope where rock, soil, and vegetation have slumped catastrophically and slid down the mountain; remaining substrate consists of bare rock, scree, or talus; vegetative cover can range from sparse on recent slides to wooded on areas that have had a longer recovery period since the last disturbance (landslides often remain prone to regular snow avalanche disturbance) ……... ……..***Montane landslide barren and thicket***

73b. Open slopes with large, lichen-covered rocks with little or no soil accumulation and vascular plant cover (generally <5%); this community is typically found below a cliff system, although it can be found in the absence of cliffs which have since wasted away……..***Montane lichen talus barren***

KEY TO WETLAND NATURAL COMMUNITIES

1a. Freshwater wetlands not influenced by tidal inundation; halophytic vegetation listed in the alternate choice not present; includes marshes, peatlands, swamps, floodplains, riverbanks, and seeps.

Key to Palustrine Natural Communities

1b. Brackish and salt water wetlands subjected to tidal inundation and subtidal habitats; halophytic (salt-loving) vegetation present such as cordgrasses (*Spartina* spp.), widgeon-grass (*Ruppia maritima*), saltmarsh rush (*Juncus gerardii*), saltmarsh arrow-grass (*Triglochin maritima*), sea-coast tuber-bulrush (*Bolboschoenus robustus*), glassworts (*Salicornia* spp.), and eelgrass (*Zostera marina*).

Key to Estuarine Natural Communities

KEY TO PALUSTRINE NATURAL COMMUNITIES

1a. Communities directly associated with periodic flooding along a river or large stream (third order or higher); forested floodplains and open riverbanks and shores ……. **2**

1b. Wetland natural communities not directly associated with a river or large stream (third order or higher); occurs in wet depressions or sloped settings, along pond or lake shores, or along drainages of small streams (i.e., first and second order) ……. **37**

2a. Primarily forested habitats above the bankful stage of a river that receive periodic overbank flooding **3**

2b. Open habitats along rivers and large streams; dominant vegetation is shrubby or herbaceous, but may be sparsely vegetated as well; includes river channels and riverbanks, as well as herbaceous and scrub-shrub marshes along low-gradient portions of rivers and streams **10**

3a. Floodplain forests of major rivers in which silver maple (*Acer saccharinum*) is a dominant or co-dominant in the canopy……. **4**

3b. Floodplain forests in which silver maple (*Acer saccharinum*) is sparse or absent **6**

4a. Floodplain forests with a canopy comprised of sugar maple (*Acer saccharum*), silver maple (*Acer saccharinum*), and white ash (*Fraxinus americana*); along rivers mostly in central and northern NH with flashy, high-energy flood regimes ……. ***Sugar maple - silver maple - white ash floodplain forest***

4b. Floodplain forests dominated by silver maple (*Acer saccharinum*); generally without sugar maple (*Acer saccharum*); along rivers mostly in central and southern NH with low to moderate-energy flood regimes **5**

5a. Silver maple (*Acer saccharinum*) dominated forest with a lush herb layer characterized by ostrich fern (*Matteuccia struthiopteris* ssp. *pensylvanica*) and wood nettle (*Laportea canadensis*); much lower graminoid cover than the alternate choice; soils are generally silt loams or very fine sandy loams……. ……. ***Silver maple - wood nettle - ostrich fern floodplain forest***

5b. Silver maple (*Acer saccharinum*) dominated forest; characteristic herbs are sensitive fern (*Onoclea sensibilis*) and small-spiked false nettle (*Boehmeria cylindrica*); wood nettle (*Laportea canadensis*) is usually absent; graminoids are frequent, including sweet wood-reed (*Cinna arundinacea*), slender wood-reed (*Cinna latifolia*), and fringed sedge (*Carex crinita*); typically with sandier and more acidic soils than the alternate choice ……... ……. ***Silver maple - false nettle - sensitive fern floodplain forest***

6a. Balsam fir (*Abies balsamea*) is dominant in the canopy or co-dominant with red maple (*Acer rubrum*), black cherry (*Prunus serotina*), and white pine (*Pinus strobus*); occurs in northern and (occasionally) central NH ...…….…… ……..……. ***Balsam fir floodplain/silt plain***

6b. Balsam fir (*Abies balsamea*) is absent or rare **7**

7a. Floodplain forests dominated or co-dominated by swamp white oak (*Quercus bicolor*); green ash (*Fraxinus pennsylvanica*), when present, is diagnostic; only occurs within 30 miles of the coast at less than 150 ft. elevation ……. ……..……. ***Swamp white oak floodplain forest***

7b. Swamp white oak (*Quercus bicolor*) is absent or rare **8**

8a. Forest has a sparse to moderately well developed canopy dominated by sycamore (*Platanus occidentalis*) and a tall, well developed American hornbeam (*Carpinus caroliniana* ssp. *virginiana*) shrub layer; only known from southwestern NH and a single location near the seacoast ***Sycamore floodplain forest***

8b. Sycamore (*Platanus occidentalis*) is absent or rare **9**

9a. Forest dominated by sugar maple (*Acer saccharum*) and red oak (*Quercus rubra*); ironwood (*Ostrya virginiana*) is characteristic in the subcanopy ……***Sugar maple - ironwood - short husk floodplain forest***

9b. Floodplain forest dominated by red maple (*Acer rubrum*); frequent shrubs include common winterberry (*Ilex verticillata*), *Viburnum* spp., and highbush blueberry (*Vaccinium corymbosum*); sugar maple (*Acer saccharum*) and ironwood (*Ostrya virginiana*) are generally absent or sparse in this community. .....***Red maple floodplain forest***

10a. Communities characterized by shrub species; may be tall shrubs such as speckled alder (*Alnus incana* ssp. *rugosa*) and buttonbush (*Cephalanthus occidentalis*), medium-height shrubs such as meadowsweet (*Spiraea alba* var. *latifolia*), or low-growing shrubs such as eastern dwarf cherry (*Prunus pumila* var. *depressa*) and hairy hudsonia (*Hudsonia tomentosa*)*……..**11**

10b. Communities not characterized by shrubs (exception may include shrubby portions of ***dry river bluffs***); characterized by herbaceous vegetation (sparse to dense cover)**19**

11a. Moderate gradient river channel communities characterized by low growing shrub eastern dwarf cherry (*Prunus pumila* var. *depressa*) or combination of hairy hudsonia (*Hudsonia tomentosa*)* and silverling (*Paronychia argyrocoma*)*….**12**

11b. Communities on moderate or low-gradient rivers characterized by tall or medium-height shrubs; the indicator species in the alternate choice sparse or absent**13**

12a. River channel community on sand, gravel, and cobble in which eastern dwarf cherry (*Prunus pumila* var. *depressa*) is always present and often dominant; known only from the Connecticut and Pemigewasset Rivers…….***Dwarf cherry river channel***

12b. Moderate energy river channel community characterized by the presence of hairy hudsonia (*Hudsonia tomentosa*)* and silverling (*Paronychia argyrocoma*)*; known only from the upper Saco River…….***Hudsonia - silverling river channel***

13a. Community dominated by buttonbush (*Cephalanthus occidentalis*) in oxbow settings that are flooded for all or most of the growing season……..…….***Buttonbush shrubland***

13b. Buttonbush (*Cephalanthus occidentalis*) sparse or absent**14**

14a. Community of marsh settings on fringes of low-gradient rivers; characterized by a mix of wetland shrubs and herbs; dominant shrubs include highbush blueberry (*Vaccinium corymbosum*), common winterberry (*Ilex verticillata*), and sweet gale (*Myrica gale*); typical herbs include bluejoint (*Calamagrostis canadensis*), tussock sedge (*Carex stricta*), and cinnamon fern (*Osmundastrum cinnamomeum*)……***Mixed tall graminoid - scrub-shrub marsh***

14b. Shrub species highbush blueberry (*Vaccinium corymbosum*), common winterberry (*Ilex verticillata*), and sweet gale (*Myrica gale*) generally sparse or absent**15**

15a. Thickets along major streams and minor rivers dominated by meadowsweet (*Spiraea alba* var. *latifolia*); several other woody species may be present with lower cover, including withe-rod (*Viburnum nudum* var. *cassinoides*) and rhodora (*Rhododendron canadense*)……..……***Meadowsweet alluvial thicket***

15b. Shrublands in which meadowsweet (*Spiraea alba* var. *latifolia*) may be present, but is not the dominant shrub… **16**

16a. Low riverbank community characterized by a sparse to moderate cover of willows (*Salix* spp.); frequent willow species include heart-leaved willow (*S. eriocephala*), black willow (*S. nigra*), and silky willow (*S. sericea*); graminoid cover is low; frequent herbs include hemp dogbane (*Apocynum cannabinum*) and common grass-leaved-goldenrod (*Euthamia graminifolia*)…… .....***Willow low riverbank***

16b. Upper riverbank and floodplain communities dominated by tall shrubs; alders (*Alnus* spp.) are frequent dominants or co-dominants; willows (*Salix* spp.) may be present, but are not dominant**17**

17a. Shrublands dominated by speckled alder (*Alnus incana* ssp. *rugosa*) or smooth alder (*Alnus serrulata*); other woody species may be frequent, but are not co-dominant with alder.....***Alder alluvial shrubland***

17b. Alluvial shrublands that contain alders (*Alnus* spp.) at most as a co-dominant or in lower cover associated with a more diverse mix of woody species……. **18**

18a. Alluvial shrubland on low to moderate-gradient rivers; common shrubs include silky dogwood (*Swida amomum*), speckled alder (*Alnus incana* ssp. *rugosa*), smooth alder (*Alnus serrulata*), red-osier dogwood (*Swida sericea*), and smooth arrowwood (*Viburnum dentatum* var. *lucidum*)……***Alder - dogwood - arrowwood alluvial thicket***

18b. Alluvial shrubland on moderate-gradient rivers; thickets of tree saplings and tall shrubs are interspersed with sizable patches of bare substrate; characteristic species include meadowsweet (*Spiraea alba* var. *latifolia*), willows (*Salix* spp.), dogwoods (*Swida* spp.), alders (*Alnus* spp.), and birches (*Betula* spp.) and other tree saplings ……..……***Mixed alluvial shrubland***

19a. Sparsely vegetated communities on riverbank outcrops or sand deposits above the main river channel (may be moderately vegetated with herbs, shrubs, and trees on more stable sandy substrates); when not exposed to flood waters, conditions are typically very dry..... **20**
19b. River channels, floodplains, marshes, or seeps; usually not sparsely vegetated, but if sparsely vegetated, then not on extremely dry sands (i.e., ***dry river bluff***) or riverbank outcrops..... **23**

20a. Communities on sand substrate……..…….....**21**
20b. Communities on riverbank outcrops …….. .....**22**

21a Community occurs on steep, eroding, sandy riverbanks; shrubs and sparse tree cover may occur on more stable portions of the riverbank; plants typical of dry, sandy disturbed sites are characteristic, such as little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), and poverty oatgrass (*Danthonia spicata*)…….. ..... ***Dry river bluff***
21b. Usually sparsely vegetated open sand plains on high floodplain; vascular plants are scattered and are primarily grasses and other graminoids; cover of cryptogrammic crust can be extensive; known only from the Merrimack River in Canterbury…….....***Riverwash plain and dunes***

22a. Riverbank outcrops on acidic bedrock; vegetation is usually extremely sparse, but may include a diverse array of forbs and grasses; characteristic species include pointed auricle path rush (*Juncus tenuis*), hawkweeds (*Hieracium* spp.), lady fern (*Athyrium angustum*), little bluestem (*Schizachyrium scoparium*), and big bluestem (*Andropogon gerardii*); northern examples may include flattened oatgrass (*Danthonia compressa*), dwarf blueberry (*Vaccinium cespitosum*)*, and three-toothed cinquefoil (*Sibbaldiopsis tridentata*) ..... ***Acidic riverbank outcrop***
22b. Riverbank outcrops on circumneutral bedrock; generally supports an array of circumneutral indicator species, including Scotch bellflower (*Campanula rotundifolia*), balsam groundsel (*Packera paupercula*)*, Jesup's milk vetch (*Astragalus robbinsii* var. *jesupii*)*, wild chives (*Allium schoenoprasum*)*, rusty cliff fern (*Woodsia ilvensis*), and Christmas fern (*Polystichum acrostichoides*); only known from the Connecticut River ..... ***Circumneutral riverbank outcrop***

23a. Community characterized by extensive groundwater seepage on riverbank slopes and outcrops **24**
23b. Community not characterized by riverbank seepage..... **25**

24a. Acidic seeps on riverbanks creating fen-like conditions; typical species include leatherleaf (*Chamaedaphne calyculata*), large cranberry (*Vaccinium macrocarpon*), small-flowered agalinis (*Agalinis paupercula*), lance-leaved violet (*Viola lanceolata*), rhodora (*Rhododendron canadense*), maleberry (*Lyonia ligustrina*), round-leaved sundew (*Drosera rotundifolia*), and many others…..... …***Acidic riverside seep***
24b. Circumneutral to calcareous riverbank seeps on outcrops and occasionally on steep terraces where there is year-round influence of enriched groundwater seepage; differentiated from the alternate choice by the presence of rare calciphiles such as brook lobelia (*Lobelia kalmii*)*, sticky false asphodel (*Triantha glutinosa*)*, fen grass-of-Parnassus (*Parnassia glauca*)*, elk sedge (*Carex garberi*)*, needle beaksedge (*Rhynchospora capillacea*)*, variegated scouring-rush (*Equisetum variegatum*), balsam groundsel (*Packera paupercula*)*, musky monkey-flower (*Mimulus moschatus*)*, and shining ladies'-tresses (*Spiranthes lucida*)*; only known from the Connecticut River……***Calcareous riverside seep***

25a. Communities on sand, gravel, cobble, boulder, or bedrock deposits in the river channel or on elevated riverbanks and only flooded during high water periods……. **26**
25b. Emergent marsh and aquatic bed communities within the river channel or in oxbow settings that are typically indicated by a higher density of vegetation and the presence of emergent marsh forbs.....**32**

26a. Bedrock and boulders in channel rapids supporting riverweed (*Podostemum ceratophyllum*).....***Riverweed river rapid***
26b. Communities on sand, gravel, cobble, boulder, or bedrock deposits in the river channel or on elevated riverbanks and only flooded during high water periods; not rapids supporting riverweed (*Podostemum ceratophyllum*)……..... **27**

27a. Communities on high riverbanks and floodplains, on silty or sandy soils **28**
27b. Communities on sand, gravel, cobble, or boulder deposits in river channels and on low riverbanks **29**

28a. Herbaceous community on silt or fine sandy soils, on low to moderate-energy riverbanks, with a variable mix of graminoids and forbs that is similar in appearance to meadow marshes; several variants described; dominant species, depending on variant, include reed canary grass (*Phalaris arundinacea*), bluejoint (*Calamagrostis canadensis*), Canada goldenrod (*Solidago canadensis*), fringed brome (*Bromus ciliatus*), common grass-leaved-goldenrod (*Euthamia graminifolia*), and lesser bladder sedge (*Carex vesicaria*)…….....***Herbaceous riverbank/floodplain***

28b. Herbaceous community usually on deep, medium-grained sand on high riverbanks and floodplains of moderate-energy streams with flashy flood regimes; dominated by a fairly consistent mix of bluejoint (*Calamagrostis canadensis*), wrinkle-leaved goldenrod (*Solidago rugosa*), smooth goldenrod (*Solidago gigantea*), and virgin's bower (*Clematis virginiana*)……***Bluejoint - goldenrod - virgin's bower riverbank/floodplain***

29a. Moderate to high energy river channels generally with sparse vegetation (<20% cover), and a coarse substrate of boulders and cobbles or cobbles and sand **30**

29b. Moderate to low energy river channels with generally moderate herbaceous cover (>20%) and sandy substrate; vegetative composition is highly variable, but some potential species include blue grasses (*Poa* spp.), panicgrasses (*Panicum* spp.); sedges (*Carex* spp.); bedstraws (*Galium* spp.), water-parsnip (*Sium suave*), spotted touch-me-not (*Impatiens capensis*), and Virginia marsh-St. John's-wort (*Triadenum virginicu……***Mesic herbaceous river channel***

30a. Community dominated by twisted sedge (*Carex torta*) (average 15% cover); shrub cover is generally sparse; substrate is a variable mix of cobbles, gravel, and sand.....***Twisted sedge low riverbank***

30b. Communities not dominated by twisted sedge (*Carex torta*)..... **31**

31a. High energy river channels characterized by a coarse substrate of boulders and cobbles; sparsely vegetated with tall shrubs, tree seedlings, and herbs; tall shrubs include willows (*Salix* spp.) and speckled alder (*Alnus incana* ssp. *rugosa*); grasses are may include bentgrasses (*Agrostis* spp.), reed canary grass (*Phalaris arundinacea*), and little bluestem (*Schizachyrium scoparium*)…… .....***Boulder - cobble river channel***

31b. Moderate to high energy river channels characterized by sparse vegetation on a mix of sand, gravel, and cobbles; species richness and cover are variable; common herbs include blue grasses (*Poa* spp.), bentgrasses (*Agrostis* spp.), bluejoint (*Calamagrostis canadensis*), hemp dogbane (*Apocynum cannabinum*), and field horsetail (*Equisetum arvense*)…….....***Cobble - sand river channel***

32a. Meadow marshes that are seasonally flooded during the spring with water levels that draw down below the soil surface during the growing season ...……..... **33**

32b. Emergent marshes and aquatic beds, typically semi-permanently to permanently flooded, respectively..... **34**

33a. Community characterized by short (<2 ft. tall) herbaceous vegetation under seasonally flooded or intermittently exposed situations, such as mud-flats of recently drawn-down beaver ponds or exposed soil along wet river shores; often has large areas of unvegetated mud; common species include yellow-seeded false pimpernel (*Lindernia dubia*), golden hedge-hyssop (*Gratiola aurea*), beggar-ticks (*Bidens* spp.), and common spikesedge (*Eleocharis palustris*) ……..……..... ***Short graminoid - forb meadow marsh/mudflat***

33b. Community characterized by medium to tall (1–6 ft. tall) graminoid species; does not typically include large areas of unvegetated surface; typical species include bluejoint (*Calamagrostis canadensis*), white cut grass (*Leersia virginica*), rice cut grass (*Leersia oryzoides*), three-way sedge (*Dulichium arundinaceum*), tussock sedge (*Carex stricta*), woolly bulrush (*Scirpus cyperinus*), and blue iris (*Iris versicolor*) .....***Tall graminoid meadow marsh***

34a. Medium-depth marsh dominated almost exclusively by broad-leaved cattail (*Typha latifolia*) and/or narrow-leaved cattail (*Typha angustifolia*) ……...……...……...***Cattail marsh***

34b. Medium-depth or deep water marshes not dominated by broad-leaved cattail (*Typha latifolia*) and/or narrow-leaved cattail (*Typha angustifolia*); cattails may be present, but not as in the alternate choice **35**

35a. Medium-depth marsh dominated by bayonet rush (*Juncus militaris*); three-square bulrush (*Schoenoplectus pungens*) is a common associate ……..… ..... ***Bayonet rush emergent marsh***

35b. Medium-depth or deep water marshes not dominated by bayonet rush (*Juncus militaris*) **36**

36a. Usually semi-permanently flooded substrates, inundated by shallow to deep water for most or all of the growing season; vegetation is a mix of emergent graminoids, spongy tissue species, and some floating-leaved and submersed plants such as American bur-reed (*Sparganium americanum*), common arrowhead (*Sagittaria latifolia*), pickerelweed (*Pontederia cordata*), spikesedges (*Eleocharis* spp.), soft-stemmed bulrush (*Schoenoplectus tabernaemontani*), bullhead pond-lily (*Nuphar variegata*), and white water-lily (*Nymphaea odorata*)…….…… ..... ***Emergent marsh***

36b. Permanently flooded community with water depths generally at least 2 ft.; floating-leaved aquatic species are dominant, and include white water-lily (*Nymphaea odorata*), bullhead pond-lily (*Nuphar variegata*), water-shield (*Brasenia schreberi*), little floating-heart (*Nymphoides cordata*), and pondweeds (*Potamogeton* spp.)…….***Aquatic bed***

37a. Community has a forest or woodland structure, with >25% tree cover **38**

37b. Community is dominated by shrubs and/or herbaceous species, with <25% tree cover **69**

38a. Forested swamps with conifers as the dominant canopy trees; includes swamps dominated by Atlantic white cedar (*Chamaecyparis thyoides*), northern white cedar (*Thuja occidentalis*), black spruce (*Picea mariana*), red spruce (*Picea rubens*), American larch (*Larix laricina*), balsam fir (*Abies balsamea*), hemlock (*Tsuga canadensis*), and pitch pine (*Pinus rigida*)…… **39**

38b. Forested swamps with hardwoods as the dominant canopy trees; includes swamps dominated by red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), swamp white oak (*Quercus bicolor*), black ash (*Fraxinus nigra*), and yellow birch (*Betula alleghaniensis*)……..... **55**

39a. Communities in which Atlantic white cedar (*Chamaecyparis thyoides*) is dominant or co-dominant **40**

39b. Communities in which Atlantic white cedar (*Chamaecyparis thyoides*) is sparse or absent **44**

40a. Atlantic white cedar (*Chamaecyparis thyoides*) swamp with a dense understory of giant rhododendron (*Rhododendron maximum*)*……. .....***Atlantic white cedar - giant rhododendron swamp***

40b. Atlantic white cedar (*Chamaecyparis thyoides*) swamp without *Rhododendron maximum* (giant rhododendron)*….. .. **41**

41a. Swamp with broken canopy of Atlantic white cedar (*Chamaecyparis thyoides*) and red maple (*Acer rubrum*) over dense heath shrub layer dominated by leatherleaf (*Chamaedaphne calyculata*) and sheep laurel (*Kalmia angustifolia*)…… ……..…….…….....***Atlantic white cedar - leatherleaf swamp***

41b. Atlantic white cedar (*Chamaecyparis thyoides*) swamp without dense cover of leatherleaf (*Chamaedaphne calyculata*) ……..…… **42**

42a. Atlantic white cedar (*Chamaecyparis thyoides*) swamp found along pond or stream borders characterized by the presence of numerous herbs typical of marsh habitats; frequent species include Virginia marsh-St. John's-wort (*Triadenum virginicum*), blue iris (*Iris versicolor*), bluejoint (*Calamagrostis canadensis*), and common arrowhead (*Sagittaria latifolia*)…….....***Seasonally flooded Atlantic white cedar swamp***

42b. Atlantic white cedar (*Chamaecyparis thyoides*) swamp found in basins and without the herbaceous marsh species listed in the alternate choice……..... **43**

43a. Swamp characterized by a mix of Atlantic white cedar (*Chamaecyparis thyoides*), yellow birch (*Betula alleghaniensis*), red maple (*Acer rubrum*), and sweet pepperbush (*Clethra alnifolia*); occurs at low elevations within 30 miles of the coast…….…….....***Atlantic white cedar - yellow birch - pepperbush swamp***

43b. Atlantic white cedar (*Chamaecyparis thyoides*) swamp characterized by the presence of northern species not found in other Atlantic white cedar communities; diagnostic species include red spruce (*Picea rubens*), yellow bluebead-lily (*Clintonia borealis*), and creeping spicy-wintergreen (*Gaultheria hispidula*); occurs at elevations greater than 500 ft. and more than 30 miles from the coast.....***Inland Atlantic white cedar swamp***

44a. Communities in which northern white cedar (*Thuja occidentalis*) is dominant, co-dominant, or frequent in the canopy ……..... **45**

44b. Communities in which northern white cedar (*Thuja occidentalis*) is sparse or absent **49**

45a. Northern white cedar (*Thuja occidentalis*) swamp with abundant hemlock (*Tsuga canadensis*) and red maple (*Acer rubrum*); only found in the Saco River watershed ..... ***Northern white cedar - hemlock swamp***

45b. Swamps in which hemlock (*Tsuga canadensis*) is absent..... **46**

46a. Minerotrophic swamp characterized by a mix of tree species, particularly black ash (*Fraxinus nigra*); other frequent species include yellow birch (*Betula alleghaniensis*), balsam fir (*Abies balsamea*), red spruce (*Picea rubens*); northern white cedar (*Thuja occidentalis*) is frequent but not dominan….. ..... ***Northern hardwood - black ash - conifer swamp***
46b. Northern white cedar (*Thuja occidentalis*) is dominant or co-dominant in the canopy **47**

47a. Northern white cedar (*Thuja occidentalis*) swamp without many minerotrophic indicator species; black spruce (*Picea mariana*), sheep laurel (*Kalmia angustifolia*), and creeping spicy-wintergreen (*Gaultheria hispidula*) are more abundant than in the alternate choice…….***Acidic northern white cedar swamp***
47b. Northern white cedar (*Thuja occidentalis*) swamps with numerous minerotrophic indicator species, such as naked bishop's-cap (*Mitella nuda*), long-stalked sedge (*Carex pedunculata*), and one-sided-shinleaf (*Orthilia secunda*)…….**48**

48a. Seasonally saturated northern white cedar (*Thuja occidentalis*) swamp on slopes characterized by groundwater seepage; moss cover is fairly low; typical seepage and rich-site indicator species include zig-zag goldenrod (*Solidago flexicaulis*), foam-flower (*Tiarella cordifolia*), and Jack-in-the-pulpit (*Arisaema triphyllum*)… .***Northern white cedar seepage forest***
48b. Northern white cedar (*Thuja occidentalis*) swamp with balsam fir (*Abies balsamea*) generally the most frequent associate; diverse bryophyte groundcover and well developed hummock-hollow microtopography; extensive groundwater seepage not apparent; seepage indicator species present but not dominant ..... ……..*****Northern white cedar - balsam fir swamp***

49a. Pitch pine (*Pinus rigida*) is a dominant to sub-dominant tree **50**
49b. Pitch pine (*Pinus rigida*) is absent or sparse **51**

50a. Community is a forested peatland; pitch pine (*Pinus rigida*) is the diagnostic tree in the canopy, with red maple (*Acer rubrum*), black spruce (*Picea mariana*), and white pine (*Pinus strobus*) also typically present; a moderate to dense shrub layer includes leatherleaf (*Chamaedaphne calyculata*), rhodora (*Rhododendron canadense*), and maleberry (*Lyonia ligustrina*)……. ..... ***Pitch pine - heath swamp***
50b. Community occurs on sites with a high water table and has a mix of wetland and upland species; pitch pine (*Pinus rigida*) is co-dominant or sub-dominant to red maple (*Acer rubrum*) in the canopy; canopy associates include white pine (*Pinus strobus*), red oak (*Quercus rubra*), and red spruce (*Picea rubens*); the tall shrub layer has abundant highbush blueberry (*Vaccinium corymbosum*), as well as common winterberry (*Ilex verticillata*) and mountain holly (*Ilex mucronata*) ……..…….. ..... ***Red maple - pitch pine - cinnamon fern forest***

51a. Hemlock (*Tsuga canadensis*) is a dominant or co-dominant tree in the canopy; cinnamon fern (*Osmundastrum cinnamomeum*) may be abundant, but other wetland plants are not dominant..... ……***Hemlock - cinnamon fern forest***
51b. Hemlock (*Tsuga canadensis*) is absent or sparse **52**

52a. Community is a small forest seep, typically within an upland forest dominated by red spruce (*Picea rubens*) and/or balsam fir (*Abies balsamea*); characterized by active groundwater seepage and lush cover of *Sphagnum* mosses; typical herbaceous species include American false hellebore (*Veratrum viride*), sharp-toothed nodding-aster (*Oclemena acuminata*), and northern wood sorrel (*Oxalis montana*)……..……***Acidic Sphagnum forest seep***
52b. Community is a forested swamp; not characterized by groundwater seepage **53**

53a. Forested swamp dominated by black spruce (*Picea mariana*); heath shrubs are frequent and often abundant and include Labrador tea (*Rhododendron groenlandicum*), sheep laurel (*Kalmia angustifolia*), rhodora (*Rhododendron canadense*), and leatherleaf (*Chamaedaphne calyculata*); cinnamon fern (*Osmundastrum cinnamomeum*) may be present, but is not abundant…… ..... ***Black spruce swamp***
53b. Forested swamps dominated by red spruce (*Picea rubens*) and/or American larch (*Larix laricina*), along with other conifers; black spruce (*Picea mariana*) may be present, but is not dominant; heath shrubs typically less abundant than in alternate choice; cinnamon fern (*Osmundastrum cinnamomeum*) frequent and often abundant …….....**54**

54a. Moderately-enriched swamp dominated by American larch (*Larix laricina*) and balsam fir (*Abies balsamea*); red spruce (*Picea rubens*) may be present, along with other conifers, but is not dominant .....***Larch - mixed conifer swamp***
54b. Nutrient poor swamp dominated by red spruce (*Picea rubens*); American larch (*Larix laricina*) sparse or absent ..... ……..*****Red spruce swamp***

55a. Forested wetlands typically sloped, characterized by groundwater seepage or seepage discharge zones; herbaceous species indicative of seepage zones include foam-flower (*Tiarella cordifolia*), golden-saxifrage (*Chrysosplenium americanum*), eastern rough sedge (*Carex scabrata*), and/or skunk-cabbage (*Symplocarpus foetidus*)…… **56**
55b. Forested wetlands on level terrain, not characterized by groundwater seepage **61**

56a. Small seeps that are generally less than 0.25 acres in size; several seeps may occur near one another within a drainage, but do not constitute a single, continuous wetland **57**
56b. Seepage forests and swamps that are generally greater than 0.25 acres in size **58**

57a Circumneutral seeps that are characterized by a number of indicator species, such as wood nettle (*Laportea canadensis*), northern maidenhair fern (*Adiantum pedatum*), zig-zag goldenrod (*Solidago flexicaulis*), plantain-leaved sedge (*Carex plantaginea*), blue cohosh (*Caulophyllum thalictroides*), and marginal wood fern (*Dryopteris marginalis*), among others …… ***Circumneutral hardwood forest seep***
57b. Subacid seeps in which the circumneutral indicator species in the alternate choice are sparse or absent ..... …… ***Subacid forest seep***

58a. Swamps and seepage forests found primarily in the northern half of the state; northern hardwoods and conifers dominant in the canopy, including yellow birch (*Betula alleghaniensis*), sugar maple (*Acer saccharum*), balsam fir (*Abies balsamea*), and red spruce (*Picea rubens*) **59**
58b. Seepage swamps found primarily in the southern half of the state; red maple (*Acer rubrum*) is dominant or co-dominant; northern hardwoods and conifers listed in the alternate choice absent or in low abundance **60**

59a. Swampy, semi-rich northern hardwood forest on lower mountain slopes with frequent seep openings and seepage runs; dominant trees are typically sugar maple (*Acer saccharum*) and yellow birch (*Betula alleghaniensis*); black ash (*Fraxinus nigra*), when present, is generally restricted to the wetter areas ..... ***Northern hardwood seepage forest***
59b Mixed hardwood conifer swamps where black ash (*Fraxinus nigra*) can be dominant or co-dominant with yellow birch (*Betula alleghaniensis*), balsam fir (*Abies balsamea*), and red spruce (*Picea rubens*) ..... …… ***Northern hardwood - black ash - conifer swamp***

60a. Enriched seepage swamp in which red maple (*Acer rubrum*) is dominant or co-dominant with black ash (*Fraxinus nigra*); the herbaceous layer is diverse and includes numerous seepage indicators including swamp small-flowered-saxifrage (*Micranthes pensylvanica*), water avens (*Geum rivale*), marsh-marigold (*Caltha palustris*), small enchanter's-nightshade (*Circaea alpina*), golden-saxifrage (*Chrysosplenium americanum*), and New England groundsel (*Packera schweinitziana*), among others…… ..... ***Red maple - black ash swamp***
60b. Seepage swamps that are less enriched than the alternate choice; black ash (*Fraxinus nigra*) is absent or in low abundance; the herbaceous layer is less diverse and most of the indicator species listed in the alternate choice are less abundant or lacking; skunk-cabbage (*Symplocarpus foetidus*) is a dominant or co-dominant herb; other frequent herbs include spotted touch-me-not (*Impatiens capensis*), sensitive fern (*Onoclea sensibilis*), and cinnamon fern (*Osmundastrum cinnamomeum*)……..... ***Red maple - skunk cabbage swamp***

61a. Swamp white oak (*Quercus bicolor*) is a dominant or co-dominant tree in the canopy..... ***Swamp white oak basin swamp***
61b. Swamp white oak (*Quercus bicolor*) is absent or sparse **62**

62a. Swamps in poorly or very poorly drained basins with organic soils and *Sphagnum* mosses dominant or abundant; red maple (*Acer rubrum*) is typically dominant or may be co-dominant with black gum (*Nyssa sylvatica*); herbaceous species indicative of mineral enrichment such as sensitive fern (*Onoclea sensibilis*), *Athyrium angustum* (lady fern), *Calamagrostis canadensis* (bluejoint), and *Rubus pubescens* (dwarf raspberry) generally not present…… **63**
62b. Forest communities on mineral soils or with mineral enrichment; soils not organic; *Sphagnum* mosses not typically dominant or abundant; herbaceous species sensitive fern (*Onoclea sensibilis*), lady fern (*Athyrium angustum*), bluejoint (*Calamagrostis canadensis*), and dwarf raspberry (*Rubus pubescens*) are frequent or abundant (except in **68**) **64**

63a. Black gum (*Nyssa sylvatica*) and red maple (*Acer rubrum*) are co-dominant in the canopy .... ***Black gum - red maple basin swamp***
63b. Red maple (*Acer rubrum*) dominated swamp; black gum (*Nyssa sylvatica*) is absent or sparse..... ..... ***Red maple - Sphagnum basin swamp***

64a. Swamp with red maple (*Acer rubrum*) dominated canopy over a dense herbaceous layer dominated by lake sedge (*Carex lacustris*) (25–70% cover)……. ..... ***Red maple - lake sedge swamp***
64b. Swamps without lake sedge (*Carex lacustris*) as a dominant species **65**

65a. Swamps that may be seasonally flooded or saturated **66**
65b. Forests with a seasonally high water table that occur in transition areas between wetlands and uplands, or on wet mineral soil "flats" (marine sediments or sand plains with high water tables); may be either temporarily flooded or maintain a seasonally high water table **67**

66a. Red maple (*Acer rubrum*) swamps associated with stream drainages that are seasonally flooded; clonal graminoids such as bluejoint (*Calamagrostis canadensis*) and tussock sedge (*Carex stricta*) are the most frequent dominants in the understory……..... ***Seasonally flooded red maple swamp***
66b. Red maple (*Acer rubrum*) swamps usually in headwater basins that lack seasonal, over-bank flooding; a diverse shrub layer is typical, and includes common winterberry (*Ilex verticillata*), smooth arrowwood (*Viburnum dentatum* var. *lucidum*), and speckled alder (*Alnus incana* ssp. *rugosa*); sensitive fern (*Onoclea sensibilis*) and tussock sedge (*Carex stricta*) are generally abundant; other frequent species include spotted touch-me-not (*Impatiens capensis*), blue iris (*Iris versicolor*), and swamp yellow-loosestrife (*Lysimachia terrestris*)…….. ***Red maple - sensitive fern swamp***

67a. Red maple (*Acer rubrum*) is the dominant tree in a diverse canopy that may include American elm (*Ulmus americana*), white ash (*Fraxinus americana*), shagbark hickory (*Carya ovata*), basswood (*Tilia americana*), and white pine (*Pinus strobus*); lady fern (*Athyrium angustum*) is frequently abundant, and sensitive fern (*Onoclea sensibilis*) and violets (*Viola* spp.) are common; only known from silt soil near Great Bay…….. ***Red maple - elm - lady fern silt forest***
67b. Forest canopy has red maple (*Acer rubrum*) co-dominant with either red oak (*Quercus rubra*) or pitch pine (*Pinus rigida*) (pitch pine may be sub-dominant); trees such as American elm (*Ulmus americana*), white ash (*Fraxinus americana*), and basswood (*Tilia americana*) are sparse or absent; highbush blueberry (*Vaccinium corymbosum*) is a frequent shrub and cinnamon fern (*Osmundastrum cinnamomeum*) is common **68**

68a. Forest typically dominated by red maple (*Acer rubrum*) and red oak (*Quercus rubra*), along with other species; scattered highbush blueberry (*Vaccinium corymbosum*) is scattered and black huckleberry (*Gaylussacia baccata*) may be abundant in the shrub layer; cinnamon fern (*Osmundastrum cinnamomeum*) is common; wetland indicators otherwise in low abundance……..... ***Red maple - red oak - cinnamon fern forest***
68b. Pitch pine (*Pinus rigida*) is co-dominant or sub-dominant to red maple (*Acer rubrum*) in the canopy; canopy associates include white pine (*Pinus strobus*), red oak (*Quercus rubra*), and red spruce (*Picea rubens*); the tall shrub layer includes abundant highbush blueberry (*Vaccinium corymbosum*), as well as mountain holly (*Ilex mucronata*) and common winterberry (*Ilex verticillata*); only known from sandy soils in the Ossipee region……..…… ……..…..... ***Red maple - pitch pine - cinnamon fern forest***

69a. Open wetlands with primarily organic soils (peatlands) (muck or peat >16" deep); dominant vegetation type may be shrubs or herbaceous species, but *Sphagnum* mosses are almost always present; sedges or heath shrubs generally more abundant than grasses and forbs……..... **70**
69b. Open wetlands with primarily mineral soils (organic layer <16" deep, if present); *Sphagnum* mosses may be present, but cover is generally not high; sedges and heath shrubs are generally less abundant than grasses, forbs, and non-heath shrubs……..... **97**

70a. Peatlands at higher elevations (above 2,500 ft.), in montane, alpine, and subalpine areas **71**
70b. Peatlands at lower elevations (generally below 2,900 ft.) lacking alpine-restricted species **76**

71a. Oligotrophic, level or sloping peatland in subalpine and alpine areas with a mixture of low elevation peatland species and alpine-restricted species like *Empetrum nigrum* (black crowberry) and *Vaccinium uliginosum* (alpine blueberry); peat mosses (*Sphagnum rubellum* and *S. magellanicum*) often prominent **72**
71b. Level to sloping peatlands lacking the alpine species listed in the alternate choice **74**

72a. Community with shallow peat soils on the brow of alpine/subalpine cliffs; diagnostic species are Pickering's reed grass (*Calamagrostis pickeringii*), White Mountain avens (*Geum peckii*)*, and the peat moss *Sphagnum compactum*; known only from the top of Cannon Cliff……..... ***Subalpine sloping fen***
72b. Community with peat soils 8–30 in. deep; diagnostic species in the alternate choice rare or absent **73**

73a. Open community characterized by species of saturated conditions, such as small cranberry (*Vaccinium oxycoccos*), tussock cottonsedge (*Eriophorum vaginatum* ssp. *spissum*), and bog laurel (*Kalmia polifolia*); leatherleaf (*Chamaedaphne calyculata*) has generally >10% cover; White Mountain avens (*Geum peckii*)* occurs in Presidential Range examples……..... ***Alpine/subalpine bog***

73b. Wooded community characterized by the trees black spruce (*Picea mariana*) and balsam fir (*Abies balsamea*), and without the species indicative of saturated conditions in the alternate choice ..... ***Wooded subalpine bog/heath snowbank***

74a. Community dominated by the tall shrub speckled alder (*Alnus incana* ssp. *rugosa*), with other frequent shrubs including rhodora (*Rhododendron canadense*), mountain holly (*Ilex mucronata*), and withe-rod (*Viburnum nudum* var. *cassinoides*); trees are scattered; small openings support herbaceous plants; restricted to the upper East Branch of the Pemigewasset River watershed in the White Mountains……..... ***Montane alder - heath shrub thicket***

74b. Community dominated by heath shrubs or herbs; speckled alder (*Alnus incana* ssp. *rugosa*) sparse or absent **75**

75a. Community characterized by the grass Pickering's reed grass (*Calamagrostis pickeringii*) (5–25% cover); *Sphagnum* is ubiquitous under a dense herb layer (20–60+% cover) and moderate dwarf shrub layer (<5–20% cover); herbs include star sedge (*Carex echinata*), Michaux's sedge (*Carex michauxiana*), Wiegand's sedge (*Carex wiegandii*)*, and few-seeded sedge (*Carex oligosperma*); shrubs include leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), and Labrador tea (*Rhododendron groenlandicum*); restricted to the upper East Branch of the Pemigewasset River watershed in the White Mountains…..... ***Montane sloping fen***

75b. Community in small bedrock depressions in exposed montane settings; common shrubs include leatherleaf (*Chamaedaphne calyculata*), rhodora (*Rhododendron canadense*), and mountain holly (*Ilex mucronata*); characteristic herbs include three-seeded sedge (*Carex trisperma*), hoary sedge (*Carex canescens*), and round-leaved sundew (*Drosera rotundifolia*); Pickering's reed grass (*Calamagrostis pickeringii*) is absent……. ***Montane level fen/bog***

76a. Communities characterized by a low cover (<25%) or absence of low peatland shrubs such as leatherleaf (*Chamaedaphne calyculata*) and sheep laurel (*Kalmia angustifolia*), and absence or very low abundance of tall shrubs or trees; bryophytes and/or herbaceous plants are dominant..... **77**

76b. Communities characterized by a high cover (>25%) of low peatland shrubs such as leatherleaf (*Chamaedaphne calyculata*) and sheep laurel (*Kalmia angustifolia*), and/or presence of tall shrubs, such as highbush blueberry (*Vaccinium corymbosum*) and mountain holly (*Ilex mucronata*), or trees, particularly black spruce (*Picea mariana*).... **84**

77a. Communities are characterized by dominance of marsh species; typical marsh species include American bur-reed (*Sparganium americanum*), mannagrasses (*Glyceria* spp.), woolly bulrush (*Scirpus cyperinus*), spikesedges (*Eleocharis* spp.), and bluejoint (*Calamagrostis canadensis*); *Sphagnum* moss cover is usually low to moderate...…….... **78**

77b. Peatland communities with high cover of bryophytes or algae and absence of marsh species listed in the alternate choice……..... **80**

78a. Typically a saturated to seasonally-flooded community dominated by graminoids on a grounded peat mat; characteristic species include swollen-beaked sedge (*Carex utriculata*), three-way sedge (*Dulichium arundinaceum*), bluejoint (*Calamagrostis canadensis*), and hoary sedge (*Carex canescens*); transitional between marsh communities on mineral soils and open peatlands……..... ***Sedge meadow marsh***

78b. Typically seasonally to semi-permanently flooded communities on peatland edges; typical deep water species include white water-lily (*Nymphaea odorata*), bullhead pond-lily (*Nuphar variegata*), and American bur-reed (*Sparganium americanum*); may occupy floating peat mats **79**

79a. Typically a seasonally to semi-permanently flooded community in the upland-wetland transition zone around the peatland; characterized by marsh species such as American bur-reed (*Sparganium americanum*), mannagrasses (*Glyceria* spp.), and woolly bulrush (*Scirpus cyperinus*); aquatic species, such as white water-lily (*Nymphaea odorata*) and bullhead pond-lily (*Nuphar variegata*) may be present in semi-permanently flooded moats .. .. ***Marshy moat***

79b. Community on quiet margins of ponds and lakes or stagnant, slow-moving streams on floating, thin, well-decomposed peat; transitional between emergent marsh and open peatland communities; vegetation is mix of short-statured species and deep water plants including white water-lily (*Nymphaea odorata*), spikesedges (*Eleocharis* spp.), Virginia marsh-St. John's-wort (*Triadenum virginicum*), and pickerelweed (*Pontederia cordata*)…….. ***Floating marshy peat mat***

80a. Strongly minerotrophic peatlands; pHs from 6.3–8.4; characterized by strong minerotrophic indicators such as inland sedge (*Carex interior*), yellow-green sedge (*Carex flava*), porcupine sedge (*Carex hystericina*), meager sedge (*Carex exilis*)*, and alpine clubsedge (*Trichophorum alpinum*) **81**

80b. Oligotrophic peatlands; pHs generally ≤ 4.1; absence or rarity of minerotrophic indicators in alternate choice; dominant species include large cranberry (*Vaccinium macrocarpon*), small cranberry (*Vaccinium oxycoccos*), horned bladderwort (*Utricularia cornuta*), white beaksedge (*Rhynchospora alba*), and three-way sedge (*Dulichium arundinaceum*)..... **82**

81a. Community found in the hollows of a calcareous patterned fen known only from one site in northern NH; vegetation is characterized by an abundant brown algal mat, low vascular plant cover (ca. 12%), and sparse cover of *Sphagnum contortum**; herbaceous plants include meager sedge (*Carex exilis*)*, buck-bean (*Menyanthes trifoliata*), alpine clubsedge (*Trichophorum alpinum*), and lesser bladderwort (*Utricularia minor*); rare species include livid sedge (*Carex livida*)*, moor rush (*Juncus stygius* ssp. *americanus*)*, and sparse-flowered sedge (*Carex tenuiflora*)*…… ……..... ***Circumneutral - calcareous flark***

81b. Community occurs on level to gently sloping sites influenced by enriched groundwater seepage; not found in patterned fens; characteristic species include inland sedge (*Carex interior*), yellow-green sedge (*Carex flava*), porcupine sedge (*Carex hystericina*), water avens (*Geum rivale*), and New England groundsel (*Packera schweinitziana*), among others ……. ***Calcareous sedge - moss fen***

82a. Wet, turfy, bright green to black mats of *Cladopodiella fluitans* (a leafy liverwort) densely interwoven with leaves of horned bladderwort (*Utricularia cornuta*); *Cladopodiella fluitans* turns black and looks like mud from a distance ……. ……..……..... ***Liverwort - horned bladderwort fen***

82b. Low mats dominated by *Sphagnum* species; lacks muddy appearance of alternate choice **83**

83a. Spongy, open carpets and lawns of low hummocks dominated by *Sphagnum rubellum*; small cranberry (*Vaccinium oxycoccos*) is characteristic and prominent… ..... ***Sphagnum rubellum - small cranberry moss carpet***

83b. Weakly minerotrophic peat mats, often associated with wet moats along the peatland border, characterized by large cranberry (*Vaccinium macrocarpon*) and short sedges (*Carex* spp., *Rhyncospora alba*, and *Dulichium arundinaceum*); small cranberry (*Vaccinium oxycoccos*) generally not present..... ***Large cranberry - short sedge moss lawn***

84a. Community is found only in the one known examples of a calcareous patterned fen in NH; dominated by stunted northern white cedar (*Thuja occidentalis*), ranging from 3–24 ft. tall; common shrub associates include leatherleaf (*Chamaedaphne calyculata*), Labrador tea (*Rhododendron groenlandicum*), and bog rosemary (*Andromeda polifolia* var. *glaucophylla*); the poorly developed herb layer is characterized by meager sedge (*Carex exilis*)*, and less frequently round-leaved sundew (*Drosera rotundifolia*), royal fern (*Osmunda regalis* var. *spectabilis*), buck-bean (*Menyanthes trifoliata*), purple pitcherplant (*Sarracenia purpurea*), and others ..... ……..***Northern white cedar circumneutral string***

84b. Not communities of patterned fens; northern white cedar (*Thuja occidentalis*) not present..... **85**

85a. Community is characterized by significant cover (5–40+%) of tall shrubs, which may include highbush blueberry (*Vaccinium corymbosum*), common winterberry (*Ilex verticillata*), mountain holly (*Ilex mucronata*), speckled alder (*Alnus incana* ssp. *rugosa*), maleberry (*Lyonia ligustrina*), and sweet pepperbush (*Clethra alnifolia*) …….. ..... **86**

85b. Community is characterized by dominance of low to medium shrub or herbaceous species; sparse canopy of black spruce (*Picea mariana*) may or may not be present; tall shrubs in the alternate choice generally sparse or absent **92**

86a. Sweet pepperbush (*Clethra alnifolia*) is a dominant shrub, along with highbush blueberry (*Vaccinium corymbosum*) and common winterberry (*Ilex verticillata*); other coastal or southern species present may include Virginia chain fern (*Woodwardia virginica*), clammy azalea (*Rhododendron viscosum*), weak stellate sedge (*Carex seorsa*)*, and black gum (*Nyssa sylvatica*); only found in southeastern NH ..... ***Sweet pepperbush wooded fen***

86b. Community dominated by tall shrubs, but sweet pepperbush (*Clethra alnifolia*) and the other southern species listed in the alternate choice generally not present **87**

87a. Speckled alder (*Alnus incana* ssp. *rugosa*) is one of the dominant shrubs above a robust herb layer (25–90% cover) that includes lake sedge (*Carex lacustris*); low cover of trees (<25%); medium shrubs such as leatherleaf (*Chamaedaphne calyculata*) and sweet gale (*Myrica gale*) are usually abundant (5–50% cover); other frequent herbs include skunk-cabbage (*Symplocarpus foetidus*) and royal fern (*Osmunda regalis* var. *spectabilis*) …….. ……..... ***Alder - lake sedge intermediate fen***

87b. Tall shrub layer may include speckled alder (*Alnus incana* ssp. *rugosa*), but lake sedge (*Carex lacustris*) and skunk-cabbage (*Symplocarpus foetidus*) are usually absent **88**

88a. Tall shrub swamp dominated by speckled alder (*Alnus incana* ssp. *rugosa*), with other shrubs including mountain holly (*Ilex mucronata*) and withe-rod (*Viburnum nudum* var. *cassinoides*); more minerotrophic indicator species are present, and heath shrubs such as leatherleaf (*Chamaedaphne calyculata*) and sheep laurel (*Kalmia angustifolia*) are uncommon or absent ..... ***Alder wooded fen***

88b. Tall shrub swamps with highbush blueberry (*Vaccinium corymbosum*), common winterberry (*Ilex verticillata*), or mountain holly (*Ilex mucronata*); heath shrubs such as leatherleaf (*Chamaedaphne calyculata*) and sheep laurel (*Kalmia angustifolia*) are common **89**

89a. Tall shrub swamp dominated by mountain holly (*Ilex mucronata*) and withe-rod (*Viburnum nudum* var. *cassinoides*); typically a sparse canopy of black spruce (*Picea mariana*) and/or American larch (*Larix laricina*); restricted to northern NH; southern species such as highbush blueberry (*Vaccinium corymbosum*) and maleberry (*Lyonia ligustrina*) are sparse or absent ..... ***Mountain holly - black spruce wooded fen***

89b. Tall shrubs swamps with highbush blueberry (*Vaccinium corymbosum*) dominant or frequent **90**

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90b. Tall shrub swamps dominated by highbush blueberry (*Vaccinium corymbosum*), common winterberry (*Ilex verticillata*), or mountain holly (*Ilex mucronata*); sweet gale (*Myrica gale*) and meadowsweet (*Spiraea alba* var. *latifolia*) generally in low abundance **91**

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KEY TO ESTUARINE NATURAL COMMUNITIES

1a. Permanently-flooded subtidal areas that support stands of eelgrass (*Zostera marina*) ..... ***Eelgrass bed***
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