



New Hampshire Natural Heritage Bureau

DRED – Division of Forests & Lands
172 Pembroke Road, Concord, NH 03301
(603) 271-2215

Rank Specifications for Wetland Systems in New Hampshire

For use with the Level 2 Ecological Integrity Assessment Method



A Final Report to
NH Department of Environmental Services

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NH Natural Heritage Bureau
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Advancing Wetland Assessment, Classification, and Permit Review in NH



Overview of the NH Natural Heritage Bureau's Purpose and Policies

The NH Natural Heritage Bureau (NHB) finds, tracks, and facilitates the protection of New Hampshire's rare plants and exemplary natural communities. As a bureau within the NH Department of Resources and Economic Development's Division of Forests & Lands, NHB works with landowners and land managers to help them protect New Hampshire's natural heritage while meeting their land-use needs.

The New Hampshire Native Plant Protection Act (RSA 217A) authorizes NHB to collect and analyze data on state lands about the status, location, and distribution of rare or declining native plant species and exemplary natural communities and maintain that information in a comprehensive database.

The Natural Heritage database contains information about more than 7,000 plant, animal, and natural community occurrences in New Hampshire.

Report prepared by:

Bill Nichols
Senior Ecologist/State Botanist
NH Natural Heritage Bureau
Division of Forests & Lands - DRED
172 Pembroke Road
Concord, NH 03301

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Cover photo: Kettle hole bog system at Philbrick-Cricenti Bog, New London, NH (photo by Ben Kimball).

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RANK SPECIFICATIONS FOR WETLAND SYSTEMS

Wetland systems are particular associations of natural communities¹ that repeatedly co-occur in the landscape and are linked by a common set of driving forces, such as landforms, flooding, soils, and nutrient regime. Systems are at an appropriate scale for many conservation applications, including:

- Mapping and predictive modeling.
- Correspondence to wildlife and wildlife habitats.
- As broad coarse-filter² targets in conservation planning.
- Tracking locations and comparing entire sites, particularly when natural communities may be difficult to map.
- As a more appropriate level of vegetation classification for users that have relatively little experience with plants.
- Appropriate scale for wetland condition assessments (e.g., Level 2 Ecological Integrity Assessments).

NatureServe³ has advanced the Level 2⁴ Ecological Integrity Assessment (EIA) method (Faber-Langendoen 2012) for evaluating the ecological integrity of wetland systems, one of the types of “elements” of biodiversity (Stein et al. 2000, NatureServe 2002, Brown et al. 2004). The assessment establishes the degree to which, under current conditions, a wetland system matches reference conditions for structure, composition, and function, operating within the bounds of natural or historic disturbance regimes (Lindenmayer and Franklin 2002, Parrish et al. 2003, Faber-Langendoen et al. 2009). EIA is a rapid, objective, science-based method that uses a simple vegetation classification (wetland systems) to reduce variability of scores and to improve our ability to differentiate ecological integrity over a range of wetland conditions.

Rank specifications described here identify the ecological integrity criteria for each type of wetland system in New Hampshire. These criteria provide the guidance that allows wetland scientists to assign ranks to individual wetland systems from excellent (A) to poor (D) integrity. These criteria follow an indicator-based approach, one that emphasizes specific metrics (Table 1) to assess the ecological integrity of wetland systems (NatureServe 2002, Faber-Langendoen et al. 2008, Tierney et al. 2009, Unnasch et al. 2009). For each system, the rank specifications provide guidance specific to EIA metrics and identify publically accessible reference condition (or least impacted) examples in the state for comparison opportunities. These rank specifications allow a broader audience to repeatedly and objectively apply the EIA method in New Hampshire by using the reference condition system descriptions in this document. To further provide ease of use, rank specifications directly associated with EIA metrics appear in red print. See Nichols and Faber-Langendoen (2015) for a manual to

¹ Natural communities are recurring assemblages of plants and animals found in particular physical environments (see Sperduto and Nichols (2011) for more information). Natural community names throughout this document appear in bold/italicized print.

² Systems serve as efficient “coarse filters” for protecting a broad array of species, including obscure species that are little-known or not readily identifiable. This coarse-filter approach to conservation has been a key motivation in the development of the NH Natural Heritage Bureau system classification (Sperduto 2011). In turn, this classification has been used by partners who have protected many ecologically significant sites in New Hampshire.

³ NatureServe is an international network of natural heritage programs whose mission is to provide the scientific basis for effective conservation action.

⁴ The US Environmental Protection Agency identifies assessment methods as being Level 1 (desktop only), Level 2 (desktop plus rapid field survey), or Level 3 (in-depth field survey).

guide application of EIA in New Hampshire. Endangered or threatened plant species listed in this document are noted by an asterisk (*). All pH values were measured using a calibrated water pH meter.

Table 1. The set of specific indicators, or metrics, for wetlands. Optional metrics not shown (see Nichols and Faber-Langendoen 2015, Faber-Langendoen et al. 2015).

RANK FACTOR	ECOLOGICAL FACTOR	METRIC NAME
LANDSCAPE CONTEXT	LANDSCAPE	Land Use Index
	BUFFER	Perimeter with Natural Buffer
		Width of Natural Buffer
CONDITION	VEGETATION	Vegetation Structure
		Native Plant Species Composition
		Invasive Nonnative Plant Species Cover
	HYDROLOGY	Water Source
		Hydroperiod
		Hydrologic Connectivity
	SOIL	Soil Condition
	SIZE	SIZE

An EIA-based indicators approach provides a more defensible, consistent, and repeatable method for assessing wetland condition to inform conservation, restoration, monitoring, and mitigation.

OPEN OLIGOTROPHIC PEATLANDS

ALPINE/SUBALPINE BOG SYSTEM (S1)

Landscape Settings: Concavities on ridges and on moderate to steep slopes over bedrock in alpine/subalpine zones from 2,900–4,900 ft. elevation.

Distribution: Restricted to the White Mountains.

NatureServe Ecological System Crosswalk: Acadian-Appalachian Alpine Tundra; Acadian-Appalachian Subalpine Woodland and Heath-Krummholz. These ecological systems include alpine and subalpine bogs embedded within the surrounding upland matrix.

Soils: Poorly to moderately decomposed peat soils over bedrock, generally less than 75 cm deep. Some combination of limited drainage, cold wet climate, late melting snowpacks, low evapotranspiration rate, and self-maintaining *Sphagnum* mats contribute to peat accumulation.

Nutrient Status and pH: Oligotrophic; pH <4.0.

Spatial Pattern: Small patch; circular to irregular shape; concentric zonation or uniform.

Comparative Size: A (>5 ac); B (1–5 ac); C (0.25–1 ac); D (<0.25 ac).

Vegetation Structure (vertical & horizontal): Dwarf shrub and moss/liverwort lawns.

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

Diagnostic natural communities:

Alpine/subalpine bog (S1)

Subalpine sloping fen (S1)

Wooded subalpine bog/heath snowbank (S1S2)

Associated systems: In parts of the White Mountains, alpine/subalpine bog systems form a mosaic with subalpine heath - krummholz/rocky bald systems that have collectively been referred to as “heath balds” (Fahey 1976; Doyle 1987).

These “heath balds” occur mostly below 4,000 ft. elevation on flat to gently sloping ridgetops of the Mahoosuc, Carter-Moriah, and Baldface Ranges. Smaller examples are found in several other scattered locations. Otherwise alpine/subalpine bog systems are found either within the higher elevation alpine tundra mosaic in the Presidential Range, or embedded as patches within high-elevation spruce - fir forest systems.

Invasive Nonnative Plant Species Cover: No invasive species have been recorded in this system in New Hampshire.

Native Plant Species Composition: Dominated primarily by lowland bog plants found in poor level fen/bog systems, but are distinguished from them by the presence of alpine and subalpine species. Species characteristic of alpine/subalpine bog systems but absent or rare in poor level fen/bogs of lowlands are marked below with plus sign (+). Rare (endangered and threatened) species are noted by an asterisk (*).

Alpine/subalpine bog:

Trees: absent or sparse

Dwarf shrubs alpine/subalpine indicators:

Empetrum nigrum (black crowberry)+

Rubus chamaemorus (baked-apple-berry)*+

Vaccinium uliginosum (alpine blueberry)+

Vaccinium vitis-idaea (mountain cranberry)+

Wooded subalpine bog/heath snowbank:

Trees: prominent

Abies balsamea (balsam fir)

Picea mariana (black spruce)

Dwarf shrubs alpine/subalpine indicators:

Empetrum nigrum (black crowberry)+

Rubus chamaemorus (baked-apple-berry)*+ (rare but diagnostic)

Wooded subalpine bog/heath snowbank(continued):

Alpine/subalpine bog (continued):

Other dwarf shrubs:

Chamaedaphne calyculata (leatherleaf) >10%

Kalmia angustifolia (sheep laurel) <10%

Kalmia polifolia (bog laurel)

Rhododendron groenlandicum (Labrador-tea)

Vaccinium oxycoccos (small cranberry)

Herbs:

Eriophorum vaginatum ssp. *spissum* (tussock cottonsedge)

Trichophorum cespitosum (tufted clubsedge)+

Bryophytes and lichens: peat mosses constant & abundant

Cetraria islandica (lichen)

Cladina rangiferina (lichen)

Sphagnum fuscum (peat moss)

Sphagnum capillifolium (peat moss)

Dwarf shrubs alpine/subalpine indicators (continued):

Vaccinium uliginosum (alpine blueberry)+

Vaccinium vitis-idaea (mountain cranberry)+

Other dwarf shrubs:

Chamaedaphne calyculata (leatherleaf) <10%

Kalmia angustifolia (sheep laurel)

Rhododendron groenlandicum (Labrador-tea)

Bryophytes and lichens: peat mosses less frequent & abundant

Cetraria islandica (lichen)

Cladina rangiferina (lichen)

Subalpine sloping fen:

Similar to *alpine/subalpine bog* but differs by having an abundance of:

Calamagrostis pickeringii (Pickering's reed grass)

Geum peckii (White Mountain avens)*

Sphagnum compactum (a pioneer peat moss)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy): Unknown in this habitat.

Native species sensitive to anthropogenic disturbance: Unknown.

Water Source: Topogenous to soligenous; surface runoff, seepage, cloud-intercept especially important for *subalpine sloping fen*.

Hydroperiod: Permanently saturated to seasonally saturated.

Stressors: Stressors that may alter vegetation and soil and degrade the ecological integrity of bogs in alpine and subalpine habitats include increased nutrient inputs and trampling from hikers. Trampling can impact hummock/hollow microtopography, create permanent trails, and kill plants.

Reference Condition Examples (A to B+ Ranked): Shelburne-Moriah Mountain (Shelburne).



Alpine/subalpine bog system on Shelburne-Moriah Mountain in Shelburne (photo by Ben Kimball).

KETTLE HOLE BOG SYSTEM (S2)

Landscape Settings: Closed-basin, kettle hole depressions in glacial outwash or ice-contact deposits.

Kettle hole bogs are found where big chunks of glacial ice were stranded and partially buried in glacial outwash or other coarse ice-contact deposits. The ice chunks subsequently melted, leaving ponds in holes in the ground, with no hydrologic inlets or outlets. Over millennia, peat has progressively filled in the kettle holes from the edges inward toward the pond center. Most kettle holes still have a central bog pond with a floating mat border, while for some the kettle surface is covered entirely with peat which has filled in the pond.

Distribution: Broadly distributed but concentrated in the central and southern portions of the state where kettle holes are more abundant.

NatureServe Ecological System Crosswalk: North-Central Interior and Appalachian Acidic Peatland; Atlantic Coastal Plain Northern Bog.

Soils: Deep, poorly decomposed peat.

Nutrient Status and pH: Oligotrophic due to very limited terrestrial runoff influence from their small watersheds and coarse, porous soils, and to the dominance of precipitation as the primary water source; pH ≤ 4.0 (often higher in the nearshore zone).

Spatial Pattern: Small patch; circular to irregular shape; more or less concentric zonation.

Comparative Size: A (>25 ac); B (5–25 ac); C (1–5 ac); D (<1 ac).

Vegetation Structure (vertical & horizontal): Moat, sparse woodland, tall shrub, dwarf shrub, moss carpets/lawns with mats of black liverwort.

There is often a moat separating the peat mat from the surrounding upland, which is largely a result of increased decomposition due to elevated nutrient levels from upland runoff as well as periodic, seasonal drawdown of the water table. A typical community sequence from the upland border towards the center of the kettle hole is *marshy moat* (when present), tall shrub fen or *black spruce swamp*, followed by a dense *leatherleaf - black spruce bog* zone, then a floating, reddish-colored open moss carpet (*Sphagnum rubellum*) with extremely dwarfed shrubs, and patches of *Sphagnum* pools with *Sphagnum cuspidatum* and the liverwort *Cladopodiella fluitans*.

Diagnostic natural communities:

Highbush blueberry - mountain holly wooded fen
(S3S4)

Leatherleaf - black spruce bog (S3)

Liverwort - horned bladderwort fen (S3)

Marshy moat (S4)

Sphagnum rubellum - small cranberry moss carpet
(S3)

Peripheral or occasional natural communities:

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

Leatherleaf - sheep laurel shrub bog (S2S3)

Water willow - Sphagnum fen (S3)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Frangula alnus (glossy false buckthorn)

Lythrum salicaria (purple loosestrife)

Phalaris arundinacea (reed canary grass)

Phragmites australis (common reed)

Rhamnus cathartica (European buckthorn)

Solanum dulcamara (climbing nightshade)

Typha angustifolia (narrow-leaved cattail)

Native Plant Species Composition: The vegetation is dominated by species indicative of oligotrophic conditions including scattered, stunted *Picea mariana* (black spruce), numerous dwarf heath shrubs [*Chamaedaphne calyculata*

(leatherleaf), *Vaccinium oxycoccos* (small cranberry), *Kalmia angustifolia* (sheep laurel), *K. polifolia* (bog laurel)], lawns (wet, floating lawns dominated by low, turfy mats of the leafy liverwort *Cladopodiella fluitans*, which turns black and looks like mud from a distance), *Utricularia* spp. (bladderworts), and *Rhynchospora alba* (white beaksedge). Indicators of oligotrophic conditions found in kettle hole and poor level fen/bog systems are listed below. Rare (endangered and threatened) species are noted by an asterisk (*).

Dwarf to short shrubs:

Andromeda polifolia var. *glaucophylla* (bog rosemary)
Chamaedaphne calyculata (leatherleaf)
 <20" high, max 36"
Gaylussacia baccata (black huckleberry)
Gaylussacia bigeloviana (dwarf huckleberry)*
Kalmia angustifolia (sheep laurel)
Kalmia polifolia (bog laurel)
Rhododendron groenlandicum (Labrador-tea)
Vaccinium oxycoccos (small cranberry)

Herbs and carnivorous plants:

Carex billingsii (Billings' sedge)
Drosera intermedia (spatulate-leaved sundew)
Drosera rotundifolia (round-leaved sundew)
Eriophorum vaginatum ssp. *spissum* (tussock cottonsedge)
Eriophorum virginicum (tawny cottonsedge)
Sarracenia purpurea (purple pitcherplant)

Tall shrubs and trees (sparse):

Picea mariana (black spruce) stunted
Vaccinium corymbosum (highbush blueberry)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy): The presence of *Typha latifolia* (broad-leaved cattail) in bogs and poor fens usually indicates altered hydrology and water chemistry. The following species are **mostly absent** in kettle hole and poor level fen/bog systems and are indicators of weakly to moderately minerotrophic conditions (or limited to peatland margins; pH low 4s to low 5s).

Herbs:

Carex canescens (hoary sedge)
Carex lacustris (lake sedge)
Carex lasiocarpa ssp. *americana* (wire sedge)
Carex stricta (tussock sedge)
Carex utriculata (swollen-beaked sedge)
Dulichium arundinaceum (three-way sedge)
Lysimachia terrestris (swamp yellow-loosestrife)
Osmundastrum cinnamomeum (cinnamon fern)
Triadenum virginicum (Virginia marsh-St. John's-wort)

Shrubs and trees:

Acer rubrum (red maple)
Alnus incana ssp. *rugosa* (speckled alder)
Chamaedaphne calyculata (leatherleaf)
 >20" high, usually ca. 36"
Ilex verticillata (common winterberry)
Myrica gale (sweet gale)
Spiraea alba var. *latifolia* (meadowsweet)
Spiraea tomentosa (rosy meadowsweet)
Vaccinium macrocarpon (large cranberry)

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Andromeda polifolia* var. *glaucophylla* (bog rosemary), *Carex billingsii* (Billings' sedge), *Eriophorum vaginatum* ssp. *spissum* (tussock cottonsedge), *Gaylussacia bigeloviana* (dwarf huckleberry)*, *Kalmia polifolia* (bog laurel), *Rhododendron groenlandicum* (Labrador-tea), *Sarracenia purpurea* (purple pitcherplant), and *Vaccinium oxycoccos* (small cranberry).

Water Source: Topogenous; precipitation is a primary water source; very limited terrestrial runoff from small watersheds.

Hydroperiod: Permanently saturated.

Stressors: Threats include fragmentation, habitat displacement and degradation, invasion of non-native species, trampling, alteration of hydrology, and impacts to water quality. Trampling can impact hummock/hollow microtopography, create permanent trails, and kill plants. Hydrologic alterations, both direct (e.g., connectivity changes, draining, channeling/ditching, diversions, and damming) and indirect (e.g., road construction and vegetation removal on adjacent slopes), can significantly degrade the ecological integrity of peatlands. Lowering the water table, or conversely increasing surface water inputs, can lead to shifts in species composition and community types. Logging in and near peatlands may influence hydrologic patterns, nutrient cycles, habitat integrity and

fragmentation, and sedimentation. Because most peatlands are naturally acidic and low in nutrients, they are particularly susceptible to alteration by elevated nutrient inputs. Increased nutrient inputs (e.g., from nearby roads, agriculture, development, or logging) can cause this system to shift away from its natural range of variability, leading to an increase in fen and marsh species and creating opportunity for invasive plants and “weedy” native species. The related management implication is to increase the size of buffer areas and to limit or control certain activities near these wetland types. Buffers reduce the impact of disturbances outside the system and ensure that other characteristics and processes within the community remain intact. Buffers help protect natural communities from the deleterious effects of increased nutrients, reduced water quality, altered water quantity, invasion by exotic species, windthrow, loss of secondary plant or animal habitat, and future deleterious changes in surrounding land use that may increase threats over the long term. Nutrient-poor systems, such as most types of peatland, may require larger setbacks than other systems because of their high susceptibility to changes in nutrient concentrations.

Reference Condition Examples (A to B+ Ranked): Philbrick-Cricenti Bog (New London) and Heath Pond Bog Natural Area (Ossipee and Effingham).



Kettle hole bog system at Heath Pond Bog in Ossipee and Effingham (photo by Ben Kimball).

POOR LEVEL FEN/BOG SYSTEM (S3)

Landscape Settings: Nearly closed-basins to broad drainageways with sluggish, meandering streams, and adjacent to lakes but away from the influence of the lake-water; most frequent in areas of glacial outwash or ice-contact deposits.

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

NatureServe Ecological System Crosswalk: North-Central Interior and Appalachian Acidic Peatland; Boreal-Laurentian-Acadian Acidic Basin Fen.

Soils: Deep, poorly decomposed peat.

Nutrient Status and pH: Oligotrophic to weakly minerotrophic; pH generally ≤ 4.1 (extremely acidic with limited amount of minerotrophic influence from surrounding uplands); pH often higher in the nearshore zone.

Spatial Pattern: Small to large patch, occasionally extensive; circular to irregular shaped; more or less concentric zonation, less often irregular zonation.

Comparative Size: A (>125 ac); B (125–25 ac); C (25–5 ac); D (<5 ac).

Vegetation Structure (vertical & horizontal): Moat, sparse woodland, tall shrub, dwarf shrub, moss carpets/lawns; well-developed hummock - hollow topography.

A typical community sequence from the upland border towards the center of the peatland is a tall shrub fen or *black spruce swamp* border, followed by a dense *leatherleaf - black spruce bog* zone, then a reddish open moss carpet (*Sphagnum rubellum*) with extremely dwarfed shrubs, and occasionally patches of *Sphagnum* pools or lawns with *Sphagnum cuspidatum* or other aquatic peat mosses. There is sometimes a wet moat separating the peat mat from the surrounding upland. This develops from a combination of elevated nutrient levels in upland runoff and the periodic seasonal draw-down of the water table that increases the decomposition of the peat mat at the peatland margin. If a moat is not present, the outer zone is usually dominated by a peat swamp or a tall shrub fen (most commonly *highbush blueberry - mountain holly wooded fen*).

Diagnostic natural communities:

Highbush blueberry - mountain holly wooded fen
(S3S4)

Leatherleaf - black spruce bog (S3)

Leatherleaf - sheep laurel shrub bog (S2S3)

Montane level fen/bog (S2)

Sphagnum rubellum - small cranberry moss carpet
(S3)

Peripheral or occasional natural communities:

Large cranberry - short sedge moss lawn (S3)

Marshy moat (S4)

Mountain holly - black spruce wooded fen (S3)

Water willow - Sphagnum fen (S3)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Frangula alnus (glossy false buckthorn)

Lythrum salicaria (purple loosestrife)

Phalaris arundinacea (reed canary grass)

Phragmites australis (common reed)

Rhamnus cathartica (European buckthorn)
Solanum dulcamara (climbing nightshade)

Typha angustifolia (narrow-leaved cattail)

Native Plant Species Composition: Dominated by species indicative of oligotrophic to, at most, weakly minerotrophic conditions including scattered, stunted *Picea mariana* (black spruce), and extensive areas of mostly dwarfed heath shrubs (<0.5 m; *Chamaedaphne calyculata* (leatherleaf), *Vaccinium oxycoccos* (small cranberry), *Kalmia angustifolia* (sheep laurel), *Kalmia polifolia* (bog laurel)). Floristic differences are evident in northern or higher elevation examples compared to coastal or southern examples, but the overall vegetation patterns are similar. Characteristic species composition by vegetation zone is listed below. Rare (endangered and threatened) species are noted by an asterisk (*).

Dwarf to short shrubs:

Andromeda polifolia var. *glaucophylla* (bog rosemary)
Chamaedaphne calyculata (leatherleaf)
<20" high, max 36"
Gaylussacia baccata (black huckleberry)
Gaylussacia bigeloviana (dwarf huckleberry)*
Kalmia angustifolia (sheep laurel)
Kalmia polifolia (bog laurel)
Rhododendron groenlandicum (Labrador-tea)
Vaccinium oxycoccos (small cranberry)

Herbs and carnivorous plants:

Carex billingsii (Billings' sedge)
Drosera rotundifolia (round-leaved sundew)
Drosera intermedia (spatulate-leaved sundew)
Eriophorum vaginatum ssp. *spissum* (tussock
cottonsedge)
Eriophorum virginicum (tawny cottonsedge)
Sarracenia purpurea (purple pitcherplant)

Tall shrubs and trees (sparse):

Picea mariana (black spruce)
Vaccinium corymbosum (highbush blueberry)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy): The presence of *Typha latifolia* (broad-leaved cattail) in bogs and poor fens usually indicates altered hydrology and water chemistry. The following species are **mostly absent** in kettle hole and poor level fen/bog systems and are indicators of weakly to moderately minerotrophic conditions (or limited to peatland margins; pH low 4s to low 5s).

Herbs:

Carex canescens (hoary sedge)
Carex lacustris (lake sedge)
Carex lasiocarpa ssp. *americana* (wire sedge)
Carex stricta (tussock sedge)
Carex utriculata (swollen-beaked sedge)
Dulichium arundinaceum (three-way sedge)
Lysimachia terrestris (swamp yellow-loosestrife)
Osmundastrum cinnamomeum (cinnamon fern)
Triadenum virginicum (Virginia marsh-St. John's-
wort)

Shrubs and trees:

Acer rubrum (red maple)
Alnus incana ssp. *rugosa* (speckled alder)
Chamaedaphne calyculata (leatherleaf)
>20" high, usually ca. 36"
Ilex verticillata (common winterberry)
Myrica gale (sweet gale)
Spiraea alba var. *latifolia* (meadowsweet)
Spiraea tomentosa (rosy meadowsweet)
Vaccinium macrocarpon (large cranberry)

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Andromeda polifolia* var. *glaucophylla* (bog rosemary), *Carex billingsii* (Billings' sedge), *Eriophorum vaginatum* ssp. *spissum* (tussock cottonsedge), *Gaylussacia bigeloviana* (dwarf huckleberry)*, *Kalmia polifolia* (bog laurel), *Rhododendron groenlandicum* (Labrador-tea), *Sarracenia purpurea* (purple pitcherplant), and *Vaccinium oxycoccos* (small cranberry).

Water Source: Topogenous with very little or no groundwater or lake and stream influence (limited limnogenous and soligenous influence); often with outlet stream, but without inlet streams.

Hydroperiod: Permanently saturated.

Stressors: Threats include fragmentation, habitat displacement and degradation, invasion of non-native species, trampling, alteration of hydrology, and impacts to water quality. Trampling can impact hummock/hollow microtopography, create permanent trails, and kill plants. Hydrologic alterations, both direct (e.g., connectivity

changes, draining, channeling/ditching, diversions, and damming) and indirect (e.g., road construction and vegetation removal on adjacent slopes), can significantly degrade the ecological integrity of peatlands. Lowering the water table, or conversely increasing surface water inputs, can lead to shifts in species composition and community types. Logging in and near peatlands may influence hydrologic patterns, nutrient cycles, habitat integrity and fragmentation, and sedimentation. Because most peatlands are naturally acidic and low in nutrients, they are particularly susceptible to alteration by elevated nutrient inputs. Increased nutrient inputs (e.g., from nearby roads, agriculture, development, or logging) can cause this system to shift away from its natural range of variability, leading to an increase in fen and marsh species and creating opportunity for invasive plants and “weedy” native species. The related management implication is to increase the size of buffer areas and to limit or control certain activities near these wetland types. Buffers reduce the impact of disturbances outside the system and ensure that other characteristics and processes within the community remain intact. Buffers help protect natural communities from the deleterious effects of increased nutrients, reduced water quality, altered water quantity, invasion by exotic species, windthrow, loss of secondary plant or animal habitat, and future deleterious changes in surrounding land use that may increase threats over the long term. Nutrient-poor systems, such as most types of peatland, may require larger setbacks than other systems because of their high susceptibility to changes in nutrient concentrations.

Reference Condition Examples (A to B+ Ranked): Heath Pond Bog Natural Area (Ossipee and Effingham) and Red Hill Pond (Sandwich).



Poor level fen/bog system at Red Hill Pond in Sandwich (photo by Dan Spurduto).

OPEN MINEROTROPHIC PEATLANDS (WEAKLY TO STRONGLY MINEROTROPHIC)

MEDIUM LEVEL FEN SYSTEM (S3S4)

Landscape Settings: Mostly along stream and lake borders where the nutrient levels and seasonal fluctuations of water levels are greater than in poor level fens, but less than in emergent marshes (thus allowing peat to accumulate over the long term); also occur in open headwater basins and drained depressions in glacial outwash or ice-contact deposits.

Distribution: Broadly distributed in New Hampshire.

NatureServe Ecological System Crosswalk: North-Central Interior and Appalachian Acidic Peatland; Boreal-Laurentian-Acadian Acidic Basin Fen.

Soils: Deep, poorly to moderately well-decomposed peat.

Nutrient Status and pH: Weakly to moderately minerotrophic; pH generally in low 4s to mid 5s.

Spatial Pattern: Small to large patch; irregularly circular or linear; irregular or banded zonation parallel to stream or pond border; streams often pass through peatland (has inlet and outlet).

Comparative Size: A (>125 ac); B (125–25 ac); C (25–5 ac); D (<5 ac).

Vegetation Structure (vertical & horizontal): Sparse woodland, tall shrub, medium-height shrub, sedge-dominated fen, moss carpets/lawns; well-developed hummock - hollow topography in many of its constituent communities.

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

Diagnostic natural communities:

Moss lawns and sedge/medium-shrub fens:

Bog rosemary - sedge fen (S3)

Large cranberry - short sedge moss lawn (S3)

Sweet gale - meadowsweet - tussock sedge fen (S4)

Wire sedge - sweet gale fen (S3)

Tall shrub fens:

Alder wooded fen (S3S4)

Highbush blueberry - sweet gale - meadowsweet shrub thicket (S4)

Sweet pepperbush wooded fen (S2)

Winterberry - cinnamon fern wooded fen (S4)

Peripheral or occasional natural communities:

Alder - lake sedge intermediate fen (S2S3)

Floating marshy peat mat (S3S4)

Marshy moat (S4)

Montane level fen/bog (S2)

Sedge meadow marsh (S4)

Water willow - Sphagnum fen (S3)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Frangula alnus (glossy false buckthorn)
Iris pseudacorus (yellow flag)
Lythrum salicaria (purple loosestrife)
Phalaris arundinacea (reed canary grass)

Phragmites australis (common reed)
Rhamnus cathartica (European buckthorn)
Solanum dulcamara (climbing nightshade)
Typha angustifolia (narrow-leaved cattail)

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

Herbs:

Carex canescens (hoary sedge)
Carex lacustris (lake sedge)
Carex lasiocarpa (wire sedge)
Carex stricta (tussock sedge)
Carex utriculata (swollen-beaked sedge)
Dulichium arundinaceum (three-way sedge)
Lysimachia terrestris (swamp yellow-loosestrife)
Osmundastrum cinnamomeum (cinnamon fern)
Triadenum virginicum (Virginia marsh-St. John's-wort)

Shrubs and trees:

Acer rubrum (red maple)
Alnus incana ssp. *rugosa* (speckled alder)
Chamaedaphne calyculata (leatherleaf)
>20" high, usually ca. 36"
Ilex verticillata (common winterberry)
Larix laricina (American larch)
Myrica gale (sweet gale)
Spiraea alba var. *latifolia* (meadowsweet)
Spiraea tomentosa (rosy meadowsweet)
Toxicodendron vernix (poison-sumac)
Vaccinium macrocarpon (large cranberry)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):
Possibilities for this system include *Typha latifolia* (broad-leaved cattail).

Native species sensitive to anthropogenic disturbance: Very few native species found in this system fall into this category. Possibilities include *Carex lacustris* (lake sedge) and *Toxicodendron vernix* (poison-sumac).

Water Source: Topogenous and limnogenous (limited soligenous influence); with more minerotrophic influence than poor level fen/bogs due to the effects of upland runoff, exposure to lake and stream water, or limited groundwater seepage.

Hydroperiod: Permanently saturated.

Stressors: Threats include fragmentation, habitat displacement and degradation, invasion of non-native species, trampling, alteration of hydrology, and impacts to water quality. Trampling can impact hummock/hollow microtopography, create permanent trails, and kill plants. Hydrologic alterations, both direct (e.g., connectivity changes, draining, channeling/ditching, diversions, and damming) and indirect (e.g., road construction and vegetation removal on adjacent slopes), can significantly degrade the ecological integrity of peatlands. Lowering the water table, or conversely increasing surface water inputs, can lead to shifts in species composition and community

types. Logging in and near peatlands may influence hydrologic patterns, nutrient cycles, habitat integrity and fragmentation, and sedimentation.

Reference Condition Examples (A to B+ Ranked): Betty Meadows (Northwood), NW of Lake Umbagog (Errol), Little and Big Church Ponds (Livermore/Albany), Bradford Bog (Bradford), Berry Pond (Moultonborough/Sandwich), and Ossipee Lake Natural Area (Ossipee).



Medium level fen system at Ossipee Lake Natural Area in Ossipee (photo by Ben Kimball).

MONTANE SLOPING FEN SYSTEM (S1)

Landscape Settings: Moderate- to high-elevation (above 2,400 ft.) valley bottoms and adjacent gently sloped mountain side-slopes; occur on definite soligenous slopes, shallow level depressions, and small drainage-ways associated with old beaver dams (abandoned decades ago and have subsequently filled in with organics). Surfaces are nearly level to sloping (up to 10–20 degrees).

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

NatureServe Ecological System Crosswalk: Acadian-Appalachian Subalpine Woodland and Heath-Krummholz. This ecological system includes sloped montane fens embedded within the surrounding upland matrix.

Soils: Shallow, well-decomposed peat; often on glacial lake bed or other silty-gravelly mineral deposits.

Nutrient Status and pH: Weakly to moderately minerotrophic; average pH 5.3 (4.2 to 6.3).

Spatial Pattern: Small to large patch; oval to irregular or linear shapes, irregular zonation.

Comparative Size: A (>125 ac); B (125–25 ac); C (25–5 ac); D (<5 ac).

Vegetation Structure (vertical & horizontal): Graminoid - moss lawns, graminoid - shrub, tall shrub, sparse woodland and woodland; hummock - hollow topography is moderately well to poorly developed. This system consists of *montane sloping fens* (key diagnostic community) occurring in a mosaic with *montane alder - heath shrub thickets* and *montane heath woodlands*. The *montane sloping fen* is dominated by graminoids or graminoids and shrubs, and is the only known fen in the state or region that is characterized by a grass (*Calamagrostis pickeringii*).

Diagnostic natural communities:

Montane alder - heath shrub thicket (S1)

Montane sloping fen (S1)

Peripheral or occasional natural communities:

Montane heath woodland (S2)

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

Invasive Nonnative Plant Species Cover: None known at this time.

Native Plant Species Composition: *Calamagrostis pickeringii* (Pickering's reed grass) on average contributes about 5% cover, and *Carex wiegandii* (Wiegand's sedge)* is frequent. Numerous other northern poor and medium fen plants are present (listed below). Rare (endangered and threatened) species are noted by an asterisk (*).

Montane sloping fen:

Herbs:

Calamagrostis pickeringii (Pickering's reed grass)

Carex echinata (star sedge)

Carex pauciflora (few-flowered sedge)

Carex oligosperma (few-seeded sedge)

Carex wiegandii (Wiegand's sedge)*

Drosera rotundifolia (round-leaved sundew)

Eriophorum virginicum (tawny cottonsedge)

Platanthera clavellata (little club-spur bog-orchid)

Solidago uliginosa (bog goldenrod)

Veratrum viride (American false hellebore)

Shrubs:

Chamaedaphne calyculata (leatherleaf)

Ilex mucronata (mountain holly)

Kalmia polifolia (bog laurel)

Rhododendron groenlandicum (Labrador-tea)

Rhododendron canadense (rhodora)

Lowland peatland plants are absent, including:

Gaylussacia baccata (black huckleberry)

Ilex verticillata (common winterberry)

Vaccinium corymbosum (highbush blueberry)

Woodwardia virginica (Virginia chain fern)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):

Unknown in this habitat.

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Calamagrostis pickeringii* (Pickering's reed grass), *Carex oligosperma* (few-seeded sedge), *Carex pauciflora* (few-flowered sedge), *Kalmia polifolia* (bog laurel), *Rhododendron canadense* (rhodora), *Rhododendron groenlandicum* (Labrador-tea), *Solidago uliginosa* (bog goldenrod), and *Woodwardia virginica* (Virginia chain fern).

Water Source: Soligenous and topogenous.

Hydroperiod: Permanently saturated.

Stressors: Threats include fragmentation, habitat displacement and degradation, invasion of non-native species, trampling, alteration of hydrology, and impacts to water quality. Trampling can impact hummock/hollow microtopography, create permanent trails, and kill plants. Hydrologic alterations can significantly degrade the ecological integrity of peatlands. Lowering the water table, or conversely increasing surface water inputs, can lead to shifts in species composition and community types. Logging in and near peatlands may influence hydrologic patterns, nutrient cycles, habitat integrity and fragmentation, and sedimentation.

Reference Condition Examples (A to B+ Ranked): Upper East Branch of the Pemigewasset River watershed near Shoal and Ethan Ponds (Lincoln), North Bald Cap Mtn. in the Mahoosuc Range (Success), and Whitewall Mountain (Bethlehem).



Montane sloping fen system on Whitewall Mountain in Bethlehem (photo by Dan Sperduto).

PATTERNED FEN SYSTEM (S1)

Landscape Settings: Extensive flats (peatland and lowland spruce - fir forest/swamps).

Distribution: Known from only three sites in extreme northern New Hampshire. Patterned peatlands reach their southern extent in New Hampshire where patterning is less well developed than further north; they are more extensive and well-developed in boreal and subpolar areas where precipitation greatly exceeds evaporation.

NatureServe Ecological System Crosswalk: Boreal-Laurentian-Acadian Acidic Basin Fen.

Soils: Moderately well to well decomposed peat.

Nutrient Status and pH: Weakly minerotrophic (acidic examples) to strongly minerotrophic (circumneutral to alkaline examples); pH 4–5 (acidic examples); pH 6.3–8.0 (circumneutral to alkaline examples).

Spatial Pattern: Small to large patch; oblong to broad ovals; repeating parallel zonation of strings (hummock ridges) and flarks (hollows).

Comparative Size: A (>125 ac); B (125–25 ac); C (25–5 ac); D (<5 ac).

Vegetation Structure (vertical & horizontal): Dwarf shrub with stunted conifers, graminoid - moss carpets.

Slow groundwater movement through broad gently sloped peatlands forms a series of linear hummock ridges, called strings, separated by parallel hollows known as flarks. Strings and flarks are arranged perpendicularly to the flow of water through the peatland and can form a regular to intricate pattern of parallel ridges and hollows.

Diagnostic natural communities:

Flarks:

Circumneutral - calcareous flark (S1)

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

Liverwort - horned bladderwort fen (S3)

Sphagnum rubellum - small cranberry moss carpet (S3)

Strings:

Leatherleaf - black spruce bog (S3)

Northern white cedar circumneutral string (S1)

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

Invasive Nonnative Plant Species Cover: None known at this time.

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

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

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

Characteristic species composition by vegetation zone is listed below. Rare (endangered and threatened) species are noted by an asterisk (*).

Acidic strings:

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

Northern white cedar circumneutral string:

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

Acidic flarks:

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

Circumneutral - calcareous flark:

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

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):
Unknown in this habitat.

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Carex exilis* (meagre sedge)*, *Carex livida* (livid sedge)*, *Carex tenuiflora* (sparse-flowered sedge)*, *Juncus stygius* ssp. *americanus* (moor rush)*, *Menyanthes trifoliata* (buck-bean), *Muhlenbergia glomerata* (spike muhly), *Rhododendron groenlandicum* (Labrador-tea), *Salix pedicellaris* (bog willow), *Sarracenia purpurea* (purple pitcherplant), *Trichophorum alpinum* (alpine clubsedge), *Utricularia cornuta* (horned bladderwort), and *Vaccinium oxycoccos* (small cranberry),.

Water Source: Soligenous with some topogenous influence.

Hydroperiod: Permanently saturated.

Stressors: Threats include fragmentation, habitat displacement and degradation, invasion of non-native species, trampling, alteration of hydrology, and impacts to water quality. Trampling can impact hummock/hollow microtopography, create permanent trails, and kill plants. Hydrologic alterations can significantly degrade the ecological integrity of peatlands. Lowering the water table, or conversely increasing surface water inputs, can lead to shifts in species composition and community types. Logging in and near peatlands may influence hydrologic patterns, nutrient cycles, habitat integrity and fragmentation, and sedimentation.

Reference Condition Examples (A to B+ Ranked): South Bay Bog (Pittsburg), East Inlet (Pittsburg), and Umbagog Lake (Borderline Fen in Errol).



Patterned fen system at Borderline Fen in Errol (photo by Dan Spurduto).

CALCAREOUS SLOPING FEN SYSTEM (S1S2)

Landscape Settings: Headwater positions, openings in northern white cedar swamps, steep terraces of rivers or streams, and side slopes of hills. Also in small basins, kettles, or catchments with seepage influence and stream margins flowing through marshes or swamps in areas with calcareous bedrock. Certain expressions of these systems often occur where disturbance maintains vegetation in an early successional state, such as beaver meadows and grazed pastures or hay fields. While some examples are nearly level, most have gentle to prominent slopes.

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

NatureServe Ecological System Crosswalk: Laurentian-Acadian Alkaline Fen.

Soils: Well decomposed shallow to moderately deep peat. Peat depth varies with landscape setting; deeper peat accumulation occurs in basins and gentle slopes relative to steeper slopes or periodically disturbed areas such as terraces along major rivers or old pastures.

Nutrient Status and pH: Strongly minerotrophic; pH ranges from 6.7 to 8.2 (average 7.2).

Spatial Pattern: Small patch; irregular zonation or uniform; often with rivulets or small open pools.

Comparative Size: A (>5 ac); B (5–1 ac); C (1–0.25 ac); D (<0.25 ac).

Vegetation Structure (vertical & horizontal): Graminoid - moss carpets, sedge - medium height sparse shrubland.

Diagnostic natural communities:

Calcareous sedge - moss fen (S2)

Associated systems: This system is most often associated with montane/near-boreal minerotrophic peat swamp system, and occasionally drainage marsh - shrub swamp or spruce - fir forest/swamp systems.

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Alnus glutinosa (European alder)

Berberis thunbergii (Japanese barberry)

Cynanchum louiseae (black swallowwort)

Frangula alnus (glossy false buckthorn)

Lonicera morrowii (Morrow's honeysuckle)

Lythrum salicaria (purple loosestrife)

Phalaris arundinacea (reed canary grass)

Phragmites australis (common reed)

Rhamnus cathartica (European buckthorn)

Tussilago farfara (coltsfoot)

Native Plant Species Composition: *Calcareous sedge - moss fens* are dominated by a distinct assemblage of low sedges and other graminoids over a carpet of “brown” mosses and several uncommon to rare peat mosses. Scattered willow and dogwood shrubs are often present. These peatlands are among the most botanically diverse in New Hampshire and contain many calciphilic plant species in addition to more common wetland species. There are often orchids and other uncommon herbs interspersed among the graminoids and shrubs; these orchids and herbs are absent in oligotrophic to moderately minerotrophic peatland systems (such as medium and poor level fen/bogs and kettle hole bogs). Many of these species are rare, and restricted to these systems. Characteristic species composition by vegetation zone is listed below. Rare (endangered and threatened) species are noted by an asterisk (*).

Trees and shrubs:

Dasiphora floribunda (shrubby-cinquefoil)

Swida sericea (red-osier dogwood)

Thuja occidentalis (northern white cedar)

Bryophytes:

Aulacomnium palustre (moss)

Bryum pseudotriquetrum (moss)

Campyllum stellatum (moss)

Pellia epiphylla (liverwort)

Philonotus fontana (moss)

Sphagnum warnstorffii (peat moss)

Tomenthypnum nitens (moss)

Herbs:

Carex aurea (golden-fruited sedge)*
Carex castanea (chestnut sedge)*
Carex hystericina (porcupine sedge)
Carex interior (inland sedge)
Carex flava (yellow-green sedge)
Cypripedium reginae (showy lady's-slipper)*
Lobelia kalmii (brook lobelia)*
Packera schweinitziana (New England groundsel)
Parnassia glauca (fen grass-of-Parnassus)*
Petasites frigidus var. *palmatus* (northern sweet-coltsfoot)*
Trichophorum cespitosum (tufted clubsedge)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):
Equisetum spp. and *Typha latifolia* (broad-leaved cattail).

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Carex interior* (inland sedge), *Cypripedium reginae* (showy lady's-slipper)*, *Parnassia glauca* (fen grass-of-Parnassus)*, *Petasites frigidus* var. *palmatus* (northern sweet-coltsfoot)*, and *Trichophorum cespitosum* (tufted clubsedge).

Water Source: Soligenous; considerable minerotrophic year-round seepage through base-rich or carbonate-bearing bedrock types.

Hydroperiod: Permanently saturated.

Stressors: Alterations of hydrology, both direct (e.g., connectivity changes, draining, channeling/ditching, diversions, and damming) and indirect (e.g., road construction and vegetation removal on adjacent slopes), can significantly degrade the ecological integrity of peatlands. Lowering the water table, or conversely increasing surface water inputs, can lead to shifts in species composition and community types. Trampling can impact hummock/hollow microtopography, create permanent trails, and kill plants. Some type of disturbance is required to maintain the open fen vegetation structure (e.g., grazing, flooding, windthrow, or fire).

Reference Condition Examples (A to B+ Ranked): Stewartstown and Monroe (all are on private property).



Calcareous sloping fen system in Monroe (photo by Ben Kimball).

OLIGOTROPHIC PEAT SWAMPS

BLACK SPRUCE PEAT SWAMP SYSTEM (S2S3)

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

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

NatureServe Ecological System Crosswalk: Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen.

Soils: Moderately deep to very deep, moderately decomposed peat.

Nutrient Status and pH: Oligotrophic to weakly minerotrophic; pH generally in 3s to mid 4s, occasionally higher.

Spatial Pattern: Small to large patch, occasionally extensive; circular to irregular shape, often as exterior zone around open peatlands or sometimes in mosaics with more open peatlands.

Comparative Size: A (>125 ac); B (125–25 ac); C (25–5 ac); D (<5 ac).

Vegetation Structure (vertical & horizontal): Forest to woodland and tall shrub.

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

Diagnostic natural communities:

Black spruce swamp (S3)

Highbush blueberry - mountain holly wooded fen
(S3S4)

Mountain holly - black spruce wooded fen (S3)

Peripheral or occasional natural communities:

Acidic northern white cedar swamp (S1)

Alder wooded fen (S3S4)

Larch - mixed conifer swamp (S3)

Northern white cedar - balsam fir swamp (S2)

Red spruce swamp (S3)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Berberis thunbergii (Japanese barberry)

Frangula alnus (glossy false buckthorn)

Lythrum salicaria (purple loosestrife)

Phragmites australis (common reed)

Rhamnus cathartica (European buckthorn)

Solanum dulcamara (climbing nightshade)

Native Plant Species Composition: This system corresponds to acidic, nutrient-poor wooded peatlands dominated by boreal conifers and heath shrubs, particularly *Picea mariana* (black spruce) and to a lesser extent *Larix laricina* (eastern larch) and other conifers. Characteristic species composition by vegetation zone is listed below.

Black spruce swamp:

Trees and shrubs:

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

Dwarf shrubs:

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

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):

Unknown in this habitat.

Native species sensitive to anthropogenic disturbance: Very few native species found in this system fall into this category. Possibilities include *Rhododendron canadense* (rhodora).

Water Source: Topogenous.

Hydroperiod: Permanently saturated to seasonally flooded.

Stressors: Development threats include fragmentation, habitat displacement and degradation, invasion of non-native species, alterations of flood regimes, and impacts to water quantity and quality (including pollution, eutrophication, and reduction through withdrawal). Impervious surfaces and other alterations to surrounding landcover can affect hydrology and degrade water quality through siltation and pollutants such as fertilizers, pesticides, and road residue. Trampling can impact hummock/hollow microtopography, create permanent trails, and kill plants. Logging of forested wetlands may impact hydrologic patterns and alter habitat for forest-restricted species. Regionally, there has been a tendency towards younger, second-growth swamp forests in the region. Logging of adjacent uplands may influence hydrologic patterns, nutrient cycles, habitat integrity and fragmentation, and sedimentation. Naturally acidic, low-nutrient wetland types are particularly susceptible to alteration by elevated nutrient inputs. Residential and industrial pollution, including road, sewage, and agricultural runoff, are sources of nutrients and pollutants that may result in eutrophication. The management implication is to increase the size of buffer areas and limit or control certain activities near these wetland types. Combinations of different types of stressors together with their scope and severity determine the degree to which a system's ecological integrity shifts from a natural condition (A rank) toward more degraded conditions (B, C, or D ranks).

Reference Condition Examples (A to B+ Ranked): Cypress Brook (Beans Purchase), Norton Pool (Pittsburg), Stearns Branch vicinity (Success), Trudeau Road vicinity (Bethlehem), Bear Brook State Park (disjunct example in Allentown/Deerfield), and South Bay Bog (Pittsburg).



Black spruce peat swamp system at South Bay Bog in Pittsburg (photo by John Burns).

COASTAL CONIFER PEAT SWAMP SYSTEM (S1S2)

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

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

NatureServe Ecological System Crosswalk: Northern Atlantic Coastal Plain Basin Peat Swamp.

Soils: Deep, moderately well decomposed peat.

Nutrient Status and pH: Oligotrophic to weakly minerotrophic; pH generally less than 5, occasionally higher. Some inland examples of this system are very acidic (pH as low as 3.4); seasonally flooded portions of these systems that transition to emergent marshes have higher pH (4.4 to 6.5).

Spatial Pattern: Small to large patch; circular to irregular shape; uniform or forming exterior zone around open peatlands, sometimes in mosaics with more open peatlands.

Comparative Size: A (>125 ac); B (125–25 ac); C (25–5 ac); D (<5 ac).

Vegetation Structure (vertical & horizontal): Forest to woodland with tall shrub patches.

The system is characterized by one or more of the five Atlantic white cedar natural communities or the pitch pine - heath swamp. Atlantic white cedar or pitch pine dominates some or all of a peatland basin, mixing in some areas with *red maple - Sphagnum basin swamps*. Patches of tall shrub peatland thickets (fens with <25% tree cover) are common as part of the swamp mosaic. Where these tall shrub fens become extensive, they should be considered part of an adjacent open peatland system.

Diagnostic natural communities:

Atlantic white cedar - leatherleaf swamp (S1)

Atlantic white cedar - giant rhododendron swamp
(S1)

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

Highbush blueberry - mountain holly wooded fen
(S3S4)

Inland Atlantic white cedar swamp (S1)

Pitch pine - heath swamp (S1S2)

Red maple - Sphagnum basin swamp (S4)

Seasonally flooded Atlantic white cedar swamp (S2)

Sweet pepperbush wooded fen (S2)

Peripheral or occasional natural communities:

Black gum - red maple basin swamp (S3)

Black spruce swamp (S3)

Highbush blueberry - winterberry shrub thicket
(S4)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Berberis thunbergii (Japanese barberry)

Frangula alnus (glossy false buckthorn)

Lythrum salicaria (purple loosestrife)

Nasturtium officinale (two-rowed water-cress)

Phragmites australis (common reed)

Rhamnus cathartica (European buckthorn)

Solanum dulcamara (climbing nightshade)

Native Plant Species Composition: This system corresponds to acidic, oligotrophic peatlands in central and southern New Hampshire dominated by *Chamaecyparis thyoides* (Atlantic white cedar), and occasionally *Pinus rigida* (pitch pine). Coastal plain and southern species are more common in this wetland system than in more inland, northern, or higher elevation temperate peat swamps. These include *Clethra alnifolia* (sweet pepperbush), *Rhododendron maximum* (giant rhododendron)*, and *Sphagnum flavicomans* (peat moss). Characteristic species composition by vegetation zone is listed below. Rare (endangered and threatened) species are noted by an asterisk (*).

Trees:

Acer rubrum (red maple) - abundant
Chamaecyparis thyoides (Atlantic white cedar) - abundant
Betula alleghaniensis (yellow birch) - frequent
Picea rubens (red spruce) - frequent
Tsuga canadensis (hemlock) - frequent

Herbs:

Carex trisperma (three-seeded sedge)
Coptis trifolia (three-leaved goldthread)
Mitchella repens (partridge-berry)
Osmunda regalis var. *spectabilis* (royal fern)
Osmundastrum cinnamomeum (cinnamon fern)
Parathelypteris simulata (Massachusetts fern)

Shrubs:

Clethra alnifolia (sweet pepperbush)
Ilex mucronata (mountain holly)
Ilex verticillata (common winterberry)
Kalmia angustifolia (sheep laurel)
Kalmia latifolia (mountain laurel)
Rhododendron maximum (giant rhododendron)*
Vaccinium corymbosum (highbush blueberry)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):
Unknown in this habitat.

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Chamaecyparis thyoides* (Atlantic white cedar), *Parathelypteris simulata* (Massachusetts fern), and *Rhododendron maximum* (giant rhododendron)*.

Water Source: Topogenous.

Hydroperiod: Permanently saturated to seasonally flooded.

Stressors: Development threats include fragmentation, habitat displacement and degradation, invasion of non-native species, alterations of flood regimes, and impacts to water quantity and quality (including pollution, eutrophication, and reduction through withdrawal). Impervious surfaces and other alterations to surrounding landcover can affect hydrology and degrade water quality through siltation and pollutants such as fertilizers, pesticides, and road residue. Trampling can impact hummock/hollow microtopography, create permanent trails, and kill plants. Logging of forested wetlands may impact hydrologic patterns and alter habitat for forest-restricted species. Regionally, there has been a tendency towards younger, second-growth swamp forests in the region. Logging of adjacent uplands may influence hydrologic patterns, nutrient cycles, habitat integrity and fragmentation, and sedimentation. Naturally acidic, low-nutrient wetland types are particularly susceptible to alteration by elevated nutrient inputs. Residential and industrial pollution, including road, sewage, and agricultural runoff, are sources of nutrients and pollutants that may result in eutrophication. The management implication is to increase the size of buffer areas and limit or control certain activities near these wetland types. The importance of beaver flowages for supporting a variety of habitats for wetland-dependent flora and fauna is well established. However, impacts to natural community types previously unimpacted by beavers may be on the rise. Wetland loss from human encroachment increases the likelihood that the remaining wetland basins will be converted to beaver flowages. Larger beaver populations may further intensify the problem. The recent loss of many Atlantic white cedar and black gum swamps in the southeastern portion of the state where human encroachment is greatest may be examples of this possible trend. Combinations of different types of stressors together with their scope and severity determine the degree to which a system's ecological integrity shifts from a natural condition (A rank) toward more degraded conditions (B, C, or D ranks).

Reference Condition Examples (A to B+ Ranked): Loverens Mill (Antrim), Manchester Cedar Swamp (Manchester), Cedar Swamp Pond (Kingston), White Lake State Park (Tamworth), and Locke Pond (Rye).



Coastal conifer peat swamp system at Locke Pond in Rye (photo by Ben Kimball).

TEMPERATE PEAT SWAMP SYSTEM (S3S4)

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

Distribution: Found in central and southern New Hampshire.

NatureServe Ecological System Crosswalk: North-Central Appalachian Acidic Swamp.

Soils: Deep, moderately well decomposed peat. *Red maple - Sphagnum basin swamp*, the typical community found in this system, is usually a peatland (>40 cm organic matter) but sometimes occurs on mineral soils with a histic epipedon (shallow organic layer <40 cm) where there may be more seasonal water fluctuations than in deep peat settings. Mineral histic examples may occupy the entire swamp basin, or more commonly just the swamp areas marginal to uplands where organic accumulation is less.

Nutrient Status and pH: Oligotrophic to weakly minerotrophic; pH generally less than 5.3 (as low as 3.7), although pH and trophic levels can be higher around the system margins where there is a shift in natural community type.

Spatial Pattern: Small to large patch, circular to irregular shape; uniform or forming exterior zone around open peatlands, sometimes in mosaics with more open peatlands.

Comparative Size: A (>125 ac); B (125–25 ac); C (25–5 ac); D (<5 ac).

Vegetation Structure (vertical & horizontal): Forest to woodland with tall shrub patches.

Red maple - Sphagnum basin swamp is the typical community found in this system. Patches of tall shrub fens (<25% tree cover) are common as part of the swamp mosaic; where these tall shrub fens become extensive, they may be considered part of an adjacent open peatland system. The transition to upland forests in this swamp system is often marked by a border of *hemlock - cinnamon fern forest* or *red maple - red oak - cinnamon fern forest*.

Diagnostic natural communities:

Black gum - red maple basin swamp (S3)

Highbush blueberry - mountain holly wooded fen
(S3S4)

Highbush blueberry - winterberry shrub thicket (S4)

Red maple - Sphagnum basin swamp (S4)

Swamp white oak basin swamp (S1)

Winterberry - cinnamon fern wooded fen (S4)

Peripheral or occasional natural communities:

Hemlock - cinnamon fern forest (S4)

Red maple - pitch pine - cinnamon fern forest
(S1S2)

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

Red maple - sensitive fern swamp (S3S4)

Red spruce swamp (S3)

Seasonally flooded red maple swamp (S4S5)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Berberis thunbergii (Japanese barberry)

Frangula alnus (glossy false buckthorn)

Lythrum salicaria (purple loosestrife)

Phragmites australis (common reed)

Rhamnus cathartica (European buckthorn)

Solanum dulcamara (climbing nightshade)

Native Plant Species Composition: This system corresponds to acidic, oligotrophic peatlands in central and southern New Hampshire dominated by *Acer rubrum* (red maple) with variable amounts of conifers and other hardwoods. *Picea rubens* (red spruce) is a common but minor associate, but otherwise northern conifers are absent or sparse, particularly in southern New Hampshire. The tall shrub layer is well developed and dominated by *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (common winterberry). An abundance of peat mosses

(*Sphagnum* spp.), *Osmundastrum cinnamomeum* (cinnamon fern), and other herbs are characteristic. It is characterized by oligotrophic to weakly minerotrophic conditions, and therefore lacks minerotrophic indicators (although sometimes found around the margins) indicative of temperate minerotrophic swamps, such as *Onoclea sensibilis* (sensitive fern), *Toxicodendron radicans* (poison-ivy), *Lindera benzoin* (northern spicebush), and *Fraxinus nigra* (black ash). More southern or low elevation examples are more likely to contain species restricted to coastal or southern parts of the state. Rare (endangered and threatened) species are noted by an asterisk (*).

Trees and shrubs:

Abundant species:

Acer rubrum (red maple)
Ilex verticillata (common winterberry)
Vaccinium corymbosum (highbush blueberry)

Occasional to locally abundant species (broad distribution):

Betula alleghaniensis (yellow birch)
Ilex mucronata (mountain holly)
Kalmia angustifolia (sheep laurel)
Picea rubens (red spruce)
Tsuga canadensis (hemlock)

Occasional to locally abundant species (restricted to coastal or southern NH):

Clethra alnifolia (sweet pepperbush)
Ilex laevigata (smooth winterberry)
Kalmia latifolia (mountain laurel)
Nyssa sylvatica (black gum)
Quercus bicolor (swamp white oak)
Rhododendron maximum (giant rhododendron)*
Rhododendron viscosum (clammy azalea)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):

Unknown in this habitat.

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Nyssa sylvatica* (black gum), *Parathelypteris simulata* (Massachusetts fern), *Quercus bicolor* (swamp white oak), *Rhododendron maximum* (giant rhododendron)*, *Rhododendron viscosum* (clammy azalea), *Woodwardia areolata* (netted chain fern)*, and *Woodwardia virginica* (Virginia chain fern).

Water Source: Topogenous.

Hydroperiod: Permanently saturated to seasonally flooded.

Stressors: Development threats include fragmentation, habitat displacement and degradation, invasion of non-native species, alterations of flood regimes, and impacts to water quantity and quality (including pollution, eutrophication, and reduction through withdrawal). Impervious surfaces and other alterations to surrounding landcover can affect hydrology and degrade water quality through siltation and pollutants such as fertilizers, pesticides, and road residue. Trampling can impact hummock/hollow microtopography, create permanent trails, and kill plants. Logging of forested wetlands may impact hydrologic patterns and alter habitat for forest-restricted species. Regionally, there has been a tendency towards younger, second-growth swamp forests in the region. Logging of adjacent uplands may influence hydrologic patterns, nutrient cycles, habitat integrity and fragmentation, and sedimentation. Naturally acidic, low-nutrient wetland types are particularly susceptible to alteration by elevated nutrient inputs. Residential and industrial pollution, including road, sewage, and agricultural runoff, are sources of nutrients and pollutants that may result in eutrophication. The management implication is to increase the size of buffer areas and limit or control certain activities near these wetland types. The importance of beaver flowages for supporting a variety of habitats for wetland-dependent flora and fauna is well established. However, impacts to natural community types previously unimpacted by beavers may be on the rise. Wetland loss from human encroachment increases the likelihood that the remaining wetland basins will be converted to beaver flowages. Larger beaver populations may further intensify the

problem. The recent loss of many Atlantic white cedar and black gum swamps in the southeastern portion of the state where human encroachment is greatest may be examples of this possible trend. Combinations of different types of stressors together with their scope and severity determine the degree to which a system's ecological integrity shifts from a natural condition (A rank) toward more degraded conditions (B, C, or D ranks).

Reference Condition Examples (A to B+ Ranked): Pawtuckaway State Park (Nottingham) and Fox State Forest (Hillsboro).



Temperate peat swamp system at Fox State Forest in Hillsborough (photo by Ben Kimball).

MINEROTROPHIC PEAT SWAMPS

MONTANE/NEAR-BOREAL MINEROTROPHIC PEAT SWAMP SYSTEM (S2)

Landscape Settings: Headwater basins and broad drainageways, extensive flats, pond and lake basins, and adjacent gentle slopes.

Distribution: Occurs north and northwest of the White Mountains; there are a few cedar swamps south of the White Mountains, which contain the *northern white cedar - hemlock swamp* community. Northern white cedar swamps have a northeastern-boreal distribution in North America (Great Lakes to Canadian Maritimes), and extend into northern New Hampshire, mostly north of the White Mountains.

NatureServe Ecological System Crosswalk: Acadian-Appalachian Conifer Seepage Forest; Laurentian-Acadian Alkaline Conifer-Hardwood Swamp.

Soils: Deep to moderately deep, well-decomposed peat, grading to mineral soils in sloped swamp margins. The peat or muck in the *northern white cedar - balsam fir swamps* are usually over a meter in depth and well decomposed; soils in *northern hardwood - black ash - conifer swamps* consist of shallow, well decomposed muck over silty material.

Nutrient Status and pH: Moderately to strongly minerotrophic; pH range 4.9–7.5.

Spatial Pattern: Small to large patches, sometimes extensive; circular-oval or irregular shape; uniform or sometimes with sedgy or shrubby openings or surrounding open peatlands.

Comparative Size: A (>125 ac); B (125–25 ac); C (25–5 ac); D (<5 ac).

Vegetation Structure (vertical & horizontal): Forest to woodland with tall shrub or herbaceous openings.

At least two swamp types are typically present: *northern white cedar - balsam fir swamps* tend to occur on organic soils (muck and peat >16 in.); and *northern hardwood - black ash - conifer swamps* are often found toward the swamp margins on level to sloping mineral soil (shallow organic layer 0–16 in.). The sloping mineral soil margins can also transition to *northern white cedar seepage forest*. In contrast to more acidic black spruce peat swamps, this swamp system is strongly influenced by minerotrophic groundwater seepage. On sites with a moderate degree of mineral enrichment, the *larch - mixed conifer swamp* may be present. Overall, the swamps are conifer-dominated or mixed hardwood - conifer dominated. *Alder wooded fens* are often part of this system, and can mark the transition to open peatland systems or alder alluvial shrublands along large streams. *Calcareous sedge - moss fens* occur in a few swamps, in openings where calcareous groundwater discharge is prominent.

Diagnostic natural communities:

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

Peripheral or occasional natural communities:

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

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Lonicera morrowii (Morrow's honeysuckle)
Lonicera tatarica (Tatarian honeysuckle)
Lythrum salicaria (purple loosestrife)

Phragmites australis (common reed)
Rhamnus cathartica (European buckthorn)

Native Plant Species Composition: These are diverse swamp systems that harbor many vascular plants (>200 species) and bryophytes (>65 species), particularly those preferring circumneutral conditions. Abundant to frequent northern conifers and hardwoods includes northern white cedar, *Abies balsamea* (balsam fir), *Larix laricina* (American larch), and *Picea* spp. (spruces); *Fraxinus nigra* (black ash), *Betula alleghaniensis* (yellow birch), and *Acer rubrum* (red maple). Rare (endangered and threatened) species are noted by an asterisk (*).

Northern white cedar - balsam fir swamp:

Trees:

Abundant species:

Abies balsamea (balsam fir)

Thuja occidentalis (northern white cedar)

Occasional species:

Acer rubrum (red maple)

Betula alleghaniensis (yellow birch)

Fraxinus nigra (black ash)

Picea spp. (spruces)

Dwarf shrubs and herbs:

Carex leptalea (bristly-stalk sedge)

Carex trisperma (three-seeded sedge)

Coptis trifolia (three-leaved goldthread)

Dryopteris cristata (crested wood fern)

Osmundastrum cinnamomeum (cinnamon fern)

Oxalis montana (northern wood sorrel)

Rubus dalibarda (dewdrop)

Rubus pubescens (dwarf raspberry)

Tiarella cordifolia (foam-flower)

Bryophytes:

Amblystegium riparium (moss)

Bazzania trilobata (liverwort)

Hylocomium splendens (moss)

Rhizomnium punctatum (moss)

Rhytidiadelphus subpinnatus (moss)

Rhytidiadelphus triquetrus (moss)

Sphagnum girgensohnii (peat moss)

Sphagnum russowii (peat moss)

Sphagnum subtile (peat moss)

Thuidium delicatulum (moss)

Characteristic species largely absent from other cedar swamp communities:

Carex pedunculata (long-stalked sedge)

Mitella nuda (naked bishop's-cap)

Orthilia secunda (one-sided-shinleaf)

Platanthera obtusata (blunt-leaved bog-orchid)

Rhamnus alnifolia (alder-leaved buckthorn)

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

Carex castanea (chestnut sedge)*

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

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

Cypripedium reginae (showy lady's-slipper)*

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

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

Northern hardwood - black ash - conifer swamps:

Trees:

Abundant species:

Abies balsamea (balsam fir)

Betula alleghaniensis (yellow birch)

Fraxinus nigra (black ash)

Picea rubens (red spruce)

Frequent species:

Acer rubrum (red maple)

Picea glauca (white spruce)

Populus balsamifera (balsam poplar)

Fraxinus americana (white ash)

Thuja occidentalis (northern white cedar)

Herbs:

Carex gynandra (nodding sedge)

Chrysosplenium americanum (golden-saxifrage)

Galium kamtschaticum (boreal bedstraw)

Geum rivale (water avens)

Hydrocotyle americana (American marsh-pennywort)

Impatiens capensis (spotted touch-me-not)

Onoclea sensibilis (sensitive fern)

Packera schweinitziana (New England groundsel)

Tiarella cordifolia (foam-flower)

Shrubs:

Alnus incana ssp. *rugosa* (speckled alder)
Ilex verticillata (common winterberry)
Lonicera canadensis (American honeysuckle)
Toxicodendron radicans (poison-ivy)
Viburnum nudum (withe-rod)

Bryophytes:

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

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy): *Abies balsamea* (balsam fir).

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Chrysosplenium americanum* (golden-saxifrage), *Cypripedium parviflorum* var. *makasin* (greater yellow lady’s-slipper)*, *Cypripedium parviflorum* var. *pubescens* (large yellow lady’s-slipper)*, *Cypripedium reginae* (showy lady’s-slipper)*, *Galium kamtschaticum* (boreal bedstraw), *Fraxinus nigra* (black ash), *Mitella nuda* (naked bishop’s-cap), *Orthilia secunda* (one-sided-shinleaf), *Petasites frigidus* var. *palmaris* (northern sweet-coltfoot)*, *Platanthera obtusata* (blunt-leaved bog-orchid), *Rhamnus alnifolia* (alder-leaved buckthorn), and *Tiarella cordifolia* (foam-flower).

Water Source: Topogenous and soligenous.

Hydroperiod: Permanently saturated to seasonally flooded.

Stressors: Development threats include fragmentation, habitat displacement and degradation, invasion of non-native species, alterations of flood regimes, and impacts to water quantity and quality (including pollution, eutrophication, and reduction through withdrawal). Impervious surfaces and other alterations to surrounding landcover can affect hydrology and degrade water quality through siltation and pollutants such as fertilizers, pesticides, and road residue. Trampling can impact hummock/hollow microtopography, create permanent trails, and kill plants. Logging of forested wetlands may impact hydrologic patterns and alter habitat for forest-restricted species. Regionally, there has been a tendency towards younger, second-growth swamp forests in the region. Logging of adjacent uplands may influence hydrologic patterns, nutrient cycles, habitat integrity and fragmentation, and sedimentation. Combinations of different types of stressors together with their scope and severity determine the degree to which a system’s ecological integrity shifts from a natural condition (A rank) toward more degraded conditions (B, C, or D ranks).

Reference Condition Examples (A to B+ Ranked): Good examples with *northern hardwood - black ash - conifer swamp* 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). Good examples with *northern white cedar - balsam fir swamp* occur at Hurlbert Swamp (Colebrook).



Near-boreal minerotrophic peat swamp system at Hurlbert Swamp in Stewartstown (photo by Ben Kimball).

MINEROTROPHIC MINERAL SWAMPS (WEAKLY TO STRONGLY MINEROTROPHIC)

TEMPERATE MINEROTROPHIC SWAMP SYSTEM (S3S4)

Landscape Settings: Depressional headwater basins and drainage ways; sloping mineral soils around open wetlands; pond and lake basins; non-riparian.

Distribution: Widespread south of the White Mountains.

NatureServe Ecological System Crosswalk: North-Central Interior and Appalachian Rich Swamp.

Soils: Ranges from examples with shallow organic layers over silty or sandy mineral soils and apparent seepage influence to sometimes relatively shallow, well decomposed peat.

Nutrient Status and pH: Moderately to strongly minerotrophic; pH in the 5s and 6s.

Spatial Pattern: Small to large patches; circular-oval or irregular shaped; uniform, sometimes with shrubby openings or surrounding open wetlands.

Comparative Size: A (>125 ac); B (125–25 ac); C (25–5 ac); D (<5 ac).

Vegetation Structure (vertical & horizontal): Forest to woodland with tall shrub openings.

Includes seepage swamps and other more common minerotrophic swamp types. Shrubby openings are common in these swamps. The *red maple - sensitive fern swamp* community is the most common swamp type in this system. This system is often bordered by *hemlock - cinnamon fern* or *red maple - red oak - cinnamon fern forests* that are intermediate between swamp and upland forest. Examples that transition to emergent marshes may contain *seasonally flooded red maple swamp* and those that transition to peatlands may contain *red maple - Sphagnum basin swamp*.

Diagnostic natural communities:

Highbush blueberry - winterberry shrub thicket (S4)

Red maple - black ash swamp (S3)

Red maple - lake sedge swamp (S3)

Red maple - sensitive fern swamp (S3S4)

Red maple - skunk cabbage swamp (S2)

Peripheral or occasional natural communities:

Alder seepage thicket (S3)

Hemlock - cinnamon fern forest (S4)

Red maple - elm - lady fern silt forest (S1S2)

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

Red maple - Sphagnum basin swamp (S4)

Seasonally flooded red maple swamp (S4S5)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Alliaria petiolata (garlic-mustard)

Berberis thunbergii (Japanese barberry)

Berberis vulgaris (common barberry)

Celastrus orbiculatus (Asian bittersweet)

Frangula alnus (glossy false buckthorn)

Lonicera morrowii (Morrow's honeysuckle)

Lonicera tatarica (Tatarian honeysuckle)

Lythrum salicaria (purple loosestrife)

Microstegium vimineum (Japanese stiltgrass)

Ranunculus repens (spot-leaved crowfoot)

Rhamnus cathartica (European buckthorn)

Solanum dulcamara (climbing nightshade)

Native Plant Species Composition: Dominated by *Acer rubrum* (red maple), with lesser quantities of other hardwoods (*Fraxinus nigra* (black ash), *Betula alleghaniensis* (yellow birch)) and occasional conifers, particularly *Tsuga canadensis* (hemlock). Many of the species found in temperate peat swamps can also be found in this system, including southern and coastal species, but species indicative of moderately to strongly minerotrophic conditions are diagnostic (listed below). Northern conifers, shrubs, and herbs of montane/near-boreal swamps are absent or sparse. The shrub layer is typically well developed, as are the herb and bryophyte layers, which are also quite diverse. *Sphagnum* mosses are usually in relatively low abundance compared to temperate peat swamp systems, but can be abundant in particularly seepy locations. These swamps support a substantial non-*Sphagnum* bryophyte layer.

Strongly sloping examples on seepy silty soils often can have a great deal of black ash, *Carex lacustris* (lake sedge), or *Symplocarpus foetidus* (skunk-cabbage).

Trees and shrubs:

Abundant species:

Acer rubrum (red maple)
Ilex verticillata (common winterberry)

Occasional to locally abundant species:

Betula alleghaniensis (yellow birch)
Tsuga canadensis (hemlock)
Vaccinium corymbosum (highbush blueberry)

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

Alnus incana ssp. *rugosa* (speckled alder)
Fraxinus americana (white ash)
Fraxinus nigra (black ash)
Lindera benzoin (northern spicebush)
Rubus pubescens (dwarf raspberry)
Sambucus nigra ssp. *canadensis* (common elderberry)
Spiraea alba var. *latifolia* (meadowsweet)
Swida amomum var. *schuetzeana* (northwestern silky dogwood)
Swida sericea (red-osier dogwood)
Toxicodendron radicans (poison-ivy)
Toxicodendron vernix (poison-sumac)
Ulmus americana (American elm)
Viburnum dentatum var. *lucidum* (smooth arrowwood)
Viburnum lentago (nannyberry)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):

Possibilities for this system include *Spiraea alba* var. *latifolia* (meadowsweet) and *Toxicodendron radicans* (poison-ivy).

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Fraxinus nigra* (black ash) and *Lindera benzoin* (northern spicebush).

Herbs and bryophytes:

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

Carex lacustris (lake sedge)
Carex stricta (tussock sedge)
Onoclea sensibilis (sensitive fern)

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

Caltha palustris (marsh-marigold)
Geum rivale (water avens)
Hydrocotyle americana (American marsh-pennywort)
Impatiens capensis (spotted touch-me-not)
Mnium spp. (mosses)
Sphagnum squarrosum (peat moss)
Symplocarpus foetidus (skunk-cabbage)
Viola spp. (violets)

Water Source: Topogenous to soligenous.

Hydroperiod: 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.

Stressors: Development threats include fragmentation, habitat displacement and degradation, invasion of non-native species, alterations of flood regimes, and impacts to water quantity and quality (including pollution, eutrophication, and reduction through withdrawal). Impervious surfaces and other alterations to surrounding landcover can affect hydrology and degrade water quality through siltation and pollutants such as fertilizers, pesticides, and road residue. Logging of forested wetlands may impact hydrologic patterns and alter habitat for forest-restricted species. Regionally, there has been a tendency towards younger, second-growth swamp forests in the region. Logging of adjacent uplands may influence hydrologic patterns, nutrient cycles, habitat integrity and fragmentation, and sedimentation. Combinations of different types of stressors together with their scope and severity determine the degree to which a system's ecological integrity shifts from a natural condition (A rank) toward more degraded conditions (B, C, or D ranks).

Reference Condition Examples (A to B+ Ranked): Paul Brook Swamp (Newington).



Temperate minerotrophic swamp system at Paul Brook Swamp in Newington (photo by Ben Kimball).

FOREST SEEP/SEEPAGE FOREST SYSTEM (S4)

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

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

NatureServe Ecological System Crosswalk: North-Central and Northeastern Seep.

Soils: Usually silty or loamy, sometimes sandy, with a shallow muck layer; poorly to very poorly drained non-riparian.

Nutrient Status and pH: Moderately to strongly minerotrophic; subacid to circumneutral (pH mid 5s to >7).

Spatial Pattern: Small patches, points, or narrow-linear zones perpendicular (e.g., slope-bases) or parallel to flow direction such as seepage runs; uniform zonation or sometimes with multiple, parallel seepage runs.

Comparative Size: A (>5 ac); B (5–1 ac); C (1–0.25 ac); D (<0.25 ac).

Vegetation Structure (vertical & horizontal): Forest or woodland tree canopy, usually sparse to moderate shrub layer, and very dense herb and bryoid layer.

This is a broadly defined, spatially small wetland system that corresponds to forest seeps, seepage runs along headwater streamlets, and to their somewhat larger counterparts of northern New Hampshire, seepage forests. These tend to be small, isolated, sloping seepage wetlands up to about 5 acres in size, with most examples being much smaller (<0.25 ac). Seepage forest examples are found primarily in northern New Hampshire; examples further south tend to be small patch forest seeps.

Diagnostic natural communities:

Acidic Sphagnum forest seep (S3S4)

Circumneutral hardwood forest seep (S3)

Northern hardwood - black ash - conifer swamp (S3)

Northern hardwood seepage forest (S3)

Subacid forest seep (S3S4)

Peripheral or occasional natural communities:

Alder seepage thicket (S3)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Berberis thunbergii (Japanese barberry)

Iris pseudacorus (yellow iris)

Myosotis scorpioides (water forget-me-not)

Nasturtium officinale (two-rowed water-cress)

Native Plant Species Composition: They have some floristic similarities to other minerotrophic swamp systems, but they have a more limited set of vascular plants in any given example, and are more variable from one seep to another. They are well demarcated, however, by a set of seepage and other minerotrophic plants that, as a group, primarily occur in seeps. Rare (endangered and threatened) species are noted by an asterisk (*).

Seepage indicators:

Cardamine pensylvanica (Pennsylvania bitter-cress)

Carex disperma (soft-leaved sedge)

Carex leptalea (bristly-stalk sedge)

Carex scabrata (eastern rough sedge)

Chelone glabra (white turtlehead)

Chrysosplenium americanum (golden-saxifrage)

Geum rivale (water avens)

Circaea alpina (small enchanter's-nightshade)

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

Cystopteris bulbifera (bulbil fragile fern)

Equisetum sylvaticum (wood horsetail)

Galium kamtschaticum (boreal bedstraw)

Platanthera dilatata (white northern bog-orchid)

Glyceria melicaria (northeastern manna-grass)
Hydrocotyle americana (American marsh-pennywort)
Mitella diphylla (two-leaved bishop's-cap)
Neottia convallarioides (broad-leaved twayblade)*
Neottia cordata (heart-leaved twayblade)*

Sphagnum squarrosum and other bryophytes
Symphotrichum puniceum (purple-stemmed
American-aster)
Tiarella cordifolia (foam-flower)
Veratrum viride (American false hellebore)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):
Unknown in this habitat.

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Chrysosplenium americanum* (golden-saxifrage), *Circaea alpina* (small enchanter's-nightshade), *Cypripedium parviflorum* var. *pubescens* (large yellow lady's-slipper)*, *Cystopteris bulbifera* (bulbil fragile fern), *Galium kamschaticum* (boreal bedstraw), *Mitella diphylla* (two-leaved bishop's-cap), *Neottia convallarioides* (broad-leaved twayblade)*, *Neottia cordata* (heart-leaved twayblade)*, and *Tiarella cordifolia* (foam-flower).

Water Source: Soligenous and topogenous.

Hydroperiod: Seasonally to permanently saturated.

Stressors: This system can be impacted by logging, agriculture, development, invasives, and altered hydrology. Impervious surfaces and other alterations to surrounding landcover can affect hydrology and degrade water quality through siltation and pollutants such as fertilizers, pesticides, and road residue. Combinations of different types of stressors together with their scope and severity determine the degree to which a system's ecological integrity shifts from a natural condition (A rank) toward more degraded conditions (B, C, or D ranks).

Reference Condition Examples (A to B+ Ranked): Good examples of *northern hardwood seepage forest* occur at Scott Brook Headwaters (Pittsburg) and Dry Brook (Lincoln). Good examples of *acidic Sphagnum forest seeps* occur along entrenched streams draining into Indian Stream (Pittsburg). Good examples of the *circumneutral hardwood forest seep* occur at Black Mtn. (Benton), Crommet Creek vicinity (Durham), and St. Gaudens National Historic Site (Cornish).



Forest seep/seepage forest system at St. Gaudens National Historic Site in Cornish (photo by Ben Kimball).

OPEN-BASIN AND STREAMSIDE WETLANDS

DRAINAGE MARSH - SHRUB SWAMP SYSTEM (S5)

Landscape Settings: Open basins (i.e., those that have an outlet) and along small, low-gradient, seasonally flooded streams (mostly first- and second-order), lower energy sections of rivers and major streams, and ponds and lakes.

Distribution: Widespread throughout New Hampshire.

NatureServe Ecological System Crosswalk: Laurentian-Acadian Freshwater Marsh; Laurentian-Acadian Wet Meadow/Shrub Swamp.

Soils: Sandy and silty mineral materials and/or well decomposed muck (often shallow organics over mineral soil).

Nutrient Status and pH: Moderately to strongly minerotrophic; pH mostly in 5s and 6s.

Spatial Pattern: Medium (to large) patch; extensive broad-linear shape with inlets and outlets; irregular or linear zonation (parallel to stream corridors and pond/lake margins).

Comparative Size: A (>125 ac); B (125–25 ac); C (25–5 ac); D (<5 ac).

Vegetation Structure (vertical & horizontal): Aquatic bed, herbaceous emergent and meadow marsh, medium and tall shrubland and shrub thicket, woodland swamp; often a patchwork of shrubs and herbs.

There is considerable variation among examples of this system in terms of diversity of communities, flood regimes, and successional states present, but there is relatively little geographic variation across the state. Periodic beaver activity sets successional states back towards deeper water communities (pond, aquatic beds, and/or emergent marsh), while beaver dam abandonment and subsequent pond drainage shifts the successional track back towards meadow marsh and more wooded states. Some abandoned beaver meadows consist of sedge meadow marshes characterized by minerotrophic peat mosses and marsh herbs on well decomposed muck and often with standing snags indicative of raised water levels. These peaty marshes likely succeed to shrub or swamp states with continued drainage.

Diagnostic natural communities:

Aquatic beds and marshes:

Aquatic bed (S5)

Bayonet rush emergent marsh (S2)

Cattail marsh (S4)

Emergent marsh (S5)

Herbaceous seepage marsh (S3)

Lake sedge seepage marsh (S3)

Sedge meadow marsh (S4)

Short graminoid - forb meadow marsh/mudflat (S4)

Tall graminoid meadow marsh (S4)

Shrublands, shrub thickets, and woodland swamps:

Alder alluvial shrubland (S3)

Alder - dogwood - arrowwood alluvial thicket (S4)

Buttonbush shrubland (S4)

Highbush blueberry - winterberry shrub thicket
(S4)

Meadowsweet alluvial thicket (S3S4)

Mixed alluvial shrubland (S4)

Mixed tall graminoid - scrub-shrub marsh (S4S5)

Seasonally flooded red maple swamp (S4S5)

Associated systems: The drainage marsh - shrub swamp system can occur with the medium level fen system (particularly along sluggish drainages or within inlets away from the influence of streams) and is sometimes transition to oligotrophic peat swamp or minerotrophic swamp systems.

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Aquatics:

Cabomba caroliniana (fanwort)

Egeria densa (Brazilian water-weed)

Marsilea quadrifolia (European water-clover)

Myriophyllum heterophyllum (variable-leaf
watermilfoil)

Myriophyllum spicatum (Eurasian watermilfoil)

Najas minor (brittle water nymph)

Potamogeton crispus (curly pondweed)

Trapa natans (water chestnut)

Marshes and shrublands:

Alnus glutinosa (European black alder)
Cirsium palustre (marsh thistle)
Epilobium hirsutum (hairy willow-herb)
Frangula alnus (glossy false buckthorn)
Iris pseudacorus (yellow flag)
Lychnis flos-cuculi (ragged robin lychnis)
Lysimachia nummularia (moneywort)
Lysimachia vulgaris (garden yellow-loosestrife)
Lythrum salicaria (purple loosestrife)

Myosotis scorpioides (forget-me-not)
Nasturtium officinale (two-rowed water-cress)
Persicaria longiseta (Oriental lady's-thumb smartweed)
Phalaris arundinacea (reed canary grass)
Phragmites australis (common reed)
Ranunculus repens (creeping buttercup)
Solanum dulcamara (climbing nightshade)

Native Plant Species Composition: Species and community composition are influenced to some extent by stream and soil characteristics (i.e., mineral vs. organic soils) and geography, although many of the natural communities in this system have wide geographic ranges. Most of the variation among examples relates to diversity of flood regime conditions and effects of beaver activity on community composition. Characteristic species composition by vegetation zone is listed below.

Aquatic bed species:

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

Emergent marsh species:

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

Meadow marsh species:

Calamagrostis canadensis (bluejoint)
Carex stricta (tussock sedge)
Carex utriculata (swollen-beaked sedge)
Eutrochium dubium (coastal plain Joe-Pye weed)
Glyceria canadensis (rattlesnake manna grass)
Juncus spp. (rushes)
Leersia spp. (cut grasses)
Lysimachia terrestris (swamp yellow-loosestrife)
Scirpus cyperinus (woolly bulrush)
Triadenum virginicum (marsh-St. John's-wort)

Shrubland and woodland swamp species:

Acer rubrum (red maple)
Alnus incana ssp. *rugosa* (speckled alder)
Cephalanthus occidentalis (common buttonbush)
Ilex verticillata (common winterberry)
Myrica gale (sweet gale)
Salix spp. (willows)
Spiraea spp. (meadowsweets)
Swida spp. (dogwoods)
Vaccinium corymbosum (highbush blueberry)
Viburnum spp. (viburnums)

Seepage marsh species:

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

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):

Equisetum arvense (field horsetail)
Juncus tenuis (path rush)
Lemna spp. (duckweeds)
Muhlenbergia frondosa (wire-stemmed muhly)
Muhlenbergia schreberi (nimblewill muhly)
Panicum capillare (witch panicgrass)
Panicum dichotomiflorum (fall panicgrass)
Parthenocissus quinquefolia (Virginia-creeper)
Persicaria pensylvanica (Pennsylvania smartweed)

Phalaris arundinacea (reed canary grass)
Note: Because *Phalaris arundinacea* can be invasive in wetlands with a history of human disturbance, it is possible the taxon represents a mixture of native and introduced genotypes in New England (Haines 2011).

Solidago canadensis (Canada goldenrod)
Toxicodendron radicans (poison-ivy)
Typha latifolia (broad-leaved cat-tail)
Note: *Typha latifolia* can be an aggressive native in settings with unnatural water level fluctuations & nutrient inputs.
Wolffia spp. (water-meals)
Viola sororia (woolly blue violet)

Native species sensitive to anthropogenic disturbance:

Very few native species found in this system fall into this category. Possibilities include *Carex bullata* (button sedge), *Carex exilis* (meager sedge), *Carex lasiocarpa* ssp. *americana* (wire sedge), and *Lathyrus palustris* (marsh vetchling).

Water Source: Primarily influenced by lake, pond, or stream water (limnogenous); secondarily surface runoff (topogenous) and groundwater seepage (soligenous).

Hydroperiod: Most examples exhibit a broad flood regime gradient from permanently flooded or intermittently exposed (aquatic beds) to semi-permanently flooded (emergent marshes) to seasonally flooded conditions (meadow marshes, shrublands, and wooded swamps); very poorly to poorly drained.

Stressors: Historic and contemporary land use practices have impacted the hydrologic, geomorphic, and biotic structure and function of many marshes. Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roading or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. If the alteration is long term, wetland systems may reestablish to reflect new hydrology and composition (e.g., cat-tail can be an aggressive invader). Human land uses both within the marshes as well as in adjacent upland areas can reduce connectivity between wetland patches and upland areas. Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can also have a substantial impact on wetland condition. For example, land uses in the watershed have the potential to contribute excess nutrients into the system which could lead to the establishment of non-native species and/or dominance of “weedy” native species. Combinations of different types of stressors together with their scope and severity determine the degree to which a system’s ecological integrity shifts from a natural condition (A rank) toward more degraded conditions (B, C, or D ranks).

Reference Condition Examples (A to B+ Ranked): Broad Brook Headwaters (Pisgah State Park, Chesterfield), Mountain Brook (Pawtuckaway State Park, Deerfield and Nottingham), and Great Meadows (Kensington and Exeter).



Drainage marsh - shrub swamp system at Great Meadows along the Exeter River in Kensington and Exeter (photo by Ben Kimball).

SAND PLAIN POND SHORE AND BASIN MARSHES

SANDY POND SHORE SYSTEM (S1)

Landscape Settings: Primarily in central and southern New Hampshire in association with sand plain regions and occasionally along lakes in till settings where there is a local accumulation of sand along the shore.

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

NatureServe Ecological System Crosswalk: Laurentian-Acadian Lakeshore Beach.

Soils: Sand and gravel, sometimes peaty sands; poorly to very poorly drained.

Nutrient Status and pH: Oligotrophic.

Spatial Pattern: Extensive narrow-linear shape; narrow zonation parallel to shoreline.

Comparative Size: A (>1 mi in length); B (1–0.3 mi); C (0.3–0.1 mi); D (<0.1 mi).

Vegetation Structure (vertical & horizontal): Tall-medium shrub, tall herbaceous, short herbaceous, floating and submersed aquatic.

These sandy to gravelly shores and peaty sand shores are a stressful environment for plants to grow due to the infertile mineral soil, widely fluctuating water levels, and regular wave action and ice scouring. Narrow vegetation zones are strung parallel to the shoreline and relate to elevation above the lake and degree of wave and ice disturbance (ranging from shrub border to *aquatic beds*). The primary diagnostic natural community types of this system are the *bulblet umbrella-sedge open sandy pond shore* and *water lobelia aquatic sandy pond shore*. Examples with peaty sand development occur on only a few lakes (including Ossipee Lake) and are characterized by the *twig-rush sandy turf pond shore* community with a high diversity of rare coastal plain species. A few examples on Ossipee Lake have the rare *hudsonia inland beach strand* community, characterized by sand plain species on a dry beach ridge.

Diagnostic natural communities:

Bayonet rush emergent marsh (S2)

Bulblet umbrella-sedge open sandy pond shore (S2)

Hudsonia inland beach strand (S1)

Montane sandy pond shore (S1)

Sweet gale - alder shrub thicket (S3)

Twig-rush sandy turf pond shore (S1)

Water lobelia aquatic sandy pond shore (S2)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Frangula alnus (glossy false buckthorn)

Lythrum salicaria (purple loosestrife)

Nasturtium officinale (two-rowed water-cress)

Phalaris arundinacea (reed canary grass)

Phragmites australis (common reed)

Poa compressa (flat-stemmed blue grass)

Rhamnus cathartica (European buckthorn)

Solanum dulcamara (climbing nightshade)

Native Plant Species Composition: While these wetlands do contain many common wetland species, a high proportion of the plants present are stress-tolerators or ruderals, and many have coastal plain affinities and are restricted to pond shores or basin marshes in New Hampshire. Sand and gravel shores of lakes in ponds in the White Mountains and North Country have some floristic and geomorphic similarities, but lack coastal plain and southern species. Further sampling and evaluation of these examples is needed to determine if they warrant consideration as separate systems. Rare (endangered and threatened) species are noted by an asterisk (*).

Pond shore wetland species:

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

Hudsonia inland beach strand:

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

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):

Possibilities for this system include *Bidens frondosa* (Devil's beggar-ticks), *Calamagrostis canadensis* (bluejoint), *Carex scoparia* (pointed broom sedge), *Euthamia graminifolia* (common grass-leaved-goldenrod), *Panicum virgatum* (switch panicgrass), *Spiraea alba* var. *latifolia* (meadowsweet), and *Symphytotrichum racemosum* (small white American-aster).

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Cladium mariscoides* (twig-rush), *Eriocaulon aquaticum* (seven-angled pipewort), *Juncus militaris* (bayonet rush), *Juncus pelocarpus* (brown-fruited rush), *Lobelia dortmanna* (water lobelia), and *Hudsonia tomentosa* (hairy hudsonia)*.

Water Source: Limnogenous.

Hydroperiod: Seasonally and semi-permanently, intermittently exposed, and permanently flooded.

Stressors: Threats include fragmentation, habitat displacement and degradation, invasion of non-native species, aquatic plant control, recreation (e.g., boating, beachgoers, and all-terrain vehicles), managed water levels, and impacts to water quality. Because they are naturally acidic and low in nutrients, they are particularly susceptible to alteration by elevated nutrient inputs from nearby roads, agriculture, development, logging, etc.

Reference Condition Examples (A to B+ Ranked): Reference condition examples are unknown in New Hampshire. Examples with “fair” condition include Ossipee Lake (Ossipee) and Massabesic Lake (Manchester and Auburn). Good examples of *montane sandy pond shores* occur at Gentian Pond (Success), Greeley Ponds (Livermore), Umbagog Lake (Errol), and Lily Pond (Livermore).



Sandy pond shore system on Ossipee Lake in Ossipee (photo by Dan Sperduto).

SAND PLAIN BASIN MARSH SYSTEM (S1)

Landscape Settings: Sand plain settings in closed shallow basins with no inlets or outlets in outwash, ice-contact deposits and other glacio-fluvial soils; semi-perched or groundwater-connected.

Distribution: Mostly east-central and southern New Hampshire although a few examples that lack coastal plain species can be found in the White Mountain region.

NatureServe Ecological System Crosswalk: Northern Atlantic Coastal Plain Pond.

Soils: Sand or gravelly sand with shallow muck or sandy muck surface horizons; poorly to very poorly drained. In contrast to peatlands in closed basins, these wetlands have widely fluctuating seasonal and annual water levels, and no or relatively little organic matter accumulation in at least a portion of the basin.

Nutrient Status and pH: Oligotrophic.

Spatial Pattern: Small patch; individual basins with oval, circular and irregular shapes; occur as single basins or as clumps of separate basins in close proximity with no or only intermittent surface water connection; concentric zonation.

Comparative Size: A (>25 ac); B (25–5 ac); C (5–1 ac); D (<1 ac).

Vegetation Structure (vertical & horizontal): Tall-medium shrub, tall herbaceous, short herbaceous, floating and submersed aquatic.

Concentric vegetation zonation is typical and wave and ice action is absent.

Diagnostic natural communities:

Highbush blueberry - winterberry shrub thicket (S4)

Meadow beauty sand plain marsh (S1)

Meadowsweet - robust graminoid sand plain marsh
(S3S4)

Montane sandy basin marsh (S1)

Sharp-flowered manna-grass shallow peat marsh (S1)

Spikesedge - floating-leaved aquatic mudflat marsh
(S1)

Three-way sedge - manna-grass mudflat marsh
(S2S3)

Peripheral or occasional natural communities:

Buttonbush shrubland (S4)

Pitch pine - heath swamp (S1S2)

Red maple - Sphagnum basin swamp (S4)

Swamp white oak basin swamp (S1)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Frangula alnus (glossy false buckthorn)

Lythrum salicaria (purple loosestrife)

Nasturtium officinale (two-rowed water-cress)

Phalaris arundinacea (reed canary grass)

Phragmites australis (common reed)

Poa compressa (flat-stemmed blue grass)

Rhamnus cathartica (European buckthorn)

Solanum dulcamara (climbing nightshade)

Native Plant Species Composition: As with sandy pond shores, these wetlands have infertile mineral soils and support a combination of common wetland marsh plants and uncommon stress-tolerators and ruderals (including numerous coastal plain species) that are rare or infrequent in other habitats in the state. Examples with the *meadow beauty sand plain marsh* contain numerous rare and coastal plain species that are associated with a well-developed sandy drawdown zone. Rare (endangered and threatened) species are noted by an asterisk (*).

Characteristic species:

Agalinis paupercula var. *borealis* (boreal small-flowered agalinis)

Cladium mariscoides (twig-rush)

Cyperus dentatus (bulblet umbrella sedge)

Dichanthelium acuminatum ssp. *spretum* (hairy rosette-panicgrass)

Eleocharis tenuis (slender spikessedge)

Eriocaulon aquaticum (seven-angled pipewort)

Euthamia caroliniana (coastal plain grass-leaved-goldenrod)*

Gratiola aurea (golden hedge-hyssop)

Juncus pelocarpus (brown-fruited rush)

Rhexia virginica (Virginia meadow beauty)

Sagittaria latifolia (common arrowhead)

Viola lanceolata (lance-leaved violet)

Xyris difformis (bog yellow-eyed-grass)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):

Possibilities for this system include *Alnus incana* ssp. *rugosa* (speckled alder), *Bidens cernua* (nodding beggar-ticks), *Bidens connata* (purple-stemmed beggar-ticks), *Bidens frondosa* (Devil's beggar-ticks), *Calamagrostis canadensis* (bluejoint), *Dichanthelium acuminatum* ssp. *spretum* (hairy rosette-panicgrass), *E. flavescens* var. *olivacea* (yellow spikessedge), *Eleocharis obtusa* (blunt spikessedge), *Eleocharis palustris* (common spikessedge), *Erechtites hieraciifolius* (American burnweed), *Euthamia graminifolia* (common grass-leaved-goldenrod), *Glyceria canadensis* (rattlesnake mannagrass), *Nuphar variegata* (bullhead pond-lily), *Persicaria hydropteroides* (false water-pepper smartweed), *Persicaria pensylvanica* (Pennsylvania smartweed), *Panicum dichotomiflorum* (fall panicgrass), *Muhlenbergia uniflora* (bog muhly), *Scirpus cyperinus* (woolly bulrush), *Sparganium americanum* (American bur-reed), and *Spiraea alba* var. *latifolia* (meadowsweet).

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Cladium mariscoides* (twig-rush), *Euthamia caroliniana* (coastal plain grass-leaved-goldenrod)*, *Juncus pelocarpus* (brown-fruited rush), *Rhexia virginica* (Virginia meadow beauty), and *Xyris difformis* (bog yellow-eyed-grass).

Water Source: Topogenous and groundwater influence (vertical fluctuations dominant).

Hydroperiod: Seasonally and semi-permanently flooded to intermittently exposed.

Stressors: Threats include fragmentation, habitat displacement and degradation, invasion of non-native species, all-terrain vehicles, alteration of hydrology, and impacts to water quality. Hydrologic alterations, both direct (e.g., connectivity changes, draining, channeling/ditching, diversions, and damming) and indirect (e.g., road construction and vegetation removal on adjacent slopes), can significantly degrade ecological integrity. Lowering the water table, or conversely increasing surface water inputs, can lead to shifts in species composition and community types. Logging in and near these wetlands may influence hydrologic patterns, nutrient cycles, habitat integrity and fragmentation, and sedimentation. Because they are naturally acidic and low in nutrients, they are particularly susceptible to alteration by elevated nutrient inputs. Increased nutrient inputs (e.g., from nearby roads, agriculture, development, or logging) can cause this system to shift away from its natural range of variability, creating opportunity for invasive plants and “weedy” native species. The related management implication is to increase the size of buffer areas and to limit or control certain activities near these wetland types. Buffers reduce the impact of disturbances outside the system and ensure that other characteristics and processes within the community remain intact. Buffers help protect natural communities from the deleterious effects of increased nutrients, reduced water quality, altered water quantity, invasion by exotic species, windthrow, loss of secondary plant or animal habitat, and future deleterious changes in surrounding land use that may increase threats over the long term. Nutrient-poor systems may require larger setbacks than other systems because of their high susceptibility to changes in nutrient concentrations.

Reference Condition Examples (A to B+ Ranked): Reference condition examples are unknown in New Hampshire. Examples with “fair” condition are Grassy Pond and Rocky Hill Pond (Litchfield). Good examples of *montane sandy basin marsh* occur at Bragdon Ledge and Sugarloaf Basins (Albany).



Sand plain basin marsh system in southern New Hampshire (photo by Ben Kimball).

RIVER CHANNELS (AND ASSOCIATED RIVERBANKS AND OPEN FLOODPLAINS)

LOW-GRADIENT SILTY-SANDY RIVERBANK SYSTEM (S3)

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

Distribution: Broadly distributed throughout the state.

NatureServe Ecological System Crosswalk: Laurentian-Acadian Floodplain Forest; Eastern Boreal Floodplain; Central Appalachian River Floodplain; Northeastern Erosional Bluff.

Soils: Primarily alluvial sands, loams, and silt loams.

Nutrient Status and pH: Moderately minerotrophic.

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

Comparative Size: A (>3 mi in length); B (3–1 mi in length); C (1–0.3 mi in length); D (<0.3 mi in length).

Vegetation Structure (vertical & horizontal): Tall shrub, medium-height shrub, herbaceous emergent, sparsely vegetated, aquatic.

Sandy or silty channel bars are occasional, but gravel and cobble bars are relatively rare or absent in this depositional environment. *Aquatic bed* and *emergent marsh* communities are common, whereas these are typically absent or not well developed in higher energy settings of moderate- and high-gradient sections of river. These communities are typically indicated by a higher density of vegetation and emergent marsh forbs, including species absent from high-energy environments. Adjacent floodplains typically have red or silver maple floodplain forest communities, but examples of this system may lack well-developed wooded floodplain forests. Instead they may have extensive alluvial alder floodplains along large streams that are flooded at least annually, or they may transition rapidly to upland.

Diagnostic natural communities:

River channels and low riverbanks:

Cobble - sand river channel (S3S4)

Mesic herbaceous river channel (S4)

Twisted sedge low riverbank (S3S4)

Riverbanks:

Alder alluvial shrubland (S3)

Alder - dogwood - arrowwood alluvial thicket (S4)

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

Herbaceous riverbank/floodplain (S4)

Meadowsweet alluvial thicket (S3S4)

Emergent marshes and aquatic beds:

Aquatic bed (S5)

Bayonet rush emergent marsh (S2)

Cattail marsh (S4)

Emergent marsh (S5)

Short graminoid - forb meadow marsh/mudflat (S4)

Peripheral or occasional natural communities:

Dry river bluff (S2S3)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Aquatics:

Cabomba caroliniana (fanwort)

Egeria densa (Brazilian water-weed)

Marsilea quadrifolia (European water-clover)

Myriophyllum heterophyllum (variable-leaf
watermilfoil)

Myriophyllum spicatum (Eurasian watermilfoil)

Najas minor (brittle waternymph)

Potamogeton crispus (curly pondweed)

Trapa natans (water chestnut)

Marshes and shrublands:

Alnus glutinosa (European black alder)
Berberis thunbergii (Japanese barberry)
Celastrus scandens (American bittersweet)
Cirsium palustre (marsh thistle)
Cynanchum louiseae (black swallowwort)
Epilobium hirsutum (hairy willow-herb)
Fallopia japonica (Japanese knotweed)
Fallopia sachalinensis (giant knotweed)
Frangula alnus (glossy false buckthorn)
Iris pseudacorus (yellow flag)
Lonicera ×bella (Bella's honeysuckle)
Lonicera morrowii (Morrow's honeysuckle)
Lonicera tatarica (Tatarian honeysuckle)

Lychnis flos-cuculi (ragged robin lychnis)
Lysimachia nummularia (moneywort)
Lythrum salicaria (purple loosestrife)
Myosotis scorpioides (forget-me-not)
Nasturtium officinale (two-rowed water-cress)
Persicaria longiseta (Oriental lady's-thumb smartweed)
Phalaris arundinacea (reed canary grass)
Phragmites australis (common reed)
Ranunculus repens (creeping buttercup)
Rosa multiflora (multiflora rose)
Solanum dulcamara (climbing nightshade)
Tussilago farfara (coltsfoot)

Native Plant Species Composition: Typically, this system has a high diversity of species. Shrubber portions of this system are characterized by alder, dogwoods, and Viburnums, and sometimes a diverse assemblage of other shrubs.

Herbs in river channel and riverbank communities:

Agrostis spp. (bentgrasses)
Apocynum cannabinum (hemp dogbane)
Bidens spp. (beggar-ticks)
Bulbostylis capillaris (tufted hair-sedge)
Calamagrostis canadensis (bluejoint)
Carex crinita (fringed sedge)
Carex lupulina (hop sedge)
Carex torta (twisted sedge)
Cicuta spp. (water-hemlocks)
Eleocharis spp. (spikesedges)
Equisetum arvense (field horsetail)
Eutrochium spp. (Joe-Pye-weeds)
Glyceria spp. (manna grasses)
Hieracium spp. (hawkweeds)
Impatiens capensis (spotted touch-me-not)
Iris versicolor (blue iris)
Juncus spp. (rushes)
Leersia spp. (cut grasses)
Lycopus uniflorus (northern water-horehound)
Lysimachia terrestris (swamp yellow-loosestrife)
Onoclea sensibilis (sensitive fern)

Osmundastrum cinnamomeum (cinnamon fern)
Panicum spp. (panicgrasses)
Persicaria spp. (smartweeds)
Poa spp. (blue grasses)
Puccinellia spp. (manna grasses)
Schoenoplectus smithii var. *setosus* (Smith's bulrush)
Schoenoplectus torreyi (Torrey's bulrush)
Scirpus cyperinus (woolly bulrush)
Sium suave (water-parsnip)
Solidago spp. (goldenrods)
Symphotrichum spp. (American-asters)
Thelypteris palustris var. *pubescens* (marsh fern)
Triadenum virginicum (Virginia marsh-St. John's-wort)

Shrub and vines of riverbank and river channel communities:

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

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):

Possibilities for this system include *Bidens* spp. (beggar-ticks), *Bulbostylis capillaris* (tufted hair-sedge), *Calamagrostis canadensis* (bluejoint), *Eleocharis* spp. (spikesedges), *Equisetum arvense* (field horsetail), *Juncus tenuis* (path rush), *Persicaria* spp. (smartweeds), *Scirpus cyperinus* (woolly bulrush), and *Solidago* spp. (goldenrods).

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Carex torta* (twisted sedge) and *Schoenoplectus torreyi* (Torrey's bulrush).

Water Source: Primarily influenced by river water (limnogenous).

Hydroperiod: Temporarily to permanently flooded.

Stressors: Riverbank systems have been impacted by development, river channelization, invasives, clearing of natural buffers, hydrologic alterations, and dam construction. Impervious surfaces and other alterations to surrounding landcover can affect flow and degrade water quality through siltation and pollutants such as fertilizers, pesticides, and road residue. Combinations of different types of stressors together with their scope and severity determine the degree to which a system's ecological integrity shifts from a natural condition (A rank) toward more degraded conditions (B, C, or D ranks).

Reference Condition Examples (A to B+ Ranked): Pine River (Ossipee and Effingham) and Blackwater River (Salisbury).



Low-gradient silty-sandy riverbank system along the Blackwater River in Salisbury (photo by Ben Kimball).

MODERATE-GRADIENT SANDY-COBBLY RIVERBANK SYSTEM (S3)

Landscape Settings: River channels and riverbanks (below the bankful transition to floodplain) along moderate-gradient, moderate to high-energy sections of rivers and large streams.

Distribution: Broadly distributed throughout the state.

NatureServe Ecological System Crosswalk: Laurentian-Acadian Floodplain Forest; Central Appalachian Stream and Riparian.

Soils: Primarily alluvial sand, gravel, and cobble.

Nutrient Status and pH: Oligotrophic to moderately minerotrophic.

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

Comparative Size: A (>3 mi in length); B (3–1 mi in length); C (1–0.3 mi in length); D (<0.3 mi in length).

Vegetation Structure (vertical & horizontal): Sparse woodland, tall shrub, medium-height shrub, herbaceous, sparsely vegetated, aquatic.

Rapids or riffle sections are common among the depositional bars. Floodplain forests (primarily silver maple, sugar maple, and balsam fir types) are often adjacent to this riverbank system. This system lacks extensive deposits of boulders and rock that are characteristic of high-gradient rocky riverbanks. It has a higher abundance of coarse deposits (gravel to cobble) compared to low-gradient silty-sandy riverbanks. This system includes extensive alder thickets on large northern streams or small rivers that are flooded at least annually and are without floodplain forests. This system lacks well-developed emergent marsh vegetation found in low-gradient riverbank systems.

Diagnostic natural communities:

River channels and low riverbanks:

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

Medium to high riverbanks and open floodplains:

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

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Alnus glutinosa (European black alder)
Berberis thunbergii (Japanese barberry)
Celastrus scandens (American bittersweet)
Cirsium palustre (marsh thistle)
Cynanchum louiseae (black swallowwort)
Epilobium hirsutum (hairy willow-herb)
Fallopia japonica (Japanese knotweed)
Fallopia sachalinensis (giant knotweed)

Frangula alnus (glossy false buckthorn)
Iris pseudacorus (yellow flag)
Lonicera ×bella (Bella's honeysuckle)
Lonicera morrowii (Morrow's honeysuckle)
Lonicera tatarica (Tatarian honeysuckle)
Lychnis flos-cuculi (ragged robin lychnis)
Lysimachia nummularia (moneywort)
Lythrum salicaria (purple loosestrife)

Myosotis scorpioides (forget-me-not)
Nasturtium officinale (two-rowed water-cress)
Persicaria longiseta (Oriental lady's-thumb smartweed)
Phalaris arundinacea (reed canary grass)
Phragmites australis (common reed)

Ranunculus repens (creeping buttercup)
Rosa multiflora (multiflora rose)
Solanum dulcamara (climbing nightshade)
Tussilago farfara (coltsfoot)

Native Plant Species Composition: Ice and flood scour are important annual disturbances, producing sparse to moderate cover of herbs and shrubs on coarse substrates. Thus the natural communities in this system on average are sparsely vegetated. Rare (endangered and threatened) species are noted by an asterisk (*).

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

Andropogon gerardii (big bluestem)
Calamagrostis pickeringii (Pickering's reed grass)
Hudsonia tomentosa (hairy hudsonia)*
Paronychia argyrocoma (silverling)*

Prunus pumila var. *depressa* (eastern dwarf cherry)
Prunus susquehanae (Appalachian dwarf cherry)
Schizachyrium scoparium (little bluestem)
Solidago simplex ssp. *randii* var. *monticola* (montane Rand's goldenrod)
Vaccinium cespitosum (dwarf blueberry)*

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy): Possibly *Schizachyrium scoparium* (little bluestem).

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Calamagrostis pickeringii* (Pickering's reed grass), *Carex torta* (twisted sedge), *Hudsonia tomentosa* (hairy hudsonia)*, *Paronychia argyrocoma* (silverling)*, *Solidago simplex* ssp. *randii* var. *monticola* (montane Rand's goldenrod), and *Vaccinium cespitosum* (dwarf blueberry)*.

Water Source: Primarily influenced by river water (limnogenous).

Hydroperiod: Temporarily to seasonally flooded.

Stressors: Riverbank systems have been impacted by development, river channelization, invasives, clearing of natural buffers, hydrologic alterations, and dam construction. Impervious surfaces and other alterations to surrounding landcover can affect flow and degrade water quality through siltation and pollutants such as fertilizers, pesticides, and road residue. Combinations of different types of stressors together with their scope and severity determine the degree to which a system's ecological integrity shifts from a natural condition (A rank) toward more degraded conditions (B, C, or D ranks).

Reference Condition Examples (A to B+ Ranked): Albany Intervale (Albany, Livermore, and Waterville Valley), Dead Diamond River (Second College Grant, Atkinson & Gilmanton, and Pittsburg), and (Second College Grant, Dixs Grant, and Dixville).



Moderate-gradient sandy-cobbly riverbank system along the Pemigewasset River near Plymouth (photo by Ben Kimball).

HIGH-GRADIENT ROCKY RIVERBANK SYSTEM (S3)

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

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

NatureServe Ecological System Crosswalk: Laurentian-Acadian Floodplain Forest.

Soils: Primarily bedrock, boulders, stones, and some cobble with interstitial sand and gravel; degradational environments in which fine sediments are transported downstream at high or low river stages, leaving boulders and bedrock as the dominant channel substrate.

Nutrient Status and pH: Oligotrophic to moderately minerotrophic.

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

Comparative Size: A (>1 mi in length); B (1–0.3 mi in length); C (0.3–0.1 mi in length); D (<0.1 mi in length).

Vegetation Structure (vertical & horizontal): Sparse woodland, tall to medium-height shrub, herbaceous, sparsely vegetated.

Alder alluvial thickets and other herbaceous to wooded communities occur on slightly higher riverbanks. Outcrops are present in some examples; riverside seeps are rare.

Diagnostic natural communities:

River channels:

Boulder - cobble river channel (S3)

Cobble - sand river channel (S3S4)

Riverweed river rapid (S2S3)

Riverbanks:

Acidic riverbank outcrop (S3)

Acidic riverside seep (S1)

Alder alluvial shrubland (S3)

Calcareous riverside seep (S1)

Circumneutral riverbank outcrop (S1)

Herbaceous riverbank/floodplain (S4)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species that may occur in this system in New Hampshire:

Alnus glutinosa (European black alder)
Berberis thunbergii (Japanese barberry)
Celastrus scandens (American bittersweet)
Cirsium palustre (marsh thistle)
Cynanchum louiseae (black swallowwort)
Epilobium hirsutum (hairy willow-herb)
Fallopia japonica (Japanese knotweed)
Fallopia sachalinensis (giant knotweed)
Frangula alnus (glossy false buckthorn)
Iris pseudacorus (yellow flag)
Lonicera ×bella (Bella's honeysuckle)
Lonicera morrowii (Morrow's honeysuckle)
Lonicera tatarica (Tatarian honeysuckle)

Lychnis flos-cuculi (ragged robin lychnis)
Lysimachia nummularia (moneywort)
Lythrum salicaria (purple loosestrife)
Myosotis scorpioides (forget-me-not)
Nasturtium officinale (two-rowed water-cress)
Persicaria longiseta (Oriental lady's-thumb smtwd.)
Persicaria maculosa (lady's-thumb smartweed)
Phalaris arundinacea (reed canary grass)
Phragmites australis (common reed)
Ranunculus repens (creeping buttercup)
Rosa multiflora (multiflora rose)
Solanum dulcamara (climbing nightshade)
Tussilago farfara (coltsfoot)

Native Plant Species Composition: Sparsely vegetated; ice and flood scour are pronounced. Rare or uncommon northern and subalpine plants are found in this system along northern rivers (not found in low energy settings or southern New Hampshire). Rare (endangered and threatened) species are noted by an asterisk (*).

Trees and shrubs:

Alnus incana ssp. *rugosa* (speckled alder)
Salix spp. (willows)
Seedlings and saplings of tree species

Herbs:

Calamagrostis canadensis (bluejoint)
Carex torta (twisted sedge)
Danthonia spicata (poverty oatgrass)
Deschampsia anadyrensis (glaucous hair grass)
Deschampsia flexuosa (wavy hair grass)
Doellingeria umbellata (tall white-aster)
Eutrochium maculatum (spotted Joe-Pye weed)
Fragaria virginiana (common strawberry)
Houstonia caerulea (little bluet)
Osmunda claytoniana (interrupted fern)
Panicum spp. (panicgrasses)
Solidago bicolor (white goldenrod)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy): *Alnus incana* ssp. *rugosa* (speckled alder), *Calamagrostis canadensis* (bluejoint), *Fragaria virginiana* (common strawberry), and *Houstonia caerulea* (little bluet).

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Carex torta* (twisted sedge), *Agrostis mertensii* (northern bentgrass), *Calamagrostis pickeringii* (Pickering's reed grass), *Calamagrostis stricta* ssp. *inexpansa* (northern neglected reed grass)*, *Hieracium robinsonii* (Robinson's hawkweed)*, *Triantha glutinosa* (sticky false asphodel)*, and *Vaccinium cespitosum* (dwarf blueberry)*.

Rare or uncommon northern and subalpine plants:

Agrostis mertensii (northern bentgrass)
Calamagrostis pickeringii (Pickering's reed grass)
Calamagrostis stricta ssp. *inexpansa* (northern neglected reed grass)*
Hieracium robinsonii (Robinson's hawkweed)*
Vaccinium cespitosum (dwarf blueberry)*

Riverside seeps:

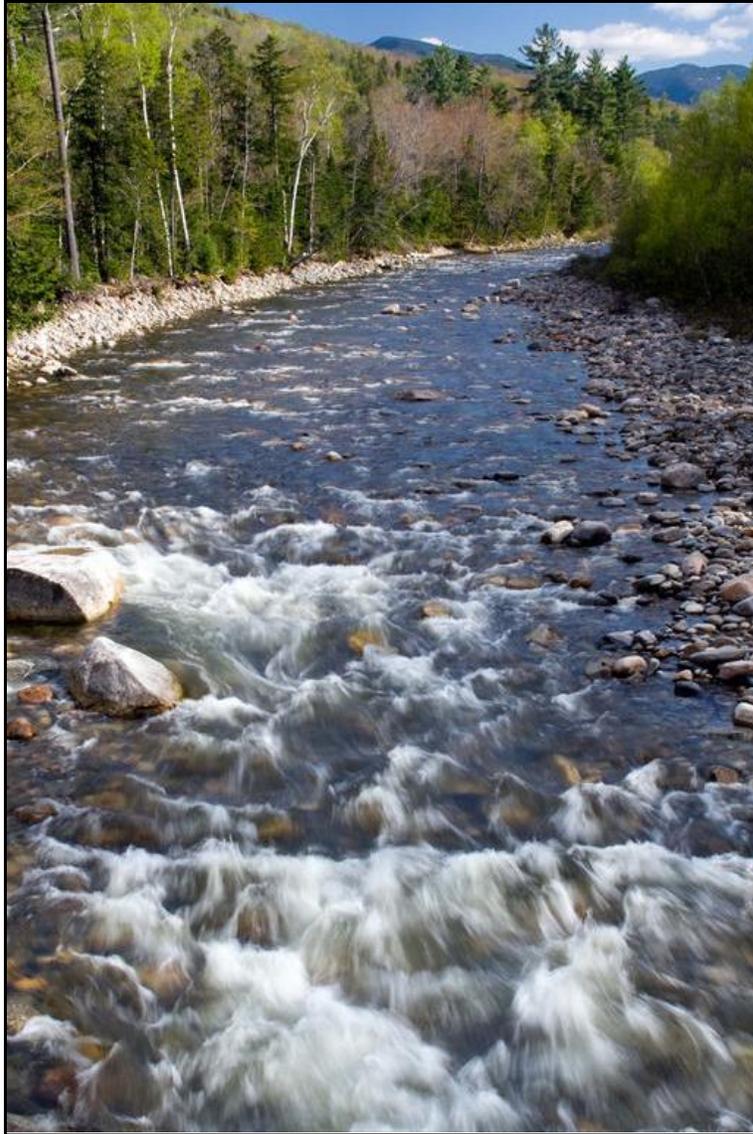
Carex garberi (elk sedge)*
Drosera rotundifolia (round-leaved sundew)
Triantha glutinosa (sticky false asphodel)*

Water Source: Primarily influenced by river water (limnogenous).

Hydroperiod: Temporarily to seasonally flooded.

Stressors: High-gradient riverbanks have been impacted by development, invasives, hydrologic alterations, clearing of natural buffers, and trampling from hikers, fisherman, and boaters. Impervious surfaces and other alterations to surrounding landcover can affect flow and degrade water quality through siltation and pollutants such as fertilizers, pesticides, and road residue. Combinations of different types of stressors together with their scope and severity determine the degree to which a system's ecological integrity shifts from a natural condition (A rank) toward more degraded conditions (B, C, or D ranks).

Reference Condition Examples (A to B+ Ranked): Diamond Gorge (Second College Grant) and Peabody River (Gorham).



High-gradient rocky riverbank system along the Peabody River near Gorham (photo by Ben Kimball).

FLOODPLAIN FORESTS (AND ASSOCIATED RIVERBANKS AND OPEN FLOODPLAINS)

MONTANE/NEAR-BOREAL FLOODPLAIN SYSTEM (S2)

Landscape Settings: Floodplains (above bankful) along moderate-gradient sections of rivers and large streams.

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

NatureServe Ecological System Crosswalk: Laurentian-Acadian Floodplain Forest; Eastern Boreal Floodplain.

Soils: Sandy alluvium (loamy sand, sandy loam, silt loams, and occasionally sand over gravel or cobble).

Nutrient Status and pH: Moderately minerotrophic.

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

Comparative Size: A (>1 mi in length); B (1–0.3 mi in length); C (0.3–0.1 mi in length); D (<0.1 mi in length).

Vegetation Structure (vertical & horizontal): Forest, woodland, sparse woodland, tall to medium-height shrub, herbaceous, and aquatic.

The most diagnostic natural communities are sugar maple and balsam fir floodplain forests, and occasionally red maple floodplain forest. When silver maple floodplain forests are present they typically form a narrow border and are not the dominant forest type. Moderate gradient sandy-cobbly riverbanks are typically adjacent to these floodplains, although some examples occur on higher- or lower-gradient sections of river. Some smaller, northern river floodplains contain balsam fir floodplain/silt plains and alder thickets that lack sugar maple floodplain forest communities.

Diagnostic natural communities:

Floodplain forests:

Balsam fir floodplain/silt plain (S2)

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

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

Herbaceous and shrubby floodplains:

Alder alluvial shrubland (S3)

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

Herbaceous riverbank/floodplain (S4)

Mixed alluvial shrubland (S4)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Alliaria petiolata (garlic-mustard)
Alnus glutinosa (European black alder)
Berberis thunbergii (Japanese barberry)
Celastrus scandens (American bittersweet)
Cirsium palustre (marsh thistle)
Cynanchum louiseae (black swallowwort)

Peripheral or occasional natural communities:

Floodplain forests:

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

Epilobium hirsutum (hairy willow-herb)
Fallopia japonica (Japanese knotweed)
Fallopia sachalinensis (giant knotweed)
Ficaria verna ssp. *bulbifera* (fig-crowfoot)
Frangula alnus (glossy false buckthorn)
Hesperis matronalis (dame's-rocket)

Iris pseudacorus (yellow flag)
Lonicera ×bella (Bella's honeysuckle)
Lonicera morrowii (Morrow's honeysuckle)
Lonicera tatarica (Tatarian honeysuckle)
Lychnis flos-cuculi (ragged robin lychnis)
Lysimachia nummularia (moneywort)
Lythrum salicaria (purple loosestrife)
Myosotis scorpioides (forget-me-not)
Nasturtium officinale (two-rowed water-cress)

Persicaria longiseta (Oriental lady's-thumb smartweed)
Phalaris arundinacea (reed canary grass)
Phragmites australis (common reed)
Ranunculus repens (creeping buttercup)
Robinia pseudoacacia (black locust)
Rosa multiflora (multiflora rose)
Solanum dulcamara (climbing nightshade)
Tussilago farfara (coltsfoot)

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

Sugar maple - ironwood - short husk floodplain forest:

Trees:

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

Herbs:

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

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):

Possibly *Calamagrostis canadensis* (bluejoint), *Pinus strobus* (white pine), *Spiraea alba* var. *latifolia* (meadowsweet), and *Toxicodendron radicans* (poison-ivy).

Native species sensitive to anthropogenic disturbance: It is likely very few native species found in this system fall into this category.

Water Source: Primarily influenced by river water (limnogenous).

Hydroperiod: Temporarily flooded with flashy flood regime (high intensity, short-duration floods from mountain runoff events).

Stressors: Floodplain systems have been fragmented and impacted by agriculture, timber harvesting, development, river channelization, and dam construction. Impervious surfaces and other alterations to surrounding landcover can affect flow and degrade water quality through siltation and pollutants such as fertilizers, pesticides, and road residue. Combinations of different types of stressors together with their scope and severity determine the degree to which a

system's ecological integrity shifts from a natural condition (A rank) toward more degraded conditions (B, C, or D ranks).

Reference Condition Examples (A to B+ Ranked): Indian Stream (Pittsburg).



Montane/near-boreal floodplain system flanking a gravel barren along the Saco River (photo by Dan Sperduto).

MAJOR RIVER SILVER MAPLE FLOODPLAIN SYSTEM (S2)

Landscape Settings: Floodplains (above bankful) along moderate-gradient and low-gradient sections of major rivers.

Distribution: Primarily along main-stems of Connecticut and Merrimack Rivers; occasionally on lower reaches of major tributaries.

NatureServe Ecological System Crosswalk: Laurentian-Acadian Floodplain Forest.

Soils: Alluvium soils range from well drained coarse sands on levees, to poorly drained silts and mucks in floodplain sloughs, vernal pools, and other depressions. As water levels rise over riverbanks, sediment is transported from upstream and deposited where water slows and spreads out across the floodplain terraces.

Nutrient Status and pH: Moderately to strongly minerotrophic.

Spatial Pattern: Linear (large); extensive broad to meandering linear and semi-circular zones parallel to riverbanks or corresponding to floodplain terracing and oxbow, slough, or over-flow channel formations.

Comparative Size: A (>3 mi in length); B (3–1 mi in length); C (1–0.3 mi in length); D (<0.3 mi in length).

Vegetation Structure (vertical & horizontal): Forest, woodland, sparse woodland, tall to medium-height shrub, herbaceous, and aquatic bed.

Forest canopies are dominated by mature *Acer saccharinum* (silver maple), which forms a tall, arching, cathedral-like ceiling above the level floodplain adjacent to the river channel. Whereas shrubs are poorly represented, vines tend to be abundant, especially in canopy gaps and along forest edge transitions to other communities. Floodplain forests of this system often form a mosaic with more open floodplain communities. Shrub thickets and herbaceous meadows may occur on low floodplains and adjacent riverbanks. Aquatic beds, emergent marshes, and shrub thickets in oxbows may also occur and are typically flooded annually. *Riverwash plain and dunes* occur on a few sandy pointbar floodplains of the Merrimack River and are kept open by some combination of infrequent scouring by major floods and subsequent shifting windblown sands.

Diagnostic natural communities:

Alder alluvial shrubland (S3)

Alder - dogwood - arrowwood alluvial thicket (S4)

Aquatic bed (S5)

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

Emergent marsh (S5) – in oxbows

Herbaceous riverbank/floodplain (S4)

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

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

Peripheral or occasional natural communities:

Buttonbush shrubland (S4) – in oxbows

Red maple floodplain forest (S2S3)

Riverwash plain and dunes (S1)

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

Associated systems: Most often adjacent to the low-gradient silty-sandy riverbank system and sometimes the moderate-gradient sandy-cobbly riverbank system. Frequently transitions to river terraces dominated by upland forest types, occasionally including rich and semi-rich forests.

Invasive Non-Native Plant Species Cover: Invasive plants are problematic in many examples, particularly *Celastrus orbiculatus* (Asian bittersweet) and *Berberis thunbergii* (Japanese barberry). Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Alliaria petiolata (garlic-mustard)

Alnus glutinosa (European black alder)

Berberis thunbergii (Japanese barberry)

Cardamine impatiens (narrow-leaved bitter-cress)

Celastrus scandens (American bittersweet)

Cirsium palustre (marsh thistle)

Cynanchum louiseae (black swallowwort)
Epilobium hirsutum (hairy willow-herb)
Fallopia japonica (Japanese knotweed)
Fallopia sachalinensis (giant knotweed)
Ficaria verna ssp. *bulbifera* (fig-crowfoot)
Frangula alnus (glossy false buckthorn)
Heracleum mantegazzianum (giant cow-parsnip)
Hesperis matronalis (dame's-rocket)
Iris pseudacorus (yellow flag)
Lonicera ×bella (Bella's honeysuckle)
Lonicera morrowii (Morrow's honeysuckle)
Lonicera tatarica (Tatarian honeysuckle)
Lychnis flos-cuculi (ragged robin lychnis)
Lysimachia nummularia (moneywort)

Lythrum salicaria (purple loosestrife)
Microstegium vimineum (Japanese stiltgrass)
Myosotis scorpioides (forget-me-not)
Nasturtium officinale (two-rowed water-cress)
Persicaria longiseta (Oriental lady's-thumb smartweed)
Phalaris arundinacea (reed canary grass)
Phragmites australis (common reed)
Ranunculus repens (creeping buttercup)
Rhamnus cathartica (European buckthorn)
Robinia pseudoacacia (black locust)
Rosa multiflora (multiflora rose)
Solanum dulcamara (climbing nightshade)
Tussilago farfara (coltsfoot)

Native Plant Species Composition: Floodplains are characterized by one or both types of silver maple floodplain forest, and sometimes oxbow marshes and various meadow and thicket communities. The *silver maple - wood nettle - ostrich fern floodplain forest* type is most common along the Connecticut River, while the *silver maple - false nettle - sensitive fern* type is most common on the Merrimack, Ashuelot, Contoocook, and Suncook Rivers. This type exhibits different dominant herbs and generally more grasses and sedges. On smaller rivers, silver maple floodplain forest communities may be reduced to a narrow band or relatively small portion of the floodplain system compared to other forest types or disappear altogether. Red maple and other floodplain forest types predominate when silver maple disappears. Characteristic species composition by floodplain forest type is listed below.

Silver maple - wood nettle - ostrich fern floodplain forest:

Trees:

Abundant species:

Acer saccharinum (silver maple)

Occasional to locally abundant species:

Celtis occidentalis (common hackberry)

Fraxinus americana (white ash)

Juglans cinerea (white walnut)

Populus deltoides (eastern cottonwood)

Ulmus americana (American elm)

Herbs and vines:

Common species:

Laportea canadensis (Canada wood-nettle)

Matteuccia struthiopteris ssp. *pensylvanica* (ostrich fern)

Occasional species:

Arisaema triphyllum (Jack-in-the-pulpit)

Athyrium angustum (narrow lady fern)

Boehmeria cylindrica (small-spiked false nettle)

Cinna arundinacea (sweet wood-reed)

Impatiens capensis (spotted touch-me-not)

Onoclea sensibilis (sensitive fern)

Thalictrum pubescens (tall meadow-rue)

Vitis riparia (river grape)

Silver maple - false nettle - sensitive fern floodplain forest:

Trees:

Abundant species:

Acer saccharinum (silver maple)

Occasional to locally abundant species:

Ulmus americana (American elm)

Herbs and vines:

Common species:

Boehmeria cylindrica (small-spiked false nettle)

Onoclea sensibilis (sensitive fern)

Occasional species:

Arisaema triphyllum (Jack-in-the-pulpit)

Athyrium angustum (narrow lady fern)

Carex crinita (fringed sedge)

Carex intumescens (greater bladder sedge)

Cinna arundinacea (sweet wood-reed)

Cinna latifolia (slender wood-reed)

Impatiens capensis (spotted touch-me-not)

Matteuccia struthiopteris ssp. *pensylvanica* (ostrich fern)

Thalictrum pubescens (tall meadow-rue)

Toxicodendron radicans (poison-ivy)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):

<i>Equisetum arvense</i> (field horsetail)	<i>Phalaris arundinacea</i> (reed canary grass)
<i>Juncus tenuis</i> (path rush)	Note: Because <i>Phalaris arundinacea</i> can be invasive in wetlands with a history of human disturbance, it is possible the taxon represents a mixture of native and introduced genotypes in New England (Haines 2011).
<i>Muhlenbergia frondosa</i> (wire-stemmed muhly)	
<i>Muhlenbergia schreberi</i> (nimblewill muhly)	
<i>Panicum capillare</i> (witch panicgrass)	
<i>Panicum dichotomiflorum</i> (fall panicgrass)	
<i>Parthenocissus quinquefolia</i> (Virginia-creeper)	<i>Typha latifolia</i> (broad-leaved cat-tail)
<i>Persicaria pensylvanica</i> (Pennsylvania smartweed)	<i>Solidago canadensis</i> (Canada goldenrod)
	<i>Toxicodendron radicans</i> (poison-ivy)
	<i>Viola sororia</i> (woolly blue violet)

Native species that may be sensitive to anthropogenic disturbance:

<i>Arisaema dracontium</i> (green-dragon)	<i>Matteuccia struthiopteris ssp. pensylvanica</i> (ostrich fern)
<i>Celtis occidentalis</i> (common hackberry)	
<i>Eleocharis diandra</i> (Wright's spikeweed)	<i>Mikania scandens</i> (climbing hempvine)
<i>Fraxinus pennsylvanica</i> (green ash)	<i>Pilea pumila</i> (Canada clearweed)
<i>Hypericum ascyron</i> (great St. John's-wort)	<i>Pyrola asarifolia</i> (pink shinleaf)
<i>Laportea canadensis</i> (wood nettle)	<i>Salix nigra</i> (black willow)
<i>Lipocarpa micrantha</i> (small-flowered dwarf-bulrush)	<i>Solidago simplex ssp. randii var. racemosa</i> (riverbank Rand's goldenrod)

Water Source: Primarily influenced by river water (limnogenous).

Hydroperiod: Temporarily flooded and range from poorly drained to moderately well drained. Flooding on major rivers is affected by snowmelt from the White Mountains that peaks a bit later in the spring than melting snowpacks along tributaries. This floodplain system may require major periodic flood events with historical return intervals for long term maintenance of floodplain forests on medium and high terraces.

Stressors: Floodplain systems along major rivers are a regionally imperiled habitat and have been fragmented and impacted by agriculture, timber harvesting, development, river channelization, dam construction, and invasives. The flat, relatively productive soils are prime for alternative land use, especially higher terraces that are no longer regularly flooded. Historical flood regimes, the natural processes that create and sustain floodplain systems, have been altered by dam control of major rivers, eliminating or lengthening the flood return interval on medium and high floodplains. Combinations of different types of stressors together with their scope and severity determine the degree to which a system's ecological integrity shifts from a natural condition (A rank) toward more degraded conditions (B, C, or D ranks).

Reference Condition Examples (A to B+ Ranked): New Hampshire appears to lack reference condition examples due to human-related impacts. A good example (B ranked) occurs at Franklin Falls Reservoir—U.S. Army Corps of Engineers (New Hampton to Franklin). A good example of a natural community that is diagnostic of the system is the silver maple - false nettle - sensitive fern floodplain forest at the New Hampshire Technical Institute (NHTI) and Society for the Protection of New Hampshire Forests (SPNHF) Headquarters (Concord).



Major river silver maple floodplain system along the Merrimack River (photo by Ben Kimball).

TEMPERATE MINOR RIVER FLOODPLAIN SYSTEM (S3)

Landscape Settings: Floodplains (above bankful) along moderate-gradient and low-gradient sections of minor rivers and large streams.

Distribution: Found along major streams and minor rivers throughout central and southern New Hampshire, including the tributaries of the Merrimack and Connecticut Rivers and smaller rivers in the Piscataqua and Ossipee River watersheds.

NatureServe Ecological System Crosswalk: Laurentian-Acadian Floodplain Forest; Central Appalachian Stream and Riparian.

Soils: Sandy to silty alluvium (loamy sand, sandy loam, silt loams).

Nutrient Status and pH: Moderately to strongly minerotrophic.

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

Comparative Size: A (>1 mi in length); B (1–0.3 mi in length); C (0.3–0.1 mi in length); D (<0.1 mi in length).

Vegetation Structure (vertical & horizontal): Forest, woodland, sparse woodland, tall to medium-height shrub, herbaceous, and aquatic.

This system is indicated by the dominance of *red maple floodplain forest* and occasionally other types (e.g., sycamore, swamp white oak, and balsam fir), often in a mosaic with oxbow marshes, vernal pools, and floodplain meadows and thickets. Canopies of these forests are strongly dominated by *Acer rubrum* (red maple), and the understory ranges from open to viny and somewhat shrubbier than silver maple floodplains, with an abundance of ferns. Silver maple floodplain forests may form narrow borders or small patches, but do not dominate extensive areas as they do along the main-stems of major rivers. This system includes *swamp white oak floodplain forests* restricted to silty alluvial and marine sediments in the coastal region. Low, medium, and high floodplain variants are distinguishable in many occurrences, which correspond to slightly different elevations and thus flood return intervals.

Diagnostic natural communities:

Floodplain forests:

Red maple floodplain forest (S2S3)

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

Swamp white oak floodplain forest (S1)

Sycamore floodplain forest (S1)

Herbaceous and shrub floodplain communities:

Alder alluvial shrubland (S3)

Alder - dogwood - arrowwood alluvial thicket (S4)

Meadowsweet alluvial thicket (S3S4)

Herbaceous riverbank/floodplain (S4)

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

Emergent marsh (S5) – in oxbows

Peripheral or occasional natural communities:

Floodplain forests:

Balsam fir floodplain/silt plain (S2)

Shrub floodplain communities:

Buttonbush shrubland (S4) – in oxbows

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

<i>Alliaria petiolata</i> (garlic-mustard)	<i>Lonicera tatarica</i> (Tatarian honeysuckle)
<i>Alnus glutinosa</i> (European black alder)	<i>Lychnis flos-cuculi</i> (ragged robin lychnis)
<i>Berberis thunbergii</i> (Japanese barberry)	<i>Lysimachia nummularia</i> (moneywort)
<i>Berberis vulgaris</i> (common barberry)	<i>Lythrum salicaria</i> (purple loosestrife)
<i>Cardamine impatiens</i> (narrow-leaved bitter-cress)	<i>Microstegium vimineum</i> (Japanese stiltgrass)
<i>Celastrus scandens</i> (American bittersweet)	<i>Myosotis scorpioides</i> (forget-me-not)
<i>Cirsium palustre</i> (marsh thistle)	<i>Nasturtium officinale</i> (two-rowed water-cress)
<i>Cynanchum louiseae</i> (black swallowwort)	<i>Persicaria longiseta</i> (Oriental lady's-thumb smartweed)
<i>Epilobium hirsutum</i> (hairy willow-herb)	<i>Phalaris arundinacea</i> (reed canary grass)
<i>Fallopia japonica</i> (Japanese knotweed)	<i>Phragmites australis</i> (common reed)
<i>Fallopia sachalinensis</i> (giant knotweed)	<i>Ranunculus repens</i> (creeping buttercup)
<i>Ficaria verna</i> ssp. <i>bulbifera</i> (fig-crowfoot)	<i>Rhamnus cathartica</i> (European buckthorn)
<i>Frangula alnus</i> (glossy false buckthorn)	<i>Robinia pseudoacacia</i> (black locust)
<i>Heracleum mantegazzianum</i> (giant cow-parsnip)	<i>Rosa multiflora</i> (multiflora rose)
<i>Hesperis matronalis</i> (dame's-rocket)	<i>Solanum dulcamara</i> (climbing nightshade)
<i>Iris pseudacorus</i> (yellow flag)	<i>Tussilago farfara</i> (coltsfoot)
<i>Lonicera ×bella</i> (Bella's honeysuckle)	
<i>Lonicera morrowii</i> (Morrow's honeysuckle)	

Native Plant Species Composition: Low, medium, and high floodplain variants are marked by shifts in abundance of species preferential to wetter or drier conditions. Invasive plants are problematic in many examples of this system, particularly *Celastrus orbiculatus* (Asian bittersweet) and *Berberis thunbergii* (Japanese barberry).

Floodplain forest communities:

Trees:

Abundant species:

Acer rubrum (red maple)
Occasional to locally abundant species:
Carya ovata (shagbark hickory)
Fraxinus americana (white ash)
Prunus serotina (black cherry)
Quercus bicolor (swamp white oak)
Quercus rubra (red oak)
Tilia americana (basswood)

Shrubs:

Carpinus caroliniana ssp. *virginiana* (American hornbeam)
Ilex verticillata (common winterberry)
Swida amomum var. *schuetzeana* (northwestern silky dogwood)
Toxicodendron radicans (poison-ivy)
Vaccinium corymbosum (highbush blueberry)
Viburnum spp. (viburnums)

Herbs:

Athyrium angustum (narrow lady fern)
Boehmeria cylindrica (small-spiked false nettle)
Impatiens capensis (spotted touch-me-not)
Onoclea sensibilis (sensitive fern)
Osmunda regalis var. *spectabilis* (royal fern)

Common species of shrub and herbaceous floodplain communities:

Shrubs:

Alnus incana ssp. *rugosa* (speckled alder)
Cephalanthus occidentalis (common buttonbush)
Clematis virginiana (virgin's-bower)
Salix sericea (silky willow)
Spiraea alba var. *latifolia* (meadowsweet)
Swida sericea (red-osier dogwood)

Herbs:

Calamagrostis canadensis (bluejoint)
Carex crinita (fringed sedge)
Carex lupulina (hop sedge)
Carex stricta (tussock sedge)
Carex vesicaria (lesser bladder sedge)
Doellingeria umbellata (tall white-aster)
Euthamia graminifolia (common grass-leaved-goldenrod)
Onoclea sensibilis (sensitive fern)
Solidago gigantea (smooth goldenrod)
Solidago rugosa (wrinkle-leaved goldenrod)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy): *Alnus incana* ssp. *rugosa* (speckled alder), *Calamagrostis canadensis* (bluejoint), *Euthamia graminifolia* (common grass-leaved-goldenrod), *Solidago gigantea* (smooth goldenrod), *Solidago rugosa* (wrinkle-leaved goldenrod), *Spiraea alba* var. *latifolia* (meadowsweet), and *Toxicodendron radicans* (poison-ivy).

Native species sensitive to anthropogenic disturbance: It is likely very few native species found in this system fall into this category.

Water Source: Primarily influenced by river water (limnogenous).

Hydroperiod: Temporarily flooded. Compared to their major river counterparts, minor river floodplains appear to have reduced flood intensity, duration, and earlier peak floods due to absence or reduced importance of mountain snow-pack meltwater.

Stressors: Floodplain systems have been fragmented and impacted by agriculture, timber harvesting, development, river channelization, dam construction, and invasives. Impervious surfaces and other alterations to surrounding landcover can affect flow and degrade water quality through siltation and pollutants such as fertilizers, pesticides, and road residue. Combinations of different types of stressors together with their scope and severity determine the degree to which a system's ecological integrity shifts from a natural condition (A rank) toward more degraded conditions (B, C, or D ranks).

Reference Condition Examples (A to B+ Ranked): Pine River (Ossipee and Effingham).



Temperate minor river floodplain system along the Lamprey River (photo by Ben Kimball).

TIDAL AND SUBTIDAL (ESTUARINE)

SALT MARSH SYSTEM (S1)

Landscape Settings: Intertidal coastal embayments.

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

NatureServe Ecological System Crosswalk: Northern Atlantic Coastal Plain Tidal Salt Marsh; Acadian Coastal Salt Marsh.

Soils: Marine peat; organic materials 16 to 50" thick overlying sandy materials (low marsh); organic materials >50" over sand, silt, or bedrock (high marsh); shallow peats (<16") are occasional in areas towards outer limits of salt marsh (seaward and inland). Salt marsh soil water salinity roughly corresponds to polyhaline levels (18–30 ppt); salinity levels in pannes found in the high salt marsh are typically in the range of 40–50(–60) ppt.

Nutrient Status and pH: Strongly minerotrophic.

Spatial Pattern: Large patch, narrow-linear to irregularly linear; narrow to broad linear bands fringing coastal shorelines, with scattered orbicular patches: linear bands of low salt marsh; broad-linear patches of high salt marsh; intermittent strands of brackish marsh along upland border; small orbicular patches of pannes and pools.

Comparative Size: A (>1,250 ac); B (1,250–250 ac); C (250–50 ac); D (<50 ac).

Vegetation Structure (vertical & horizontal): Primarily herbaceous.

The transition between high and low salt marsh occurs approximately at the mean high water mark; from here high salt marsh stretches landward to the upper reaches of spring tides. Small salt pools and pannes are common, particularly in the high marsh. Brackish marshes occur where fresh water runoff along the upland border reduces salt concentrations to meso-haline levels.

Diagnostic natural communities:

High salt marsh (S3)

Low salt marsh (S3)

Marsh elder shrubland (S1)

Salt pannes and pools (S3)

Peripheral or occasional natural communities:

Brackish marsh (S2S3)

Coastal shoreline strand/swale (S2)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Lepidium latifolium (broad-leaved pepperweed)

Lythrum salicaria (purple loosestrife)

Phragmites australis (common reed)

Typha angustifolia (narrow-leaved cattail)

Native Plant Species Composition: *Low salt marshes* are dominated by *Spartina alterniflora* (smooth cordgrass) and occur between mean sea level and mean high tide in areas protected from high-energy wave action. Other vascular halophytes occur in low abundance. Macroalgae (seaweed) may also be present. *High salt marshes* are strongly dominated by *Spartina patens* (saltmeadow cordgrass), with lesser amounts of other graminoids. *Brackish marshes* are often indicated by *Bolboschoenus robustus* (sea-coast tuber-bulrush), *Carex paleacea* (chaffy sedge), and *Typha angustifolia* (narrow-leaved cat-tail), among other species. *Salt pannes and pools* (pools are deeper) are low wet areas isolated from tidal creeks that occur in both saline and brackish marshes where they support fine-scale natural communities (less than 1m² to over 100 m²). Species composition varies with salinity, hardness of substrate, elevation, soil oxygen, hydroperiod, and other factors.

The abilities of individual plant species to tolerate the challenging combination of stresses in salt marshes dictate which plant species grow where. There are numerous factors that affect plant distribution: hydroperiod (duration and frequency of tidal flooding), soil salinity, soil oxygen, nutrient availability, elevation of substrate, concentration of

growth inhibitors, storms, ice-scouring, land use history, and competitive interactions and biological facilitation between and among species. Rare (endangered and threatened) species are noted by an asterisk (*).

Low salt marsh:

Abundant species:

Spartina alterniflora (smooth cordgrass)

Occasional to locally abundant species:

Ascophyllum nodosum (knotted wrack)

Atriplex spp. (oraches)

Eleocharis parvula (little-headed spikeweed)*

Fucus spp. (rockweeds)

Salicornia depressa (common glasswort)

Spergularia marina (saltmarsh sand-spurry)

Suaeda spp. (sea-blites)

High salt marsh:

Dominant species:

Spartina patens (saltmeadow cordgrass)

Occasional species

Distichlis spicata (saltgrass)

Juncus gerardii (saltmarsh rush)

Spartina alterniflora (smooth cordgrass; short form)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):

Atriplex spp. (oraches), *Distichlis spicata* (saltgrass), *Salicornia depressa* (common glasswort), and *Typha angustifolia* (narrow-leaved cat-tail).

Native species sensitive to anthropogenic disturbance: Unknown.

Brackish marsh:

Bolboschoenus robustus (sea-coast tuber-bulrush)

Carex paleacea (chaffy sedge)

Typha angustifolia (narrow-leaved cat-tail)

Salt pannes and pools:

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

Ruppia maritima (widgeon-grass)

Spartina alterniflora (smooth cordgrass; short form)

Stuckenia pectinata (Sago false pondweed)*

Triglochin maritima (saltmarsh arrow-grass)

Zannichellia palustris (horned-pondweed)*

Water Source: Ocean water at least occasionally diluted by fresh water runoff.

Hydroperiod: Intermittently flooded and exposed by tidal fluctuation.

Stressors: From the time of European settlement until recently, salt marshes were routinely drained by farmers to increase the productivity of salt-meadow cordgrass and spike grass for hay, pasture, mulch, and in an effort to reduce *Aedes sollicitans* (salt marsh mosquito) populations. The ecological impacts of ditching include reduced flood duration, lowered water table, and changes in species composition across many groups of organisms in the marsh (insects, mollusks, crustaceans, shorebirds, waterfowl, and plants). Stressors from climate change include loss of marsh from sea level rise, precipitation changes, and warmer temperatures and increased flooding that accelerate peat breakdown. Other human-related stressors include impacts from invasive species, insufficient tidal flow, freshwater runoff, filling, pollution, dredging for docks and marinas, and cultural eutrophication.

Reference Condition Examples (A to B+ Ranked): Reference condition examples are unknown in New Hampshire. An example with “good to fair” condition is Berry’s Brook (Rye).



Salt marsh system at Berry's Brook in Rye (photo by NHB staff).

BRACKISH RIVERBANK MARSH SYSTEM (S1)

Landscape Settings: Tidal riverbanks and near mouths of low-gradient coastal rivers feeding estuaries.

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

NatureServe Ecological System Crosswalk: Northern Atlantic Coastal Plain Brackish Tidal Marsh; Acadian Estuary Marsh.

Soils: Marine peat and silt and clay; organic materials 16 to 50" thick overlying silty materials; oligo- to meso-haline (0.5–18 ppt) (fresh water marshes occur where salinity levels are 0.5 ppt or less during the period of annual low fresh water flow). Much of the high and low marsh soil along stream and river mouths entering the Great Bay complex and the narrow margins around the bay consists of organic materials 16 to 50" thick overlying silty materials. Some stretches of riverbank consist of marine silt or clay, and gravelly or cobbly material is found along upper sections of large streams corresponding to this system.

Nutrient Status and pH: Strongly minerotrophic.

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

Comparative Size: A (>1 mi in length); B (1–0.3 mi in length); C (0.3–0.1 mi in length); D (<0.1 mi in length).

Vegetation Structure (vertical & horizontal): Herbaceous, sparsely vegetated.

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

Diagnostic natural communities:

High brackish riverbank marsh (S1S2)

Low brackish riverbank marsh (S1S2)

Peripheral or occasional natural communities:

Brackish marsh (S2S3)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded (or probable) in this system in New Hampshire:

Lythrum salicaria (purple loosestrife)

Phragmites australis (common reed)

Typha angustifolia (narrow-leaved cattail)

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

Dominant to locally abundant species:

Bolboschoenus robustus (sea-coast tuber-bulrush)
Spartina alterniflora (smooth cordgrass)
Typha angustifolia (narrow-leaved cat-tail)

Other common species:

Agrostis stolonifera (creeping bentgrass)
Carex paleacea (chaffy sedge)
Juncus gerardii (saltmarsh rush)
Schoenoplectus pungens (three-square bulrush)
Spartina patens (saltmeadow cordgrass)
Spartina pectinata (prairie cordgrass)
Solidago sempervirens (seaside goldenrod)
Symphotrichum novi-belgii (New York American-
aster)

Characteristic rare plants:

Crassula aquatica (pygmy-weed)*
Lilaeopsis chinensis (eastern grasswort)*
Limosella australis (Atlantic mudwort)*
Samolus valerandi ssp. parviflorus (seaside
brookweed)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy): *Typha angustifolia* (narrow-leaved cat-tail).

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Lilaeopsis chinensis* (eastern grasswort)*, *Limosella australis* (Atlantic mudwort)*, and *Samolus valerandi ssp. parviflorus* (seaside brookweed)*.

Water Source: Flooded by tidal salt water that is diluted by fresh water flowing in from the watershed above.

Hydroperiod: Intermittently flooded and exposed by tidal fluctuation.

Stressors: Stressors from climate change include loss of marsh from sea level rise, precipitation changes, and warmer temperatures that accelerate peat breakdown. Other human-related stressors include impacts from invasive species, insufficient tidal flow, channelization, freshwater runoff, filling, pollution, and cultural eutrophication.

Reference Condition Examples (A to B+ Ranked): Reference condition examples are unknown in New Hampshire. An example with “fair” condition is Garvin Brook (Dover).



Brackish tidal riverbank marsh system along Garvin Brook in Dover (photo by Bill Nichols).

COASTAL SALT POND MARSH SYSTEM (S1)

Landscape Settings: Partially protected, supratidal coastal basins.

Distribution: Adjacent to high-energy maritime shorelines along immediate coast.

NatureServe Ecological System Crosswalk: Atlantic Coastal Plain Northern Salt Pond Marsh.

Soils: Pawcatuck mucky peat over fine to coarse mineral and rocky substrates. Ponded water in 2011 was nearly fresh (weakly oligohaline) but salinity in this system type periodically increases from salt water intrusion during storm events when sea water washes over cobble berms.

Nutrient Status and pH: Strongly minerotrophic.

Spatial Pattern: Small patch.

Comparative Size: A (>25 ac); B (25–5 ac); C (5–1 ac); D (<1 ac).

Vegetation Structure (vertical & horizontal): Shrub thicket, meadow marsh, herbaceous emergent, flats, aquatic bed.

The system occupies a coastal basin that is separated from the ocean by a *maritime cobble beach* and *maritime shrub thicket*. The *coastal salt pond flat* occurs adjacent to the emergent marsh but in lower lying areas that are seasonally to semi-permanently flooded. Plants develop from rhizomatous perennials creeping into this community from the emergent marsh at higher elevations or emerge from buried or recently deposited seeds as inundated areas are exposed. The *coastal salt pond emergent marsh* occurs between the flat and meadow marsh in saturated to semi-permanently flooded settings with seasonably variable water levels. Water levels in shallower portions of the emergent marsh range from a few to several centimeters for most of the growing season. Later in the growing season, the soil surface may be exposed for the remainder of the summer. In deeper sections of the emergent marsh, 0.5 m or more of water may semi-permanently inundate the ground. These soils are exposed only during drier periods. The *coastal salt pond meadow marsh* is semi-permanently saturated to seasonally flooded and is located on higher ground adjacent to the emergent marsh. Flooding typically occurs during the spring or high-runoff and precipitation events, but in most years, the water table remains at or below the surface for much of the growing season. In addition to the three preceding rare communities, a narrow and discontinuous band of *highbush blueberry - winterberry shrub thicket* occurs along the upper edge of the *coastal salt pond meadow marsh*.

Diagnostic natural communities:

Coastal salt pond emergent marsh (S1)

Coastal salt pond flat (S1)

Coastal salt pond meadow marsh (S1)

Peripheral or occasional natural communities:

Highbush blueberry - winterberry shrub thicket (S4)

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

Invasive Nonnative Plant Species Cover: Listed below are invasive species recorded in this system in New Hampshire:

Celastrus orbiculatus (Asian bittersweet)
Frangula alnus (glossy false buckthorn)
Lythrum salicaria (purple loosestrife)
Phragmites australis (common reed)
Solanum dulcamara (climbing nightshade)

Typha angustifolia (narrow-leaved cattail)
It is unclear if *Typha angustifolia*, a species that dominates the marsh, is native here or not. Additional research is required to distinguish native occurrences from exotic haplotypes that may now exist even in populations of “native” species. If non-native, it would be considered an invasive species as well.

Native Plant Species Composition: Vegetation is highly variable both temporally and spatially, likely the result of the dynamic nature of the hydrologic and salinity processes governing the system. Many of the plant species

occurring in the coastal salt pond marsh system can be found in fresh or brackish wetlands, but when growing together indicate brackish conditions. Other plant species that found only in fresh water habitats are restricted here to higher ground along the wetland's upper edge, where plant diversity is highest. Rare (endangered and threatened) species are noted by an asterisk (*).

Coastal salt pond flat:

Eleocharis flavescens var. *olivacea* (yellow spikesedge)
Eleocharis parvula (little-headed spikesedge)*
Eleocharis uniglumis (one-glumed spikesedge)*
Lemna minor (common duckweed)
Nymphaea odorata (white water-lily)

Coastal salt pond emergent marsh:

Bolboschoenus robustus (sea-coast tuber-bulrush)
Phragmites australis (common reed) – invasive nonnative
Typha angustifolia (narrow-leaved cat-tail) – nativity unclear
Schoenoplectus pungens (three-square bulrush)
Schoenoplectus tabernaemontani (soft-stemmed bulrush)

Coastal salt pond meadow marsh:

Agrostis stolonifera (creeping bentgrass)
Lythrum hyssopifolia (hyssop-leaved loosestrife)
Lythrum salicaria (purple loosestrife) – invasive nonnative
Solidago sempervirens (seaside goldenrod)
Spartina pectinata (prairie cordgrass)
Symphotrichum novi-belgii (New York American-aster)
Thelypteris palustris var. *pubescens* (marsh fern)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy): The nativity status of *Typha angustifolia*, a species that dominates our only example, is uncertain (if native, it would be included here). Other possibilities for this system include *Lemna minor* (common duckweed).

Native species sensitive to anthropogenic disturbance: Native species found in this system that may fall into this category include *Eleocharis parvula* (little-headed spikesedge)* and *Eleocharis uniglumis* (one-glumed spikesedge)*.

Water Source: Salt water intrusion during storm events when sea water washes over cobble berms (also possibly by intrusion through porous berm sediments), freshwater runoff, and precipitation.

Hydroperiod: Temporarily to seasonally flooded on higher ground to semi-permanently flooded in low elevation areas. Much of the ponded area that exists early in the growing season draws down later in the summer, exposing mud flats in low areas. Water levels can also rise rapidly after a storm.

Stressors: Human-related stressors include impacts from invasive species, altered hydrology, sea level rise, freshwater runoff, filling, pollution, and cultural eutrophication. The Massachusetts Natural Heritage & Endangered Species Program states, “Overwintering populations of Canada geese may provide sufficient nutrient enrichment to change the character of the ponds, allowing algae and pondweeds not native to the ponds to grow and reduce the habitat available to the plants of the pondshore community.”

Reference Condition Examples (A to B+ Ranked): Reference condition examples do not occur in New Hampshire. The only example of this system located in New Hampshire occurs at Odiorne Point State Park (Rye) – its condition is “good to fair.”



Coastal salt pond marsh system at Odiorne Point State Park in Rye (photo by Sara Cairns).

SPARSELY VEGETATED INTERTIDAL SYSTEM (S1S2)

Landscape Settings: Partially protected, intertidal coastal embayments.

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

NatureServe Ecological System Crosswalk: North Atlantic Intertidal Mudflat; North Atlantic Tidal Sand Flat.

Soils: Fine to coarse mineral and rocky substrates. *Coastal shoreline strand/swales* on coarse to fine mineral sediments; *intertidal rocky shores* on rocky or cobbly materials; and *intertidal flats* on broad to narrow, nearly flat extents of sand, mud, and silt.

Nutrient Status and pH: Moderately to strongly minerotrophic.

Spatial Pattern: Large patch, extensive narrow-linear to extensive fringes; uniform or narrow zonation parallel to shore.

Comparative Size: A (>1,250 ac); B (1,250–250 ac); C (250–50 ac); D (<50 ac).

Vegetation Structure (vertical & horizontal): Sparsely vegetated.

This system corresponds to intertidal areas with sparse vascular vegetation that occur between salt marsh, brackish marsh or upland systems landward and subtidal systems seaward. *Coastal shoreline strand/swales* are flooded less than daily and are often characterized by plant stems and other detritus washed in on the higher tides and covering much of the substrate surface. These upper intertidal areas form either large patches or narrow strands along protected low-energy shorelines and are important habitat for various arthropods, shore birds, and other animals. *Intertidal rocky shores* are on open stretches of estuarine rivers and streams or quiet, partially enclosed shores. They are flooded daily by tides. Macroalgae are often common on bedrock and rubble including *Ascophyllum nodosum* (knotted wrack) on larger outcrops and *Fucus vesiculosus* (bladder wrack) on less stable strata. Rocky shores may form large patches or narrow strands below the upper intertidal shoreline and are important habitat for various arthropods, predatory fish, wading birds, mud snails, and other animals. *Intertidal flats* are gently sloping, sparsely vegetated areas between salt or brackish marshes landward and subtidal communities seaward (including tidal creek channels). They form in depositional environments protected from high-energy wave action along the coast behind rocky spits, barrier beaches, and sand bars or along bays and rivers.

Diagnostic natural communities:

Coastal shoreline strand/swale (S2)

Intertidal flat (S3)

Intertidal rocky shore (S3)

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

Invasive Nonnative Plant Species Cover: *Puccinellia maritima* (seaside alkali grass), although perhaps not invasive, might be considered weedy in some settings. This species is sometimes regarded to be native in northeastern North America. Haines (2011) writes “Under such an interpretation, some authors have separated the northeastern plants from European plants as *P. americana*. However, it does not appear to be possible to separate many collections in the absence of geographic data. Further, this species is believed to be largely or wholly introduced by Davis and Consaul (2007). Given that its distribution is limited to areas of the northeastern coastline with a long history of settlement and that it is known to have been introduced to some states on ballast dumps, it is here considered non-native as well.”

Native Plant Species Composition: Vascular plant cover is sparse to generally no more than 25%.

Coastal shoreline strand/swale:

Spergularia marina (saltmarsh sand-spurry)

Salicornia depressa (common glasswort)

Suaeda linearis (annual sea-blite)

Limonium carolinianum (Carolina sea-lavender)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy): None known.

Native species sensitive to anthropogenic disturbance: None known.

Water Source: Flooded by tidal salt water that is diluted by fresh water flowing in from the watershed above.

Hydroperiod: Intermittently flooded and exposed by tidal fluctuation.

Stressors: Human-related stressors include impacts from invasive species, altered hydrology, sea level rise, freshwater runoff, filling, pollution, increased sediments, cultural eutrophication, dredging, unsustainable shellfishing, shoreline manipulation like retaining walls, and docks and marinas.

Reference Condition Examples (A to B+ Ranked): Reference condition examples are unknown in New Hampshire. An example with “good to fair” condition occurs at Great Bay.



Sparsely vegetated intertidal system at Great Bay National Wildlife Refuge (photo by Ben Kimball).

SUBTIDAL SYSTEM (S2)

Landscape Settings: Lowest (subtidal) portions of coastal embayments.

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

NatureServe Ecological System Crosswalk: Northern Atlantic Coastal Plain Seagrass Bed.

Soils: Mineral sediments and mud; saline to brackish.

Nutrient Status and pH: Strongly minerotrophic.

Spatial Pattern: Large patch, extensive flats to narrow-linear; broad patches, linear, and irregular zonation.

Comparative Size: A (>1,250 ac); B (1,250–250 ac); C (250–50 ac); D (<50 ac).

Vegetation Structure (vertical & horizontal): Sparsely vegetated to unvegetated.

In New Hampshire, subtidal systems include the *eelgrass bed* community and other (currently unclassified) aquatic communities on the bottoms of estuarine creeks, channels, and bays. The system performs important ecological functions including supporting oyster, eelgrass, and flounder populations, providing refuge for fish and invertebrates that retreat from exposed eelgrass beds, intertidal flats, and estuarine marshes at low tide, and serving as spawning and nursery areas for numerous species of aquatic animals (Short 1992).

Diagnostic natural communities:

Eelgrass bed (S1)

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

Invasive Nonnative Plant Species Cover: Unknown.

Native Plant Species Composition: Vascular plants are typically absent or sparse in this system. Seaweeds are an important component of channel/bay bottoms and their surrounding environments. A total of 169 seaweed species have been documented as occurring in the Great Bay Estuary (Mathieson and Penniman 1991). *Eelgrass beds* dominated by *Zostera marina* (eel-grass) occur in estuarine waters, on mud rich in organic matter, or on sand bottoms. This rooted aquatic vascular plant covers nearly half of the bottom of Great Bay (2,585 acres). *Eelgrass beds* trap sediments, dissolved nutrients, and larval organisms flowing through the community and are an important contributor to ecosystem health and productivity. They serve as breeding, nursery, and feeding areas for many species of fish and invertebrates. *Eelgrass beds* also provide foraging grounds for waterfowl and wading birds that feed on the eelgrass or the fish and invertebrates the beds harbor.

Eelgrass bed:

Zostera marina (eelgrass)

Native species that can be indicative of anthropogenic disturbance (when appearing aggressive or weedy):

Unknown.

Native species sensitive to anthropogenic disturbance: Unknown.

Water Source: Salt water that is diluted by fresh water flowing in from the watershed above.

Hydroperiod: Permanently flooded. This system corresponds to continuously-submerged subtidal areas.

Stressors: Human-related stressors include impacts from sea level rise, marinas, dredging, freshwater runoff, filling, pollution, increased sediments, and cultural eutrophication.

Reference Condition Examples (A to B+ Ranked): Reference condition examples are unknown in New Hampshire. An example with “good to fair” condition occurs at Great Bay.



Subtidal system at the southern edge of Great Bay (photo by Ben Kimball).

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