Appendix B

Habitat & Community Summaries

Vermont's Wildlife Action Plan 2015

Conservation at Multiple Scales

Introduction

The Conservation at Multiple Scales section of this appendix explains how conservation is organized in this Wildlife Action Plan. This same information is included as chapter 4 of the Wildlife Action Plan. It is also included here for easy reference for users of this section of the report.

Vermont's list of Species of Greatest Conservation Need (SGCN) comprises 133 vertebrate species 200 invertebrate species (such as the Tawny Emperor Butterfly, Cobblestone Tiger Beetle, and Giant Floater mussel) and 813 plants (vascular and bryophytes). Developing individual conservation plans for each of these species would have been exhausting and impractical. Moreover, implementing so many individual plans would be impossible due to insufficient staffing, resources and funds. In short, it would be monumentally inefficient.

Fortunately, an easier and more efficient approach exists. It consists of designing and implementing conservation at multiple scales. This is commonly referred to as the "coarse filter-fine filter" approach and is widely accepted by scientists, wildlife managers and planners. The underlying concept is that if examples of all coarse-filter features are conserved at the scale at which they naturally occur, most of the species they contain—from the largest trees and mammals to the smallest insects—will also be conserved (Hunter 1991; NCASI 2004; Schulte et al. 2006). The coarse-filter approach is well documented in the scientific literature (Jenkins 1985; Noss 1987; Hunter et al. 1988; Hunter 1991; Noss and Cooperrider 1994; Haufler et al. 1996; Jenkins 1996; Poiani et al. 2000; USDA 2004). Habitat management historically practiced by Fish and Wildlife agencies to create young forests and shrublands that benefit dozens of "shrub and early-successional species" including Moose, New England Cottontail, American Woodcock and Ruffed Grouse is an example of a 'habitat-scale' coarse filter.

To best and most efficiently conserve all our SGCN, this Wildlife Action Plan focuses on three scales of conservation:

1. **Landscapes**: Include the features that contribute to ecological function at the state and regional levels, including a network of large, connected habitat blocks and another of aquatic habitats and riparian areas. Species requiring large habitat block, mixes of forest, wetlands and waters and connections between them will benefit most from landscape-level conservation but most other SGCN can also benefit.

2. **Habitats and Natural Communities**: Include the range of naturally occurring and anthropogenic habitats (such as young forest and grasslands). Terrestrial natural communities follow the classification system developed by Sorenson and Thompson (2005) which ties in with the ecological systems classification developed for the Northeast Association of Fish & Wildlife Agencies (Gawler 2008) for the 13 northeastern states. Aquatic communities follow the classification developed by Langdon et.al. (1998).

3. **Species and Groups of Species**: these are the SGCN for which we have identified specific conservation needs that would not be covered by conservation efforts at the other two scales.

Not all species, however, are best conserved by coarse-filters alone. For example, species dependent on multiple habitats at different times during their life cycles, those that occur in small geographic areas, those with highly specialized needs, those that travel across large geographic areas and those that are particularly rare often require focused attention. To ensure that the needs of these species

are also addressed, fine filter conservation strategies are also needed. Species-specific conservation reports can be found in Appendices A1-A5.

Efficiency in conservation effort can be realized by first identifying landscape conservation priorities that will effectively capture many natural communities, habitats, and species found within them. Natural community and habitat level conservation can effectively capture many of the remaining species. And finally, species-specific conservation action will be required for those species that are not captured at landscape or habitat/natural community scales. Typically, these are species that are very rare, are declining across their range, aggregate for breeding, and/or require large home ranges.

Given the species focus of the congressional requirements for Wildlife Action Plan development, we began at the species level by assessing SGCN individually (Appendix A). Then SGCN were organized by taxonomic group and by the habitats they use. This resulted in conservation strategies at the three levels listed above (and in table 4.1).

Table B.1 Organization of Conservation Information in this Report

Level	Organization	Location in this Action Plan
1-Species	6 group summaries (amphibians & reptiles, birds, fishes, invertebrates, mammals and plants) 133 individual species and 15 invertebrates group summaries	Chapter 5 Appendix A
2-Habitats & Natural Communities	125 communities & cultural habitats grouped into 24 summaries	Appendix B
3-Landscapes	Statewide and regional conservation strategies Landscapes Landscape Report	Chapter 1 Chapter 6 Appendix F

Selection of Classification Systems

We delineated landscapes based on the following elements: Interior Forest Blocks, Connectivity Blocks, Surface Waters and Riparian Areas, Riparian Areas for Connectivity, Physical Landscape Diversity Blocks, and Wildlife Road Crossings. Landscape conservation is discussed in chapter 6 and Appendix F of this Wildlife Action Plan.

Though great strides have been made in developing vegetation classification systems that function at the site, landscape, region and national scales (Barnes 1979, Allen and Starr 1982, Forman and Godron 1986, Cleland et. al 1997, Grossman et. al 1998), they are incomplete. No system satisfactorily integrates aquatic and terrestrial communities and cultural habitats1 used by wildlife nationwide.

In lieu of a unified habitat classification system, Vermont's Action Plan technical teams selected the best features of five peer-reviewed vegetation classification systems that can be cross-walked with those used in other states to support broader scale conservation efforts—regionally, nationally, and internationally. Forest Cover Types (Eyre 1980) and U.S Forest Service Forest Inventory & Analysis Types (USDA 2003) were used for early successional stage forests. Natural Communities (Thompson and Sorenson 2000) were the basis for most terrestrial vegetation. "A Classification of the Aquatic Communities of Vermont" by Langdon et al. (1998) was adapted for aquatic community designations and cultural habitats1 were adapted from Reschke (1990). Landscape scale communities were adapted from Poiani et.al. (2000).

1 Cultural habitats are communities and sites that are either created and/or maintained by human activities or are modified by human influence to such a degree that the physical condition is substantially different from what existed prior to human influence (adapted from Reschke 1990).

One hundred twenty-five aquatic and natural community types, cultural habitats and land cover types, capturing most of the habitat required by SGCN were selected from the five systems (table 4.2). Each was assigned to one of 22 categories. Because Lake Champlain and the Connecticut River harbor most of the fish diversity in Vermont, these two waterbodies were broken out from the taxonomy to provide for a more targeted assessment. Technical teams then developed assessment summaries for each that include descriptions and general locations; current conditions; desired conditions based on the needs of associated SGCN; priority problems; conservation strategies to address problems (along with the identification of potential conservation partners and funding sources); and a listing of relevant plans and planning processes pertinent to a habitat type.

Our terrestrial classification is designed to roll up to the Northeast Terrestrial Habitat Classification System (Gawler 2008) with standardized terminology and compatible habitat classifications. It allows the Action Plan to describe the aspects of conservation particular to Vermont, while facilitating conservation at a broader regional level. A Companion to the Terrestrial and Aquatic Maps has been published by TNC (Anderson et al. 2013). It includes profiles of each habitat type in the Northeast, distribution maps, state acreage figures, SGCN identification concern, and an assessment of overall conditions in the region.

Habitat Succession, Species of Greatest Conservation Need & the Action Plan

Plant succession produces cumulative change in the types of plant species occupying a given area through time. Succession is complicated by factors such as disturbance (large and small), local conditions, seed banks and soil legacies (Oliver 1981). A highly simplified timeline begins when land is cleared. Pioneer species typically return first followed by other species generally better adapted to the new and changing conditions created by the previous suite of species. Given sufficient time and appropriate conditions the area moves roughly through early, middle, and late successional stages—often referred to as mature or old growth. A disturbance, if sufficiently large, can re-set the clock anytime and succession begins again. The best-known examples are forest succession but it occurs in virtually all vegetated areas. For example, lichen communities on granite mountaintops experience successional changes (Wessels 2002).

Succession can significantly impact habitat for Species of Greatest Conservation Need and other wildlife as in the edge habitat example noted earlier. Generally, as succession moves from early (young forests) to late stages some wildlife will lose out (e.g., Spruce Grouse, American Woodcock, Cottontail Rabbit) and others will benefit (e.g., American Marten, Northern Goshawk). Others still prefer a mix of successional stages in appropriate configurations (e.g., Canada Lynx).

Over the past two centuries the mix of successional stages available to Vermont's wildlife has changed dramatically in both distribution and abundance. Though precise estimates (current and historic) are unavailable, prior to 1800 a significant percentage of Vermont's forests were in late-successional stages (>150-300 years and older). One-hundred years later young forests (early-successional stages of 1-15 years) dominated the state and today mid-successional forests (60-100 years) are most abundant. Wildlife populations have responded in turn. Vermont's SGCN list contains relatively few species requiring mid-successional forests and more that thrive in early and late-successional representations.

Because the loss of late-successional forests in the eastern U.S. occurred prior to the advent of modern wildlife biology and the current scarcity of later-successional stages (particularly northern hardwood forest types) our understanding how wildlife utilized these stages is not as advanced as our knowledge of wildlife in early successional stages. Historic records and research in late-successional areas elsewhere indicate that the distribution and abundance of some wildlife species was much greater when late-successional forests were in greater abundance—even if these species

can survive without them. Given the lack of this condition on the landscape it is advisable to increase its availability to wildlife.

The habitat, community and landscape summaries that follow here and in Chapter 6 address the habitat needs of Species of Greatest Conservation Need that use vegetation types in one or more successional stages. Conservation strategies address these needs as well as those of species that prefer a mosaic of successional stages.

Table B.2: Landscape, Community, Habitat & Cover Type Categories

* Categories marked with an asterisk "*" are considered major categories for the purposes of organizing this report (24 in all). Conservation summaries were developed addressing characteristics and location, current and desired condition, SGCN using this habitat category, priority problems impacting this category, conservation strategies to address the problems and a list of other plans and planning entities with significant interest in this area.

*Landscapes

Interior Forest Blocks
Connectivity Blocks
Surface Waters and Riparian Areas
Riparian Areas for Connectivity
Physical Landscape Diversity Blocks
Wildlife Road Crossing

Aquatic Communities

***Riparian Areas**

***Riverine** (Langdon et.al. 1998)
- Brook trout
- Brook trout-slimy sculpin
- Blacknose dace-slimy sculpin
- Blacknose dace-bluntnose minnow
- Blacknose dace creek chub
- Tessellated darter-fallfish
- Blacknose dace-slimy sculpin
- White sucker-tessellated darter

***Lower Connecticut River**
(Atlantic salmon-American shad community)

***Lower Lake Champlain Tributaries**
(Redhorse-lake sturgeon community)

***Lakes & Ponds**
- Dystrophic lakes
- Meso-eutrophic lakes
- Oligotrophic lakes
- High elevation acidic lakes

***Lake Champlain**

Cultural Habitats

(Reschle 1990)

***Building & structures**

***Mine & Gravel Pits**

***Grassland & Hedgerows**
- Grasslands
- Hedgerow
- Old field/shrub
- Orchard

*Young Forests

(Successional Stages, Forest Cover Types, Eyre 1980, US Dept of Agriculture 2003)

Stages: Seedling/Sapling Sapling/Pole Timber, Pole Timber

Cover types

Boreal Conifers
- Balsam fir
- Black spruce
- White spruce

Boreal Hardwoods
- Aspen
- Pin cherry
- Paper birch

Spruce-Fir
- Red spruce
- Red spruce-balsam fir
- Paper birch-red spruce-balsam fir

Pine and Hemlock
- Eastern white pine

Table 4.2 continued: Terrestrial Natural Communities (Thompson & Sorenson 2005)

Open or Shrub Wetlands

*Open Peatlands
- Alpine peatland
- Dwarf shrub bog
- Black spruce woodland bog
- Pitch pine woodland bog
- Poor fen
- Rich fen
- Intermediate fen

*Marshes & Sedge Meadows
- Deep bulrush marsh
- Deep broadleaf marsh
- Shallow emergent marsh
- Sedge meadow
- Cattail marsh
- Wild rice marsh

*Wet Shores
- Calcareous riverside seep
- River cobble shore
- Lakeshore grassland
- Riverside sand or gravel shore
- Outwash plain pondshore
- River mud shore
- Rivershore grassland

*Shrub Swamps
- Buttonbush basin swamp
- Alder swamp
- Alluvial shrub swamp
- Sweet gale shoreline swamp
- Buttonbush swamp

Forested Wetlands

*Floodplain Forests
- Silver maple-ostrich fern riverine floodplain forest
- Lakeside floodplain forest
- Silver maple-sensitive fern riverine floodplain forest
- Sugar maple-ostrich fern riverine floodplain forest

*Hardwood Swamps
- Red maple-black ash swamp
- Red maple-northern white cedar swamp
- Calcareous red maple-tamarack swamp
- Red or silver maple-green ash swamp
- Red maple-black gum swamp
- Red maple-white pine-huckleberry swamp

*Softwood Swamps
- Northern white cedar swamp
- Spruce-fir-tamarack swamp
- Black spruce swamp
- Hemlock swamp

*Seeps & Vernal Pools
- Vernal pools
- Seeps

Open Upland Communities

*Upland shores
- Riverside outcrop
- Lake sand beach
- Lake shale or cobble beach
- Erosional river bluff
- Sand dune

*Outcrops & Upland Meadows
- Alpine meadow
- Boreal outcrop
- Serpentine outcrop
- Temperate acidic outcrop
- Temperate calcareous outcrop

*Cliffs & Talus
- Boreal acidic cliff
- Boreal calcareous cliff
- Temperate acidic cliff
- Temperate calcareous cliff
- Open talus

Upland Forests & Woodlands

*Spruce-Fir Northern Hardwood Forest
- Subalpine krummholz
- Montane spruce-fir forest
- Lowland spruce-fir forest
- Montane yellow birch-red spruce forest
- Boreal talus woodland
- Cold-air talus woodland
- Red spruce-northern hardwood forest
- Red Spruce-Heath Rocky Ridge Forest

*Northern Hardwood Forest
- Northern hardwood forest
- Rich northern hardwood forest
- Mesic red oak-northern hardwood forest
- Hemlock forest
- Hemlock-northern hardwood forest
- Northern hardwood talus woodland

*Oak-Pine-Northern Hardwood Forest
- Limestone bluff cedar-pine forest
- Mesic maple-ash-hickory-oak forest
- Mesic Clayplain Forest
- White pine-red oak-black oak forest
- Dry oak forest
- Dry Red Oak-White Pine Forest
- Pine-oak-heath sandplain forest
- Dry oak-hickory-hophornbeam forest
- Red cedar woodland
- Red pine forest or woodland
- Pitch pine-oak-heath rocky summit
- Dry oak woodland
- Sand-Over-Clay Forest
- Temperate Hemlock Forest
- Temperate Hemlock-Hardwood Forest
- Transition Hardwoods Limestone Forest

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Northern Hardwood Forest Summary

Characteristics and Location

The Northern Hardwood Forest is typically best developed at Vermont's middle elevations and these are widespread in the state. Beech, sugar maple, and yellow birch are the predominant tree species, but hemlock, red oak, red maple, white ash, basswood, and white pine can be common as well, and red spruce makes an occasional appearance.

These are the dominant communities in nearly all biophysical regions, excepting the higher elevations of the Green Mountains and the warmer regions of the Champlain Valley, Taconic Mountains, and Southern Vermont Piedmont. Where the natural communities serve as landscape level habitat (i.e., matrix), they should be represented in large blocks of contiguous forest (1,000 acre to 20,000-acre blocks or larger) of various successional stages, elevations, and soils.

The natural communities that comprise Northern Hardwood forest formation habitat are found in every biophysical region of the state.

Natural communities of the Northern Hardwood Forest

Northern Hardwood Forest: A variable community, generally dominated by beech, sugar maple, and yellow birch. This community occurs as a landscape natural community type (i.e., matrix) throughout the state.

Rich Northern Hardwood Forest: High diversity hardwood-dominated forests of sugar maple, white ash, basswood, and hophornbeam, with excellent productivity and high herb diversity. These forests are closely associated with limestone and other calcium-rich bedrock types. Maidenhair fern, blue cohosh and wood nettle are characteristic herbs. This community occurs as a landscape natural community type (i.e., matrix) in the Taconic Mountains.

Mesic Red Oak-Northern Hardwood Forest: Northern hardwood species and red oak co-dominate. In the northern parts of Vermont this occurs on warm south-facing slopes, especially near major rivers. In southern Vermont, it occurs in cooler settings such as north-facing mid elevation slopes as well and can be common or sometimes the matrix.

Hemlock Forest: Small forest patches dominated by hemlock, often on shallow soils and cool sites. Found throughout Vermont.

Hemlock-Northern Hardwood Forest: Mixed forest of hemlock and northern hardwoods. This community occurs as a landscape natural community type (i.e., matrix) in at least the Southern Vermont Piedmont and the Taconic Mountains.

Northern Hardwood Talus Woodland: A small patch community with characteristic species including yellow birch, mountain maple, red berried elder, rock polypody, and Virginia creeper.

Northern Hardwood Forest Condition

Historical Perspective: Northern Hardwood Forests have dominated the Vermont landscape for at least the last 4,500 years, a period over which there was a gradual cooling of the climate. These past forests are believed to have closely resembled the composition of forests of today. Notable differences in the presettlement northern hardwood forests were the predominance of beech, making up over 40% of the trees (Siccama 1971) and the lower abundance of sugar maple. Although red spruce has decreased in abundance since presettlement times at mid-elevations, it has increased in abundance in valleys due to regeneration in old fields (Hamburg and Cogbill 1988). Similarly, white pine is now more abundant due to its regrowth in abandoned fields (Cogbill 2000). Presettlement forests also likely had much less red maple, white birch, and poplars than the forests of today, as these species are associated with younger forests (Cogbill 2000).

Current Condition: Vermont's Northern Hardwood Forest has become more widespread as farmland on the slopes and in the valleys has reverted to forest. However, human population growth and economic development result in forestland conversion and fragmentation that yield smaller blocks of contiguous Northern Hardwood Forest. While much of the Northern Hardwood Forest has been cleared or logged at one time, current land management trends will likely yield less early successional habitat in the future.

Desired Condition (SGCN Needs): Northern Hardwood Forest should be represented in both large blocks of contiguous forestland that contribute to the full complement of landscape level habitat for wide-ranging species and interior forest dwelling species, as well as in the natural community types that serve specific SGCN associated with that type. The large, contiguous forest blocks of Northern Hardwood Forest should exist in 1,000 to 20,000-acre blocks and should include representation of all successional stages, elevations, and soils should be well represented within each biophysical region. Prey wildlife species supported by northern hardwoods are an important component to maintaining several of the wide-ranging wildlife. In addition, the value of hard mast as wildlife food (i.e., nuts and acorns) from northern hardwoods is important for many SGCN with stands of bear-scarred American beech being a classic example. Interior forest conditions that occur in larger unfragmented forest blocks are critical for many species.

Implementing the 2005 Wildlife Action Plan

Actions by the Vermont Fish & Wildlife Department and partners to implement the Wildlife Action Plan in Northern Hardwood Forests since 2005 include:

Contiguous forest/habitat blocks and associated linkages were identified and prioritized as part of the "habitat block project" conducted from 2007 to 2014. Using GIS analysis of existing data, this projected identified 4,055 unfragmented forest blocks in Vermont and ranked each block for its biological and physical landscape diversity values. The project also identified a modeling tool for identifying likely wildlife corridors in Vermont. Partners included Vermont Land Trust (VLT), the Forests, Parks & Recreation Department (VFPR), The Nature Conservancy (TNC), Audubon Vermont, and Green Mountain National Forest (GMNF). The project results are now used extensively in VFWD technical assistance to towns. The project report is "Vermont Habitat Blocks and Habitat Connectivity: An Analysis using Geographic Information Systems."

VFWD has acquired in fee and through conservation easements many high priority sites that include landscape scale Northern Hardwood Forests and provide critical landscape connectivity. These include Bird Mountain in Rutland County and Athens Dome in Windham County. From 2005-2013, the Department acquired 41 separate parcels (excluding fishing access areas) in fee totaling more than 4,100 acres to be added to WMAs or to create new WMAs. VFWD also acquired more than 2,300 acres under conservation easement during the same period. These projects either directly or indirectly benefit SGCN. Partner organizations including the VFPR, TNC, The Trust for Public Land, Vermont Land Trust and many local land trusts acquired and managed lands similarly benefitting SGCN.

VFWD provided technical assistance to private landowners, user groups and forest managers to manage for SGCN including, species associated with early successional and late successional habitat through the Natural Resources Conservation Service-funded WHIP and EQIP programs. Over the period from 2003-2013, the Department has worked on approximately 986 WHIP and 220 EQIP projects representing a total of 1,206 new wildlife habitat enhancement projects with as many private landowners throughout Vermont. Within each of these projects the following practices are the most common: Early Successional Habitat Development (Patch Cuts), Upland Wildlife Habitat Development (Mast and Apple Tree Release), and Invasive Species Control (in the form of Herbaceous weed control, and Brush Management).

VFWD provided technical assistance to every Vermont Regional Planning Commission and nearly every town on a variety of wildlife and land planning related issues, including SGCN conservation, habitat blocks, and wildlife corridors. Conserving Vermont's Natural Heritage (Austin et.al. 2004) was reprinted and distribution of this planning document continues.

The Vermont Forest Roundtable was first convened in 2006 as a venue for information exchange on keeping Vermont's forests as forests. Organized by the Vermont Natural Resources Council, the Roundtable regularly hosts consulting foresters, professional planners, state agency officials (including VFWD and VFPR), landowners, sportsmen, forest products industry representatives, conservation groups, biomass energy organizations and academics. The Roundtable formed with an initial focus on parcelization and forest fragmentation issues. It's since facilitated discussions on trends in Vermont's real estate market and rising forestland values, property tax policy, land use and conservation planning, estate planning, landowner incentive programs such as the Current Use Program, and the long-term sustainability of the forest products industry.

Approximately two million acres of Vermont's forestland is enrolled in the Use Value Appraisal program, which requires active management of enrolled land. In 2009, changes to the program allowed forest areas to be enrolled as "Ecologically Sensitive Treatment Areas," meaning that instead of being managed exclusively for timber, they can be managed for their values as significant natural communities. At the same time, the Use Value Appraisal program was also revised to allow for enrollment and management for significant wildlife habitat. To qualify, Vermont Fish & Wildlife staff review and approve proposals based on the Department's standards of significance for natural communities and wildlife habitat. Staff also work with consulting and county foresters to help them learn about treatment areas.

VFWD and the Vermont Agency of Transportation (VTrans) established a joint Wildlife-Transportation Steering Committee in 2007 to guide and support interagency cooperation to

make Vermont's transportation system safer for both people and wildlife. VTrans published its Vermont Transportation & Habitat Connectivity Guidance Document in 2012. Together they currently support three wildlife camera and road tracking projects to advance our understanding of wildlife's use of transportation infrastructure. These studies are providing VTrans with improved infrastructure design criteria and VFWD with an enhanced understanding of wildlife movement at key locations in the state.

The Staying Connected Initiative was established in 2008 to maintain and improve landscape connectivity across the Northern Appalachian/Acadian region of the eastern U.S. and Canada (NY, VT, NH, ME, MA and the eastern provinces) through research, land use planning, land management, land protection and road barrier mitigation. The comprehensive approach of the partnership allows the targeting of specific wildlife movement pinch points and coordinated action and affords some assurance that expensive state investment in wildlife-friendly transportation infrastructure is not undone by conflicting land uses in the near vicinity beyond the transportation right-of-way. Partners include VFWD, TNC, VNRC, VTrans, NWF, Wildlife Conservation Society, and the fish and wildlife and transportation agencies of partner states). VFWD has also worked closely with the North Atlantic Landscape Conservation Cooperative on a pilot conservation design for the Connecticut River watershed.

Beginning in 2008, the Wildlife Management Institute led the implementation of the Woodcock Conservation Plan in the northeast. Audubon Vermont's Forest Bird Initiative and Foresters for the Birds, in partnership with the Vermont Parks & Recreation Department, provides technical assistance to landowners and foresters to support forest management and policies benefitting a suite of responsibility birds (include Wood Thrush, Black-throated Blue Warbler and Canada Warbler). The program is proving to be an excellent mechanism to bring forest landowners with an interest in bird conservation into being active forest stewards.

In 2014-2015 VFWD and partners including Vermont Land Trust, Vermont Forests, Parks & Recreation, The Nature Conservancy, and the Northwoods Stewardship Center produced "Vermont Conservation Design: Maintaining and Enhancing an Ecologically Functional Landscape" (Sorenson et al. 2015). This report identifies coarse-filter conservation targets for landscape scale features including forest blocks, riparian areas, wildlife and landscape connectivity, and physical landscape diversity that are necessary to effectively conserve many finer scale conservation elements in the face of climate change and habitat loss, including natural communities, rare species, and SGCN.

In 2015, VFWD, in collaboration with VFPR and NRCS developed the Landowner's Guide--Wildlife Habitat Management for Lands in Vermont which provides technical assistance on recognizing wildlife habitat and then managing it to benefit wildlife in tandem with other management goals such as timber production.

Species of Greatest Conservation Need in Northern Hardwood Forest

High Priority
Canada Warbler (Wilsonia canadensis)
Jefferson Salamander (Ambystoma jeffersonianum)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpata)
Butterflies-Hardwood Forest Group (4 species)
Silver-haired Bat (Lasionycteris noctivigans)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Northern Long-eared Bat (Myotis septentrionalis)
Woodland Vole (Microtus pinetorum)
Long-tailed or Rock Shrew (Sorex dispar)
Pygmy Shrew (Sorex hoyi)
Water Shrew (Sorex palustris)
Southern Bog Lemming (Synaptomys cooperi)

Medium Priority
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Black-billed Cuckoo (Coccyzus erythropthalmus)
Black-throated Blue Warbler (Dendroica caerulescens)
Wood Thrush (Hylocichla mustelina)
American Woodcock (Scolopax minor)
Chestnut-sided Warbler (Dendroica pensylvanica)
Ruffed Grouse (Bonasa umbellus)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
DeKay's Brownsnake (Storeria dekayi)
Long-tailed Weasel (Mustela frenata)
Hairy-tailed Mole (Parascalops breweri)
Masked Shrew (Sorex cinereus)
Smoky Shrew (Sorex fumeus)
Common Gray Fox (Urocyon cinereoargenteus)

SGCN Note: Vascular plant SGCN not listed here: 32 species (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/ Information Need Category	Problem/ Information Need Detail	Rank
Habitat Conversion	Permanent conversion of large blocks of forestland to housing development, commercial development, and roads	High
Habitat Fragmentation	Break up of large forest blocks, riparian corridors, and migration paths	High
Impacts of Roads and Transportation Systems	Human and motorized disturbance from new roads and trails in sensitive habitats (e.g., denning sites, breeding sites, feeding areas)	High
Distribution of successional stages	Lack of appropriate landscape level approach to management resulting in a lack of either late or early successional habitat in appropriate size and juxtaposition.	High
Climate Change	May affect species composition	Low
Pollution	Acid rain, sulfur and mercury deposition	High
Invasive Exotic Species	Introduction of exotics species such as sudden oak death, hemlock wooly adelgid, beech bark disease, emerald ash borer, and garlic mustard could affect survival of species such as marten, black bear, Edwards hairstreak, West Virginia white, small mammals, songbirds, etc.	High
Incompatible Recreation	Inappropriate location of ski, hiking, snowmobile trails, illegal ATV use, rock climbing.	Medium
Habitat Degradation	Loss of key feeding areas (beech stands, riparian areas, snags, cavity trees, etc.). Loss of dead and down material, fragmentation of contiguous forests.	High
Herbivory	Excessive deer and moose browsing alters tree regeneration, composition, and ability to compete with invasive exotics	Medium

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Expand the Vermont Conservation Design (2015) to address finer scale elements (e.g., natural communities, habitats, SGCN).	Adoption of conservation targets (numeric and distributional goals) for natural communities, habitat, species.	TNC, VLT, FPR, DEC, CHC	SWG PR, NRCS, USFWS
Encourage long-term conservation efforts to keep forests forested including supporting Use Value Appraisal, Forest Legacy, State Lands Acquisition and Management and Vermont Housing and Conservation Board projects to protect intact forests.	Number of acres conserved, by type and quality	ANR, FPR, VLT, TNC, TPL, VHCB, Local Land Trusts	VHCB, VLT, Forest Legacy
Provide technical assistance to private landowners, user groups consulting foresters and forest managers to improve forest structure and manage for SGCN including, SGCN associated with early successional and late successional habitat and Ecologically Sensetive Treattement Areas.	Number landowners managing for SGCN. Acres of forest managed to improve forest structure.	NRCS, TNC, ANR, SAF, VWA, Coverts, Audubon	SWG
Distribute *Landowners Guide - Wildlife Habitat Management for Lands in Vermont* (VFWD 2015)		NRCS, TNC, ANR, SAF, VWA, Coverts, Audubon	SWG/PR
Provide financial incentives for private landowners minimize fragmentation to SGCN habitats and to restore and enhance degraded habitats.	Number of acres affected/restored	VFWD, NRCS	EQIP, FSA
Provide technical assistance to realtors, engineers, and licensed designers to help landowners shape their land use to better maintain habitat and to legal advisors to help with succession planning	Number programs presented	VNRC	VFWD
Provide technical assistance to town and regional planning organizations, distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004) and *Community Strategies for Vermont's Forests and Wildlife* (VNRC 2013)	Number of towns contacted; Number of towns incorporating wide-ranging species into planning	VFWD, RPCs, AVCC, VFS	VFWD
Provide technical assistance to state and federal land management agencies	Number of state and federal land management plans that include SGCN conservation.	ANR, USFWS, USFS	ANR, USFWS, NRCS
Work with VTrans to identify and maintain wildlife highway/road crossings and with recreational user groups to avoid road and trail placement in sensitive habitats	Number functional linkages across highways/roads	VFWD, VTrans, VAST, GMHA	SWG, PR, VTrans
Manage deer and moose populations at levels that provide suitable harvest opportunities, but do not impair forest regeneration	Number of deer and moose/square mile.	VFWD	PR
Identify, prioritize and control problematic native and invasive species deleterious to SGCN and prevent introduction of these	Acres surveyed/mapped; acres with dominant native vegetation protected or restored	DEC, FPR, USFWS, GMNF, NRCS,	ANR, NRCS, FSA

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
species. Develop plants at landscape-scale.		municipal & watershed groups, foresters	
Investigate the impact of invasive earthworms on Vermont forest habitats: survey the extent of infestations, and develop education and technical assistance programs, best management practices and rules as needed.		VFWD, VFPR, UVM	SWG

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Bat Conservation Plan	Bat habitat conservation	VFWD
Partners in Flight	Bird conservation plan	PIF, VCE, VFWD, Audubon, USFWS
Vermont Forest Resources Plan (2015 Update Draft)	Conservation of healthy forests and the sustainable use and management of Vermont's Forests	VFPR
Vermont Transportation & Habitat Connectivity Guidance Document.	Informs transportation planning, design, construction, operations and maintenance activities and related wildlife and ecological systems monitoring	VTrans

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Spruce-Fir-Northern Hardwood Forest Summary

Characteristics and location

These forests characterize our coldest regions. At higher elevations and in low cold, moist areas, red spruce and balsam fir may dominate the canopy. Warmer or better drained sites have significant amounts of hardwoods (yellow birch, sugar maple, and beech) along with softwoods in the canopy. Human or natural disturbance can also lead to temporary dominance by hardwood species.

These forests occur where growing seasons are short, summers are cool, and winters are harsh. The conifer-dominated forests blanket our highest peaks above 2,500 feet as well as occurring in cold lowland pockets within large areas of Northern Hardwood Forest. The mixed forests of red spruce and northern hardwoods are more widely distributed.

Natural communities of the Spruce-Fir-Northern Hardwood Forest

Subalpine Krummholz: Low, dense thickets of balsam fir and black spruce at high elevations. Generally shallow to bedrock.

Montane Spruce-fir Forest: Dominated by red spruce and balsam fir, with occasional heartleaf birch, paper birch, and yellow birch. Higher elevations of the Green Mountains and other ranges generally above 2,500 feet.

Lowland Spruce-Fir Forest: Dominated by red spruce and balsam fir, with occasional white spruce, black spruce, paper birch, and yellow birch. Lowlands of Northeastern Highlands and cold valleys elsewhere.

Montane Yellow Birch-Red Spruce Forest: Mixed forest of mountain slopes at elevations typically from 2,000 to 2,900 feet, dominated by yellow birch and red spruce.

Red Spruce-Northern Hardwood Forest: Mixed forest of red spruce, yellow birch, sugar maple, beech, and balsam fir found on generally cooler and drier sites than Northern Hardwood Forest, generally below 2,400 feet elevation.

Red Spruce-Heath Rocky Ridge Forest: A forest of red spruce and heath shrubs (low blueberries) that occurs on ridgelines, low summits, and exposed ledges where there are thin, well-drained soils over acidic bedrock. It is uncommon, but forms small to large forest patches at 1,500' to 2,500' elevations in all but Vermont's lowest elevations.

Boreal Talus Woodlands: Rockfall slopes in cold settings dominated by heart-leaved paper birch with occasional red spruce. Appalachian polypody, skunk currant, and mountain maple are often abundant.

Cold-Air Talus Woodland: Rare. Found where cold air drains at the bases of large talus areas. Characteristic plants are black spruce, abundant mosses and liverworts, foliose lichens, and Labrador tea.

Spruce-Fir-Northern Hardwood Forest Condition

Historical Perspective: In recent geologic time, forests dominated by spruce and fir became established in eastern North America only as recently as 8,000 years ago (Webb 1987). A warming trend, known as the hypsithermal interval, occurred from about 6,000 to 4,000 years ago, at which time spruce and fir dominated forests were greatly reduced in distribution. There has been a general expansion of spruce and fir since this time associated with a general cooling of climate (Klyza and Trombulak 1999).

Balsam fir has increased substantially when compared to presettlement forests, likely the result of its competitive advantage over spruce after heavy cutting (Whitney 1994). Red spruce has decreased in abundance at mid-elevation because of natural climate warming after the "little ice age" and forest harvesting, whereas it has increased in abundance in valley settings because of regeneration in old fields (Hamburg and Cogbill 1988).

Current Condition: Many of the natural communities within the spruce–fir–northern hardwood formation exist at high elevations and are often on shallow, acidic, infertile soils. They are, therefore, particularly susceptible to global climate change and acid rain. Montane Spruce-Fir Forest is commonly considered one of the landscape forest types most vulnerable to expected climatic warming. In addition, fragmentation through permanent conversion of forest blocks to roads, houses, ridgeline development, and ski trails pose the most significant problems to this forest type and the species that depend on it.

Desired Condition (SGCN Needs): Many of the below listed SGCN depend upon large, contiguous, interconnected, forest blocks. Where they exist within a biophysical region, examples of large, intact blocks of appropriate natural communities should be conserved to ensure the long-term viability of the associated SGCN (i.e. Montane Spruce-Fir Forest: Blackpoll Warbler, Olive-sided Flycatcher, Bicknell's Thrush, Bay-breasted Warbler; Lowland Spruce Fir Forest: Black-backed Woodpecker, Gray Jay, Bay-breasted Warbler), and Spruce Grouse. Contiguous forest blocks will ideally exist in 1,000-20,000-acre blocks at various elevations and of various soil types. Conservation of these blocks should incorporate SCGN distribution and habitat needs.

Implementing the 2005 Wildlife Action Plan

Actions by the Vermont Fish & Wildlife Department and partners to implement the Wildlife Action Plan in Spruce-Fir-Northern Hardwood Forest's since 2005 include:

Contiguous forest/habitat blocks and associated linkages were identified and prioritized as part of the "habitat block project" conducted from 2007 to 2014. Using GIS analysis of existing data, this projected identified 4,055 unfragmented forest blocks in Vermont and ranked each block for its biological and physical landscape diversity values. The project also identified a modeling tool for identifying likely wildlife corridors in Vermont. Partners included Vermont Land Trust, the Forests, Parks & Recreation Department, The Nature Conservancy, Audubon Vermont, and Green Mountain National Forest. The project results are now used extensively in VFWD technical assistance to towns. The project report is "Vermont Habitat Blocks and Habitat Connectivity: An Analysis using Geographic Information Systems."

VFWD has acquired in fee and through conservation easements many high priority sites that include landscape scale Spruce-Fir-Northern Hardwood Forests and provide critical landscape connectivity. These include Bird Mountain in Rutland County and Athens Dome in Windham County. These projects either directly or indirectly benefit SGCN. Partner organizations including the Forests, Parks & Recreation Department, The Nature Conservancy, The Trust for Public Land, Vermont Land Trust and many local land trusts acquired and managed lands similarly benefitting SGCN.

VFWD provided technical assistance to private landowners, user groups and forest managers to manage for SGCN including, species associated with early successional and late successional habitat through the Natural Resources Conservation Service-funded WHIP and EQIP programs. Over the period from 2003-2013, the Department has worked on approximately 986 WHIP and 220 EQIP projects representing a total of 1,206 new wildlife habitat enhancement projects with as many private landowners throughout Vermont. Within each of these projects the following practices are the most common: Early Successional Habitat Development (Patch Cuts), Upland Wildlife Habitat Development (Mast and Apple Tree Release), and Invasive Species Control (in the form of Herbaceous weed control, and Brush Management).

VFWD provided technical assistance to every Vermont Regional Planning Commission and nearly every town on a variety of wildlife and land planning related issues, including SGCN conservation, habitat blocks, and wildlife corridors. Conserving Vermont's Natural Heritage (Austin et.al. 2004) was reprinted and distribution of this planning document continues.

The Vermont Forest Roundtable was first convened in 2006 as a venue for information exchange on keeping Vermont's forests as forests. Organized by the Vermont Natural Resources Council, the Roundtable regularly hosts consulting foresters, professional planners, state agency officials (including VFWD and VFPR), landowners, sportsmen, forest products industry representatives, conservation groups, biomass energy organizations and academics. The Roundtable formed with an initial focus on parcelization and forest fragmentation issues. It's since facilitated discussions on trends in Vermont's real estate market and rising forestland values, property tax policy, land use and conservation planning, estate planning, landowner incentive programs such as the Current Use Program, and the long-term sustainability of the forest products industry.

Approximately two million acres of Vermont's forestland is enrolled in the Use Value Appraisal program, which requires active management of enrolled land. In 2009, changes to the program allowed forest areas to be enrolled as "Ecologically Sensitive Treatment Areas," meaning that instead of being managed exclusively for timber, they can be managed for their values as significant natural communities. At the same time, the Use Value Appraisal program was also revised to allow for enrollment and management for significant wildlife habitat. To qualify, Vermont Fish & Wildlife staff review and approve proposals based on the Department's standards of significance for natural communities and wildlife habitat. Staff also work with consulting and county foresters to help them learn about treatment areas.

VFWD and the Vermont Agency of Transportation (VTrans) established a joint Wildlife-Transportation Steering Committee in 2007 to guide and support interagency cooperation to make Vermont's transportation system safer for both people and wildlife. VTrans published its Vermont Transportation & Habitat Connectivity Guidance Document in 2012. Together

they currently support three wildlife camera and road tracking projects to advance our understanding of wildlife's use of transportation infrastructure. These studies are providing VTrans with improved infrastructure design criteria and VFWD with an enhanced understanding of wildlife movement at key locations in the state.

The Staying Connected Initiative was established in 2008 to maintain and improve landscape connectivity across the Northern Appalachian/Acadian region of the eastern U.S. and Canada (NY, VT, NH, ME, MA and the eastern provinces) through research, land use planning, land management, land protection and road barrier mitigation. The comprehensive approach of the partnership allows the targeting of specific wildlife movement pinch points and coordinated action and affords some assurance that expensive state investment in wildlife-friendly transportation infrastructure is not undone by conflicting land uses in the near vicinity beyond the transportation right-of-way. Partners include VFWD, TNC, VNRC, VTrans, NWF, Wildlife Conservation Society, and the fish and wildlife and transportation agencies of partner states). VFWD has also worked closely with the North Atlantic Landscape Conservation Cooperative on a pilot conservation design for the Connecticut River watershed.

Audubon Vermont's Foresters for the Birds program, developed in partnership with the Vermont Parks & Recreation Department in 2008, provides foresters and landowners with education and technical assistance to manage forest lands for bird habitats. The program is proving to be an excellent mechanism to bring forest landowners with an interest in bird conservation into being active forest stewards.

In 2014-2015 VFWD and partners including Vermont Land Trust, Vermont Forests, Parks & Recreation, The Nature Conservancy, and the Northwoods Stewardship Center produced "Vermont Conservation Design: Maintaining and Enhancing an Ecologically Functional Landscape" (Sorenson et al. 2015). This report (Action Plan Appendix F) identifies coarse-filter conservation targets for landscape scale features including forest blocks, riparian areas, wildlife and landscape connectivity, and physical landscape diversity that are necessary to effectively conserve many finer scale conservation elements in the face of climate change and habitat loss, including natural communities, rare species, and SGCN.

In 2015, VFWD, in collaboration with VFPR and NRCS developed the Landowner's Guide--Wildlife Habitat Management for Lands in Vermont which provides technical assistance on recognizing wildlife habitat and then managing it to benefit wildlife in tandem with other management goals such as timber production.

SGCN in Spruce-Fir Northern Hardwood Forest

High Priority
Bicknell's Thrush (Catharus bicknelli)
Spruce Grouse (Falcipennis canadensis)
Canada Warbler (Wilsonia canadensis)
Jefferson Salamander (Ambystoma jeffersonianum)
Wood Turtle (Glyptemys insculpta)
Beetles-Tiger Beetle Group (7 species)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Lynx (Lynx canadensis)
American Marten (Martes americana)
Rock Vole (Microtus chrotorrhinus)
Woodland Vole (Microtus pinetorum)
Long-tailed or Rock Shrew (Sorex dispar)
Water Shrew (Sorex palustris)
Northern bog lemming (Synaptomys borealis)
Southern Bog Lemming (Synaptomys

Medium Priority
Northern Goshawk (Accipiter gentilis)
Chimney Swift (Chaetura pelagica)
Black-billed Cuckoo (Coccyzus erythropthalmus)
Olive-sided Flycatcher (Contopus cooperi)
Black-throated Blue Warbler (Dendroica caerulescens)
Bay-breasted Warbler (Dendroica castanea)
Blackpoll Warbler (Setophaga striata)
Gray Jay (Perisoreus canadensis)
Black-backed Woodpecker (Picoides arcticus)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Wolf (Canis ?)
Mountain Lion (Puma concolor couguar)
Long-tailed Weasel (Mustela frenata)
Hairy-tailed Mole (Parascalops breweri)
Masked Shrew (Sorex cinereus)
Smoky Shrew (Sorex fumeus)

SGCN Note: Vascular plant SGCN not listed here: 16 species (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/ Information Need Category	Problem/ Information Need Detail	Rank
Habitat Conversion	Permanent conversion of large blocks of forestland to housing development, and commercial development including: quarries, wind farm, roads, and recreational development	High
Habitat Fragmentation	Break up of large forest blocks, riparian corridors, and migration paths	High
Impacts of Roads and Transportation Systems Incompatible Recreation	Human and motorized disturbance from new roads and trails in sensitive habitats (e.g., denning sites, breeding sites, feeding areas) Conversion of habitat to roads and trails may interrupt movement corridors and provide habitat for competing species.	Medium
Distribution of successional stages	Lack of appropriate landscape level approach to management resulting in habitat degradation (lack of either late or early successional habitat in appropriate size and juxtaposition).	Medium
Climate Change	Expected to alter species composition of many Montane-Spruce-Fir Northern Hardwood Forest types and communities and stress sensitive SGCN associated with these forests.	High
Pollution	Acid rain, sulfur and mercury deposition may affect prey base and vernal pool chemistry	High
Habitat Degradation	Loss of concentrated food, cover, breeding habitats (deer wintering areas, vernal pools, conifer wetlands, coarse woody debris etc.).	High
Incompatible recreation	Inappropriate location of ski, hiking, snowmobile trails, illegal ATV use, rock climbing.	Medium
Herbivory	Excessive deer and moose browsing alters native tree regeneration, composition, and resistance to invasive exotics.	Medium

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Expand the Vermont Conservation Design to address finer scale elements including similar analyses and mapping to set conservation goals for all-natural community types, habitats, SGCN and other species for which these serve as coarse filters, and to identify the SGCN and other rare species not "captured" by a coarse filter. Identify and establish habitat for climate adaptation refugia	Numeric and distributional goals for landscape and natural community scale elements.	TNC, VLT, FPR, DEC	SWG
Encourage long-term conservation efforts to keep forests forested (e.g., support Use Value Appraisal, Forest Legacy, State Lands Acquisition and Management and VT Housing & Conservation Board projects)	Number of acres conserved	ANR, FPR, VLT, TNC, TPL, VHCB, Local Land Trusts	VHCB, VLT, Forest Legacy
Provide technical assistance to private landowners, user groups, consulting foresters and forest managers to improve forest structure and maintain and enhance SGCN habitat in Spruce-Fir NHF and Ecologically Sensetive Treattement Areas. Distribute *Landowners Guide - Wildlife Habitat Management for Lands in Vermont* (VFWD 2015)	Number landowners/user groups/forest managers managing for Spruce-Fir SGCN. Acres of Spruce-Fir forest managed to improve forest structure	NRCS, TNC, VFWD, FPR, Coverts, SAF, VWA, Keeping Track	SWG/PR
Financial incentives for private landowners to maintain and enhance SGCN habitat in Spruce-Fir NHF	Number of acres affected/restored	VFWD, NRCS	EQIP
Technical assistance to town and regional planning organizations to maintain and enhance SGCN habitat in Spruce-Fir NHF. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns contacted; Number of towns incorporating the needs of SGCN in Spruce-Fir NHF into planning	VFWD, RPCs, AVCC, VFS	VFWD
Technical assistance to state and federal land management agencies to maintain and enhance SGCN habitat in Spruce-Fir NHF	Number of state and federal land management plans for Spruce-Fir NHF providing for lynx and marten habitat. Number of state and federal land management plans for Spruce-Fir NHF that include SGCN in their management objectives.	ANR, USFWS, USFS, SAF	ANR
Maintain forested buffers along stream and rivers (See ANR buffer policy)	Number of miles of streams with intact buffers	ANR, VLT, TNC, NWF, Coverts	SWG, EQIP, Trout Unlimited, NRCS
Work with VTrans to identify and maintain wildlife highway/road crossings	Number functional linkages across highways/roads	VFWD, VTrans	SWG, PR, VTrans
Work with recreational groups to reduce the number of trails in sensitive habitats	Number of sensitive habitats with limited disturbance	GMC, VAST, VT Ski Area Association	

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Increase cooperation/coordination between adjacent states and provinces to support and encourage trans-jurisdictional actions to address issues such as global climate change, acid rain and other pollutants.	Implementation of trans-jurisdictional actions.	USFWS, USFS, ANR, other states, TNC, Quebec,	USFWS, IAFWA
Manage moose populations at levels that provide suitable prey, but do not impair forest regeneration	Number of moose/square mile	ANR	PR
Identify, prioritize and control problematic native and invasive species deleterious to SGCN and prevent introduction of these species.	Acres surveyed/mapped; acres with dominant native vegetation protected or restored	USFWS, GMNF, FPR, NRCS, municipal & watershed groups, foresters	ANR, NRCS, FSA
Investigate the impact of invasive earthworms on Vermont forest habitats: survey the extent of infestations, and develop education and technical assistance programs, best management practices and rules as needed.		VFWD, VFPR, UVM	SWG

Coordination with other plans

Plan or planning entity	Goal/Scope of plan	Lead
Bat Conservation Plan	Bat habitat conservation	VFWD
Spruce Grouse Recovery Plan	Spruce grouse reintroduction	VFWD
Partners in Flight	Bird conservation plan	PIF, VFWD, Audubon, USFWS
Riparian Management Guidelines for Agency of Natural Resources Lands (Draft 2015)	Informs the development of recommendations for Act 250-regulated projects	ANR
2015 Update Vermont Forest Resources Plan (Draft)	Conservation and Management of VT Forests	VFPR
Vermont Transportation & Habitat Connectivity Guidance Document	Informs transportation planning, design, construction, operations and maintenance activities and related wildlife and ecological systems monitoring	VTrans

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Oak-Pine-Northern Hardwood Forest Summary

Characteristics and Location

The Oak-Pine-Northern Hardwood Forest is best developed in the warmer regions of Vermont—the Southern Vermont Piedmont, Champlain Valley, and the lower elevations in the Taconic Mountains. Forest communities in this formation generally occur as large patches or locally as small patches within Northern Hardwood Forests and on dry, south-facing slopes and ridgetops. An exception to this is the Clayplain Forest of the Champlain Valley, which prior to European settlement occurred as a landscape scale (matrix) forest, but now has been reduced to forest fragments due to extensive agricultural use of the valley's clay soils. In the Oak-Northern Hardwood Forest Formation, hardwoods such as sugar maple, beech and white ash may be present, but warmer climate species such as red oak, shagbark hickory, and white oak are dominants of the forest canopy. White pine is also a prominent part of these forests.

The natural communities that comprise the Oak-Pine-Northern Hardwood forest type are diverse in their species composition, but all have species that occur in warmer climates, or on dryer sites such as south-facing slopes and ridges.

Natural communities of the Oak-Pine-Northern Hardwood Forest

Red Pine Forest or Woodland: Maintained by fire, these small areas are dominated by red pine, have very shallow soils, and have blueberries and huckleberries in the understory. They are widespread, and often surrounded by Northern Hardwood Forests.

Pitch Pine-Oak-Heath Rocky Summit: These are fire-adapted communities on dry, acidic ridgetops where red oak, white oak, pitch pine, scrub oak, and white pine are characteristic trees. Heath shrubs (blueberries and huckleberries) are abundant.

Limestone Bluff Cedar-Pine Forest: Northern white cedar dominates these areas of shallow soils over calcareous bedrock usually on the Lake Champlain shoreline. Red pine, white pine, hemlock, and hardwoods are also present. Characteristic herbs are ebony sedge and rock polypody. This community has suffered high degree of loss from historic levels due to shoreline development.

Red Cedar Woodland: These are open glade-like communities on ledge crests, where red cedar is native and persistent, and grasses and sedges dominate the ground layer.

Dry Oak Woodland: These are very open areas with trees of low stature on dry, south facing hilltops. Grasses and Pennsylvania sedge are dominant on the forest floor.

Dry Oak Forest: These forests occur on rocky hilltops with very shallow, infertile soils. Red oak, chestnut oak and white oak can all be present; usually other tree species are absent. Heath shrubs dominate the understory.

Dry Oak-Hickory-Hophornbeam Forest: These forests occur on till-derived soils, but they are often found on hilltops and bedrock exposures are common. Soils are well drained, but are more fertile than in Dry Oak Forests. Red oak, sugar maple,

hophornbeam, and shagbark hickory are variously dominant. Sometimes sugar maple is the dominant tree, sometimes it is oak and hickory. Pennsylvania sedge forms lawns.

Mesic Maple-Ash-Hickory-Oak Forest: Sugar maple, white ash, hickories and red and white oak are present in varying abundances. This community needs better documentation.

Transition Hardwoods Limestone Forest: occurs in warm climate regions of Vermont where calcareous bedrock is close to the soil surface. Trees may be stunted and typical include sugar maple, white ash, shagbark hickory, basswood, hophornbeam, butternut, white oak, yellow oak (Quercus muehlenbergii), and bladdernut (Staphylea trifolia). A diverse community with a carpet of herbs reflecting calcium-rich conditions.

Mesic Clayplain Forest: Found on the Vergennes clay soils of the Champlain Valley, this forest is typically dominated by white oak, red maple, bur oak, swamp white oak, hemlock, and shagbark hickory. Maple-leaved viburnum is a typical shrub. Clayplain forests in Vermont have declined by 87.9% since pre-European settlement (Lapin 2003) due primarily to agricultural land use.

Sand-Over-Clay Forest: This large patch forest type occurs on specific soil types of the Champlain Valley where there is a sandy layer overlying clay. Hemlock, red maple, red oak, white oak, and black birch are all typical tree species and witch-hazel is a common shrub.

White Pine-Red Oak-Black Oak Forest: These forests are found on coarse-textured soils. Red and black oak co-dominate along with white pine. Beech and hemlock are also common. Heath shrubs are common in the understory.

Pine-Oak-Heath Sandplain Forest: This is a rare community type, found on dry sandy soils in warmer areas. Characteristic species are white pine, pitch pine, black oak, and red oak with an understory dominated by heath shrubs. Due to high development pressure, only 5% of the original 15,000 acres of sandplain forest in Chittenden County remain (Engstrom 1991).

Temperate Hemlock Forest: Similar to Hemlock Forest, but these dark, hemlock-dominated, small patch forests of warmer regions of the state have white oak, red oak, black birch as canopy associates, instead of northern hardwood species.

Temperate Hemlock-Hardwood Forest: Found in warmer climatic regions of Vermont, this mixed forest is co-dominated by hemlock, white oak, red oak, and black birch.

Transition Hardwood Talus Woodland: These talus woodlands are found in warmer areas, often on limestone but occasionally on slate, schist, granite, gneiss, or other rock. Some characteristic species are red oak, basswood, white ash, sweet birch, bitternut hickory, northern white cedar, hackberry, bulblet fern, and American yew.

Oak-Pine-Northern Hardwood Forest Condition

Historical Perspective: The natural communities that we recognize now are not static – they have changed dramatically over time as component species have migrated across the landscape in response to climatic change. The Oak-Pine-Northern Hardwood Forest Formation (and its characteristic species: pines, oaks, and hickories) provides a good example of how species migrations are independent of each other. After the retreat of the glaciers to the north, pine became well established in the northeastern United States by about 12,000 years ago, while oak was not well established until about 8,000 years ago, and hickory arrived in New England 2,000 to 3,000 years after the first increase in oak populations (Jacobson et al. 1987; Prentice et al. 1991).

It is often thought that white pine dominated the presettlement landscape of Vermont, but evidence from early land surveys indicates that it had a variable and restricted distribution (Cogbill 2000). Pine was abundant only in scattered areas of the Champlain and Connecticut River valleys, and was generally uncommon elsewhere. White pine has more than doubled in frequency since presettlement times, apparently due to its establishment and growth in abandoned agricultural fields (Cogbill 2000).

Current Condition: Of the three landscape level forests in Vermont, the Oak-Pine-Northern Hardwood Forest has been the most altered by human activities. The primary reason is that this forest type is most closely associated with the Champlain and Connecticut River Valleys – Vermont's most populated and prized agricultural regions. The Oak-Pine-Northern Hardwood Formation occurs in the warmest regions of the state that are generally the most desirable for settlement and agriculture. Human alteration of the landscape has most significantly altered two of natural community types of this formation: Mesic Clayplain Forest and Pine-Oak-Heath Sandplain Forest are now both considered rare forest types. In fact, in the southern Champlain Valley 87.9% of the Clay Plain Forest has been lost or degraded (Lapin 2003), primarily because of conversion to agricultural uses. One of Vermont's rarest and most threatened natural communities is the Pine-Oak-Heath Sandplain Forest of the northern Champlain Valley. Because of its high value for residential development, it has been estimated that only 5% of the original 15,000 acres of sandplain forest now remain in Chittenden County (Engstrom 1991). Many of the rarest SGCN are directly associated with these communities.

Many of the other natural communities of this forest formation are small and often found in isolated settings. Several are found along drier ridgetops that make them less vulnerable to forestland conversion. However, fire suppression over the past 200 years or more has taken away one of the more important natural disturbances vital to regenerating some of the oak-pine forest types. Without fire, regenerating oak following timber removal is difficult in some settings, particularly when under the influence of herbivory (i.e., deer browsing, hare and rabbit girdling). Invasive plants (e.g., honeysuckle, buckthorn) and exotic insects (e.g., gypsy moth) can have significant effects on the quality of the wildlife habitat.

Desired Condition (SGCN Needs): Oak-Pine-Northern Hardwood Forest should be represented in both large blocks of contiguous forestland that contribute to the full complement of landscape level forest for wide-ranging species, as well as in the natural community types that serve specific SGCN associated with that type. Although contiguous forest blocks are limited in size and availability for the rarer forest types, where they exist,

large, contiguous forest blocks of Oak-Pine-Northern Hardwood Forest will ideally exist in blocks 1,000 acres or more of various elevations and soils. The oak component of this forest serves as important fall foods for numerous mammals, including some key prey species (e.g., deer, small mammals) for wide-ranging wildlife. Because much of the rarer Oak-Pine-Northern Hardwood Forest types have been converted to agriculture and development, the remaining fragmented blocks of these types will ideally be maintained, if not enlarged, as well as interconnected through forested or riparian corridors.

Implementing the 2005 Wildlife Action Plan

Actions by the Vermont Fish & Wildlife Department and partners to implement the Wildlife Action Plan in Oak-Pine Northern Hardwood Forest's since 2005 include:

Contiguous forest/habitat blocks and associated linkages were identified and prioritized as part of the "habitat block project" conducted from 2007 to 2014. Using GIS analysis of existing data, this projected identified 4,055 unfragmented forest blocks in Vermont and ranked each block for its biological and physical landscape diversity values. The project also identified a modeling tool for identifying likely wildlife corridors in Vermont. Partners included Vermont Land Trust, the Forests, Parks & Recreation Department, The Nature Conservancy, Audubon Vermont, and Green Mountain National Forest. The project results are now used extensively in VFWD technical assistance to towns. The project report is "Vermont Habitat Blocks and Habitat Connectivity: An Analysis using Geographic Information Systems."

VFWD has been inventorying Oak-Pine-Northern Hardwood Forest types throughout Vermont since 2007 with the goal of identifying the most important forest blocks that are dominated by this forest formation. Approximately 100 sites have seen ecological and wildlife inventories so far.

In 2013, VFWD and The Nature Conservancy, and working with other partners, completed an inventory and prioritization of clayplain forest fragments in the Champlain Valley. The high priority examples of all clayplain forest types, including Wet Clayplain Forest and Wet Sand-Over-Clay Forest, were entered into the Department's Natural Heritage Database to be used for conservation planning.

VFWD has acquired in fee and through conservation easements many high priority sites that include landscape scale Oak-Pine-Northern Hardwood Forests and provide critical landscape connectivity. These include Bird Mountain and North Pawlet Hills, both in Rutland County). Partner organizations including the Forests, Parks & Recreation Department, The Nature Conservancy, The Trust for Public Land, Vermont Land Trust and many local land trusts acquired and managed lands similarly benefitting SGCN.

VFWD provided technical assistance to private landowners, user groups and forest managers to manage for SGCN including, species associated with early successional and late successional habitat through the Natural Resources Conservation Service-funded WHIP and EQIP programs. Over the period from 2003-2013, the Department has worked on approximately 986 WHIP and 220 EQIP projects representing a total of 1,206 new wildlife habitat enhancement projects with as many private landowners throughout Vermont. Within each of these projects the following practices are the most common: Early Successional

Habitat Development (Patch Cuts), Upland Wildlife Habitat Development (Mast and Apple Tree Release), and Invasive Species Control (in the form of Herbaceous weed control, and Brush Management).

VFWD provided technical assistance to every Vermont Regional Planning Commission and nearly every town on a variety of wildlife and land planning related issues, including SGCN conservation, habitat blocks, and wildlife corridors. Conserving Vermont's Natural Heritage (Austin et.al. 2004) was reprinted and distribution of this planning document continues.

The Vermont Forest Roundtable was first convened in 2006 as a venue for information exchange on keeping Vermont's forests as forests. Organized by the Vermont Natural Resources Council, the Roundtable regularly hosts consulting foresters, professional planners, state agency officials (including VFWD and VFPR), landowners, sportsmen, forest products industry representatives, conservation groups, biomass energy organizations and academics. The Roundtable formed with an initial focus on parcelization and forest fragmentation issues. It's since facilitated discussions on trends in Vermont's real estate market and rising forestland values, property tax policy, land use and conservation planning, estate planning, landowner incentive programs such as the Current Use Program, and the long-term sustainability of the forest products industry.

Approximately two million acres of Vermont's forestland is enrolled in the Use Value Appraisal program, which requires active management of enrolled land. In 2009, changes to the program allowed forest areas to be enrolled as "Ecologically Sensitive Treatment Areas," meaning that instead of being managed exclusively for timber, they can be managed for their values as significant natural communities. At the same time, the Use Value Appraisal program was also revised to allow for enrollment and management for significant wildlife habitat. To qualify, Vermont Fish & Wildlife staff review and approve proposals based on the Department's standards of significance for natural communities and wildlife habitat. Staff also work with consulting and county foresters to help them learn about treatment areas.

VFWD and the Vermont Agency of Transportation (VTrans) established a joint Wildlife-Transportation Steering Committee in 2007 to guide and support interagency cooperation to make Vermont's transportation system safer for both people and wildlife. VTrans published its Vermont Transportation & Habitat Connectivity Guidance Document in 2012. Together they currently support three wildlife camera and road tracking projects to advance our understanding of wildlife's use of transportation infrastructure. These studies are providing VTrans with improved infrastructure design criteria and VFWD with an enhanced understanding of wildlife movement at key locations in the state.

The Staying Connected Initiative was established in 2008 to maintain and improve landscape connectivity across the Northern Appalachian/Acadian region of the eastern U.S. and Canada (NY, VT, NH, ME, MA and the eastern provinces) through research, land use planning, land management, land protection and road barrier mitigation. The comprehensive approach of the partnership allows the targeting of specific wildlife movement pinch points and coordinated action and affords some assurance that expensive state investment in wildlife-friendly transportation infrastructure is not undone by conflicting land uses in the near vicinity beyond the transportation right-of-way. Partners include VFWD, TNC, VNRC, VTrans, NWF, Wildlife Conservation Society, and the fish and wildlife and transportation agencies of partner

states). VFWD has also worked closely with the North Atlantic Landscape Conservation Cooperative on a pilot conservation design for the Connecticut River watershed.

Audubon Vermont's Foresters for the Birds program, developed in partnership with the Vermont Parks & Recreation Department in 2008, provides foresters and landowners with education and technical assistance to manage forest lands for bird habitats. The program is proving to be an excellent mechanism to bring forest landowners with an interest in bird conservation into being active forest stewards.

In 2014-2015 VFWD and partners including Vermont Land Trust, Vermont Forests, Parks & Recreation, The Nature Conservancy, and the Northwoods Stewardship Center produced "Vermont Conservation Design: Maintaining and Enhancing an Ecologically Functional Landscape" (Sorenson et al. 2015). This report (Action Plan Appendix F) identifies coarse-filter conservation targets for landscape scale features including forest blocks, riparian areas, wildlife and landscape connectivity, and physical landscape diversity that are necessary to effectively conserve many finer scale conservation elements in the face of climate change and habitat loss, including natural communities, rare species, and SGCN.

In 2015, VFWD, in collaboration with VFPR and NRCS developed the Landowner's Guide--Wildlife Habitat Management for Lands in Vermont which provides technical assistance on recognizing wildlife habitat and then managing it to benefit wildlife in tandem with other management goals such as timber production.

SGCN in Oak-Pine Northern Hardwood Forest

High Priority
Jefferson Salamander (Ambystoma jeffersonianum)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpata)
Timber Rattlesnake (Crotalus horridus)
Eastern Ratsnake (Pantherophis alleghaniensis)
Five-lined Skink (Plestiodon fasciatus)
Butterflies-Hardwood Forest Group (4 species)
Beetles-Tiger Beetle Group (7 species)
Indiana Bat (Myotis sodalis)
Silver-haired Bat (Lasionycteris noctivigans)
Eastern Red Bat (Lasiurus borealis)
Northern Long-eared Bat (Myotis septentrionalis)
Hoary Bat (Lasiurus cinereus)
Woodland Vole (Microtus pinetorum)
Southern Bog Lemming (Synaptomys cooperi)

Medium Priority
Northern Goshawk (Accipiter gentilis)
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Black-throated Blue Warbler (Dendroica caerulescens)
American Woodcock (Scolopax minor)
Chestnut-sided Warbler (Dendroica pensylvanica)
Ruffed Grouse (Bonasa umbellus)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
DeKay's Brownsnake (Storeria dekayi)
Long-tailed Weasel (Mustela frenata)
Hairy-tailed Mole (Parascalops breweri)
Masked Shrew (Sorex cinereus)

SGCN Note: Vascular plant SGCN not listed here: 128 species (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

Problem/ Information Need Category	Problem/ Information Need Detail	Rank
Habitat Conversion	Permanent conversion of forestland to housing development, commercial development, agriculture, and roads	High
Habitat Fragmentation	Break up of large forest blocks, riparian corridors, and migration paths. Wider ranging reptiles and birds depend upon contiguous habitat mosaics of 1000 ha or more.	High
Impacts of Roads and Transportation Systems Incompatible Recreation	Human and motorized disturbance from new roads and trails in sensitive habitats (e.g., denning sites, breeding sites, feeding areas)	High
Inadequate Disturbance Regime	Fire Suppression: many habitats depend upon fire.	Medium
Climate Change	May affect species composition.	Medium
Pollution	Acid rain affects on amphibians.	Medium
Habitat Degradation	Alteration of tree composition and loss of large, dead trees for cavities and roosts	Medium
Herbivory	Excessive deer browsing alters tree regeneration and composition	High
Invasive Exotic Species	Fragmented forest blocks encourage invasive plant species. Gypsy moth infestations affect oak productivity and survival.	High

Priority Conservation Strategies

See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Develop a strategy and design that identifies the coarse-filter conservation values of landscape scale features (blocks of all forest types, connectivity, physical landscape diversity) and which SGCN and other rare species are expected to be captures by these coarse filters. Conduct a similar analysis and mapping to set conservation targets for all-natural community types and the SGCN and other species for which these serve as coarse filters.	Conservation targets (numeric and distributional goals) for landscape and natural community scale elements.	TNC, VLT, FPR, DEC	SWG
Encourage long-term conservation efforts to keep forests forested (e.g., support Use Value Appraisal, Forest Legacy, State Lands Acquisition and Management and VT Housing & Conservation Board projects)	Number of acres conserved	ANR, FPR, VLT, TNC, TPL, VHCB, Local Land Trusts	VHCB, VLT, Forest Legacy
Provide technical assistance to private landowners, user groups consulting foresters and forest managers to improve forest structure and manage for SGCN in Oak-Pine NHF and Ecologically Sensetive Treattement Areas. Distribute *Landowners Guide - Wildlife Habitat Management for Lands in Vermont* (VFWD 2015)	Number of landowners managing land for SGCN Number of acres of Old-Pine forest managed to improve forest structure	NRCS, TNC, ANR, SAF, VWA, VT Coverts	SWG/PR
Financial incentives for private landowners to maintain and enhance SGCN habitat in Oak-Pine NHF	Number of acres affected/restored	VFWD, NRCS	EQIP
Technical assistance to town and regional planning organizations. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns & RPC's considering SGCN in their planning	VFWD, RPC's, AVCC, SAF, VWA, Coverts, VFS	VFWD

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Technical assistance to state and federal land management agencies	No. state and federal land mgmt plans providing for SGCN, including use of prescribed fire	ANR, USFWS, USFS	ANR
Manage deer populations at levels that provide suitable harvest opportunities, but do not impair forest regeneration	Number of deer/square mile. Level of browse. Change in the # of wildlife road mortalities	ANR	PR
Continue working with VTrans and towns to identify and improve wildlife-highway/road crossings	Number of functional linkages across highways/roads	VFWD, VTrans	SWG, PR, VTrans
Increase cooperation/coordination among adjacent states/provinces. Develop trans-jurisdictional actions to address issues such as climate change, acid rain and connectivity.	Implementation of trans-jurisdictional actions.	USFWS, USFS, ANR, other states, TNC, Quebec, VTA	USFWS, IAFWA
Identify, prioritize and control problematic native and invasive species deleterious to SGCN and prevent introduction of these species.	Acres surveyed/mapped; acres with dominant native vegetation protected or restored	USFWS, GMNF, FPR, NRCS, municipal & watershed groups, foresters	ANR, NRCS, FSA
Investigate the impact of invasive earthworms on Vermont forest habitats: survey the extent of infestations, and develop education and technical assistance programs, best management practices and rules as needed.		VFWD, VFPR, UVM	SWG

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Bat Conservation Plan	Bat habitat conservation	VFWD
ANR Long Range Management Plans	Management activities on ANR Lands	ANR
Green Mountain Forest Plan	Management activities on GMNF	USFS
Partners in Flight	Bird conservation plan	PIF, VFWD, Audubon, USFWS
The Nature Conservancy Champlain Valley Ecoregional Plan	Land conservation targets for the Champlain Valley Ecoregion	TNC
Champlain Basin Plan	Conservation of Champlain Basin resources	LCBP
Watershed Management Plans	Watershed plans for the Lake Champlain Basin	DEC
2015 Update Vermont Forest Resources Plan (Draft)	Conservation of healthy forests and the sustainable use and management of Vermont's Forests	FPR
Creating and Maintaining Resilient Forests in Vermont: Adapting Forests to Climate Change	Maintaining and improving forest resiliency	VFPR
Vermont Transportation and Habitat Connectivity Guidance Document.	Informs transportation planning, design, construction, operations and maintenance activities and related wildlife and ecological systems monitoring	VTrans

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Young Forests, Old Forests and Shrub Habitat Summary

This section augments the preceding forest summaries (Northern Hardwood, Spruce Fir and Oak Pine Northern Hardwood).

Characteristics and Location

Old forests are biologically mature forests, typically in late successional stages of development and showing minimal evidence of human disturbance. In general, old forests have: some trees exceeding 150 years old for most forest types (100 years old for balsam fir forests); dominated by native tree species characteristic of the forest type; trees of multiple ages; complex structural diversity that includes a broad distribution of tree diameters, vegetation layers, and canopy gaps; abundant coarse woody material in all stages of decay; and evidence of past natural disturbance, such as pit-and-mound micro-topography resulting from trees blowing over in wind storms. Old forests have complex soil structure compared to younger forests of the same type. The relative stability of old forests, the abundance of coarse woody material, the complex vegetation and soil structure provide preferred habitat for many species, including herbaceous species, lichens, mosses, fungi, and some species of insects, amphibians, birds, and mammals. Vermont currently has very few areas of old forest, probably less than one percent of the state, with most of the known small patches occurring in remote or inaccessible areas that have escaped past logging or clearing. Other areas of old forest are known from forested swamps, montane forests, and some rare natural community types such as Limestone Bluff Cedar-Pine Forests that have stunted trees on very shallow soils. No comprehensive inventory of Vermont's old forests has been conducted.

Young Forests are comprised of tree species seedlings and saplings between 1 and 15 years of age. The importance of these forests to wildlife, however, is more often related to forest structure than the actual age of the woody vegetation. In Vermont, most young forests are found in recently harvested forest stands, although abandoned fields and pastures that have reverted to young trees also contribute to the needs of SGCN that are dependent on this habitat type. Young forest species composition varies with the natural community that occurs at the site, but also with the land-use history, land management practices, and forest/natural community type. Natural disturbance caused by windstorms, floods, beaver activity, and fires result in stand-replacing events that develop into young forests through natural succession. The size and distribution of young forest patches is important in determining their wildlife habitat function and currently is more easily controlled through management activities than by allowing natural disturbance events to occur. No comprehensive inventory of Vermont's young forests has been conducted.

Shrublands are areas in which shrubs, woody plants with many stems arising at or near the ground, are the dominant vegetation. Typical shrubs include speckled alder, dogwoods, hazelnut, blueberries, wild cranberry, mountain holly, choke cherry, and blackberry. Shrublands occur as relatively stable natural communities in some wetland types, such as Alder Swamp, Alluvial Shrub Swamp, and Buttonbush Swamp (see the Shrub Swamp Summary in later in this chapter). In these shrub-dominated wetland natural communities, periodic flooding or other hydrologic conditions result in ongoing natural disturbance that maintains the shrub cover and retards succession to a forested community. In Vermont, shrublands also occur in areas that are specifically managed for this habitat type through periodic mowing, along managed utility corridors, and in abandoned agricultural lands. The location and extent of shrub-dominated natural communities are relatively well-known though USFWS National Wetlands Inventory and statewide natural community inventory work. The extent

of managed shrublands and abandoned agricultural lands currently in a shrub-dominated state are not currently well-inventoried.

Forest Condition

Historical Perspective: Glaciers retreated from what is now Vermont approximately 12,500 years ago. This set the stage for recolonization of the landscape by plants. Pollen records reveal that the first colonizers of the barren, post-glacial landscape were cold-tolerant, small plants that we now associate with arctic and sub-arctic tundra. Trees such as black spruce and paper birch began to appear in Vermont about 11,000 years ago, with closed canopy forests developing in many areas. Tree species migration continued over thousands of years with warmer climate species arriving in Vermont according to their individual cold-tolerances and migratory rates. By approximately 4,500 years ago, the forest composition closely resembled that of the forests present in Vermont at the time of European settlement. (Klyza and Trombulak 1999)

Native American peoples have been present in Vermont for at least 11,000 years. The size of the Native American populations in Vermont were always small. Early Paleoindians that inhabited the tundra and open woodlands had a population estimated to be less than 2,500. At the time of European settlement (1600), an estimated 4,200 Abenaki were in the Champlain Valley and as many as 3,800 in the upper Connecticut River Valley. (Klyza and Trombulak 1999) Their effect on the landscape was significant in the localized areas of vegetation management and agriculture along the river valleys and Champlain Valley. There is no evidence of widespread use of fire or other forest management in Vermont as there is for southern New England (Whitney 1999), so most of Vermont's forests were under the influence of disturbance regimes associated with wind storms. It remains uncertain if the extinction of 35 to 40 large mammal species that occurred 12,000 to 9,000 years ago was the result of climate change or Native American hunting. The alteration of the Vermont and New England landscape was much more dramatic because of European settlement. Forest that covered approximately 95 percent of the Vermont landscape in 1600 was reduced to an estimated 37 percent of the landscape in 1880. The forests were cut and cleared to provide firewood, charcoal, building materials, and agricultural land for crops and livestock. The human population of Vermont decreased around 1860s because of the Civil War, disease, emigration to the highly productive agricultural lands of the Midwest, and other factors. Since the maximum deforestation in Vermont in 1880, forests have rebounded in Vermont and now are estimated to cover 75 percent of the state (Morin et al. 2015).

It has been estimated that old forests occupied from 70 to 89 percent of the regional presettlement landscape dominated by northern hardwood forest and from 29 to 78 percent of the landscape in conifer dominated forests and swamps (Lorimer and White, 2003). The same study estimates that young forest (1-15-year age class) occupied from 1.1 to 3.0 percent of the regional presettlement landscape in areas of northern hardwood forest and 2.4 to 7.1 percent of the regional landscape in areas of spruce-northern hardwood forest. These estimates of presettlement forest conditions provide a useful background on the areas occupied by old forest and young forest but are not necessarily considered targets for each habitat type that should be created through management activities.

We do not have accurate estimates on the extent of natural shrublands in Vermont prior to European settlement. However, we do know that beaver populations were much higher than they are today. Therefore, the extent of alder swamps, shallow marshes, and wet meadows would also

have been greater than they are today, as these wetland communities are all part of the natural dynamics of beaver activity.

The percentage of early successional forest in Vermont and the region increased dramatically because of farm abandonment and young forest regeneration in the mid-1800s. Wildlife species that favor young forest increased in numbers in Vermont in response to this increase in regenerating forest. As forest cover has increased and matured in Vermont over the past 150 years, there has been a resulting decline in some species that are dependent on young forests (e.g., woodcock). Many of these declining species are listed below as SGCN.

Current Condition: Land use history has resulted in most Vermont's forests being "middle-aged". The following graph (fig 1) from Forests of Vermont and New Hampshire 2012 (Morin et al. 2015) is based on plot data across Vermont and shows the distribution forest land by age class and stocking class. This clearly shows the low percentage of land area occupied by both old forests and young forest, with most of forests in the three age classes of middle-aged forests (41-60, 61-80, and 81-100). These middle-aged forests provide many substantial functions for wildlife habitat, landscape connectivity, and ecological services, but the poor representation of old forests and young forests on the current landscape is a concern for conserving SGCN and representing biological diversity.

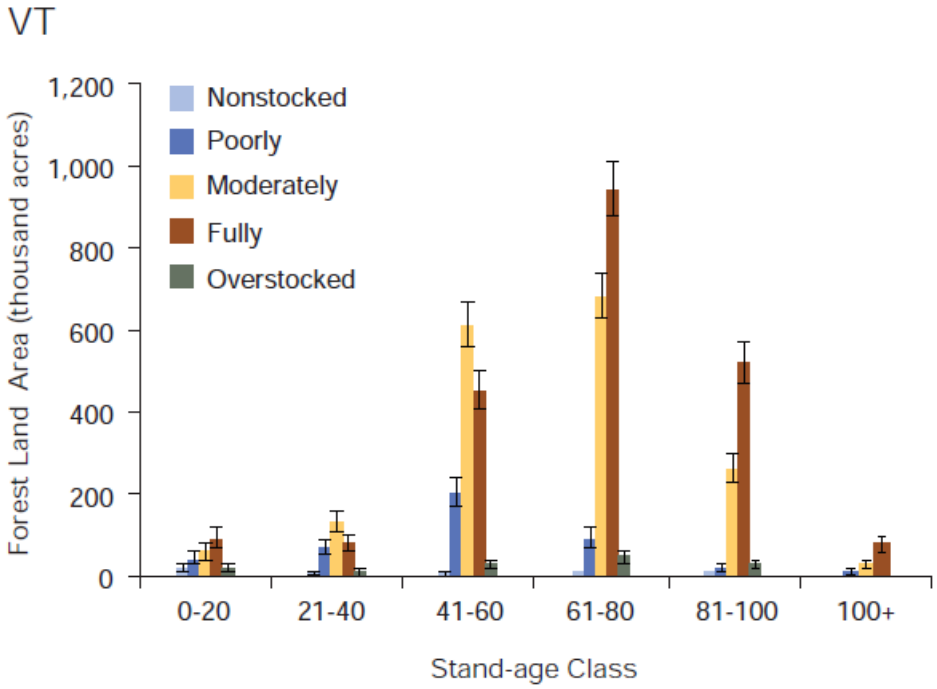

Figure 1 Vermont forests classified by age class shows that there is relatively small area of young and old forests compared to middle-aged forest.

Desired Condition (SGCN Needs): There is a clear need in Vermont to establish conservation targets for the land area and geographic distribution of old forests, young forests, and shrublands. Setting conservation targets for these habitat types should be based on estimated presettlement conditions as well as the specific needs of SGCN and other species that rely on these habitats. Although young forest and shrublands may have been a relatively minor component of the Vermont landscape in presettlement conditions, there are currently many species in Vermont that rely on these habitats now and targeted land conservation and management will be needed to ensure their

continued survival in the state. Old forests will develop over time in areas that have been designated as ecological reserves or wilderness areas, but the locations of these designated areas are biased toward high elevation and northern climate areas and the full range of natural communities and physical landscapes should be represented in old forest conditions as part of maintaining an ecologically functional landscape into the future. Some ecological characteristics of old forests can be encouraged by specific forest management techniques, but this does not replace the need for establishing old forests in which little or no active management occurs. Old forests support a high diversity of species and provide ecologically stable conditions under which evolution and natural disturbance events can occur. Over the next two years, Vermont Fish and Wildlife Department (VFWD) will be working specifically on using the best available science to set conservation targets for old forest, young forest, shrublands, and other habitats as part of the Vermont Conservation Design project.

Implementing the 2005 Wildlife Action Plan

Young forest management is a priority on VFWD's Wildlife Management Areas (WMAs). Since the adoption of the Wildlife Action Plan in 2005, an estimated 1,350 acres of Young Forest habitat has been created on WMAs. A 464-acre Young Forest Demonstration site was created on Groton State Forest, and 40 acres of Young Forest and a 4-acre woodcock courtship area have been created thus far.

Audubon Vermont's Foresters for the Birds program, developed in partnership with the Vermont Forests, Parks & Recreation Department (VFPR) in 2008, and provides foresters and landowners with education and technical assistance to manage forest lands for bird habitats. The program is proving to be an excellent mechanism to bring forest landowners with an interest in bird conservation into being active forest stewards.

Landowner's Guide--Wildlife Habitat Management for Lands in Vermont provides tips on recognizing wildlife habitat and then managing it to benefit wildlife in tandem with other management goals such as timber production. This publication was the result of a partnership of VFWD, VFPR and the USDA's Natural Resources Conservation Service.

Beginning in 2008 the Wildlife Management Institute led the implementation of the Woodcock Conservation Plan in the Northeast and published two reports on shrubland and young forest SGCN (Gilbert 2011 and Gilbert 2012).

The Environmental Quality Incentives Program (EQIP) and the former Wildlife Habitat Incentives Program (WHIP) are administered and funded by the National Resources Conservation Service (NRCS) with technical aid from VFWD Department. These programs help private landowners with the resources and expertise needed to manage their land for the benefit of fish, wildlife and overall environmental quality—be it by releasing mast or apple trees for wildlife, creating early successional habitat for nesting song birds, or controlling invasive species, these programs have helped Vermonters manage their land for wildlife. When the Wildlife Action Plan was adopted in 2005, the Vermont NRCS office quickly adopted it as a guide for its work on these programs. Over the last 10 years of this agreement, Department staff has worked with landowners on approximately 986 WHIP projects and over 220 EQIP projects throughout Vermont, resulting in the creation of nearly 3,000 acres of Young Forest habitat. This agreement is ongoing and the continued partnership is improving habitat throughout Vermont.

Species of Greatest Conservation Need in Young Forests

High Priority
Fowler's Toad (*Anaxyrus fowleri*)
North American Racer (*Coluber constrictor*)
Eastern Ratsnake (*Pantherophis alleghaniensis*)
Eastern Ribbonsnake (*Thamnophis sauritus*)
Wood Turtle (*Glyptemys insculpta*)
Whip-poor-will (*Caprimulgus vociferus*)
Bicknell's Thrush (*Catharus bicknelli*)
Common Nighthawk (*Chordeiles minor*)
Rusty Blackbird (*Euphagus carolinus*)
Spruce Grouse (*Falcipennis canadensis*)
Gray Jay (*Perisoreus canadensis*)
Eastern Towhee (*Pipilo erythrophthalmus*)
Brown Thrasher (*Toxostoma rufum*)
Canada Warbler (*Wilsonia canadensis*)
Blackpoll Warbler (*Setophaga striata*)
Golden-winged Warbler (*Vermivora chrysoptera*)
Blue-winged Warbler (*Vermivora pinus*)
Canada Lynx (*Lynx canadensis*)
Pygmy Shrew (*Sorex hoyi*)
New England Cottontail (*Sylvilagus transitionalis*)

Medium Priority
Smooth Greensnake (*Opheodrys vernalis*)
DeKay's Brownsnake (*Storeria dekayi*)
Ruffed Grouse (*Bonasa umbellus*)
Black-billed Cuckoo (*Coccyzus erythropthalmus*)
American Woodcock (*Scolopax minor*)
Bay-breasted Warbler (*Dendroica castanea*)
Prairie Warbler (*Dendroica discolor*)
Chestnut-sided Warbler (*Dendroica pensylvanica*)
Moose (*Alces alces*)
Snowshoe Hare (*Lepus americanus*)
Bobcat (*Lynx rufus*)
Long-tailed Weasel (*Mustela frenata*)

Species of Greatest Conservation Need in Old Fields/Shrubs

High Priority
Fowler's Toad (*Anaxyrus fowleri*)
North American Racer (*Coluber constrictor*)
Timber Rattlesnake (*Crotalus horridus*)
Eastern Ratsnake (*Pantherophis alleghaniensis*)
Eastern Ribbonsnake (*Thamnophis sauritus*)
Wood Turtle (*Glyptemys insculpta*)
Whip-poor-will (*Caprimulgus vociferus*)
Chimney Swift (*Chaetura pelagica*)
Common Nighthawk (*Chordeiles minor*)
Northern Harrier (*Circus cyaneus*)
Eastern Towhee (*Pipilo erythrophthalmus*)
Vesper Sparrow (*Pooecetes gramineus*)
Eastern Meadowlark (*Sturnella magna*)
Brown Thrasher (*Toxostoma rufum*)
Golden-winged Warbler (*Vermivora chrysoptera*)
Blue-winged Warbler (*Vermivora pinus*)
Bumble Bee Group (*Bumble Bee Group*)
Butterflies-Grassland Group (*Butterflies-Grassland Group*)
Moths Group (*Moths Group*)
Woodland Vole (*Microtus pinetorum*)
New England Cottontail (*Sylvilagus transitionalis*)
Silver-haired Bat (*Lasionycteris noctivagans*)
Eastern Red Bat (*Lasiurus borealis*)
Hoary Bat (*Lasiurus cinereus*)
Northern Long-eared Bat (*Myotis septentrionalis*)
Indiana Bat (*Myotis sodalis*)
Pygmy Shrew (*Sorex hoyi*)

Medium Priority
Smooth Greensnake (*Opheodrys vernalis*)
DeKay's Brownsnake (*Storeria dekayi*)
Short-eared Owl (*Asio flammeus*)
Ruffed Grouse (*Bonasa umbellus*)
Black-billed Cuckoo (*Coccyzus erythropthalmus*)
Purple Martin (*Progne subis*)
American Woodcock (*Scolopax minor*)
Field Sparrow (*Spizella pusilla*)
Prairie Warbler (*Dendroica discolor*)
Chestnut-sided Warbler (*Dendroica pensylvanica*)
Beetles-Carabid Group (*Beetles-Carabid Group*)
Long-tailed Weasel (*Mustela frenata*)
Hairy-tailed Mole (*Parascalops breweri*)
Southern Bog Lemming (*Synaptomys cooperi*)
Gray Fox (*Urocyon cinereoargenteus*)
Big Brown Bat (*Eptesicus fuscus*)
Masked Shrew (*Sorex cinereus*)

Species of Greatest Conservation Need in Shrub Swamps

High Priority
Fowler's Toad (*Anaxyrus fowleri*)
Boreal Chorus Frog (*Pseudacris maculata*)
Timber Rattlesnake (*Crotalus horridus*)
Eastern Ribbonsnake (*Thamnophis sauritus*)
Spotted Turtle (*Clemmys guttata*)
Wood Turtle (*Glyptemys insculpta*)
American Black Duck (*Anas rubripes*)
Red-shouldered Hawk (*Buteo lineatus*)
Whip-poor-will (*Caprimulgus vociferus*)
Black Tern (*Chlidonias niger*)
Common Nighthawk (*Chordeiles minor*)
Rusty Blackbird (*Euphagus carolinus*)
Eastern Towhee (*Pipilo erythrophthalmus*)
Pied-billed Grebe (*Podilymbus podiceps*)
Vesper Sparrow (*Pooecetes gramineus*)
Brown Thrasher (*Toxostoma rufum*)
Blue-winged Warbler (*Vermivora pinus*)
Bumble Bee Group (*Bumble Bee Group*)
Butterflies-Wetland Group (*Butterflies-Wetland Group*)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (*Odonates-Bog/Fen/Swamp/Marshy Pond Group*)
Water Shrew (*Sorex palustris*)
Silver-haired Bat (*Lasionycteris noctivagans*)
Eastern Red Bat (*Lasiurus borealis*)
Little Brown Bat/Myotis (*Myotis lucifugus*)
Northern Long-eared Bat (*Myotis septentrionalis*)
Indiana Bat (*Myotis sodalis*)

Medium Priority
Blue-spotted Salamander (*Ambystoma laterale*)
Spotted Salamander (*Ambystoma maculatum*)
Four-toed Salamander (*Hemidactylium scutatum*)
Common Watersnake (*Nerodia sipedon*)
Smooth Greensnake (*Opheodrys vernalis*)
DeKay's Brownsnake (*Storeria dekayi*)
Common Musk Turtle (*Sternotherus odoratus*)
Ruffed Grouse (*Bonasa umbellus*)
Black-billed Cuckoo (*Coccyzus erythropthalmus*)
Chestnut-sided Warbler (*Dendroica pensylvanica*)
Black-crowned Night-heron (*Nycticorax nycticorax*)
American Woodcock (*Scolopax minor*)
Lesser Yellowlegs (*Tringa flavipes*)
Beetles-Carabid Group (*Beetles-Carabid Group*)
Moose (*Alces alces*)
Wolf (*Canis sp?*)
Snowshoe Hare (*Lepus americanus*)
Bobcat (*Lynx rufus*)
Eastern Mountain Lion (*Puma concolor couguar*)
Masked Shrew (*Sorex cinereus*)
Gray Fox (*Urocyon cinereoargenteus*)
Big Brown Bat (*Eptesicus fuscus*)

Species of Greatest Conservation Need in Old Forests*

High Priority
Early Hairstreak (*Erora laeta*)
Northern Goshawk (*Accipiter gentilis*)
American Marten (*Martes americana*)
Silver-haired Bat (*Lasionycteris noctivagans*)
Hoary Bat (*Lasiurus cinereus*)
Small-footed Bat (*Myotis leibii*)
Little Brown Bat/Myotis (*Myotis lucifugus*)
Northern Long-eared Bat (*Myotis septentrionalis*)
Indiana Bat (*Myotis sodalis*)

Medium Priority
Hackberry Emperor (*Asterocampa celtis*)
Northern Goshawk (*Accipiter gentilis*)
Wolf (*Canis sp?*)
Northern Flying Squirrel (*Glaucomys sabrinus*)
Eastern Mountain Lion (*Puma concolor couguar*)
Big Brown Bat (*Eptesicus fuscus*)

*Except for some young forest-dependent species, most of the forest dwelling wildlife historically found in Vermont' are expected to do well or thrive in old forests.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/ Information Need Category	Problem/ Information Need Detail	Rank
Inadequate Distribution of Successional Stages	Lack of appropriate landscape level approach to management resulting in a lack both old and young forest in appropriate size and juxtaposition. Most of VT's forests are 'middle-aged' and lack the needed forest structural diversity and biological diversity	High
Information Gap	An inventory of old and young forests statewide is needed; and a monitoring/tracking system is needed for both	High
Information Gap	Land managers need geographic distribution and area targets for conservation and management	High
Invasive Exotic Species	Young forests are particularly susceptible to colonization by non-naïve invasive species (in certain parts of the state, particularly warm regions and areas with calcium rich substrates).	High
Habitat Fragmentation	Parcelization of forests making it more difficult to manage broader landscapes. Fragmentation of habitat by development, roads and trails.	High
Habitat Conversion	Conversion of habitat to urban/suburban development	High
Inventory of SGCN	Better information is needed on the distribution of young forests, old forests and shrub species (especially herps and mammals) and the relative values of the various types and sizes of young and old forests and shrublands to SGCN.	Medium

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Inventory the distribution and abundance of young forests, old forests and shrublands statewide	Number of acres positively affected by management. Population response to management	ANR, USFWS, USFS	USFS, SWG, PR
Refine our understanding of the species that utilize and/or depend on old forests, young forest and shrublands	Completion of the species phase of the Vermont Conservation Design.	ANR, GMNF, UVM	SWG, PR,
Determine targets for young and old forests and shrublands on state lands based on SGCN needs, current distribution levels by biophysical region, presettlement estimates, public demand and legal constraints and objectives of parcel ownership,	Number of state land parcels with target habitats. Number of state lands parcels meeting targets	ANR, USFS, USFWS,	USFS, ANR, PR
Work with partners and willing landowners to promote a sustainable range of forest age, structure, and composition that benefits SGCN and encourages a diverse assemblage of native plants and organisms within the landscape. Young forest habitat should be strategically located, recognizing the importance of interior forest habitat, and providing the full suite of habitat characteristics for SGCN			

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Promote conservation easements and incentives to landowners managing young and old forests and shrublands for SGCN.	Number of maintained or enhanced sites on private land	ANR, VFB, VWA, Coverts, NRCS, VLT, VHCB	EQIP, FSA
Provide technical assistance to private landowners, user groups consulting foresters and forest managers to manage for SGCN including, SGCN associated with early successional and late successional habitat and Ecologically Sensetive Treattement Areas. Distribute *Landowners Guide - Wildlife Habitat Management for Lands in Vermont* (VFWD 2015)	Number landowners managing for SGCN.	NRCS, TNC, ANR, SAF, VWA, Covert	NRCS, SWG
Manage power line right-of-ways to support SGCN that depend on young forests and shrublands and enhance surrounding areas by creating and maintaining young forests and shrublands where feasible.	Number of sites and total area designated for young forests and shrublands management	ANR, VETCO, GMP	SWG, VETCO, GMP
Develop education and outreach program to provide information about young forest SGCN and management options to enhance their populations in Vermont.	Number of maintained or enhanced sites on private land	ANR, NRCS, Coverts, VWA	SWG, EQIP, PR,
For old forests, develop education and outreach program and BMPs emphasizing long rotations and strategies producing a varied 3-dimensional stand with extensive development of vertical diversity and canopy gaps.	Number of maintained or enhanced sites on private land. Acres of appropriate habitat enrolled in UVA's ESTA program	ANR, Covets, VWA	SWG

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Partners in Flight	Regional Bird conservation	VFWD, USFWS,PIF,NABSCI
Region 5 Woodcock Management Plan	Woodcock conservation	WMI, VFWD, USFWS
Public Lands Long Range Plans	Species Conservation	ANR, GMNF, Conte Refuge
Wildlife Habitat Improvement Program, LIP	Species Conservation	NRCS

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Floodplain Forest Summary

Characteristics and Location

Floodplain forests are usually dominated by silver maple or occasionally sugar maple, with abundant ostrich fern or sensitive fern. They are closely associated with river and lake floodplains and have exposed mineral soils of alluvial origin.

Natural communities of the Floodplain Forest include: Silver Maple-Ostrich Fern Riverine Floodplain Forest, Silver Maple-Sensitive Fern Riverine Floodplain Forest, Sugar Maple-Ostrich Fern Riverine Floodplain Forest and Lakeside Floodplain Forest.

Natural communities of the Floodplain Forest:

Silver Maple-Ostrich Fern Riverine Floodplain Forest: This forest is found generally in the floodplains of moderate-gradient rivers. Silver maple and ostrich ferns are the dominant species and the soils are typically well drained sandy alluvium. Boxelder may be abundant in young forests.

Silver Maple-Sensitive Fern Riverine Floodplain Forest: These forests occur generally in the floodplains of large, low-gradient rivers. Silver maple is the dominant tree, but green ash and swamp white oak may be present. Sensitive fern and false nettle are characteristic. Soils are moist, typically mottled, silty alluvium.

Sugar Maple-Ostrich Fern Riverine Floodplain Forest: This uncommon floodplain forest type occurs along small to moderate sized high gradient rivers in areas of calcium-rich bedrock. Sugar maple, white ash, basswood, boxelder, and ostrich fern are common. There can be a diverse herbaceous layer. Soils are well drained sandy alluvium. Many examples of this community are uplands.

Northern Conifer Floodplain Forest: This rare floodplain forest occurs along small to moderate-sized rivers, primarily in northeastern Vermont. The silty alluvial soils typically support balsam fir, northern white cedar, white spruce, black cherry, and black ash.

Lakeside Floodplain Forest: These forests occur primarily within the flooding zone of Lake Champlain. Silver maple and green ash are the dominant trees. Herbs include sensitive fern, false nettle, marsh fern, white grass, and Tuckerman's sedge. Surface organic layers are present in the moist silty soils and there are mottles near the surface.

Floodplain Forest Condition

Historical Perspective: Although there is little specific information on distribution and composition of floodplain forests prior to European settlement in the region (Siccama 1971), it is expected that they covered large areas and were likely continuous bands of forest extending unbroken for miles along all our major rivers. Forests of towering silver maple and American elm likely covered many of the active floodplains, with more diverse forests of sugar maple, red oak, and other species on higher terraces of former floodplains. (Sorenson et al. 1998). Although their total numbers were relatively small, evidence suggests that the Abenaki people that lived in Vermont concentrated their villages and agriculture on and

adjacent to the floodplains of the Connecticut River, other major rivers, and Lake Champlain (Klyza and Trombulak 1999).

Current Condition: High quality floodplain forests are now uncommon in Vermont because the majority of the floodplain forest in Vermont and the region has been converted to agricultural use. Floodplains have been prized as agricultural lands because of their high soil fertility associated with annual flooding and deposition and because of the absence of stones. Because of their high value as agricultural lands, floodplain forests are now limited to fragments of their original size. The small percentage of riverine floodplains remaining in a forested condition is illustrated for Franklin County by a comparison made between the area of alluvial soils identified by the Natural Resources Conservation Service (USDA 1979) and the area of floodplain forests identified in a Vermont Fish and Wildlife Department floodplain forest inventory project (Sorenson et al. 1998). Although approximate, this comparison indicates that as little as 11% of the floodplains in Franklin County remain in a forested condition.

Significant changes to the flooding regimes of floodplain forests results from dam operation and the construction of roads, bridges, and culverts along rivers and in floodplains. Furthermore, the disturbed nature of many of the floodplain sites makes them vulnerable to invasive exotic plant species, such as goutweed (*Aegopodium podograria*), garlic mustard (*Alliaria petiolata*), dame's-rocket (*Hesperis matronalis*), honeysuckle (*Lonicera* spp.), and Japanese knotweed (*Polygonum cuspidatum*) (Sorenson et al. 1998).

Desired Condition (SGCN Needs): Floodplain forest is essential to those SGCN that require habitat mosaics of aquatic and riparian areas and upland forest. Several of the species associated with floodplain forests require a riparian mosaic that depends upon functioning floodplain wetlands (e.g., pied-billed grebe, Odonata, American black duck); many of which are most abundant in the floodplains of larger river systems. Other species such as the water shrew and spotted salamander use floodplain forest directly adjacent to the stream or river. Lastly, there are some species that require large (10-1000ha) contiguous blocks of forested habitat along stream and rivers—these range from the bald eagle to the wood turtle. In all, floodplain forest provides habitat for a total of 49 wildlife SGCN and 28 plant SGCN. Desired conditions include functional floodplain forests in healthy examples (mature, unfragmented) distributed across their range. High water quality is also an essential element of floodplain forest quality. Focus should be given to the largest examples.

Implementing the 2005 Wildlife Action Plan

VFWD continues to focus conservation work on floodplain forests due to their high habitat functions, as well as being critical for river stability. An example is the acquisition of the Johnson Farm in the northeastern corner of Vermont, in the towns of Lemington and Canaan. Acquired in 2012, the Department now owns 283 acres and manages public access on an additional 130 acres of eased land on the adjacent farm conserved by the Vermont Land Trust. The Johnson Farm Wildlife Management Area supports over eight miles of river and stream frontage, including 6.1 miles along the Connecticut River. Most of this shoreline area has well established riparian habitat or was subject to an extensive buffer restoration project in 2005-2006 through the USDA's Conservation Reserve Enhancement Program. The wetland natural community types found on the WMA includes floodplain forest, alder

swamp, sedge meadow, shallow emergent marsh, deep broadleaf marsh, cattail marsh, poor fen and river mud shore.

In 2013, the Department completed the Vermont BioFinder project, a map and database identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. A notable outcome of the project was a map of all aquatic features and the riparian areas/valley bottoms in which rivers and streams occur and the identification of these areas as critical conservation components for wildlife habitat, rare species, aquatic system health, and wildlife/landscape connectivity. The project mapping results for aquatic features, valley bottoms, and riparian connectivity together provide a tool for prioritizing restoration of riparian areas, including floodplain forests.

Species of Greatest Conservation Need in Floodplain Forests

High Priority
American Black Duck (Anas rubripes)
Bald Eagle (Haliaeetus leucocephalus)
Canada Warbler (Wilsonia canadensis)
Fowler's Toad (Anaxyrus fowleri)
Wood Turtle (Glyptemys insculpata)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Odonates-Lakes/Ponds Group (7 species)
Freshwater Snails Group (15 species)
Butterflies-Hardwood Forest Group (4 species)
Northern Long-eared Bat (Myotis septentrionalis)
Tri-colored bat (Perimyotis subflavus)
Water Shrew (Sorex palustris)

Medium Priority
Great Blue Heron (Ardea herodias)
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Cerulean Warbler (Dendroica cerulea)
Black-crowned Night-heron (Nycticorax nycticorax)
Pied-billed Grebe (Podilymbus podiceps)
Spotted Salamander (Ambystoma maculatum)
DeKay's Brownsnake (Storeria dekayi)
Masked Shrew (Sorex cinereus)

SGCN Notes: Vascular plant SGCN not listed here include 24 species (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need/Categories	Problem/Info Need Detail	Rank
Habitat Conversion	Agriculture and development	High
Habitat Fragmentation	Wider ranging birds, mammals, and reptiles require unfragmented habitat mosaics of 10-1000 ha or more	High
Inadequate Disturbance Regime	Dams, drainage ditching, filling, and runoff that affect flooding, erosion, and deposition	High
Habitat Degradation	Altering forest conditions along streams and rivers	High
Climate Change	Increased flood severity could increase erosion	Medium
Distribution of successional stages	Loss of mid-story forest cover due to lack of disturbance or active management.	Medium
Invasive Exotic Species	Loosestrife and common reed	High
Trampling or direct impacts	Human activity proximate to nesting birds	High
Inventory	Determine the location, distribution and condition of floodplain forests throughout their range.	Medium

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Locate additional floodplain forests not already mapped by FWD and assess management practices for these forests.	Number of sites located and assessed	ANR, FSA, UVM, FPR	SWG
Identify riparian areas that are high priority for restoration of floodplain forest and other natural communities to increase river stability, water quality, wildlife habitat, and connectivity.	Number of sites located and on which restoration is successfully completed.	ANR, NRCS	SWG, WRP, EQUIP
Identify areas within the state with the largest matrix of floodplain forest for inclusion in conservation opportunity area.	Number of opportunity areas identified	ANR, UVM, NRCS	WRP, SWG
Consider protection of opportunity areas via acquisition of conservation easements, management leases and fee title acquisition	Number of sites conserved	ANR, VHCB, TNC, NRCS	VHCB, WRP, TNC
Identify, prioritize and control problematic native and invasive species deleterious to SGCN and prevent introduction of these species.	Acres surveyed/mapped; acres with dominant native vegetation protected or restored	USFWS, GMNF, FPR, NRCS, municipal & watershed groups, foresters	ANR, NRCS, FSA
Manage exotic species on state owned sites and provide technical assistance to other landowners regarding control of exotics	Number of sites with control activities and/or invasive monitoring	ANR, NEPCoP, TNC, NRCS	EQIP, SWG
Technical assistance to private landowners, NGOs and government agencies to maintain and enhance floodplain forests for SGCN	Number of acres of floodplain forest managed for SGCN maintained, enhanced or restored. Number landowners incorporating SGCN into their land management.	NRCS, TNC, VFWD, FSA	EQIP, WRP, CREP, CRP, SWG
Technical assistance to towns and regional planning organizations to maintain and enhance floodplain forests for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of acres of floodplain forest managed for SGCN maintained, enhanced or restored. Number landowners incorporating SGCN into their land management, Number of towns including SGCN in their planning.	NRCS, TNC, VFWD	SWG, WRP, CREP
Financial incentives for private landowners to maintain and enhance floodplain forests for SGCN	Number of acres conserved/restored	VFWD, NRCS	EQIP, WRP
Conservation easements on higher quality sites with greatest number of SGCN or T&E listed SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT
Manage or remove dams to restore more natural flooding regimes	Number sites with adequate flooding regimes	ANR, CT River Watershed Council	ACOE

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Floodplain Forests of Vermont	Natural Community Inventory	ANR
Draft VT Bat Conservation Plan	Bat conservation	ANR
Bald Eagle recovery plan	Bald eagle recovery	NWF, ANR
Partners in Flight	Bird conservation plan	ANR, VT Audubon, USFWS
2015 Update Vermont Forest Resources Plan (Draft)	Conservation of healthy forests and the sustainable use and management of Vermont's Forests	FPR
North American Waterfowl Plan	Waterfowl populations	USFWS, ANR, DU
Riparian Management Guidelines for Agency of Natural Resources Lands (Draft 2015)	Informs the development of recommendations for Act 250-regulated projects	ANR

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Hardwood Swamps Summary

Characteristics and Location

Hardwood dominated swamps are the most common swamp type in the state. They are especially common in the warmer regions of the state on flatter topography and so reach their largest size and greatest abundance in the Champlain Valley and are least frequent in the Northeast Highlands. While two of the seven types are widely distributed, two others are restricted to a few biophysical regions, and the remaining three occur primarily in only a single biophysical region.

Hardwood swamps provide many functions, including flood storage, water quality protection, and fish, wildlife, and endangered species habitat. Because of their more open, deciduous canopy, hardwood swamps have more significant understory development than do softwood dominated swamps. This feature, along with their characteristic hummock and hollow topography, creates a landscape mosaic that provides an abundance of microhabitats.

Hardwood Swamp Natural Communities

The hardwood swamp formation includes the nine following natural community types:

Red Maple-Black Ash Seepage Swamp: This is the most common hardwood swamp type in the state. It occurs in all biophysical regions as either small or large patches. Although they occur in various settings, this natural community type is closely associated with groundwater seepage and does not typically experience surface flooding of long duration. While red maple is typically the dominant tree, black ash is very characteristic of this community. There are also other tree species present and well-developed shrub and herbaceous layers.

Red Maple-Sphagnum Acidic Basin Swamp: This is another common swamp type that is widely distributed throughout the state. Typically, it occurs in poorly drained basins with deep organic soils. Groundwater seepage is absent and the permanently saturated soils tend to be quite acidic. Since they occur in basins, most of these basin swamps are small and typically have no inlet or outlet streams. Red maple is the dominant tree, often with a co-dominance of yellow birch and various softwoods. The shrub layer is well developed, but the herb layer is less diverse, often with dominance by cinnamon fern. Moss cover typically approaches 100%.

Red Maple-Northern White Cedar Swamp: This uncommon community type exists as large patches mostly in the western part of the state. This community is limited to areas of calcareous bedrock and is often associated with floodplains, especially in the Champlain Valley. Although it can also occur in isolated basins, it can form huge wetland complexes where it is associated with larger rivers. Red maple, white cedar, and black ash typically dominate the canopy. Both the shrub and herbaceous layer tend to be sparse depending upon the degree of shading and the abundance of water-filled hollows.

Calcareous Red Maple-Tamarack Swamp: This is a rare community type that is restricted to areas of calcareous groundwater seepage. It is mostly restricted to the Vermont Valley with only a few examples in other biophysical regions. It typically

occupies small isolated basins, but may also occur as part of a large wetland complex. Red maple and tamarack dominate the canopy that can range from nearly closed to very open. In the latter situation, especially, a diversity of shrubs, herbaceous, and bryophyte species flourish.

Red or Silver Maple-Green Ash Swamp: This uncommon natural community type is largely restricted to the Champlain and Vermont Valleys. It occurs as large patches mostly associated with Lake Champlain. This swamp type typically undergoes extensive spring flooding that often results in saturated soils throughout the growing season. Although silver maple typically dominates, red maple and green ash may be very abundant. Both the shrub and herbaceous layer are well developed.

Red Maple-Black Gum Swamp: This rare community type occurs as small patches. It is mostly restricted to the southeastern part of the state with a few outliers in other regions. It occurs in small basins that are isolated from surface waters and that contain deep, saturated organic soils. Red maple and black gum co-dominate, but hemlock, yellow birch, and red spruce are also common.

Red Maple-White Pine-Huckleberry Swamp: This is a very rare natural community type that is restricted to the Champlain Valley. All known examples occur near the center of much larger wetland complexes. The canopy is dominated by red maple and white pine, but the most striking feature is the dense cover of huckleberry below. Typically, cinnamon fern dominates the herbaceous layer.

Wet Clayplain Forest: A wet forest occurring on the very poorly drained clay soil types of the Champlain Valley. These forests have a diversity of tree species, including swamp white oak, red maple, black ash, green ash, shagbark hickory, and hemlock. Due to their wetness, many Wet Clayplain Forests are the only forest fragments remaining in highly agricultural areas of the Champlain Valley.

Wet Sand-Over-Clay Forest: Similar to Wet Clayplain Forest, but occurring on wet soils with a sand layer overlying clay. Green ash, swamp white oak, and white pine are all common and there is typically a dense tall shrub layer.

Hardwood Swamps Condition

Current Condition: Although still relatively common in the state, hardwood swamps were formerly even more abundant. The primary activities resulting in loss of hardwood swamps were commercial and residential road development and road construction. Presently, agricultural conversion results in the greatest loss of swamps. Although protected by the Vermont Wetland Rules, many smaller examples are not mapped and therefore not protected under the regulations. Since many of these swamp types are most abundant in the lower, warmer regions of the state, they are subject to hydrologic impairment and incremental loss along the edges as the area around them is developed.

The primary problems to SGCN include agricultural conversion, invasion by exotics, altered hydrology, development and unrestricted logging.

Desired Condition: Forested wetlands provide habitat for several SGCN in the state. Hardwood dominated examples are especially diverse since they tend to be at lower

elevations and in warmer areas of the state than coniferous swamps. A total of 36 SGCN animals and 43 plant SGCN rely on one or more of these natural communities to provide habitat. Several of the species associated with hardwood swamps also require a habitat mosaic that depends on functioning swamps. Desired conditions include functional hardwood swamps in healthy examples (mature, unfragmented) across the distribution of their range High water quality is also essential to habitat quality. Focus should be given to the largest examples.

Implementing the 2005 Wildlife Action Plan

In 2013, VFWD and The Nature Conservancy, and working with other partners, completed an inventory and prioritization of clayplain forest fragments in the Champlain Valley. The high priority examples of all clayplain forest types, including Wet Clayplain Forest and Wet Sand-Over-Clay Forest, were entered into the Department's Natural Heritage Database to be used for conservation planning.

Species of Greatest Conservation Need in Hardwood Swamps

High Priority
American Black Duck (Anas rubripes)
Canada Warbler (Wilsonia canadensis)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Eastern Ratsnake (Pantherophis alleghaniensis)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Northern Long-eared Bat (Myotis septentrionalis)
Tri-colored bat (Perimyotis subflavus)
Pygmy Shrew (Sorex hoyi)

Medium Priority
Great Blue Heron (Ardea herodias)
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Rusty Blackbird (Euphagus carolinus)
Black-crowned Night-heron (Nycticorax nycticorax)
Pied-billed Grebe (Podilymbus podiceps)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
DeKay's Brownsnake (Storeria dekayi)
Masked Shrew (Sorex cinereus)

SGCN Notes: Vascular plant SGCN not listed here 44 (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need/Category	Problem/Info Need Detail	Rank
Habitat Conversion	Agriculture, road building, development	High
Hydrologic alteration	Sedimentation, development in watershed, road building, dams	High
Invasion by Exotic Species	Non-native species can spread and degrade the habitat for wildlife and eliminate some plant species	Medium
Habitat Degradation	Selective removal of cedar or black gum, logging on non-frozen ground, heavy cutting	High

Habitat Fragmentation	Roads, agriculture, and development break swamps into smaller patches	High
Inventory	Statewide inventory has been completed, but not all sites have been evaluated	Low

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Provide wetland data to ANR Wetlands Office and EPA	Number of sites added to Natural Heritage Database	DEC, EPA	SWG, EPA
Locate hardwood swamps and assess their management practices.	Number of sites located and assessed	ANR, FSA, UVM, FPR	SWG
Provide support and technical information to DEC Wetlands Office for designation of Class 1 wetlands	Number of wetlands reclassified to Class 1	ANR (FWD and DEC)	SWG, PR (technical assistance)
Identify areas within the state with the largest matrix of hardwood swamps for inclusion in conservation opportunity areas.	Number of opportunity areas identified	ANR, UVM	SWG
Consider protection of large hardwood swamps via acquisition of conservation easements, management leases and fee title acquisition	Number of sites conserved	ANR, VHCB, TNC	VHCB, TNC
Manage exotic species on state owned sites and provide technical assistance to other landowners regarding control of exotics	Number of sites with control activities and/or invasive monitoring. Number sites where invasive species are eliminated or controlled	NEPCoP, TNC, NRCS	SWG
Provide technical assistance to private landowners, NGOs and government organizations to plan and manage for SGCN in hardwood swamps. Distribute *Landowners Guide - Wildlife Habitat Management for Lands in Vermont* (VFWD 2015)	Number of acres maintained, enhanced or restored. Number landowners incorporating SGCN into their land management.	NRCS, TNC, VFWD, FSA	SWG, CREP, EQIP, CRP
Provide technical assistance to towns and regional planning organizations to plan and manage for SGCN in hardwood swamps. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of acres maintained, enhanced or restored. Number landowners incorporating SGCN into their land management, Number of towns including SGCN in their planning.	NRCS, TNC, VFWD	SWG, CREP
Financial incentives for private landowners	Number of acres conserved/restored	VFWD, NRCS	EQIP, WRP
Conservation easements on higher quality sites with greatest number of SGCN.	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Plan or planning entity	Goal/Scope of plan	Lead
New England Plant Conservation Programs	Recovery of various plant species in New England	ANR
North American Waterfowl Plan	Waterfowl conservation and management	ANR

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

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Sorenson, E.R., B. Engstrom, M. Lapin, R. Popp and S. Parren. 1998. Northern White Cedar swamps and Red Maple-Northern White Cedar Swamps of Vermont: Some Sites of Ecological Significance. NNHP, VT. Fish and Wildlife Department.

Thompson, E. H., and E. R. Sorenson. 2005. Wetland, Woodland, Wildland - A guide to the natural communities of Vermont. University Press of New England, Hanover and London,

Softwood Swamps Summary

Characteristics and Location

Most softwood swamps in Vermont are situated at higher elevations in the cooler regions of the state. The one exception are hemlock swamps which behave more like hardwood swamps and are in the lower, warmer portions of the state. Because of the dense shading in softwood swamps, the understory shrub and herbaceous layers are generally quite sparse. Conversely due to these same moist shady conditions, bryophyte cover tends to be quite abundant. All the natural communities in this formation occur as small patches on the landscape except for spruce-fir tamarack swamps which occur as large patch communities.

Eight natural communities included within the softwood swamp group

Northern White Cedar Swamp: This is an uncommon natural community type that is associated with calcareous bedrock and groundwater seepage that makes the dissolved minerals available to the plants. Although it occurs in most of the state's biophysical regions, this community is more abundant in the northern half of the state since white cedar declines to the south. In addition to white cedar, balsam fir may be abundant, but the dense shading results in a sparse shrub and herb layers. Only bryophytes attain abundance in these swamps.

Northern White Cedar Sloping Seepage Forest: An uncommon type of cedar swamp known only from northeastern and northcentral Vermont and closely associated with calcium-rich bedrock. Northern white cedar dominated over a sparsely vegetated and gently sloping ground with mineral-enriched ground water flows just below the surface.

Boreal Acidic Northern White Cedar Swamp: An uncommon swamp of northeastern and north central Vermont found in landform settings with swamp watersheds and no inlet or outlet streams. Northern white cedar dominates the closed canopy over a carpet of wet Sphagnum mosses. Spruce-Fir-Tamarack Swamp: This uncommon natural community is totally absent from the warmer parts of the state. They typically occupy basins that are isolated from surface water movement and have deep organic soils. The canopy is dominated by red or black spruce, fir, and tamarack in varying abundance. Generally, more tamarack is indicative of more mineral rich conditions while more black spruce is indicative of deeper peat and less enriched conditions. Despite the deep shade, several tall shrubs persist here, especially mountain holly and wild raisin. Herbs are sparse whereas bryophytes proliferate in the cool, moist conditions.

Red Spruce-Cinnamon Fern Swamp: This uncommon swamp type is most abundant in the southern Green Mountains, although it occurs throughout Vermont. Red spruce is dominant over a ground cover of cinnamon fern and Sphagnum mosses. Organic soils may be deep, but there is little mineral enrichment from groundwater.

Black Spruce Swamp: As the peaty soils become deeper and increasingly acidic and saturated, black spruce begins to replace the less tolerant red spruce. This community is restricted to only the coldest locations where they occupy basins that have gradually accumulated peat over the millennia. Black spruce dominates the canopy which is generally rather low and sparse. These swamps have low shrub and herbaceous diversity

due more to the cold, wet, acidic conditions than shading. In openings, low shrubs characteristic of bogs may be common, but bryophytes are ubiquitous throughout the community.

Hemlock-Balsam Fir-Black Ash Seepage Swamp: This uncommon swamp is found throughout Vermont at lower elevations. It is closely associated with mineral enrichment from groundwater seepage. Hemlock and/or balsam fir are dominant and black ash is typically present. Herbaceous plants and mosses are abundant and diverse, reflecting the mineral-enriched groundwater.

Hemlock-Sphagnum Acidic Basin Swamp: This rare swamp type occurs in the warmer regions of Vermont and only in landform settings with small watersheds. There are no inlet or outlet streams and peat accumulations are typically several feet or more. Hemlock is dominant over a moist swamp floor carpeted by Sphagnum mosses.

Softwood Swamps Conditions

Current Conditions: Softwoods swamps have been less impacted than either hardwood swamps or floodplain forest communities due to their location in the colder regions of the state and their generally saturated peat soils. As with the other two wetland types, softwood swamps also receive some protection from the Vermont Wetland Regulations. Nonetheless, they are still limited by habitat degradation and alteration, hydrologic impairment, and sedimentation from development on the fringes and in the watershed, road construction, and poorly planned logging. Exotic species, and herbivory, especially by moose, are also a concern. A potentially major problem for hemlock swamps is the presence in southern Vermont of the hemlock wooly adelgid, an introduced insect that could devastate the Vermont's hemlocks.

Desired Conditions: The eight natural communities in softwood swamp formation provide habitat for 26 SGCN animals. This includes many birds, but also some turtles and salamanders. A total of 33 plant SGCN occur in softwood swamps; not surprisingly, the majority of which are bryophytes which thrive in the cool, moist, shady conditions. Only spruce-fir-tamarack swamps occur as large patches; however, this community and northern white cedar swamps are often included within much larger wetland complexes. Three of the four community types exist as small patches, they are more easily protected; however, protection would need to extend beyond the wetland boundary to include at least a portion of the watershed and should include connectivity to softwood swamps. In such situations protection would need to apply to the entire complex. Desired conditions include functional softwood swamps in healthy examples (mature, unfragmented) across the distribution of their range. High water quality is also essential to habitat quality.

Implementing the 2005 Wildlife Action Plan

In 2010, VFWD completed a statewide inventory of softwood swamps which included assessment of 162 sites. Because of this project and data collected, the natural community classification was revised to include new types. Breeding bird and amphibian surveys were conducted so that animal species could be more closely associated with the natural community types. Information was provided to landowners on the importance of their swamps for the habitat they provide and recommendations for management.

Species of Greatest Conservation Need in Softwood Swamps

High Priority
American Black Duck (Anas rubripes)
Spruce Grouse (Falcipennis canadensis)
Canada Warbler (Wilsonia canadensis)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
American Marten (Martes americana)
Rock Vole (Microtus chrotorrhinus)
Northern Long-eared Bat (Myotis septentrionalis)
Northern bog lemming (Synaptomys borealis)
Southern Bog Lemming (Synaptomys cooperi)

Medium Priority
Great Blue Heron (Ardea herodias)
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Rusty Blackbird (Euphagus carolinus)
Black-crowned Night-heron (Nycticorax nycticorax)
Gray Jay (Perisoreus canadensis)
Black-backed Woodpecker (Picoides arcticus)
Pied-billed Grebe (Podilymbus podiceps)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
Masked Shrew (Sorex cinereus)
Smoky Shrew (Sorex fumeus)

SGCN Notes: Vascular plant SGCN not listed here 19 (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need/Category	Problem/Info Need Detail	Rank
Habitat Conversion	Development, road construction	High
Habitat Fragmentation	Roads and development fragment the habitat into smaller patches or from larger habitat mosaics for the wider-ranging species (e.g., wood turtle, American marten)	High
Hydrologic Alteration	Sedimentation, development in watershed, road building, dams	Medium
Invasion by Exotic Species	Non-native species (e.g., wooly adelgid) can spread and degrade the habitat for wildlife and eliminate some plant species	Medium
Habitat Degradation	Selective removal of cedar, logging on non-frozen ground, heavy cutting, lack of mature and over mature stands	High
Herbivory	Moose can eliminate regeneration in some community types	Medium
Inventory	Distribution, location and condition of these communities are not known. The ongoing statewide inventory needs to be completed to identify and protect the best examples	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Provide information to State Wetlands Office and EPA	Number of sites added to the Natural Heritage Database	DEC, EPA	SWG, EPA
Provide support and technical information to DEC Wetlands Office for designation of Class 1 wetlands	Number of wetlands reclassified to Class 1	ANR (FWD and DEC)	SWG, PR (technical assistance)
Locate additional softwood swamps of high significance and assess their management practices.	Number of sites located and assessed	ANR, FSA, UVM, FPR	SWG
Identify areas within the state with the largest matrix of softwood swamps for inclusion in conservation opportunity areas.	Number of opportunity areas identified	ANR, UVM	SWG
Consider protection of large softwood swamps via acquisition of conservation easements, management leases and fee title acquisition	Number of sites conserved	ANR, VHCB, TNC	VHCB, TNC
Manage exotic species on state owned sites and provide technical assistance to other landowners regarding control of exotics	Number of sites with control activities and/or invasive monitoring. Number sites where invasive species are eliminated or controlled	ANR, NEPCoP, TNC, NRCS	SWG
Technical assistance and/or financial incentives to private landowners, NGOs and government organizations to maintain and enhance softwood swamps for SGCN,	Number landowners incorporating SGCN into their land management, Number of acres conserved/restored	NRCS, TNC, VFWD, FSA	SWG, EQIP, CREP, CRP, WRP
Technical assistance and/or financial incentives to towns and regional planning organizations to maintain and enhance softwood swamps for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns considering SGCN in their planning for softwood swamps. Number of acres conserved/restored	NRCS, TNC, VFWD	SWG, WRP, EQIP, CRP, CREP
Conservation easements on higher quality sites with greatest number of SGCN or T&E listed SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC, NRCS	VHCB, VLT, WRP

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Plan or planning entity	Goal/Scope of plan	Lead
New England Plant Conservation Program – various Conservation Plans	Recovery of various plant species in New England	ANR
American Marten Recovery Plan	Recovery of American Marten in Vermont	ANR
North American Waterfowl Plan	Waterfowl conservation and management	ANR

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

Sorenson, E.R., B. Engstrom, M. Lapin, R. Popp and S. Parren. 1998. Northern White Cedar swamps and Red Maple-Northern White Cedar Swamps of Vermont: Some Sites of Ecological Significance. NNHP, VT. Fish and Wildlife Department.

Sorenson, E., R. Popp, B.F. Engstrom, M. Lapin, and D. Farrell. 2010. Softwood Swamps of Vermont: Distribution, Ecology, Classification, and Some Sites of Ecological Significance. Natural Heritage Inventory, Vermont Fish and Wildlife Department,

Thompson, E. H., and E. R. Sorenson. 2005. Wetland, Woodland, Wildland - A guide to the natural communities of Vermont. University Press of New England, Hanover and London,

Vernal Pools & Seeps Summary

Vernal pools are small, open-water wetlands that are filled by rain and snowmelt in spring or fall and are typically dry during the summer months. Such a pool is usually contained within a small forested basin, has no permanent inlet or outlet, and does not support fish. Forested swamps may also contain vernal pools in small depressions. During wet growing seasons, temporary pools may persist without drying completely. Years of filling and drying result in a unique type of set of conditions that supports a variety of wildlife specialized to take advantage of these conditions. Vernal pools are often rich in unique insects, molluscs, and other invertebrates, as well as amphibians. Vernal pools and adjacent forested uplands are critical breeding habitat for mole salamanders and wood frogs.

Seeps are small wetlands that occur on slopes or at the bases of slopes in upland forests. Groundwater discharge is evident at the seep margin. Scattered trees may be present but canopy closure is usually from the adjacent forest. Certain species are adapted to the living in these conditions, including some invertebrate and plant SGCN.

Vernal Pools & Seeps Condition

Current Condition: Vernal pools and the wildlife that use them face many problems, including direct loss of pools, degradation of pool quality, and alteration of the surrounding upland habitat that is critical for many amphibians non-breeding life stages. Hikers, their pets, and recreational vehicles that enter vernal pool risk destroying amphibian eggs and larvae and invertebrate SGCN. In addition, recreational vehicles that enter vernal pools can destroy the soil structure that is so important to maintaining these pools and the species that depend on them. Alterations within the forested basin that surrounds a pool can have significant impacts on the pool's hydrology and its species. Reduction in the volume of water that fills the pool means that drying will occur sooner. Loss of the adjacent canopy trees increases the solar energy reaching the pool, causing water temperature to rise more rapidly and drying the pool earlier in the warm season that usual. Premature drying has a negative impact on the invertebrates and young amphibians that require a minimum length of time (up to 4 months or more) to complete critical life stages. Removal of too many mature trees and downed logs in the surrounding upland habitat can impair the forest floor used by pool-breeding salamanders and frogs. Ditches and vehicle ruts in the surrounding forest often intercept spring migrating adults, luring them to lay eggs in spots that can dry well before the young can leave the water. Road construction or increased road traffic that bisects the upland amphibian habitat surrounding a vernal pool often results in the death of many of these animals as the make their annual migrations between the terrestrial and aquatic environments.

Seeps face problems like those of vernal pools. Activities that alter the hydrology of a seep to even a minor degree can eliminate the characteristics required by some wildlife species. The ecological significance of seeps (and vernal pools) is often not recognized during development planning, with the result being direct loss of these features.

Desired Condition (SGCN Needs): Functional vernal pools are those examples that are intact, well-buffered and interconnected to ensure productivity and movement of species associated with vernal pools. Spotted salamanders, blue-spotted salamanders, Jefferson salamanders, and wood frogs all use vernal pools for breeding. They spend almost their entire lives in the surrounding upland forests, moving up to 300 meters or more from the pool. The adults return for a brief period in the spring to leave their eggs. Water depth must be great enough to cover the egg masses (generally 30cm or more) and provide continuous

aquatic habitat until the young leave the pool (3-4 months, depending on the species and location). The terrestrial adults and juveniles can be found under cover material (logs, rocks, stumps) and in animal burrows in moist forest soils that have adequate leaf litter. Spotted turtles are seasonal users, foraging in vernal pools in the early spring. They require large wetland complexes and move between wetlands through the warm season. There are several insects, snails, fingernail clams, fairy shrimp, and other invertebrates that use vernal pools for their entire life cycle. During the dry months, these animals or their eggs remain on or under the soil surface, awaiting the return of water to the pool depression. Many other SGCN use vernal pools seasonally but do not require them.

Seeps are home to a few specialized SGCN as well as many more common species. The gray petaltail is a rare dragonfly that lays its eggs in forested seeps, where the nymphs remain and feed until reaching adulthood. Eastern Jacob's ladder is a threatened plant that is closely associated with seeps in Vermont.

Implementing the 2005 Wildlife Action Plan

VFWD contracted with the Vermont Center for Ecostudies and Arrowwood Environmental to map and inventory of vernal pools in Vermont. Approximately 5,000 vernal pools were mapped and approximately 1,200 were visited by project organizers and volunteers. The resulting mapping and database is used by the DEC Wetlands Office for regulatory purposes and has been the basis for conservation action.

VFWD has drafted conservation and management guidelines for vernal pool-breeding amphibians to provide the scientific justification for the critical nature of these pools and two "life zones "extending 100 feet and 600 feet from the pool edge. These guidelines are expected to be finalized soon and will provide the basis for site-specific vernal pool conservation and management.

Vernal pools are one of the 95 types of natural communities recognized in Vermont. Ranking specifications were developed for all-natural communities, including vernal pools, to evaluate individual examples for their relative ecological significance and importance for amphibian breeding habitat.

Species of Greatest Conservation Need in Seeps and Vernal Pools

High Priority
Whip-poor-will (Caprimulgus vociferus)
American Woodcock (Scolopax minor)
Jefferson Salamander (Ambystoma jeffersonianum)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Freshwater Snails Group (15 species)

Medium Priority
Great Blue Heron (Ardea herodias)
Ruffed Grouse (Bonasa umbellus)
Red-shouldered Hawk (Buteo lineatus)
Prairie Warbler (Dendroica discolor)
Pied-billed Grebe (Podilymbus podiceps)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
DeKay's Brownsnake (Storeria dekayi)
Eastern Ribbonsnake (Thamnophis sauritus)
Masked Shrew (Sorex cinereus)
Smoky Shrew (Sorex fumeus)

SGCN Notes: Six vascular plant SGCN are found in seeps and vernal pools (Appendix I). See individual species conservation reports in Appendices A1-A5 for information about specific Species of Greatest Conservation Need listed here.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need/Category	Problem/Info Need Detail	Rank
1. Habitat Alteration	Thermal and hydrologic alterations that reduce the quality or usability of pools and seeps; modification of surrounding upland habitat needed to maintain dependent wildlife; creation of ditches and ruts that lure amphibians to unsuitable breeding habitat	High
2. Habitat Conversion	Direct loss of pool and seep habitat due to hydrologic manipulation, filling, draining, etc.; loss of associated upland habitat due to development or conversion	Medium
3.Impacts of Roads and Transportation Systems	Roads located too close to vernal pools kill amphibians as they attempt to migrate between the pools and upland habitat; loss of animals increases with traffic volume	Medium
4. Trampling or direct impacts	Destruction of and damage to amphibian eggs and invertebrate SGCN due to people and their pets entering vernal pools	medium
5. Incompatible recreation	Damage to habitat and loss of SGCN due to recreational vehicles entering vernal pools. Trails leading to sensitive vernal pools bring recreational hikers and their pets	High
7. Pollution	Stormwater directed into pools carries sediments and contaminants that have a negative impact on this habitat and its aquatic populations	Medium
8.Disease	West Nile Virus control: Vernal pools may be annual targets of mosquito control, including the use of chemical and biological pesticides.	Medium
9. Inventory	Inventory needed for many SGCN, particularly those for which distributional and abundance information is greatly lacking	High
10. Monitoring	Monitor SGCN population trends to determine whether populations can persist; evaluate long-term effects of development near these habitats	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Monitor known SGCN populations and evaluate effects of development	Number of known SGCN sites monitored	ANR, EPA	SWG, EPA
Continue field investigation of vernal pools identified in statewide inventory of vernal pools and seeps important to SGCN	Number of completed field inventories	ANR, EPA	SWG, EPA
Identify areas within the state with the largest examples of seep and vernal pools for inclusion in conservation opportunity area.	Number of opportunity areas identified	ANR, VHCB, TNC	SWG
Promote conservation easements where appropriate	Number of acres of habitat protected and/or restored	ANR	VFWD, VHCB
Manage access at sensitive sites	Number of selected sites with managed/restricted access in place	ANR, USFWS, Green Mt. Club	
Educate foresters, landowners, developers, and municipalities about the value of vernal pools and seeps and encourage behavior that conserves wildlife dependent on these features and the necessary surrounding habitat	Number of parties contacted	ANR, Audubon, VFF, VCE, RPCs, towns	SWG, EPA
When appropriate, re-vegetate area surrounding pool or seep and restore hydrology	Number of sites restored; number of acres restored	ANR	EPA

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Develop and distribute forestry guidelines for the protection and management of vernal pools and seeps	Number of forest management activities meeting vernal pool guidelines	ANR, USFWS, SAF, VWA, NRCS,	USFWS, USFS, SWG, EQIP
Technical assistance to towns and regional planning organizations to maintain and enhance vernal pools for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns considering vernal pools and seeps in their planning.	VFWD	SWG
Develop recreational management plans for state lands where vulnerable, sensitive vernal pools and seeps occur	Number of recreational management plans adopted for state lands identified as having vulnerable vernal pools and seeps	ANR, VOGA, VASA,	
Work with VTrans and Federal Highway Administration to encourage protection of vernal pool, seep, and associated upland habitat when designing future roads; encourage the use of well-designed animal passage structures or other methods to allow safe passage for animals across existing roads	Number of cooperative projects that have avoided potential wildlife conflicts or restored safe passage	VFWD, VTrans, FHWA	

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Plan or planning entity	Goal/Scope of plan	Lead
State Outdoor Recreation Plan (SCORP)	A comprehensive recreation plan for state lands	FPR
Vermont Vernal Pool Mapping Project	Remote and field-based mapping of vernal pools	VFWD, VCE, Arrowwood
Conserving Pool-Specialist Amphibian Habitat	Vernal pool management guidelines	VFWD

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Open Peatlands Summary

Characteristics and location

Open peatlands are wetlands that accumulate peat, a type of soil which consists of partially decomposed organic matter. These wetlands are permanently saturated with a stable water table at or near the soil surface, creating a nearly anaerobic soil environment. Seasonal flooding is generally lacking in these wetlands and mosses and liverworts are abundant. With the exceptions of Black Spruce Woodland Bogs and Pitch Pine Woodland Bogs, trees are generally absent or sparse due to the very low availability of dissolved oxygen and minerals in the soil and the saturated soil conditions. Bogs are a type of peatland with slightly raised surfaces that receive most of their water from precipitation, have acidic waters poor in minerals and nutrients, and are dominated by sphagnum mosses, heath shrubs, and in some areas black spruce. Fens, on the other hand, have slightly acidic to slightly basic mineral-rich waters from groundwater discharge and seepage, may be flat or gently sloping, and are dominated by sedges, grasses, and non-sphagnum mosses. Water in fens generally has higher oxygen concentrations than in bogs resulting in greater peat decomposition. There is a continuum, however, in the variations between bogs and fens.

Open Peatlands Natural Communities

The different natural community types in this group are all considered rare:

Dwarf Shrub Bog: These are open, acid wetlands with few trees and are dominated by heath shrubs and sphagnum moss. Size ranges from one to 600 acres in isolated kettlehole basins and as inclusions in larger wetland complexes. They occur throughout Vermont but are more common in the cooler regions.

Black Spruce Woodland Bog: Stunted black spruce trees cover 25 to 60 percent of the ground over heath shrubs and sphagnum moss. Found in cold climate areas. These bogs are generally less than 50 acres in size in Vermont and are found in the cooler regions of Vermont, including the Southern Green Mountains.

Pitch Pine Woodland Bog: Pitch pine covers 25 to 60 percent of the ground over heath shrubs and sphagnum moss. This community is known only from Maquam Bog at the mouth of the Missisquoi River. Small patches of this community are scattered across this larger wetland matrix.

Alpine Peatland: This community has characteristics of both bog and poor fen, but is distinguished by its high elevation and the presence of particular plants. It is found only on the highest peaks of the Green Mountains, particularly Mount Mansfield. By their nature, these communities are limited in size to very small patches.

Poor Fen: These are open, acid peatlands dominated by sphagnum moss, sedges, and heath shrubs. There is some mineral enrichment of surface waters. Poor fens are scattered in all biophysical regions of Vermont.

Intermediate Tall Sedge Fen: These open, slightly acid to neutral fens are dominated by tall sedges, non-sphagnum mosses, and a sparse to moderate cover of shrubs. Most examples are only several acres in size, with all known sites being less than 50 acres.

These fens are found only in areas with calcium-rich bedrock, which may occur in all regions outside of the Green Mountains.

Rich Fen: These fens are similar to Intermediate Fen but typically have shallower sedge peat and more mineral-enriched surface waters. Sedges and non-sphagnum mosses dominate, and shrubs are present. All documented examples are 6 acres or less in size. Rich Fens are restricted to areas with calcium-rich bedrock in the Piedmont, Vermont Valley, and limited areas of the Taconic Mountains.

Open Peatlands Condition

Current Condition: Open peatlands occur in a variety of situations across the Vermont landscape, from small, hydrologically-isolated basins to components of large wetland matrices. The primary problems to SGCN in open peatlands include recreation, exotic species, hydrologic alterations, climate change, and habitat conversion and degradation. Peatlands are popular destinations for outdoor recreationalists interested in experiencing unique natural areas, an activity that can prove detrimental to these fragile communities and their associated SGCNs if not properly managed. Trampling of plants is a major concern especially near urban centers and at the more accessible sites. Nutrient enrichment of runoff waters due to agriculture can lead to invasion by exotic plants as well as replacement of rare plant species by more generalist species. The integrity of bogs and fens can be limited by significant changes in adjacent land use, such as development and clear-cutting, that result in increases in runoff and changes in water quality. Activities that alter the quality and quantity of water received from the groundwater recharge zone can be devastating to fen communities. Climate change is especially a concern with the Alpine Peatlands due to rising temperatures and expansion of forest cover at high elevations. Alteration of precipitation quantity and timing patterns associated with climate change puts the peatlands at risk resulting from peat decomposition rates – a fine balance in peatlands between temperature, soil saturation, and dissolved oxygen levels, and microbial activity. Development of broadcasting facilities on mountain ridgelines also impacts this community type. Alteration of natural water level fluctuations in lakes, ponds, and streams associated with peatlands can also impact these wetlands. Prevention of natural disturbance regimes, including lightning-ignited fires, may limit the Pitch Pine Woodland Bog community.

Desired Condition (SGCN Needs): Many SGCN associated with open peatlands, particularly some invertebrates and plants, are habitat specialists found only in these natural community types. Several SGCN dragonflies and damselflies require breeding and rearing habitat that is commonly described as bogs, fens, fen puddles, boggy ponds, boggy sloughs, and boggy streams. Many plants are found only in the wet, acid soils of bogs. Some vertebrates, such as bog lemmings (*Synaptomys* sp.) and spruce grouse are closely tied to bogs. Others, such as the blue-spotted salamander, four-toed salamander, spotted turtle, and water shrew, may rely on peatlands for habitat locally. Many of the other SGCN may utilize Open Peatlands but are not dependent on its specific characteristics (e.g., wood turtle, spruce grouse, and DeKay's Brownsnake).

Implementing the 2005 Wildlife Action Plan

Field work for a statewide inventory of Dwarf Shrub Bogs and Poor Fens and data is currently being analyzed. When analysis complete it will greatly expand our understanding of these rare natural community types and the birds associated with them.

The first statewide assessment of Vermont dragonfly and damselfly populations (collectively known as odonates) was completed in 2009. This survey (Pfeiffer, 2009) provides vital species distribution and occurrence information which has broadened our understanding of rare habitat-specialist dragonfly and damselfly SGCN. Habitat data collected as part of the study provides a comparative baseline for future population trend monitoring. Future efforts toward odonate SGCN conservation will continue to rely on the information resulting from this and future field studies.

Species of Greatest Conservation Need in Open Peatlands

High Priority
American Black Duck (Anas rubripes)
Spruce Grouse (Falcipennis canadensis)
Vesper Sparrow (Pooecetes gramineus)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Odonates-Lakes/Ponds Group (7 species)
Moths group (17 species)
Tiger Beetle group (7)
Butterflies-Wetland Group (6 species)
Hoary Bat (Lasiurus cinereus)
Northern Long-eared Bat (Myotis septentrionalis)
Water Shrew (Sorex palustris)
Northern bog lemming (Synaptomys borealis)
Southern Bog Lemming (Synaptomys cooperi)

Medium Priority
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Black-backed Woodpecker (Picoides arcticus)
Pied-billed Grebe (Podilymbus podiceps)
Lesser Yellowlegs (Tringa flavipes)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
Smooth Greensnake (Opheodrys vernalis)
DeKay's Brownsnake (Storeria dekayi)

SGCN Notes: Vascular plant SGCN not listed here: 61 (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem & Info Needs Category	Problem & Info Need Detail	Rank
Habitat Degradation	Significant land-use changes in adjacent areas can result in increases in runoff and changes in water quality (e.g. development, clear-cutting)	High
Habitat Conversion	Development of broadcasting facilities near alpine peatlands	Medium
Incompatible Recreation	Trampling of plants and soil in wetlands and on mountain tops	Medium
Hydrologic Alteration	Activities affecting the quantity and quality of ground water input and surface water runoff, or alter natural hydrologic regimes of associated water bodies	High

Problem & Info Needs Category	Problem & Info Need Detail	Rank
Impacts of Roads and Transportation Systems	Trails leading to sensitive peatlands bring recreational hikers	Medium
Pollution	Water quality is easily altered in peatlands and can bring about shifts in species composition (e.g., agriculture near rich fens)	High
Climate Change	Shifts in community composition in peatlands	Medium
Inadequate Disturbance Regime	Fire suppression inhibits pitch pine germination and results in shift in species composition	Medium
Statewide inventory of Open Peatland natural communities	Need to identify and locate best examples of these habitats that support the most SGCN	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct statewide inventory of Open Peatland natural communities (Dwarf Shrub Bog and Poor Fen completed by 2015)	Number of sites inventoried	VFWD, EPA	SWG, EPA
Manage access at sensitive sites	Number of selected sites with managed/restricted access in place	ANR USFWS, Green Mt. Club	
Manage for natural disturbance regime at Maquam Bay	Work with USFWS to develop and implement a fire plan to promote this natural process	VFWD, USFWS	USFWS
Technical assistance to private landowners to maintain and enhance open peatlands for SGCN.	Number landowners incorporating SGCN into their land management.	ANR, EPA, USFWS, Landowners	VFWD
Technical assistance to town and regional planning organizations to manage open peatlands for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns considering SGCN in their planning	ANR, EPA, Regional Planning Comm.	SWG, EPA, VT Watershed Grants
Develop recreational management plans for state lands where vulnerable, sensitive open peatlands occur	Number of recreational management plans adopted for state lands identified as having vulnerable peatlands	ANR, VOGA, VASA	
Financial incentives for private landowners	Number of acres conserved	NRCS, VFWD, USFWS	NRCS, other USFWS grants
Acquisition/easement of high priority sites and their groundwater recharge areas	Number of acres acquired/enrolled	NRCS, VFWD, USFWS	NRCS, other USFWS grants
Increase enforcement of access restrictions at alpine peatlands	Number of hours of increased patrol	ANR, Green Mt. Club	
Increase cooperation/coordination among states and provinces and develop trans-jurisdictional actions to address issues such as climate change and acid rain		State of VT, other states, CA provinces, US and CA federal governments	

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Plan or planning entity	Goal/Scope of plan	Lead
State Outdoor Recreation Plan (SCORP)	A comprehensive recreation plan for state lands	FPR

Literature Cited

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Marshes and Sedge Meadows Summary

Marshes and Sedge Meadows provide some of the largest natural openings to be found in Vermont. These natural communities and the streams and ponds with which they are associated provide critical habitat for many species of wildlife. Often called emergent marshes, these open wetlands have less than 25 percent shrub or tree cover, and in many cases woody plants are absent. Hydrology is the single most important factor controlling these wetlands.

Marsh and Sedge Meadow Natural Communities

Six different natural community types are included in this group:

Shallow Emergent Marsh: This is a common and variable marsh type with mineral or shallow organic soils that are moist to saturated and only seasonally inundated. Several grasses, bulrushes, and Joe-pye weed may be abundant. This community is commonly associated with old beaver impoundments. This is a widespread natural community found throughout Vermont.

Sedge Meadow: These wetlands are permanently saturated and seasonally flooded. Soils are typically shallow organic muck, although mineral soils may be present in some wetlands. Tussock sedge or other sedges are dominant plants here. This common community is found throughout Vermont, most often along stream and pond margins and in beaver meadows.

Cattail Marsh: Common cattail or narrow-leaved cattail dominates these marshes. The muck or mineral soils are typically inundated with shallow standing water throughout the year, although the substrate may be exposed in dry years. Cattail Marshes range in size from less than an acre to over 500 acres along the shores of Lake Champlain. These common wetlands occur throughout the state but are most common at lower elevations.

Deep Broadleaf Marsh: Water depth in these marshes is typically over one foot deep for most of the year, although some may have only saturated soils in dry summers. Soils are organic. Common plants include pickerelweed, broad-leaved arrowhead, and giant bur-reed. This common community type is found throughout Vermont on the sheltered margins of lakes and ponds, on the slow-moving backwaters of larger rivers, and in isolated basins. The largest examples occur in lowland areas.

Wild Rice Marsh: These uncommon marshes are dominated by wild rice, with an organic soil substrate that is inundated with one to two feet of water throughout the summer. Wild Rice Marshes are found in wave-sheltered coves and on river deltas of Lake Memphremagog and Lake Champlain, and in the slow-moving backwaters of our larger rivers (Connecticut River and lower Champlain tributaries).

Deep Bulrush Marsh: These are marshes of open water along the shores of larger lakes and ponds where there is strong wave action. They are found throughout Vermont. Water depths can range from one to six feet. Soft-stem bulrush and hard-stem bulrush dominate most of these marshes, although marsh spikerush and other bulrushes may be abundant.

Marshes & Sedge Meadows Condition

Current Condition: These natural community types are not considered rare, but do provide critical habitat to many wildlife species, including SGCN. Sedge Meadows are often successional stages that would lead to forested wetlands if left undisturbed. Although they may occur in isolated basins, Marshes and Sedge Meadows are most commonly associated with water bodies (lakes, ponds, rivers) and other wetlands and, therefore, are subject to the same problems (e.g., pollution) as these associated communities. Even small examples of marshes that provide significant wildlife habitat or other functions and values are protected under Vermont Wetland Rules. Invasive exotic species are a major problem for some of these community types. Common reed and purple loosestrife can easily become established in Shallow Emergent Marshes, and water chestnut can crowd out native species in Deep Broadleaf Marshes. Alteration of the natural hydrologic regime by dam operation or creation of impoundments can significantly impact deeper water communities. Greater inventory information is needed for all these natural community types as well as further study on the identification and significance of problems.

Desired Condition (SGCN Needs): Marshes and Sedge Meadows support a host of wildlife species. A variety of SGCN are marsh specialists. Among others, these include many plants, dragonflies, damselflies, butterflies, and birds. Several dragonflies and damselflies require breeding and rearing habitat that is commonly described as marshy ponds, marshy edges of lakes, and marshes. Black terns, least bitterns, and soras spend the nesting season raising their young within marshes. Some other SGCN, such as spotted salamanders, and northern water snakes are commonly associated with these wetland types and may rely on them locally, but do not specifically require marshes to complete their life cycles. Pygmy shrews, smooth greensnakes, and chimney swifts are examples of more casual users that may be found foraging in marshes and sedge meadows.

Species of Greatest Conservation Need in Marshes and Sedge Meadows

High Priority

American Black Duck (Anas rubripes)
Black Tern (Chlidonias niger)
Northern Harrier (Circus cyaneus)
Sedge Wren (Cistothorus platensis)
Least Bittern (Ixobrychus exilis)
Vesper Sparrow (Pooecetes gramineus)
Spiny Softshell (Turtle) (Apalone spinifera)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Boreal Chorus Frog (Pseudacris maculata)
Butterflies-Wetland Group (6 species)
Freshwater Snails Group (15 species)
Mayflies/Stoneflies/Caddisflies Group (14 species)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Odonates-Lakes/ponds Group (7 species)
Hoary Bat (Lasiurus cinereus)
Northern Long-eared Bat (Myotis septentrionalis)
Pygmy Shrew (Sorex hoyi)
Water Shrew (Sorex palustris)

Medium Priority

Short-eared Owl (Asio flammeus)
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Bobolink (Dolichonyx oryzivorus)
Pied-billed Grebe (Podilymbus podiceps)
Sora (Porzana carolina)
Lesser Yellowlegs (Tringa flavipes)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
Smooth Greensnake (Opheodrys vernalis)
Northern Water Snake (Nerodia sipedon)
Eastern Musk Turtle (Sternotherus odoratus)
DeKay's Brownsnake (Storeria dekayi)
Eastern Ribbonsnake (Thamnophis sauritus)
Long-tailed Weasel (Mustela frenata)
Muskrat (Ondatra zibethicus)
Southern Bog Lemming (Synaptomys cooperi)

SGCN Notes: Vascular plant SGCN not listed here: 27 (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problems/Info Need Categories	Problem & Info Need Detail	Rank
Habitat Conversion	Loss or fragmentation, particularly in small, unmapped (NWI) wetlands; ditching and plowing for agricultural use	High
Habitat Degradation	Cattle grazing	Medium
Hydrologic Alteration	Manipulation of the natural hydrologic regimes of associated water bodies through dam operation or impoundment can drastically impact deep water marshes in particular	High
Exotic Invasive Species	Crowding out of native plants and wildlife habitat by purple loosestrife, common reed, water chestnut, etc.	High
Pollution	Pollutants entering wetlands from runoff and tributaries can impact species and can bring about shifts in community composition	High
Statewide inventory of Marshes and Sedge Meadows	Inventory is needed for all-natural community types, as well as further study on the identification and significance of problems	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct statewide inventory of Marshes and Sedge Meadows	Number of sites inventoried. The number of high quality examples identified containing SGCN	VFWD, EPA	SWG, EPA
Protect wetlands not on NWI maps through alternative regulations (e.g., Act 250)	Number of acres conserved	ANR, Regional Planning Comm, ACOE	
Provide technical assistance and/or financial incentives to private landowners, towns and RPC's to maintain and enhance mash and sedge meadows for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number landowners incorporating SGCN into their land management, Number of towns including SGCN in their planning. Number of acres conserved	ANR, EPA, NRCS, TNC, RPC's, towns, VLCT, private landowners	NRCS, SWG, EPA, LCBP, VT Watershed Grants
Identify, prioritize and control problematic native and invasive species deleterious to SGCN and prevent introduction of these species.	Acres surveyed/mapped; acres with dominant native vegetation protected or restored	USFWS, DEC, NRCS, municipal & watershed groups	USFWS, ANR, NRCS, FSA
Financial incentives for private landowners	Number of acres conserved	NRCS, VFWD, USFWS	NRCS, other USFWS grants
Acquisition/easement of high priority sites	Number of acres acquired/enrolled	NRCS, VFWD, USFWS	NRCS, other USFWS grants, Land trusts
Use existing/new regulations to prevent damage of SGCN-important lake/pond-side and river-side wetlands caused by dam operation	Number of acres conserved	ANR, COE, Hydro operators, FERC	

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Prevent loss of SGCN-important lake/pond-side and river-side wetlands caused by new impoundments	Number of acres conserved	ANR, COE, Hydro operators, FERC	

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Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

Carle, F. C. 1994. Dragonflies and damselflies (Odonata) known to or likely to occur in Vermont. Report prepared for the Nongame & Natural Heritage Program, Vermont Fish & Wildlife Department. Waterbury, VT.

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Thompson, E. H., and E. R. Sorenson. 2005. Wetland, woodland, wildland - A guide to the natural communities of Vermont. University Press of New England, Hanover, NH.

Wet Shores Summary

Characteristics and Distribution

All the natural communities contained within the upland shore formation occur as small patches scattered irregularly over the landscape. Four of the natural communities are widely distributed while the three rarest types are restricted to one or more biophysical regions. All the community types in this formation are non-forested and maintained in this early successional state by a combination of flooding, ice scour, and erosional processes. This makes wetland shores perhaps our most dynamic and changeable group of natural communities.

Wet Shores Natural Community Types.

This formation includes the seven following types:

Outwash plain pondshores: This is among the rarest natural communities in the state and is found only in the Southern Vermont Piedmont Biophysical Region. It occurs only on sloping shorelines that are seasonally exposed due to fluctuating water levels in the gravelly soils. The vegetation is characterized by sedge, rush, and herbaceous species, many of them annuals.

River mud shore: This is a common natural community type that occurs in all eight biophysical regions. It is restricted to slow moving rivers whose shorelines are exposed during times of low flow. This community type tends to be sparsely vegetated, primarily by annuals since the shore is often exposed late in the growing season.

River sand or gravel shore: This is a common natural community type that occurs in all eight biophysical regions. It is restricted to the swifter rivers where moving water creates sand and gravel deposits. Because of their dynamic nature they are sparsely vegetated, mostly by grasses and herbs but often with a woody component consisting of willows and cottonwood.

River cobble shore: This common natural community is widely distributed across the state along high-energy waterways. Due to their dynamic nature, this community is sparsely vegetated, mostly by grass and sedge species, but often with a woody component of willows and cottonwood.

Calcareous riverside seep: This is a rare natural community type that is known mostly from the Connecticut Valley. They are restricted to areas where calcareous groundwater seeps on to exposed bedrock on rivershores. The natural processes of flooding and ice scour serve to keep the community open while the limy seepage sustains a unique flora that includes many rare species of sedges, herbs, and bryophytes.

Rivershore grassland: This is a widely distributed natural community that occurs in more sheltered, and hence more stable, portions of our larger rivers. Since the natural river processes needed to maintain their open condition occur less frequently, this community tends to have more of a woody component of shrubs and low trees mixed in with the more abundant grasses.

Lakeshore grassland: This rare natural community type is restricted to the shores of Lake Champlain and Lake Memphremagog where it occurs on gently sloping shorelines that are kept open by waves, flooding, and ice. They tend to be very narrow in width, but may extend for considerable distances along the shore. The community is dominated by grasses, sedges, and forbs with a varying amount of woody species depending upon the frequency and intensity of the natural disturbance.

Wet Shores Condition

Current Condition: All the natural communities within the wet shore formation are dependent upon the natural processes of flooding, wave action, and ice scour. As such, they all occur as small patches that are restricted to areas where these processes are focused. Since they are maintained in an open state, these natural community types provide a specialized habitat for animals and plants. Spiny softshell, spotted, and wood turtles, Fowler's toad, and tiger beetles all depend on one or more of these communities. Outwash plain pondshores and calcareous riverside seeps provide the unique habitat for plants and contain a disproportionate number of rare or Threatened species.

The primary problems to SGCN in this formation include hydrologic alteration, recreation, exotic species, and habitat conversion and degradation. Since all seven community types are dependent upon periodic disturbance by water, ice or wind, anything that prevents these natural processes from occurring would jeopardize the integrity and continued existence of the SGCN they harbor. These community types also support heavy recreational use, and trampling of vegetation is a major concern especially near urban centers and at the more accessible sites. The continual natural disturbance at these sites also provides excellent opportunity for invasive plants to become established, and recreational use adds to this potential. The river cobble shore and the two grassland types are especially subject to habitat conversion or degradation to create marinas, docks, and bathing beaches.

Desired Conditions: Although all the natural communities comprising the wet shore formation occur as small patches on the landscape, they all provide critical habitat to SGCN that utilize both the aquatic and terrestrial environment or require unfrosted areas for basking, nesting, or foraging. A total of 22 animal and 31 plant SGCN are known to utilize the wet shore communities. To protect these sites, we recommend the following activities:

Species of Greatest Conservation Need in Wet Shores

High Priority
American Black Duck (Anas rubripes)
Vesper Sparrow (Pooecetes gramineus)
Spiny Softshell (Turtle) (Apalone spinifera)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Freshwater Snails Group (15 species)
Tiger Beetle Group (7 species)
Hoary Bat (Lasiurus cinereus)
Northern Long-eared Bat (Myotis septentrionalis)
Tri-colored bat (Perimyotis subflavus)
Water Shrew (Sorex palustris)

Medium Priority
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Pied-billed Grebe (Podilymbus podiceps)
Lesser Yellowlegs (Tringa flavipes)
Smooth Greensnake (Opheodrys vernalis)
Long-tailed Weasel (Mustela frenata)

SGCN Notes: Vascular plant SGCN not listed here 54 (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Categories	Problem/Info Need Detail	Rank
Habitat Conversion	Construction of marinas, docks, bathing beaches, and other activities that remove shoreline vegetation	High
Hydrologic Alteration	Communities dependent upon wind, wave, and ice action	High
Incompatible Recreation	Intense use of shore disturbs wildlife, tramples rare plants, and introduces exotic species.	High
Invasion by Exotic Species	Non-native species can spread and degrade the habitat for wildlife and eliminate some plant species	Medium
Habitat Fragmentation	Roads and development fragment habitat along wet shores for species such as the wood turtle and Smooth Greensnake	High
Inventory	Distribution, location, and condition of this habitat are not known: A statewide inventory is needed to identify and locate the best examples of these habitats that support the most SGCN	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct statewide inventory of wet shores	Number of sites inventoried. The number of high quality examples identified containing SGCN	FPR	SWG
Provide technical assistance to private landowners to prevent or mitigate hydrologic and recreational impacts to wet shores.	Number landowners incorporating SGCN into their land management	NRCS, TNC, VFWD	SWG
Manage exotic species on state owned sites and provide technical assistance to landowners regarding control of exotics	Number of sites with control activities and/or invasive monitoring. Number of acres conserved.	ANR, NRCS, TNC, EPA	NRCS, USFS
Technical assistance to town & regional planning organizations to help maintain and/or enhance SGCN habitat, and to maintain natural processes and hydrologic conditions. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns/RPC's including SGCN in their planning	VFWD	VFWD
Conservation easements on higher quality sites with greatest number of SGCN or T&E listed SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT
Work with state and municipal managers to reduce and focus recreational impacts		ANR, VOGA	VFWD,

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
New England Plant Conservation Program – various Conservation Plans	Recovery of various plant species in New England	ANR
State Outdoor Recreation Plan	A comprehensive recreation plan for state lands	FPR

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

Thompson, E. H., and E. R. Sorenson. 2005. Wetland, Woodland, Wildland - A guide to the natural communities of Vermont. University Press of New England, Hanover and London

Shrub Swamps Summary

Characteristics and Distribution

All of Vermont's shrub dominated natural communities are wetlands, and most are thought to be retained in this early successional state by periodic flooding. Some of the community types, however, are likely to be more transitional and will eventually become forested. These transitional types are believed to have arisen following some type of disturbance either natural, such as a catastrophic flood or beaver activity, or artificially from past agricultural use. If beaver activity and natural flooding continue, examples of this community should continue to replace themselves on the landscape.

Of the four natural community types included within this formation two occur as small patches while the remaining two occupy larger areas on the landscape. Only one of the communities, buttonbush swamp, is thought to be rare in the state and restricted in its distribution to four of the state's eight biophysical regions. The other three communities are distributed throughout the state.

The shrub swamp formation includes the following four natural community types:

Alluvial Shrub Swamp: This uncommon natural community type is found on alluvial soils in the floodplains of small rivers. This is a high energy, dynamic environment that receives regular flooding and ice scour. As the stream channel naturally wanders across the floodplain, the community also migrates. Senescent channels succeed to floodplain forest while alluvial shrub swamps thrive in newly established natural levees and other such floodplain settings. While speckled alder is the dominant species here, black willow and boxelder can be very abundant under certain conditions. Ostrich fern typically dominates the ground layer although some grasses, herbs, and vines can also be common in more sheltered areas.

Alder Swamp: This is a common, widely distributed community type that occurs in a variety of settings including lakes and pond margins, backwater floodplains of rivers and streams, beaver flowerages, and poorly drained basins. Depending upon the frequency and duration of flooding, some examples may become more forested over time while others may remain shrub dominated. While speckled alder is the dominant shrub, shrubby willows, dogwoods, and young red maple may be locally abundant. Sedges and grasses along with sensitive fern and Joe pye weed typically dominate the ground layer.

Sweet Gale Shoreline Swamp: This uncommon natural community occupies shorelines of ponds and slow-moving streams. This swamp typically occurs as a narrow floating mat, but the shrubs may also be rooted directly into the peaty shore. Sweet gale dominates this community, but meadow-sweet is usually also abundant. Leatherleaf may be co-dominant in more acidic, boggy conditions. Various sedge species typically dominate the ground layer.

Buttonbush Swamp: This rare natural community occurs in two different settings: on the edges of larger lakes and ponds and in poorly drained, isolated depressions – both settings in which water is retained through much of the growing season. Buttonbush is one of the few woody plants that can tolerate seasonally flooded conditions. While in some examples

buttonbush may grow so dense that nearly all other vegetation is excluded, in other situations leatherleaf and meadow-sweet may be common. Depending upon the shrub density and degree of flooding, various herbs and grasses may become established.

Shrub Swamps Condition

Current Condition: Shrub swamps are a common wetland type and occur in a variety of situations that are either too wet or too frequently disturbed to allow trees to become established. Although some examples of Alder Swamps are becoming forested, new examples continually arise due to natural disturbance. If the natural processes of flooding, ice scour, and beaver activity continue unabated, shrub swamps will remain common in our landscape.

The primary problems to the communities and SGCN in this formation include habitat loss and fragmentation, suppression of the natural disturbance regime, hydrologic alteration, and invasive exotic species.

Desired Condition: Providing habitat for 30 SGCN makes shrub swamps among the more valuable community types for wildlife of concern is state. Especially notable is the high number of amphibians included in this total. There are few plant SGCN associated with shrub swamps, however; they provide habitat for only six vascular plants and three bryophytes. Many types of shrub swamps are commonly associated with larger wetland complexes along river and streams. Maintaining the natural flooding regimes and other natural processes including beaver activity of these shrub swamps and associated forested swamps and marshes is critical to their long-term function. Maintaining upland buffers for shrub swamps are especially important for amphibian SGCN as well as for other species.

Species of Greatest Conservation Need in Shrub Swamps

High Priority
American Woodcock (Scolopax minor)
American Black Duck (Anas rubripes)
Black Tern (Chlidonias niger)
Vesper Sparrow (Pooecetes gramineus)
Spiny Softshell (Turtle) (Apalone spinifera)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Boreal Chorus Frog (Pseudacris maculata)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Freshwater Snails Group (15 species)
Butterflies-Wetland Group (6 species)
Hoary Bat (Lasiurus cinereus)
Northern Long-eared Bat (Myotis septentrionalis)
Water Shrew (Sorex palustris)

Medium Priority
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Black-billed Cuckoo (Coccyzus erythropthalmus)
Rusty Blackbird (Euphagus carolinus)
Pied-billed Grebe (Podilymbus podiceps)
Lesser Yellowlegs (Tringa flavipes)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
Smooth Greensnake (Opheodrys vernalis)
Northern Water Snake (Nerodia sipedon)
Eastern Musk Turtle (Sternotherus odoratus)
DeKay's Brownsnake (Storeria dekayi)
Eastern Ribbonsnake (Thamnophis sauritus)

SGCN Notes: Vascular plant SGCN not listed here: 12 (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Development, road construction, docks, marinas	High
Habitat Fragmentation	Agriculture, roads	High
Hydrologic Alteration	Sedimentation, development in watershed, road building, dams, artificial lake fluctuations	High
Distribution of successional stages	Woodcock are negatively affected by maturing alder stands and adjacent openings.	High
Invasion by Exotic Species	Non-native species can spread and degrade the habitat for wildlife and eliminate some plant species	Medium
Inadequate Disturbance Regime	Suppression of natural processes such as eliminating beaver activity, limiting flooding, etc.	High
Inventory	Distribution, location and condition of these communities are not known. A statewide inventory needs to be conducted to identify and protect the best examples	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct a statewide inventory of shrub swamp natural communities	Number of high quality examples identified containing SGCN		
Provide information to State Wetlands Office & EPA	Number of sites discussed	DEC, EPA	SWG, EPA
Provide technical assistance and/or financial assistance in maintaining natural processes and hydrologic conditions to landowners, especially to municipal and private owners concerned with beaver activity.	Number landowners incorporating SGCN into their land management, Number of towns considering SGCN in their planning	USFWS, NRCS, TNC, VFWD, RPC, VLCT	NRCS, USFWS
Acquisition and conservation easements on higher quality sites with greatest number of SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT, DEC
Manage invasive species on state lands, provide technical assistance to landowners to control invasives	Number of sites with control activities and/or invasive monitoring	ANR, NEPCoP, TNC, NRCS	SWG

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
New England Plant Conservation Program – various Conservation Plans	Recovery of various plant species in New England	ANR
Partners in Flight Plan	Bird conservation	ANR, Audubon

Literature Cited

Thompson, E. H., and E. R. Sorenson. 2005. Wetland, Woodland, Wildland—A guide to the natural communities of Vermont. University Press of New England, Hanover and London.

Upland Shores Summary

Characteristics and Distribution

All the natural communities contained within the upland shore formation occur as small patches scattered irregularly over the landscape. Both the riparian associated natural communities occur in all eight biophysical regions of the state. In contrast, the three lakeshore natural communities are more restricted with both lake or shale cobble beach and sand dunes occurring in a single biophysical region and lake sand beach in three regions. Since all the upland shores are naturally kept open, all five natural community types provide specialized habitat for animals and plants. Riverside outcrops and sand dunes provide habitat for some plants that occur nowhere else in the state. Generally, SGCN have the best potential for persisting at sites with the most intact natural processes. These same sites likely provide the best and most abundant habitat for SGCN.

The upland shores formation includes the six following natural community types:

Acidic Riverside outcrop and Calcareous Riverside Outcrop: These uncommon to rare natural community types occurs throughout the state wherever bedrock is exposed along waterways, but one occurs on acidic bedrock like granite and one occurs on calcareous bedrock like limestone. They are dependent upon natural hydrologic processes that typically keep the sites open via either flooding or ice scour. These community types are sparsely vegetated, primarily by herbaceous species with only a few shrubs and vines able to withstand the regular disturbance regime – the species composition varies with the two types, reflecting the available calcium from the bedrock.

Erosional river bluff: This is a rare natural community type with a statewide distribution that is restricted to steep banks where soil is actively eroding. Both the nature of the soils and the intensity of the erosional action greatly influences the vegetative cover of these communities, but rarely are woody species frequent.

Lake or shale cobble beach: This uncommon natural community can occur on any large lake in the state, but the only significant examples occur on Lake Champlain. Due to the constant wave action and seasonal flooding and ice scour, they tend to be sparsely vegetated. Although the vegetation is mostly herbaceous, willows, cottonwood, silver maple, and ash can become established at their upper reaches.

Lake sand beach: This is a rare natural community with the most extensive examples on the shore of Lake Champlain, and only scattered examples occurring in other regions of the state. Their formation and sustenance depends upon a regular source of material this is subsequently transported and deposited by waves and/or wind. Due to the constant wind and wave action and seasonal flooding and ice scour, this community is largely kept open. Typically, herbs, grasses, and low sedges dominate although willows, cottonwood, box elder, and ash often becomes established at their higher reaches.

Sand dune: This extremely rare natural community is restricted to the present and previous shoreline of Lake Champlain where dunes are situated on the leeward side of sand beaches. They are dependent upon a continual supply of depositional sand and will be adversely affected by anything that inhibits this process. Because of the shifting

nature of the substrate and the dry windy conditions, they are sparsely vegetated mostly by grasses, low sedges, and viney herbs. Cottonwoods, aspen, and gray birch eventually become established and make the dune system more stable.

Upland Shores Condition

Current Condition: All five community types within this formation are dependent upon continual disturbance by water, ice and wind and therefore occur near lakes and rivers. They all reach their best development on the shores of Lake Champlain or other larger lakes and rivers in the state. Because they are desirable places to be, recreational use has impacted many our upland shores. The three lake associated shores are especially subject to habitat conversion or degradation to create marinas, docks, and bathing beaches. Trampling of plants is a major concern especially near urban centers and at the more accessible sites. The continual natural disturbance at these sites provides excellent opportunity for invasive plants to become established.

Desired Condition: Functional upland shores are primarily undeveloped sites where natural processes operate and human disturbance of SGCN is limited. Although upland shores occur as small patches on the landscape, they provide a very specialized habitat that is utilized by a few SGCN and that may not be available elsewhere. Eight SGCN animals and one suite of species (tiger beetles) utilize upland shores. In addition, 33 SGCN plants are dependent upon this formation. To protect the natural communities contained within this formation we would do the following:

Species of Greatest Conservation Need in Upland Shores

High Priority
Common Tern (Sterna hirundo)
Spiny Softshell (Turtle) (Apalone spinifera)
Fowler's Toad (Anaxyrus fowleri)
Beetles-Tiger Beetle Group (7 species)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Chimney Swift (Chaetura pelagica)
Masked Shrew (Sorex cinereus)

SGCN Notes: Vascular plant SGCN not listed here 40 (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Construction of marinas, docks, bathing beaches, retaining walls, rip-rap	Medium
Hydrologic Alteration	Communities dependent upon wind, wave, and ice action and supply of substrate	Medium
Incompatible Recreation	Intense use of beaches tramples rare plants, degrades dunes and introduces exotic species.	Medium
Invasion by Exotic Species	Non-native species can spread and degrade the habitat for wildlife and eliminate some plant species	Medium
Inventory	Distribution, location, and condition of this habitat are not known. A statewide inventory is needed to identify and locate the best examples of these habitats that support the most SGCN	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct a statewide inventory of upland shore natural communities to identify the best sites and those with SGCN	Number of sites inventoried. Number of sites with SGCN identified	FPR	SWG
Technical assistance to private landowners to prevent or mitigate hydrologic alteration and recreational impacts and to conserve SGCN	Number landowners implementing conservation practices for SGCN	NRCS, TNC, VFWD	SWG
Technical assistance to town and regional planning organizations to prevent or mitigate hydrologic alteration and recreational impacts and to conserve SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns/organizations planning for SGCN conservation	VFWD	VFWD
Conservation easements on higher quality sites with greatest number of SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT
Work with state and municipal managers to reduce recreational impacts on these sites and to focus recreational impacts elsewhere.	Number of sites where recreational impacts are managed successfully.	ANR, VOGA	VFWD
Manage exotic species on state owned sites and provide technical assistance to private landowners to control exotics	Number of sites with control activities and/or invasive monitoring	ANR, NRCS	NRCS, FSA

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
New England Plant Conservation Program – various Conservation Plans	Recovery of various plant species in New England	ANR
State Outdoor Recreation Plan (SCORP)	A comprehensive recreation plan for state lands	FPR

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

Thompson, E. H., and E. R. Sorenson. 2005. Wetland, Woodland, Wildland - A guide to the natural communities of Vermont. University Press of New England, Hanover and London,

Outcrops & Upland Meadows Summary

Characteristics and Distribution

Outcrops and upland meadows are naturally un-forested because of several factors: little or no soil, high winds, cold temperatures, and drought. Many of these factors are inter-related and work together in combination to limit tree growth. Outcrops and upland meadow are generally restricted to ridgetops and ledges where bedrock is exposed or close to the surface, and thus all the natural community types occur as small patches. They are often flat or gently sloping, but by definition, have slopes less than 60 degrees.

There are five outcrop and upland meadow natural community types:

Alpine Meadows: This very rare natural community is restricted to the highest elevations in the state where the harsh growing conditions severely restrict vegetative growth. There are only a few known examples, all restricted to the Northern Green Mountains Biophysical Region. Low herbaceous vegetation, primarily grasses and sedges, dominate although stunted fir and black spruce and various heath shrubs occur in more sheltered locations.

Boreal Outcrop: This relatively common natural community occurs at mid to high elevations and is distributed widely in the cooler areas of the state. It occurs in the Northern and Southern Green Mountains, Northern Piedmont, Northeastern Highlands, and Taconics Biophysical Regions. They are sparsely vegetated by scattered low trees, including fir, red spruce, yellow birch, red maple, heath shrubs, and grasses. In some examples, however, mosses and lichens can be abundant and even dominate.

Serpentine Outcrop: One of the rarest natural communities in the state, serpentine outcrops are restricted to the Northern and Southern Green Mountains where this rock type is exposed. Serpentine rocks and the soils derived from them are very low in most plant nutrients, instead containing high amounts of heavy metals that can reach levels that are toxic to plants. The result is a sparse flora, but also one that has adapted to these extremely harsh conditions.

Temperate Acidic Outcrop: This is a relatively common natural community that is absent from only the higher elevations and colder regions of the state. Trees, especially paper and gray birch, white and pitch pine, and red maple are frequent here although they are stunted and slow growing. Beneath then typically grow low heath shrubs, grasses, and various herbs. Mosses and lichens can also be very abundant.

Temperate Calcareous Outcrop: This is an uncommon natural community that is restricted to the warmer regions of the state; generally, the Champlain and Connecticut River Valleys, the Taconics and the Vermont Valley. The community is limited to areas with calcareous bedrock and thus support a characteristic flora of lime-loving plants. Despite their exposure and resulting doughtiness, the availability of nutrients makes these outcrops more diverse than their more acidic counterparts.

Outcrops & Upland Meadows Condition

Current Condition: All the natural communities contained within the outcrop and upland meadow formation are the result of specific conditions, and as such, they occur as small

patches and are scattered irregularly over the landscape. Only temperate acidic outcrops occur in all eight biophysical regions of the state. In contrast, alpine meadows are restricted to a single biophysical region and serpentine outcrops to two regions. Since they all are open communities within a generally forested matrix, all five natural community types provide a specialized habitat for animals and plants. They are important basking sites for reptiles, and alpine meadows, serpentine outcrops, and temperate acidic outcrops provide habitat for many plants that occur nowhere else in the state.

The primary problems to SGCN in this category include recreation, exotic species, climate change, and habitat conversion and degradation. Since all five community types provide vistas, they are often a destination for hikes, skiers, and climbers. Trampling of plants is a major concern especially near urban centers and at the more accessible sites. Invasion by exotic plants, especially at the lower elevation temperate outcrops and all communities with major trail access, is increasingly a concern. Alpine meadows are affected by ski area development while both serpentine and temperate calcareous outcrops continue to be limited by mining operations. Climate change is especially a concern with the colder alpine meadows and boreal outcrops.

Desired Condition: Outcrops and upland meadows are very specialized natural communities in Vermont since they are relatively permanent openings within a forested landscape. As such they provide specific habitat requirements for a small number of SGCN, especially some species of snakes which utilize these openings as basking sites. Although they provide significant habitat for only nine SGCN and two suites of species (moths and tiger beetles), these openings are utilized by many additional wildlife species. The number of SGCN plants (95) that rely on this formation speaks to its importance in the state despite the small area that it covers. To protect these sites, we would do the following:

SGCN in Outcrops & Upland Meadows

High Priority
North American Race (Coluber constrictor)
Timber Rattlesnake (Crotalus horridus)
Eastern Ratsnake (Pantherophis alleghaniensis)
Moths group
Beetles-Tiger Beetle Group (7 species)
Northern bog lemming (Synaptomys borealis)
Southern Bog Lemming (Synaptomys cooperi)

Medium Priority
Chimney Swift (Chaetura pelagica)
Masked Shrew (Sorex cinereus)
Smoky Shrew (Sorex fumeux

SGCN Notes: Vascular plant SGCN not listed here: 104 (Appendix I). For more information about a specific SGCN Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Quarrying activity, development, and ski area development	Medium
Climate Change	Species generally have no higher elevations to move to	High

Incompatible Recreation	Rock climbing, hiking disturbs wildlife, tramples rare plants, and introduces exotic species.	High
Invasion by Exotic Species	Non-native species can spread and degrade the habitat for wildlife and eliminate some plant species	Medium
Habitat Fragmentation	Some species require large expanses of forestland surrounding their denning sites	High
Inventory	Distribution, location, and condition of this habitat are not known. A statewide inventory is needed to identify and locate the best examples of these habitats that support the most SGCN	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct a statewide inventory of outcrop and meadow natural communities to identify the best sites and those with SGCN	The number of high quality examples identified containing SGCN	FPR	SWG
Provide technical and financial assistance to private, municipal and federal landowners to control invasive species and to minimize the impact of recreation on SGCN	Number landowners managing for SGCN. Number of acres conserved	NRCS, TNC, VFWD	SWG, NRCS
Technical assistance to town and regional planning organizations to maintain and enhance outcrops and upland meadows for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns including SGCN in their planning	VFWD	VFWD
Develop conservation easements on higher quality sites with greatest number of SGCN or T&E listed SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT
Work with hiking and rock/ice climbing groups to avoid sensitive sites. Limit hiker use and new trails on high quality state-owned sites		ANR,	VFWD,

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
New England Plant Conservation Program – various Conservation Plans	Recovery of various plant species in New England	ANR
State Outdoor Recreation Plan	A comprehensive recreation plan for state lands	FPR

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

Thompson, E. H., and E. R. Sorenson. 2005. Wetland, Woodland, Wildland - A guide to the natural communities of Vermont. University Press of New England, Hanover and London.

Cliff & Talus Summary

Characteristics and location

Cliffs are areas of exposed bedrock, with slopes greater than 60 degrees. Examples range from very small and shaded by surrounding forests to extensive sites greater than one hundred acres. Vermont's cliffs are divided based on their climatic affinities and their bedrock. Climate is the factor separating boreal cliff types from temperate cliff types. The boreal types are found in the cooler regions of the state, the Northeast Highlands and the Green Mountains, though a few are found in generally warmer regions, in especially cool situations such as at high elevations or in cold valleys. The temperate types are found either at middle to low elevations or in the warmer regions of the state. Bedrock is the factor separating acidic cliff communities from calcareous cliff communities. Granites, some quartzites, and sandstones are typically acidic, whereas limestones, dolomites, calcareous schists, and some quartzites are calcareous. [Thompson and Sorenson 2000]

Talus slopes are areas of rockfall below cliffs and are characterized by an accumulation of many rocks broken off a cliff face through physical forces including freezing and thawing.

Types of Cliff and Talus Communities:

Boreal Acidic Cliff: These are high elevation cliffs, generally above 2,000 feet, found on acidic bedrock such as granite, gneiss, quartzite, or non-calcareous schist. Vegetation is usually red spruce, balsam fir, American mountain-ash, bush-honeysuckle, three-toothed cinquefoil, and hairgrass. Eastern Hemlock is absent from these cliffs. Found primarily in the cooler regions of the state, the Northeast Highlands and the Green Mountains.

Boreal Calcareous Cliff: These are high elevation cliffs, mostly above 2,000 feet, where calcareous bedrock (usually calcareous schist, but occasionally limestone or marble) combined with seepage creates conditions that favor certain calciphilic plants, some of which are quite rare statewide.

Temperate Acidic Cliff: These are lower elevation cliffs, generally below 2,000 feet, found on acidic bedrock. Characteristic vegetation includes eastern hemlock, white pine, red maple, paper birch, harebell, and heart-leaved aster. Found primarily either at middle to low elevations or in the warmer regions of the state.

Temperate Calcareous Cliff: These are low elevation cliffs in warmer areas on limestone, marble, dolomite, or calcareous quartzite. They may be moist or dry, depending on the situation, but usually do not have abundant seepage. Some characteristic species are northern white cedar, purple clematis, smooth cliff-brake, purple-stemmed cliff brake, harebell, and herb robert. Found primarily either at middle to low elevations or in the warmer regions of the state.

Open Talus: This broadly defined community type includes all areas of open rockfall. These rockfall areas usually occur below cliffs, and can be comprised of granite, quartzite, gneiss, shale, or less commonly limestone or marble.

Cliff & Talus Condition

Current Condition: Generally, cliffs and talus communities are not directly vulnerable to habitat degradation simply because they tend to be inaccessible and limited in timber or development potential. Recreational activities and intensive quarrying may be the greatest impacts to these communities where such activities occur.

Desired Condition (SGCN Needs): Cliffs and talus are often host to habitat specialists, many of which are plants directly linked to the natural community type. In general, the larger the site, the greater the likelihood that numerous SGCN plant species will exist and that they will persist. Many of the animal species associated with this community types; however, do require accessible, unfragmented habitat mosaics. Several of the animal species require the cliff and talus for nesting or hibernation, but range as far as 1000 ha from the site. Three of the species (North American Race, rock vole, and five-lined skink) specifically benefit from active management for early successional features or small openings around the sites to provide solar radiation. The North American Race is found on only one site in Vermont. The five cliff and talus community types provides the habitat for 100 SGCN.

Species of Greatest Conservation Need in Cliffs & Talus

High Priority
North American Race (Coluber constrictor)
Timber Rattlesnake (Crotalus horridus)
Eastern Ratsnake (Pantherophis alleghaniensis)
Five-lined Skink (Plestiodon fasciatus)
Rock Vole (Microtus chrotorrhinus)
Small-footed Bat (Myotis leibii)
Long-tailed or Rock Shrew (Sorex dispar)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Eastern Ribbonsnake (Thamnophis sauritus)

SGCN Notes: Vascular plant SGCN not listed here 65 species (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Quarrying activity and poorly designed ski trails	High
Habitat Fragmentation	Wider ranging reptiles require unfragmented habitat mosaics of 1000 ha or more	High
Climate Change	Species generally have no higher elevations to move to	High
Incompatible Recreation	Rock climbing disturbs falcons and tramples rare plants	High
Distribution of successional stages	Active management for early successional openings (North American Race), young forest (rock vole), and forest openings for solar radiation (five-lined skink).	Medium
Pollution	Acid rain threatens higher elevation habitats	Medium
Research & Inventory needs	Distribution, location, and condition of this community type are not known.	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct statewide inventory of cliff and talus and identify and locate the best examples of these community types that support the most SGCN	Number of sites inventoried	FPR	SWG
Provide technical assistance and/or financial assistance private landowners to maintain and enhance cliff and talus for SGCN.	Number landowners incorporating SGCN into their land management	NRCS, TNC, FWD	SWG
Technical assistance to town and regional planning organizations for conservation practices that maintain and/or enhance habitat for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns/RPCs considering SGCN in their planning	VFWD	VFWD
Conservation easements on higher quality sites with greatest number of SGCN or T&E listed SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT
Work with hiking and rock/ice climbing groups to avoid sensitive sites	Number of sensitive sites with programs implemented to limit encroachment	ANR, GMC, VOGA	VFWD, Access Fund

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Peregrine falcon plan	Remove peregrine from ESA list	ANR
Draft VT Bat Conservation Plan		ANR
ANR Land Conservation Plan	ANR land acquisition	ANR
VT Recreation Plan (SCORP)	Recreation priorities throughout the state	ANR, GMC, VOGA

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Grassland & Hedgerows Summary

Characteristics and location

Grasslands are landscapes dominated by grasses, sedges and forbs with little to no tree or shrub cover. Most of the larger examples of this community type are the result of current or past agricultural practices. Grassland habitats are also commonly maintained at airports, fairgrounds, landfills and industrial complexes. Smaller grasslands are found in fallow beaver flowages, seasonally flooded areas adjacent to rivers, and sandplain communities, and are covered under separate summaries.

Hedgerows are linear patches of trees or shrubs, often lining field borders or roadsides. Hedgerows enable some species to more fully utilize adjacent grassland communities (for perching, nesting, sheltering or escaping predators), while other species may occupy annual or seasonal home ranges solely within hedgerows. Hedgerows also often serve as travel or dispersal corridors connecting disjunct habitat patches.

Types of Grassland & Hedgerow Communities:

Hayfields, pastures, old fields, power line and RR rights-of-way, mowed interstate medians, airports, industrial complexes. Treed and/or brushy hedgerows lining field edges and roads.

Grassland & Hedgerow Condition

Historical Perspective: Grasslands in Vermont are primarily a result of land clearing for agriculture since European settlement of the area. It has been estimated that early successional forest (1-15-year age class) occupied from 1.1-3.0% of the regional presettlement landscape in areas of northern hardwood forest and 2.4-7.1% of the regional landscape in areas of spruce-northern hardwood forest (Lorimer and White 2003).

Current Condition: Most of Vermont's grasslands occur in the Champlain Valley and to a lesser extent the Connecticut River Valley and the area around Lake Memphremagog. There are also numerous grasslands of various types and sizes scattered across the rest of the state. Most grasslands are associated with current or past agricultural practices. There are, however, grasslands that are the result of other human activities and are maintained for specific purposes. These include grasslands associated with airports (commercial and private), landfills, fairgrounds, military reservations and industrial complexes (e.g., IBM, Husky, etc.). Most of Vermont's grasslands are in private ownership, although the state and federal governments own and manage some of these areas. The counties with the highest percentages of land in agriculture and open land are Addison (35.5%), Franklin (29.5%), Grand Isle (25%) and Orleans (22%, primarily in the area surrounding Lake Memphremagog) (U.S. Department of Agriculture. 1997).

Although agriculture practices create and maintain valuable grasslands, recent intensification of these practices has had negative impacts on their quality and availability. Small diversified farming which provided a range of suitable habitat types has given way to larger, more intensively managed farms because of improved agricultural techniques. Advances in equipment, fertilizers and extensive use of potent pesticides and herbicides have resulted in greater management of hayfields (early and frequent cutting which disrupts nesting activity), conversion of hayfields to row crops or legumes, and intensive grazing (LaBarr et al. 2004).

Urban and suburban development has also resulted in a loss of grasslands. This loss comes in two forms, the direct loss of grasslands as structures and lawns replace fields, and fragmentation of large grassland areas into smaller parcels rendering them insufficient for use by some breeding grassland bird (e.g., Upland Sandpiper). In Vermont, the urban and suburban growth of Chittenden County is

expanding into Franklin and Grand Isle counties to the north and Addison county to the south. As a result, there is increasing pressure to develop agricultural lands important to grassland species (LaBarr et al. 2004).

Other factors contributing to loss of quality grasslands include incompatible management of grasslands in non-agricultural settings (i.e., airports). Although airport construction and management has provided suitable habitat for grassland species, mowing regimes, many of which are required by the Federal Aviation Administration (FAA) often disturb nesting activity. Also, a lack of airport expansion planning (new hangers, airplane parking, etc.) which considers grassland species has led to the loss of important grassland habitat at these sites (LaBarr et al. 2004).

More is known about the effects of current conditions on grassland bird species than other SGCN taxa that use grasslands and/or hedgerows. Grassland bird species have declined steadily throughout their range. Reported results from the U.S. Fish and Wildlife Service Breeding Bird Survey show that declines of grassland birds have been consistently steeper and more widespread than any other assemblage of birds (Askins 1993, Sauer et al. 2011). In Vermont, Upland Sandpiper populations have declined precipitously (Peterson 1999) and Grasshopper Sparrows are considered rare and uncommon (Ellison 1985, Record of Vermont Birds). Both Sedge Wren and Henslow's Sparrow populations have declined to where they may no longer be breeding in the state. Other obligate grassland species, although relatively abundant (i.e., Bobolink and Eastern Meadowlark) have also show significant declines in recent years (LaBarr et al. 2004).

Desired Condition (SGCN Needs): A variety of grasslands and hedgerows are needed to conserve the suite of species dependent on these habitat types. For example, Bobolinks utilize large expanses of grassland or fallow hay fields with little or no alfalfa, high litter cover and scattered broad-leafed forbs for nest-site cover (Martin and Gavin 1995). Northern Harrier habitat includes marshy meadows, wet, lightly grazed pastures, old fields, mesic grasslands, and drained marshlands. Densest populations are typically associated with large tracts of undisturbed habitats dominated by thick vegetation (MacWhirter and Bildstein 1996). Upland Sandpipers prefer large grassland areas (20-40 ha) with a mosaic of grassland types as areas of short grass are used for feeding while areas of taller grass (10-30 cm) are used for nesting. All three of these species benefit from grasslands that are not subjected to early (before July 15) mowing. American Kestrels nest in cavities or nest boxes in most open areas (< 30% canopy cover; Smallwood and Bird 2002). Gray Fox, New England Cottontail, Eastern Ratsnake, Smooth Greensnake and DeKay's Brownsnake all utilize hedgerows for foraging, denning or nesting, and/or as movement corridors.

Implementing the 2005 Wildlife Action Plan

Over the past decade, VFWD maintained an estimated 340 acres of permanent openings as old field shrub cover by brush mowing and burning an average of 105 acres annually to maintain this vegetation type on WMAs. Such permanent shrub openings have been shown to be extremely important to shrubland birds; Smetzer et al. (2014) estimated that "maintaining the current population size of shrubland birds under a management strategy based entirely on silviculture would require a 50–300% increase in silvicultural openings, depending on the species."

The Champlain Valley Bird Initiative, a partnership of Audubon VT, the Natural Resources Conservation Service and the University of Vermont similarly provides landowner with technical and financial assistance to protect and manage grassland and shrubland habitat (benefitting many species including the Eastern Towhee, Golden-winged Warbler, Field Sparrow and Bobolink).

Species of Greatest Conservation Need in Grasslands & Hedgerows

High Priority
Grasshopper Sparrow (Ammodramus savannarum)
Upland Sandpiper (Bartramia longicauda)
Northern Harrier (Circus cyaneus)
Sedge Wren (Cistothorus platensis)
Vesper Sparrow (Pooecetes gramineus)
Fowler's Toad (Anaxyrus fowleri)
Wood Turtle (Glyptemys insculpta)
North American Race (Coluber constrictor)
Timber Rattlesnake (Crotalus horridus)
Eastern Ratsnake (Pantherophis alleghaniensis)
Butterflies-Grassland Group
Moths Group
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Northern Long-eared Bat (Myotis septentrionalis)
Woodland Vole (Microtus pinetorum)
Pygmy Shrew (Sorex hoyi)
New England Cottontail (Sylvilagus transitionalis)
Southern Bog Lemming (Synaptomys cooperi)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Short-eared Owl (Asio flammeus)
Chimney Swift (Chaetura pelagica)
Black-billed Cuckoo (Coccyzus erythropthalmus)
Bobolink (Dolichonyx oryzivorus)
American Kestrel (Falco sparverius)
Purple Martin (Progne subis)
Field Sparrow (Spizella pusilla)
Eastern Meadowlark (Sturnella magna)
Lesser Yellowlegs (Tringa flavipes)
Blue-winged Warbler (Vermivora pinus)
Smooth Greensnake (Opheodrys vernalis)
DeKay's Brownsnake (Storeria dekayi)
Eastern Ribbonsnake (Thamnophis sauritus)
Long-tailed Weasel (Mustela frenata)
Hairy-tailed Mole (Parascalops breweri)
Common Gray Fox (Urocyon cinereoargenteus)

SGCN Notes: Vascular plant SGCN not listed here: 159 (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need/Category	Problem/Info Need Detail	Rank
Habitat Degradation	Widespread early hay harvest (early June) and heavy grazing rotations in pastures.	High
Habitat Conversion	conversion of agricultural habitat to urban/suburban development	High
Distribution of successional stages	Abandonment and forest succession of former agricultural land.	High
Habitat Degradation	Removal of hedgerows to accommodate larger tractors and farm machinery.	High
Habitat Fragmentation	Fragmentation of habitat by roads and trails and increase use of roads and tails by motor vehicles, including ATV's, and mountain bicycles.	High
Inventory	Distribution and condition of this habitat are not well known. Better information is necessary regarding the timing of hay mowing in landscapes with various proportions of agriculture throughout VT.	Medium
Inventory	Better information is needed on the distribution of SGCN within grasslands habitats and the relative values of the various types and sizes of these habitats to the SGCN.	Medium

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Locate grassland and assess management practices on those grasslands.	Number of sites located and assessed	ANR, FSA, UVM	SWG
Identify areas within the state with the largest matrix of grasslands for inclusion in grassland bird opportunity areas.	Number of opportunity areas identified	ANR, UVM	SWG
Ensure protection of opportunity areas via acquisition of conservation easements, management leases and fee title acquisition	Number of sites conserved	ANR, VHCB, TNC	VHCB, TNC
Develop education and outreach program to provide information about grassland/hedgerow dependent species and management options to enhance their populations in Vermont.	Number of maintained or enhanced sites on private land	ANR, FSA, VFB	SWG, EQIP, GRP, VDA
Promote conservation easements or incentives to landowners managing grasslands/hedgerows for SGCN.	Number of maintained or enhanced sites on private land	ANR, FSA, VFB	SWG, EQIP, GRP, VDA
Develop conservation plans at state airports where SGCN are regularly found.	Number of sites with conservation agreements	ANR, VTRANS, FAA	SWG, VTRANS
Continue to work with Vermont National Guard staff at Camp Johnson to manage grasslands to benefit grassland species.	Number of SGCN conserved at Camp Johnson	VNG, ANR	SWG
Maintain and manage grasslands and hedgerows on state and federal lands (wildlife management areas, state parks, National Wildlife Refuges, GMNF)	Number of sites reclaimed and/or managed	ANR, USFWS, USFS	SWG, PR
Manage power line ROW, road margins and related lands known or suspected to support SGCN that depend on grasslands and enhance surrounding habitat by creating and maintaining open habitat.	Number of sites reclaimed and/or managed	ANR, VELCO, GMP	SWG, VETCO, GMP
Support current efforts and develop new efforts to study distribution, productivity, and survivorship of grassland bird species in Vermont.	Number of hypothesis tested	ANR, UVM, Audubon, VCE	SWG, PR
Develop safe road crossings to limit road kill of snakes and turtles which use grassland habitats	Number of safe crossings developed	ANR, Towns, VTRANS,	SWG, PR, VTRANS

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
VT Grassland Bird Management Plan	Maintain and enhance grassland bird populations	VFWD, NRCS, Audubon
Partners in Flight	Regional Bird conservation	VFWD, USFWS, PIF, NABCI
VTRANS Transportation Plans	Manage airports grounds which contain a significant amount of VT's grasslands	VTRANS, VFWD

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Mines and Quarries Summary

Characteristics and location

Mines may provide many or all the habitat qualities of natural caves and can even provide better habitat in some instances. Similarly, quarries may mimic natural cliffs, outcrops, and talus slopes. These human-created cultural habitats, due to the history of Vermont are found statewide and may augment the natural habitats available to wildlife.

Types of Mines and Quarries:

Mines in Vermont include gold, silver, iron, asbestos, and talc mines.

Quarries in Vermont include marble, granite, and slate quarries

In some cases, gravel pits and road cuts may provide habitat

Mines & Quarries Condition

Current Condition: Mines and quarries occur throughout the state. Some are long abandoned, some more recent, and others currently used to lesser or greater extents. The sites vary in their structural stability and some are very dangerous (large sections of the Elizabeth Mine have collapsed) Bats are known to use some mine sites as hibernacula. Peregrine falcons may nest or roost on the walls of some rock cuts. Mine vents and other vertical rock structure may provide nesting habitat for swifts. Small-footed bats might seek shelter in between and under large rock talus created by mining or quarrying operations. In some instances, the sites are toxic due to leaching of mine tailings. Some sites have the entrances blocked, become dumping areas, or recreational vehicle parks.

Desired Condition (SGCN Needs): Some mines and quarry site provide conditions that certain species select. A mine that has appropriate temperatures and humidity may provide good wintering habitat for bats. Like caves, if the conditions change or if disturbances occur, the site may no longer be suitable habitat and can even cause the death of bats using the mine. Some rattlesnake reports historically have been from slate quarries in proximity to existing or historical den sites. Quarries could provide foraging and basking habitat as well as escape cover. Rock piles with abundant spaces that extend below the frost line could even provide denning sites. Sites providing necessary habitat for SGCN are important and should be conserved.

Species of Greatest Conservation Need using Mines and Quarries

High Priority
Chimney Swift (Chaetura pelagica)
Timber Rattlesnake (Crotalus horridus)
Little Brown Bat (Myotis lucifugus)
Northern Long-eared Bat (Myotis septentrionalis)
Indiana Bat (Myotis sodalis)
Small-footed Bat (Myotis leibii)
Tri-colored bat (Perimyotis subflavus)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Big Brown Bat (Eptesicus fuscus)

SGCN Note: For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Closure of mine entrances and filling of quarries.	High
Habitat Alteration	Modification of mine entrances or interiors that either exclude wildlife or create unsuitable conditions	High
Habitat Conversion	External surface changes to drainage patterns or tree cover that render the mine or quarry unsuitable for wildlife use.	High
Pollution	Poisonous gasses that can infiltrate a mine or runoff that contaminate a site	High
Trampling or Direct Impacts	Direct persecution of wildlife	High
Habitat conversion	Reopening an abandoned mine or cave for extraction of mineral resources	High
Incompatible recreation	Recreational use of mines or caves used by wildlife.	High
Inventory	Distribution, location, and condition of this habitat are not fully known. A statewide inventory would add to our knowledge of sites that support the most SGCN	Med

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct statewide inventory of mines and quarries important to SGCN.	Number of sites surveyed that have SGCN that are dependent on mines and quarries	VFWD, Town Conservation Commissions, AVCC	SWG, Section 6
Identify those mines or quarries important to SGCN and at risk of loss, then take actions to conserve them with priority given to structures with most vulnerable species, largest concentration of a SGCN, or the greatest number of SGCN present.	Number of protected occurrences of each SGCN using mines and quarries.	VFWD, Town Conservation Commissions, AVCC	SWG, Section 6
Raise awareness and acceptance of the need to provide cultural habitat for some SGCN that depend on mines and quarries and modify recreational and other activities.	Number of audiences reached.	Environmental Educators	
Promote conservation easements or agreements for important sites for SGCN	Number sites having conservation agreements	ANR, BCI	VHCB, VLT
Consider direct purchase of a mine or quarry if that is the most effective manner to manage for SGCN	Number of conserved SGCN that are dependent on mines and quarries	VFWD, Town Conservation Commissions, AVCC	SWG, Section 6
Provide technical assistance and economic incentives for property owners to manage mines and quarries for SGCN while protecting the health and safety of humans.	Maintained or enhanced condition of SGCN using a mine or quarry (numbers of individuals, reproductive success, survival rate)	VFWD	VFWD

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Work with landowners to provide fencing and/or appropriately designed gates that exclude human intrusion and reduce liability to landowner, while maintaining SGCN using a mine or quarries	Maintained or enhanced condition of SGCN using a mine or quarry (numbers of individuals, reproductive success, survival rate)	VFWD	VFWD
Educate users of mine and quarry sites and encourage avoidance of important sites when SGCN are vulnerable (e.g., bats fall through spring).	Increased understanding and acceptance of mine/quarry conservation by the public	VFWD, BCI, School programs, media	Marketing? Section 6
Encourage use of alternative sites that do not harbor SGCN	Increased understanding and acceptance of mine/quarry conservation by the public	VFWD, BCI, School programs, media	Marketing? Section 6

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Peregrine falcon federal monitoring plan and state recovery plan	Peregrine monitoring and management	ANR/Audubon
VT Bat Conservation Plan	Conservation of all bats, especially those currently listed in Vermont	ANR/VFWD
Rattlesnake Recovery Plan	Maintain and enhance rattlesnake populations in VT and move them toward recovery	VFWD

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Subterranean Summary

Characteristics and Location

Subterranean areas area are defined as below-surface natural features (mines are addressed under Cultural Habitats) that consist of both aquatic and terrestrial conditions. Because these areas are below ground, there is limited human access to locate and inventory these sites. Consequently, there is little information on their abundance, distribution, and condition.

Some of the best information on subterranean areas comes from the caving community. Members of the Vermont Cavers Association have interest in locating, exploring, and even surveying these areas. Some of the earlier documentation of Vermont caves is from John Scott (1959) and, more recently, Peter Quick (1994).

Most of Vermont's caves are relatively small, ranging from less than 100 feet underground to several hundred feet. Some caves contain passages that may continue far beyond what has been accessed. Most Vermont caves are solutional, meaning they have been formed through erosion from moving water.

While caves are found throughout Vermont, most of the known caves are in southern Vermont, particularly the Taconics and Southern Green Mountains regions. These areas also are known to have the geologic features most associated with underwater springs and streams that would provide subterranean aquatic habitats.

Subterranean Condition

Current Condition: Due to the geologic nature of the habitat type, caves remain in much of their original structure. Many of the more accessible caves do exhibit signs of graffiti and evidence of the destruction or removal of cave formations such as stalagmites and stalactites. Historic accounts of some caves document the loss of beautiful formations by visitors. Currently, 3 caves are gated and locked to control human visitation.

Subterranean areas provide a very consistent environment of temperature, relative humidity, and air flow. While these variables are likely important to the overall condition, there is very limited information on these variables. Changes in structure and hydrology could greatly affect these habitats provided by subterranean areas.

There are 6 species of bats known to hibernate in Vermont caves. Bats are one of the better studied wildlife species associated with subterranean areas, and have been surveyed in caves going back into the 1930s (Trombulak et al. 2001). Trend data from hibernacula surveys does provide for some evaluation of the value of specific caves to bat species and populations. Recent surveys indicate that caves may hold as few as less than 10 bats to as many as over 23,000. Interest and understanding in the invertebrate community associated with caves is just beginning.

Little is known about the condition of the subterranean aquatic habitats.

The primary activities resulting in the loss or degradation of subterranean areas involve either human disturbance to either the cave structure (thereby affecting temperature, humidity, or air flow) or the species using the area and pollutants to the aquatic elements of the subterranean areas.

Desired Condition: Subterranean areas provide habitat for a small number of SGCN in the state. However, subterranean areas provide a critical habitat component for the survival of these species. Subterranean areas should remain intact, with limited human alteration or influence from above-ground pollutants. Many of the SGCN associated with subterranean areas use the sites for denning or hibernation, but also spend a disproportionate amount of the year in the surrounding area (e.g., fall swarming for bats or breeding and birthing for rattlesnakes).

A total of 8 SGCN are associated with subterranean area.

Species of Greatest Conservation Need in Subterranean Landscapes

High Priority
Little Brown Bat (Myotis lucifugus)
Northern Long-eared Bat (Myotis septentrionalis)
Indiana Bat (Myotis sodalis)
Tri-colored bat (Perimyotis subflavus)
Small-footed Bat (Myotis leibii)
Northern Long-eared Bat (Myotis septentrionalis)
Timber Rattlesnake (Crotalus horridus)

Medium Priority
Chimney Swift (Chaetura pelagica)
Big Brown Bat (Eptesicus fuscus)

SGCN Note: For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Hydrologic alteration	Sedimentation, development in watershed, road building	Medium
Habitat Conversion	Roads, development, and agriculture remove SGCN habitat surrounding subterranean sites	High
Habitat Degradation	Alteration of cave structure, thereby influencing temperature, humidity, or air flow	High
Incompatible recreation	Disturbance to hibernating bats or denned rattlesnakes	Medium
Pollution	Aquatic pollutants	Medium
Inventory	Statewide inventory has been completed, but not all sites have been evaluated	Low

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Gate subterranean sites experiencing risk from unlimited human visitation	Number of sites gated	USFWS, TNC, VCA	SWG, USFWS
Conservation easements on higher quality sites with greatest number of SGCN or T&E listed SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC, NCC	VHCB, VLT

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Provide technical assistance and/or financial incentives to private landowners, towns and RPC's to maintain and enhance Subterranean habitat for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number landowners incorporating SGCN into their land management, Number of towns including SGCN in their planning. Number of acres conserved	NRCS, TNC, FWD, RPC, VLCT, USFWS	NRCS programs, USFWS

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Draft Bat Conservation and Recovery Plan	Conservation and recovery of Vermont bat species	ANR
Cave Management Plans	Management plans for specific caves in Vermont	ANR, VCA, NCC

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

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Buildings & Other Structures Summary

Characteristics and location

Buildings and structures may provide habitat for wildlife, generally in the form of shelter, when they provide appropriate conditions (i.e., temperature and humidity) and are relatively secure from disturbance. Sometimes the structures provide habitat for prey species (mice) that attract the foraging SGCN (snakes). In other cases the structures may simply become an extension of the natural landscape, such basking and foraging sites for skinks. Structures used by wildlife are located throughout Vermont, but are not always known or appreciated as habitat for wildlife.

Types of Buildings and Other Structures Providing Habitat for SGCN

Barns and other outbuildings, Abandoned or little used buildings, House attics, Bridges, Dams, Power poles and other vertical structures (possibly) and Towers or tall buildings that mimic cliffs.

Condition of Buildings & Other Structures

Current Condition: Buildings and other structures may be used by wildlife under a variety of circumstances. Bats may roost in abandoned building attics, the attics of occupied dwellings, or in outbuildings or covered bridges. Peregrine falcons may nest on ledges of tall buildings, tower, or bridges although we don't have any currently nesting in such locations at present. Small-footed bats might seek shelter in between and under large rock talus used to armor dams. Osprey may nest on power poles near water and chimney swifts may build their nests inside chimneys.

Desired Condition (SGCN Needs): Some buildings and other structures provide conditions that certain species select. If the site is relatively undisturbed and secure over time, large number of some species may come to depend on the site (e.g., large bat maternity colony). Change the light regime or air circulation, and the conditions may no longer be as suitable. In some cases the surrounding area, or even the specific geographic location, may determine if a structure is used by a SGCN. Only barns located near existing skink populations will be used by that species and a power pole used by osprey for nesting has to be within flying distance of fishable waters.

SGCN Using Buildings & Other Structures

High Priority
Chimney Swift (Chaetura pelagica)
Eastern Ratsnake (Pantherophis alleghaniensis)
Five-lined Skink (Plestiodon fasciatus)
Little Brown Bat (Myotis lucifugus)
Northern Long-eared Bat (Myotis septentrionalis)
Indiana bat (Myotis soldalis)
Small-footed Bat (Myotis leibii)
Tri-colored bat (Perimyotis subflavus)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Purple Martin (Progne subis)
Big Brown Bat (Eptesicus fuscus)

SGCN Note: For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Inventory	Distribution, location, and condition of this habitat are not known. A statewide inventory is needed to identify and locate the best examples of these habitats that support the most SGCN	Medium
Habitat Conversion	Loss of old buildings that provide shelter for wildlife	High
Habitat Conversion	Modification of structures that exclude wildlife or create unsuitable conditions	High
Habitat Conversion	Changes to structures that may trap or kill animals (including deliberate exclusions)	High
Pollution	Use of chemicals that may poison or kill wildlife	High
Trampling or Direct Impacts	Direct persecution of wildlife using structures	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct statewide inventory of buildings and structures important to SGCN.	Number of conserved sites with SGCN that are dependent on buildings and other structures	VFWD, Town Conservation Commissions, AVCC	SWG, Section 6
Identify those buildings or other structures important to SGCN and at risk of loss, then take actions to conserve or replace.	Number of protected occurrences of each SGCN using buildings and other structures.	VFWD, Town Conservation Commissions, AVCC	SWG, Section 6
Promote conservation easements or agreements for important sites for SGCN	Number sites having conservation agreements	ANR, BCI	VHCB, VLT
Consider direct purchase of a structure if that is the most effective manner to manage for SGCN (e.g., PA bat maternity colony in old church).	Number of conserved SGCN that are dependent on buildings and other structures	VFWD, Town Conservation Commissions, AVCC	SWG, Section 6
Provide appropriately designed structures in suitable locations to replace buildings and structures no longer available to SGCN. In some cases these need to be provided in conjunction with an exclusion	Number of protected occurrences of each SGCN using buildings and other structures.	VFWD, Town Conservation Commissions	SWG, Section 6
Provide technical assistance and economic incentives for property owners to manage their structures for SGCN while protecting the health and safety of humans.	Maintained or enhanced condition of SGCN using a building or structure (numbers of individuals, reproductive success, survival rate)	VFWD Wildlife Services	VFWD
Provide education programs and materials that improve the public's understanding of SGCN needs and perceptions of wildlife that utilize buildings and structures.	Audiences reached, Number of people attending program.	VFWD, NWF, enviro educators	SWG, PR

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Encourage coexistence with SGCN using buildings and structures	Increased understanding and acceptance of building/structure conservation by the public	VFWD, BCI, School programs, media	VFWD, USFWS

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Peregrine falcon federal monitoring plan and state recovery plan	Peregrine monitoring and management	ANR, Audubon
VT Bat Conservation Plan	Conservation and restoration of bat population	ANR
Osprey Recovery Plan	Osprey monitoring and management	ANR

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Riparian Summary

Vermont's aquatic and shoreline landscape includes all surface waters and their adjacent streambanks, floodplains, river corridors, and/or lakeshores. This landscape includes lacustrine (lake) formations, fluvial (stream and river) formations, floodplain forests, and shores and marshes. This landscape also includes thousands of miles of streambank areas that are comprised of upland communities adjacent to surface waters. The aquatic and shoreline landscape is described as an interconnected system of the lacustrine, fluvial, floodplain, marsh, shore, and upland communities that comprise it for the purpose of identifying and conserving the common habitat functions these communities provide at the landscape level.

Riparian (riverbank) areas, if maintained in continuous, sufficiently wide, interconnected corridors throughout a watershed, serve as movement corridors for many of Vermont's wildlife species. Maintaining intact terrestrial communities adjacent to surface waters also serves to protect aquatic habitats. Riparian areas help protect water quality, provide organic inputs, regulate water chemistry and physical properties (such as temperature), and provide physical aquatic habitat structure (e.g., undercut banks, large woody debris). Again, because aquatic communities are often inter-connected throughout the landscape, maintaining intact riparian areas is essential to protecting aquatic communities from the headwaters to downstream receiving waters.

> "It is a well known fact that the best fishing is where a forest is near the shore, and best of all where the limbs overhang the water. Not only do the trees afford shelter, furnish food and prevent evaporation, but at the same time they keep the water clear and cool in the summer. In the winter the forests afford protection by lessening the severity of the winter frosts, and in all forest regions the changes of temperature are not so severe as in treeless countries and on the open plain: and the effect upon the water is even greater….But the forests not only regulate the flow of water, as above stated, but they purify the water."
> **- Frank H. Carleton, from the Fifteenth Biennial Report of the Commissioners of Fish and Game of the State of Vermont, 1899-1900.**

Vermont State statute (10 V.S.A. Chapter 32 § 752. Definitions) defines *River Corridor* as "the land area adjacent to a river that is required to accommodate the dimensions, slope, planform, and buffer of the naturally stable channel and that is necessary for the natural maintenance or natural restoration of a dynamic equilibrium condition, as that term is defined in section 1422 of this title, and for minimization of fluvial erosion hazards…). River corridors include both the channel and adjacent land such that the river has access to its floodplain and accommodates both existing and future meander features resulting from the forces of fluvial dynamics. The river corridor may consist of floodplain forests, marshes and other wetlands. Maintaining or restoring river corridor processes and function enables longitudinal and horizontal connectivity between aquatic and terrestrial landforms and associated biota.

Habitat requirements, problems, and conservation strategies have been assessed and developed for both the landscape level, and the individual aquatic and terrestrial species' habitats that are associated with it. Many SGCN meet most of their habitat needs within the aquatic-terrestrial interface that the aquatic and shoreline landscape provides. These species, in particular, are discussed in this section.

Characteristics and location

Aquatic and shoreline landscapes are comprised of streams, rivers, lakes, wetlands, shorelines and floodplains that form a complex and interrelated hydrological system. This hydrological

system extends up and down streams and along lakeshores from the bottom of the water table to the top of the vegetation canopy, and includes land that is directly affected by surface water (Verry 2000). Riparian areas are known for their high biological diversity. They are "characterized by frequent disturbances related to inundation, transport of sediments, and the abrasive and erosive forces of water and ice movement that, in turn, create habitat complexity and variability…resulting in ecologically diverse communities" (Verry 2000).

The landscape level includes both the terrestrial-aquatic interface and the aquatic areas found throughout Vermont, from the mountain streams to the large valley rivers and the lakes and ponds scattered throughout the landscape. The following aquatic and terrestrial areas are associated with the aquatic and shoreline landscape (for details see the following summaries in Appendix B):

- Lakes
- Lake Champlain
- Lake Champlain Tributaries
- Connecticut River
- Floodplain Forests
- Upland Shores
- Wet Shores
- Swamps and Marshes

Landscape Condition

Current Condition: Nationwide an estimated 70% to 90% of natural riparian vegetation, vital to maintaining the integrity of riparian and aquatic habitats, has already been lost or is degraded due to human activities (Doppelt 1993). In Vermont, some of our rivers, streams, lakes, and wetlands still have intact riparian areas, while many others no longer have functioning riparian areas due to more than 200 years of intensive human use of the land.

In general, riparian areas in Vermont are most affected by habitat conversion, alteration, and fragmentation. Typically, steeper mountainous streams and high elevation lakes and ponds, less suited for human development, have well forested riparian areas with cold, clean water and stable stream channels and shorelines. Recreational activities and their associated development and forestry are the land uses most common in these areas that may affect riparian and aquatic species. Mid and low elevation waterbodies and their adjacent riparian areas are more likely to be impacted by human land uses, including clearing of riparian vegetation, alteration of stream channels and lakeshores, and direct inputs of toxins, excess nutrients, and sediments. These impacts are related primarily to roads, residences, commercial development, and agriculture, with agriculture being especially extensive in the lower valleys of the Champlain and Connecticut tributaries. Lacustrine areas and their associated shorelines are particularly impacted by lakeshore development, such as seasonal and permanent residences, marinas and docks, and public and private beaches. In many instances these developments have altered natural lakeshore and littoral zones resulting in the direct loss of habitats for SGCN through the addition of fill materials (sand, bottom barriers) and the removal of native aquatic vegetation.

The fragmentation of riparian habitat is extensive in Vermont, due primarily to Vermont's roadways paralleling the stream, rivers, and lakeshores, and use of rich floodplain areas for agriculture. Historic settlement and transportation patterns and ease of construction have resulted in roads paralleling the majority of Vermont's major waterbodies and thousands of associated bridges and culverts. This results in removal of riparian vegetation and fragmentation, both longitudinally and laterally between the waterbody and adjacent upland communities.

Desired Condition (SGCN Needs): Aquatic and shoreline areas provide several habitat functions for the species that inhabit them. Some species rely directly on both the aquatic

and terrestrial components of the riparian-aquatic interface. For example, otter use aquatic areas within 100 meters of water's edge for feeding and riparian areas for denning and as travel corridors. These species move daily between terrestrial and aquatic areas to fulfill their life needs. Other species move seasonally between the aquatic and terrestrial components of the aquatic and shoreline landscape. For example, the wood turtle uses streams and rivers for overwintering, and uses adjacent riparian areas up to 300 meters from the water's edge for foraging, breeding, nesting, and dispersal. For those species that are strictly aquatic, the adjacent terrestrial riparian areas function to protect the aquatic areas, providing shade, organic inputs, filtering and storage of overland runoff, and bank stability.

Implementing the 2005 Wildlife Action Plan

In 2013, VFWD completed the Vermont BioFinder project, a map and database identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. A notable outcome of the project was a map of all aquatic features and the riparian areas/valley bottoms in which rivers and streams occur and the identification of these areas as critical conservation components for wildlife habitat, rare species, aquatic system health, and wildlife/landscape connectivity.

VFWD provided technical assistance to every Vermont Regional Planning Commission and nearly every town on a variety of wildlife and land planning related issues, including SGCN conservation, habitat blocks, and wildlife corridors. Conserving Vermont's Natural Heritage (Austin et.al. 2004) was reprinted and distribution of this planning document continues.

The Partners for Fish & Wildlife program of the U.S. Fish & Wildlife Service, which organizes and supports community-based habitat restorations, partnered with more than 600 landowners on more than 550 projects to restore 294 miles of riparian habitat, 5,476 acres of wetland habitat, 976 acres of upland habitat and 1,200 acres of habitats impacted by invasive species. Partners also reopened 1,438 miles of stream to fish passage; and completed 11 miles of in-stream restoration.

Species of Greatest Conservation Need in Aquatic and Shoreline

High Priority

Bald Eagle (Haliaeetus leucocephalus)
Wood turtle (Glyptemys insculpata)
Common Mudpuppy (Necturus maculosus)
Silver-haired Bat (Lasionycteris noctivagans)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Tri-colored bat (Perimyotis subflavus)
Water Shrew (Sorex palustris)
Odonates-Bog/Fen/Swamp/Marshy Pond Group
Freshwater Mussels Group
Freshwater Snails Group
Lakes/ponds Odonata group
Mayflies/Stoneflies/Caddisflies Group
River/stream Odonata group
Elktoe (Alasmidonta marginata)
American Brook Lamprey (Lethenteron appendix)
Bridle Shiner (Notropis bifrenatus)
Blackchin Shiner (Notropis heterodon)
Blacknose Shiner (Notropis heterolepis)
Northern Brook Lamprey (Ichthyomyzon fossor)
Stonecat (Noturus flavus)

Medium Priority

Peregrine Falcon (Falco peregrinus)
Pied-billed Grebe (Podilymbus podiceps)
Lesser Yellowlegs (Tringa flavipes)
Northern River Otter (Lontra canadensis)
Muskrat (Ondatra zibethicus)
Masked Shrew (Sorex cinereus
Mottled Sculpin (Cottus bairdi)
Redfin Pickerel (Esox americanus)
Brook Trout (naturally reproducing populations) (Salvelinus fontinalis)
American Eel (Anguilla rostrata) Lake Champlain and Connecticut River populations.
Silver Lamprey (Ichthyomyzon unicuspis)
Sea Lamprey (Petromyzon marinus) CT River
Redbreast Sunfish (Lepomis auritus)
Atlantic Salmon (Salmo salar) naturally reproducing populations in Lakes Champlain & Memphremagog

SGCN Notes: Vascular plant SGCN not listed here include 7 species (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories used here

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Floodplain forests, lakeshores and other riparian communities converted to agriculture, roadways, and residential/commercial development. Habitat conversion is most prevalent in low and mid elevation areas.	High
Habitat Degradation	Removal or alteration of vegetative community, ground disturbance, and manipulation of shorelines and streambanks; can lead to degradation of water quality, and loss of physical habitat structure. Habitat degradation occurs primarily in upper elevation areas, in contrast to complete habitat conversion, which is more common in mid and low elevation areas.	High
Habitat Fragmentation	Interruption of movement corridors to and from breeding, feeding, and seasonal habitats via conversion, degradation, and road mortality (herps). Habitat is fragmented both longitudinally (up and down river and stream channels) and laterally (horizontally) from lake shores and stream banks connecting to upland terrestrial habitats.	High
Inadequate Disturbance Regime	Dams, drainage ditching, floodplain filling, and channel incision (floodplain abandonment) that affect flooding, erosion, and deposition processes	High
Invasion by Exotic Species	Habitat alteration from invasive plant species (e.g., Japanese knotweed, Purple loosestrife); plant inter-species competition for habitat.	High
Harvest or Collection, Trampling/Direct Impacts	Collection and harvest pressures; increased human activity disturbing breeding, nesting and movement.	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories used here
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Develop a plan to identify and prioritize existing contiguous floodplains, riparian corridors and associated wildlife habitat linkages	Increase in number of riparian habitat linkages identified and conserved	ANR, TNC, NWF, NRCS, FSA	EQIP, CRP, CREP
Technical assistance to private landowners to maintain and enhance SGCN habitat in riparian areas and floodplains.	Increase in number of acres of riparian habitat restored and/or conserved by private landowners	NRCS, ANR, USFWS, FSA, TU, watershed associations	EQIP, CREP
Financial incentives for private landowners to maintain and enhance SGCN habitat in riparian areas and floodplains.	Increase in number of acres of riparian habitat restored and/or conserved by private landowners	NRCS, ANR, USFWS, FSA, TU, watershed associations	EQIP, CREP, CRP
Technical assistance to town and regional planning organizations to maintain and enhance SGCN habitat in riparian areas and floodplains. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Increase in number of towns incorporating riparian conservation into planning and zoning	ANR, ACCD, VLCT, AVCC, NRCS, FSA	ANR, NRCS
Technical assistance to state and federal land management agencies on floodplain and riparian habitat management goals/strategies	Change in the number of state and federal land management plans providing for riparian conservation	ANR, VTrans, USFWS, USFS	

Work with VTrans, towns, and private landowners to identify and maintain (or restore) floodplain and riparian habitat connectivity and improve aquatic organism passage	Change in the number of road crossings that do not impede riparian corridor movement – longitudinally and laterally	VTrans, ANR, NRCS	EQIP, VTrans, SWG
Provide technical assistance to landowners and conservation groups on invasive exotic management and eradication		USFWS, TNC, ANR, NRCS, FSA	CRP, CREP,
Pursue funding to enable floodplain and riparian restoration and enhanced protection.	Necessary funding provided.	ANR, USFWS, USFS, NRCS, VTrans, TNC, Lake/ Watershed Associations	Vermont legislature

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
ANR State Lands Management Plans	Management practices for ANR-owned lands	FPR, VFWD
Floodplain Forests of Vermont	Natural Community Inventory	ANR
Riparian Management Guidelines for Agency of Natural Resources Lands (Draft 2015)	Informs the development of recommendations for Act 250-regulated projects	ANR
ANR Stream Geomorphic Assessments	Stream and riparian condition inventories	ANR
Conserving the Eastern Brook Trout: Action Strategies (2011)	Conserve, enhance or restore brook trout populations that have been impacted by habitat modification or other population level threats.	ANR
ANR River Corridor Planning Guide, 2nd edition	Planning, designing & protecting river corridors	ANR
The Vermont Shoreland Protection Act: A Handbook for Shoreland Development (Version 1.2, April 2015).	To allow reasonable development of shorelands along lakes and ponds while protecting aquatic habitat, water quality, and maintaining the natural stability of shorelines.	ANR

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Streams & Rivers Summary

Characteristics and location

There are more than 7,000 miles of rivers and streams in Vermont draining 4 major watersheds: Connecticut, Lake Champlain, Hudson, and Memphremagog. The headwater streams of the western Green Mountains drain to the large rivers of the lower Champlain Valley and eventually into Lake Champlain. The eastern slopes of the Green Mountains drain primarily to the Connecticut River. Portions of the Northeastern Highlands and Northern Piedmont drain north into Lake Memphremagog. The Taconic Mountains and southern Green Mountains drain into the Batten Kill, Deerfield, Walloomsac, and Hoosic rivers. These rivers, with the exception of the Deerfield, eventually drain into the Hudson River in New York. The Deerfield drains to the Connecticut River. Despite this diversity of landscape over which Vermont's streams and rivers flow, fluvial ecosystems can be described by three general categories based on physical stream characteristics. There are various biotic communities associated with each of these physical stream types, depending on both the physical stream characteristics and the geographic location of the waterbody. For example, the large rivers of the lower Lake Champlain watershed are similar in physical characteristics to the large tributaries feeding Lake Memphremagog, but some of the species found in these two settings differ due to the repopulation patterns of aquatic species into freshwater ecosystems post-glaciation. This summary does not include discussion of the lower Connecticut River tributaries and the lower Lake Champlain tributaries below the fall-line and/or below 150 feet elevation, as these areas are covered under separate summaries.

General types of Streams & Rivers communities:

High-elevation Headwater Streams: These streams are typically located in high elevation mountainous areas. They are small in size, having small drainage areas, and are located in steep valleys (typically > 4% slope). Valleys are confined, meaning the stream channel has little or no floodplain, and upland forest communities are adjacent to the channel, typically with no distinct riparian vegetative community present. Channel bed form is usually cascade over bedrock and boulders or step-pools over boulders and cobbles. Stream flow is fast and turbulent with white water common. Stream temperatures are typically very cold. Forest canopy completely shades the stream, and the food web of the system is based on inputs of organic material from the adjacent vegetation (e.g., leaves, twigs, branches). Large trees falling into the stream channel also provide important habitat features and channel bed stability, acting as cover and causing localized scour and deposition of stream sediments. Species that typically inhabit these streams include brook trout, slimy sculpin, northern spring salamander, northern dusky salamander, two-lined salamander, and numerous aquatic insects, including stoneflies and mayflies. SGCN species uniquely associated with these ecosystems include the water shrew, some specific mayfly and Odonata species and naturally reproducing populations of brook trout.

There are some headwater streams in high elevation areas that do not meet the above description. Small, low gradient streams are often found in ridgeline saddles and bowls. These streams are typically meandering, with alternating riffles and pools and gravel and sand substrates. Adjacent wetlands are often associated with these streams. These are typically still cold water systems, due to abundant groundwater feed and cooler climatic conditions influenced by high elevation, and therefore often host many of the same species as the high gradient

headwater streams. Invertebrate communities, however, are likely to be distinct from the higher gradient systems (Burnham 2005).

Mid-elevation Streams and Rivers: These streams are typically located in mid elevation areas where the steep mountains transition to the low gradient valleys. Stream channels are small to moderate in size, and are located in moderately steep valleys (typically 2-4% slope). Valleys are semi-confined, resulting in narrow floodplains. These floodplains may have narrow bands of distinct riparian vegetation, but quickly transition into upland forest communities. Channel bed form is typically step-pool or plane bed. Step-pool channels have short vertical drops over boulders and cobbles with channel spanning pools in between, which are typically dominated by cobbles and gravels. Plane bed systems lack distinct pools, and are primarily riffles, runs, and rapids over a mix of boulders, cobbles, and gravels. Stream flow is fast and somewhat turbulent with whitewater common. Stream temperatures are typically cold to cool. Forest canopy usually shades the stream but may not form a complete canopy over the channel. The aquatic food web in these channels is based largely on inputs of organic material from the adjacent vegetation (e.g., leaves, twigs, branches), though some mosses and algae are also present, providing primary production in the waterbody. Large trees falling into the stream channel and transported from upstream provide important habitat features and channel bed stability, acting as cover and causing localized scour and aggradation of the channel bed. Species that typically inhabit these streams include brook trout, slimy sculpin, blacknose dace, white sucker, longnose dace, northern dusky salamander, two-lined salamander, and numerous aquatic insects. SGCN species uniquely associated with this habitat potentially include naturally reproducing populations of brook trout, as well as American eel, wood turtle, river otter, water shrew, muskrat and some specific mayfly and Odonata species.

Low-elevation Large Valley Rivers: These rivers are located at low elevations in Vermont's large river valleys, such as the Winooski, Lamoille, Missisquoi, Barton, Otter, and Batten Kill. This description does not include those portions of the large Lake Champlain tributaries located below the fall-line. These river channels are moderate to large in size, and are located in low gradient valleys (typically <2% slope). Valleys are unconfined, and floodplains are broad and flat. Adjacent wetlands are common in the floodplains. These floodplains have extensive distinct riparian vegetation and often include unique natural communities, such as floodplain forest, marsh, and shoreline communities. The channel bed undulates vertically, being composed of alternating riffles and pools or dune-ripple formations. Riffle-pool systems are dominated by gravels and sands, where dune-ripple systems are usually dominated by sands and silts. Stream flow is slow and flat with whitewater rarely present. Stream temperatures are typically cool to warm. Forest canopy shades the near-bank area of the channel but does not form a complete canopy over the channel. The aquatic food web in these channels is based on inputs of organic material from the adjacent vegetation (e.g., leaves, twigs, and branches) and transported from upstream, as well as instream aquatic vegetation. Large trees falling into the stream channel and transported from upstream provide important habitat features, especially since coarser streambed substrates are typically lacking in these systems. Woody debris provides cover and substrate for aquatic biota, as well as helping to maintain channel bed stability and enhancing habitat complexity with localized scour and aggradation of the channel bed. Numerous cool and warmwater fish species inhabit these streams, including bluntnose minnow, fallfish, blacknose dace, creek chub, tessellated darter, and white sucker, as well as several mussel species. SGCN species uniquely associated with this habitat include American eel, blackchin shiner, bridle shiner, blacknose shiner, redfin pickerel, stonecat, giant floater, cylindrical floater, elktoe, brook

floater, wood turtle, river otter, muskrat, bald eagle, and some specific species of freshwater snails and Odonata.

Low Elevation Small Streams: These streams are small in size, but located in low gradient valleys (<2% slope) at low elevations (but above the Lake Champlain fall-line and 150 feet in elevation), and typically drain directly into a large waterbody (e.g., Lake Memphremagog, large tributaries of Lake Champlain). Valleys are unconfined, and floodplains are broad, relative to stream size, and flat. These floodplains have distinct riparian vegetation on the valley floor, and transition into upland forest communities on the valley side slopes. Adjacent wetlands are common in the floodplain. The channel bed undulates vertically, being composed of alternating riffles and pools or dune-ripple formations. Riffle-pool systems are dominated by gravels and sands, where dune-ripple systems are dominated by sands and silts. Stream flow is slow and flat. Stream temperatures are typically cool to warm. Streamside vegetation shades the channel, usually forming a closed canopy over the channel. The aquatic food web in these channels is based primarily on inputs of organic material from the adjacent vegetation (e.g., leaves, twigs, branches). Large trees falling into the stream channel provide important habitat features, especially since coarser streambed substrates are typically lacking in these systems. Woody debris provides cover and substrate for aquatic biota, as well as helping to maintain channel bed stability and enhancing habitat complexity with localized scour and aggradation of the channel bed. Typically cool and warmwater fish species inhabit these streams, such as blacknose dace and creek chub. SGCN species uniquely associated with this habitat include American eel, blackchin shiner, bridle shiner, redfin pickerel, stonecat and some specific species of Odonata.

Landscape Streams & Rivers Condition

Current Condition: In general, fluvial ecosystems in Vermont are most affected by conversion, alteration, and fragmentation. Typically steeper mountainous streams at high elevations, less suited for human development, have well forested riparian areas with cold, clean water and stable stream channels. Recreational activities and their associated development, such as ski resorts, and forestry are the land uses most common in these areas that may affect stream habitats. Mid and low elevation streams and rivers are more likely to be impacted by human land uses, including clearing of riparian vegetation, alteration of stream channels, and direct inputs of toxins, excess nutrients, and sediments. These impacts are related primarily to roads, residences, commercial development, and agriculture, the latter being especially extensive in the lower valleys of the Lake Champlain and Connecticut River tributaries.

The fragmentation of fluvial ecosystems is extensive in Vermont. A recent inventory of more than 200 culverts in the White River watershed showed more than half of the culverts inventoried were barriers to the upstream movement of all fish species present in the waterbody all of the time, and the other half of the culverts inventoried were barriers to some species and/or barriers some of the time (i.e. under certain stream flows when species movement is likely to occur) (Vermont Fish and Wildlife 2004). In addition, most of Vermont's major rivers have large flood control and/or hydroelectric dams on them, with numerous smaller dams found throughout Vermont's smaller streams. Such structures influence local habitat conditions, restrict movement of aquatic species, and alter downstream flood and sediment transport processes.

Some aquatic habitat degradation is due to lasting effects of historic land uses. During the last two centuries land use in Vermont has been dominated by extensive land clearing for forestry and agriculture, aggressive stream clearing of boulders and coarse woody debris for stream log driving

and flood control, and by dam construction and railroad and road building. Such activities have resulted in the relocation and straightening of stream and river channels throughout Vermont, resulting in an overall decrease in available fluvial habitat. For example, a recent assessment of the upper White River watershed between Granville and Stockbridge shows that 93% (17.8 of 19.1 miles) of the length of the mainstem White River has been channelized in the past, 13 miles of which are still in channelized form (Vermont Department of Environmental Conservation 2004). In addition, the extensive removal of natural substrates, such as boulders and coarse woody debris, has reduced overall stream habitat complexity throughout the Northeast (Verry 2000). The hard armoring of channels combined with the construction of flood control dams means that many of Vermont's river channels have not regained their historic sinuosity. Furthermore, the slow regrowth of the Northeast's forests means that large woody debris contribution to stream and river channels has yet to reach historic levels (Verry 2000). Zadock Thompson, who served as Vermont's Assistant State Geologist and State Naturalist in the mid 1800's, offers first-hand insight on the impacts Vermont's intensive land use history has had on the streams and rivers of the state.

> "Before the country was cleared, the whole surface of the ground was deeply covered with leaves, limbs, and logs, and the channels of all the smaller streams were much obstructed by the same. The consequence was that, when the snows dissolved in the spring, or the rains fell in the summer, the waters were retained among the leaves, or retarded by the other obstructions, so as to pass off slowly, and the streams were kept up, nearly uniform as to the size during the whole year. But since the country has become settled, and the obstructions, which retarded the water, removed by freshets, when the snow melts or the rains fall, the waters run off from the surface of the ground quickly, the streams are raised suddenly, run rapidly, and soon subside. In consequence of the water being thus carried off more rapidly, the streams would be smaller than formerly during a considerable part of the year, even though the quantity of water be the same. It is a well known fact that the freshets in Vermont are more sudden and violent than when the country was new."
> **Zadock Thompson, Natural History of Vermont, 1853**

Desired Condition (SGCN Needs): Most of Vermont's aquatic species rely on streams and rivers that provide clean water, a diversity of in-channel habitat, and unobstructed movement upstream and downstream between habitats.

Characteristics of water quality vary in streams from clear and cold with little buffering capacity in most mountain streams to somewhat turbid and cool or warm with greater buffering capacity in the large valley rivers. Species found in the mountain headwater and mid-elevation streams are typically dependent on cold well-oxygenated waters. Some species found in the headwater streams, such as brook trout, are fairly acid tolerant. Low-elevation rivers and streams typically support species with warmer water temperature requirements and tolerance to some turbidity and nutrient enrichment.

Whether in the mountain streams or large valley rivers, most aquatic SGCN require instream cover and/or substrates for protection and colonization. Most fish species seek cover for predator avoidance and to reduce metabolic (energy) demands. Mussels need firm substrates for colonization, as do most aquatic insect species. Substrates utilized may vary from rock to sand to instream aquatic vegetation, depending on the species, but all species can suffer from excessive fine sediments in the channel that can bury instream substrates. Loss of complexity and solid substrates for cover and colonization reduces overall habitat availability and quality. In addition, many species use instream substrates for reproduction. For example, brook trout deposit eggs in gravels on the channel bottom, whereas many shiner species utilize aquatic vegetation to spawn. Embedding of substrates, destabilization of substrates due to chronic channel instability, and direct removal of substrates all

impact aquatic habitats and species. The mammal and bird species associated with streams and rivers, such as bald eagle, river otter, muskrat, and water shrew, are also impacted when aquatic species are affected, as these species rely on aquatic species as prey. In addition, muskrat, otter, and particularly water shrew, utilize undercut streambanks and other stable bank areas for denning. Chronic channel instability that results in substantial streambank erosion may reduce potential denning areas for these species.

Some of the SGCN uniquely associated with streams and rivers have extensive movement requirements, such as the Atlantic salmon and American eel, migrating from freshwater streams and rivers to the Atlantic Ocean and back again. Other species move shorter distances, but still require habitat connectivity to be able to access spawning, rearing, and seasonal habitats. There are also species, such as wood turtle and river otter, that move back and forth between the aquatic and nearby terrestrial habitats both daily and seasonally. Thus, it is important to maintain habitat connectivity both longitudinally along the river channel and adjacent riparian lands, as well as laterally between the aquatic habitat and the riparian habitat.

Ideally, Vermont's rivers and streams would provide an interconnected network of habitats in which species can move upstream and downstream as needed to fulfill seasonal and diurnal habitat needs. Instream structure would provide an abundance and diversity of habitat niches and be naturally maintained by physical stream processes over time (e.g., flooding, balanced sediment transport). Streams and rivers would be connected to the adjacent riparian habitats, which in turn function to protect and provide for fluvial habitat components, such as instream coarse woody debris and pollutant removal from surface runoff.

It is difficult to quantify the number of miles of intact fluvial and riparian habitat needed to conserve SGCN as the exact distribution of all SGCN associated with fluvial habitats is not known at this time.

Implementing the 2005 Wildlife Action Plan

In 2013, VFWD and partners completed the Vermont BioFinder project, a map and database identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. A notable outcome of the project was a map of all aquatic features and the riparian areas/valley bottoms in which rivers and streams occur and the identification of these areas as critical conservation components for wildlife habitat, rare species, aquatic system health, and wildlife/landscape connectivity.

The Vermont Department of Environmental Conservation's Rivers Program completed Phase 2 mapping for most of Vermont rivers, has acquired river corridor easements, and has supported the passage of new legislation aimed at protecting river geomorphic processes.

The Partners for Fish & Wildlife program of the U.S. Fish & Wildlife Service, which organizes and supports community-based habitat restorations, partnered with more than 600 landowners on more than 550 projects to restore 294 miles of riparian habitat, 5,476 acres of wetland habitat, 976 acres of upland habitat and 1,200 acres of habitats impacted by invasive species. Partners also reopened 1,438 miles of stream to fish passage; and completed 11 miles of in-stream restoration.

Streams and Rivers provides habitat for 75 Species of Greatest Conservation Need.

Species of Greatest Conservation Need in Streams & Rivers Habitat

High Priority
Bald eagle (Haliaeetus leucocephalus)
Fowlers toad (Anaxyrus fowleri)
Wood turtle (Glyptemys insculpata)
Odonates-River/Stream Group (17)
Freshwater Mussels Group (13)
Freshwater Snails Group (15)
Mayflies/Stoneflies/Caddisflies Group (14)
Bridle shiner (Notropis bifrenatus)
Blackchin shiner (Notropis heterodon)
Blacknose shiner (Notropis heterolepis)
Stonecat (Noturus flavus)

Medium Priority
Northern river otter (Lontra canadensis)
Muskrat (Ondatra zibethicus)
Water shrew (Sorex palustris)
Redfin pickerel (Esox americanus)
Brook trout (Salvelinus fontinalis)
Northern Pearl Dace (Margariscus nachtriebi)
American Eel (Anguilla rostrata) Lake Champlain and Connecticut River populations.
Sea Lamprey (Petromyzon marinus) CT River
Atlantic salmon (Lake Champlain & Memphremagog basins naturally reproducing populations) (Salmo salar)

SGCN Notes: Lake sturgeon is addressed in the Lake Champlain tributaries summary. For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories used here

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Channel straightening and maintenance of such that reduces overall stream/river miles, loss of floodplain connectivity, impoundment of river channels	High
Habitat Alteration	Floodplain and stream channel manipulation (e.g., riprap); degradation of water quality, loss of physical habitat structure, temperature alteration	High
Habitat Fragmentation	Interruption of movement to and from breeding, feeding, and seasonal habitats via alteration and conversion; roadways, and impassable dams and culverts	High
Sedimentation	Alteration of habitat (e.g., spawning areas); smothering of organisms	High
Pollution	Acid rain threatens higher elevation habitats, nutrient overloading is common in lower elevation areas, other toxins are suspected but data is unavailable to assess impacts	High
Pollution	Catastrophic spills: toxic chemicals (e.g., chlorine) and contaminants limit mid and lower elevation habitats, especially where roadways and development are in close proximity to stream channels	High
Invasion by Exotic Species	inter-species competition for habitat and food; predation on native species, loss of native riparian vegetation community from invasive competition.	High
Hydrologic Alteration	Stream flow regulation at dams, watershed development, and withdrawals alter hydrographs and instream flows	High
Inventory need	Minimal data is available on the distribution in Vermont of many fluvial-associated SGCN	Med

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories used here
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct inventories of known and potential SGCN sites		ANR, USFS, USFWS, TU	SWG, TU, EPA, NRCS
Provide technical assistance to anglers and other conservation groups on invasive exotic management and eradication	No new introductions of invasives exotic species that impact fluvial habitats	TNC (plants), angler groups, baitfish dealers	NRCS, LCBP
Provide technical assistance to private landowners and watershed organizations on riparian, floodplain and fluvial habitat conservation	Increase in number of stream/river miles in "reference" condition, as per VTANR Stream Geomorphic Assessments	ANR, NRCS, FSA, USFWS	Clean Water Fund, LCBP, CRP, WRP, EQIP
Provide financial incentives to private landowners for conservation and protection of SGCN and their riparian and fluvial habitats and floodplains	Increase in number of stream/river miles and associated riparian areas that are conserved and/or restored	ANR, NRCS, USFWS, FSA	EQIP, USFWS, CRP, CREP, WRP
Provide technical assistance to town and regional planning organizations. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Increase in number of towns incorporating riparian and aquatic habitat conservation into planning and zoning. Increase in number of stream/river miles under regulated development that are in "reference" condition, per VTANR Stream Geomorphic Assessments	ANR, ACCD, VLCT, AVCC, TNC, watershed organizations	ACCD planning grants, LCBP, SWG
Monitor, protect and restore water quality from excessive nutrient sediment loading, other pollutants.	Miles of SGCN habitat meeting water quality standards.	ANR, USFWS, NRCS, USFS, Lake & Watershed Associations	ANR, Clean Water Fund
Support efforts to reduce the long range transport of acid rain pollutants to Vermont.	Reduction in acidity levels in monitored high elevation waterbodies	ANR, USFS, AG office, Legislature, Congress.	
Identify pollutant sources posing risks of catastrophic spills to SGCN populations and implement programs to minimize those risks		ANR, Agency of Agric., VTrans, wastewater facilities, town road managers	
Technical assistance to state and federal land management agencies to ensure consistency in program implementation and sensitivity to SGCN requirements	Change in the number of state and federal land management plans that provide for fluvial and riparian habitat conservation	ANR, USFS, USFWS, ACOE, VTrans	
Support efforts to manage flow regulation projects to minimize impacts on SGCN	Decrease in number of river miles with altered flow regimes	ANR, ACOE, VT Dam Task Force, USFWS, watershed orgs	LBCP, USFWS, ACOE, SWG
Provide technical assistance to VTrans, towns, and private landowners to identify and maintain (or restore) aquatic habitat connectivity	Change in the number of road crossings that do not impede aquatic organism movement	ANR, VTrans, Better Back Roads, USFWS, USFS, AVCC	SWG, USFWS, LCBP, VTrans

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
ANR State Lands Management Plans	Management practices for ANR-owned lands	FPR, VFWD
ANR Stream Geomorphic Assessments	Stream and riparian condition inventories	ANR
Opportunities for Action – LCBP	Aquatic resource conservation for the Lake Champlain Basin	LCBP
Conserving the Eastern Brook Trout: Action Strategies (2011) http://easternbrooktrout.org/reports/ebtjv-conservation-strategy	Conserve, enhance or restore brook trout populations that have been impacted by habitat modification or other population level threats.	ANR
ANR River Corridor Planning Guide, 2nd edition http://www.watershedmanagement.vt.gov/rivers/docs/rv_rivercorridorguide.pdf	Planning, designing & protecting river corridors	ANR
Riparian Management Guidelines for Agency of Natural Resources Lands (Draft 2015)	Informs the development of recommendations for Act 250-regulated projects	ANR

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Lake Champlain Tributaries Summary

These waters include the lower-most portions of tributaries that empty into Lake Champlain. On many rivers and streams this is defined at its upstream end by the first major waterfall or cascade, called the principal fall line. On streams which do not have this abrupt elevation change, the upstream limit for is roughly at elevation 150 feet above sea level. The SGCN supported in these waters are numerous, with many found nowhere else in the state but in these tributaries and Lake Champlain. There are several factors accounting for the unique aquatic assemblages found here, including: glacial history and ancient routes of colonization from the west and south; the barrier to upstream migration presented by the principal fall line; and the generally warmer water temperatures and finer substrates found here compared to those in higher elevation areas of Vermont. Unique species include many fishes and freshwater mussels, the common mudpuppy, and the spiny softshell. Key features include riffles, runs, and long pools with a variety of dominant substrate types. Small gravel, sand, and finer substrates are more dominant in the lowest reaches of these streams and rivers. Woody debris is prevalent, especially in deep holes in pool sections.

Lake Champlain Tributaries Condition

Current Condition: Some of the most heavily human-populated areas of the state occur adjacent to river sections included in this community type. While the larger volumes of water carried by the large rivers in Lake Champlain tributaries do afford a greater diluting potential than found in smaller rivers and streams, these Champlain tributaries are located in an area of the state where the intensity and frequency of insult to the aquatic habitat from human use is expected to be greater. For example, stormwater runoff reaching the lower Winooski River from developed lands is much greater than in most other Vermont fluvial communities. Stormwater runoff from developed lands increases the amount of sediments, nutrients, and contaminants that reach rivers instead of being trapped by the soil and vegetation. Floodplains function, in part, to absorb runoff and deliver it slowly to rivers through the soil. Paving of land sends water more directly to streams and rivers, in essence bypassing the floodplain. This creates a scouring effect on riverine habitat, due to the more extreme fluctuations in velocity of stormwater runoff.

Pollutants enter these rivers from various non-point sources as well. Agricultural lands located adjacent to rivers within these watersheds can contribute excessive amounts of silt, nutrients, and pesticides to the systems when adequate riparian buffers are not maintained. In such instances, excessive sediments can cover coarser river-bottom substrates needed by many SGCN, as well as covering some of these species themselves. Also, salt from roadways makes its way into rivers, degrading the water quality. These and other sources of non-point pollution are likely the greatest contributors of contaminants to these systems. These pollutants comes not only from adjacent lands, but from the entire watershed.

Accidental contaminant spills are rare, but can have immediate and devastating effects on the aquatic environment and the SGCN that live there. Chemicals, manure, industrial waste, and other potential contaminants stored in areas where they could reach these rivers or their tributaries if released are significant problems. Bridges and riverside roads and railways also present long stretches where accidental spills into rivers and streams can occur. A catastrophic contaminant spill could (and has) easily wipe out entire SGCN populations. As

with other sources of pollution, this problem comes from the watershed upstream as well as adjacent lands.

Direct loss of habitat occurs when fill material is placed on the river bottom. Examples of this include riprapping to stop toe erosion along streambanks, placement of piers or causeways to accommodate bridges, and construction of boating access facilities. Direct mortality of freshwater mussels, which live on the river bottom, is sometimes the result of these activities within lower Champlain rivers. The replacement of natural substrates with large stone provides reduced or unsuitable habitat for recolonization by bottom-dwelling animals. The construction of buildings and roads adjacent to rivers creates a hazard for the structures, increasing the potential that bank stabilization will be pursued.

Two dams on major rivers within the Lake Champlain tributaries (the Peterson Dam on the Lamoille and the Swanton Dam on the Missisquoi) have cut off migration for fishes and mussels, and have resulted in the loss of spawning habitat for some species. Impoundments created by these structures have altered the natural habitat from riverine to more lake-like water bodies. "De-watering" of the aquatic habitat that sometimes occurs due to atypical "hydro-peaking" dam operations leaves many benthic SGCN, particularly mussels, out of the water and exposed to the elements and predators. This can occur upstream or downstream of these structures. Existing dams located on fall lines may significantly alter the natural physicochemical regime of waters flowing downstream. The altered hydrologic regimes found below dams degrades the quality of habitat here for SGCN.

Zebra mussels that have devastated the Lake Champlain freshwater mussel community are a problem for rivers in this Lake Champlain tributaries. Adult zebra mussels have been found in the lower reaches of Otter Creek, Little Otter Creek, Lewis Creek, LaPlatte River and the Winooski River in past years. They are also present in Lake Bomoseen, whose outlet stream feeds into the Poultney River.

Desired Condition (SGCN Needs): These waters, along with Lake Champlain, support the greatest diversity of aquatic species found in the state. The larger rivers support the highest number of SGCN. Allowing these rivers to meander freely within their natural floodplains and maintaining and/or restoring natural vegetation to all or a portion of the rivers' floodplains would significantly improve the ecological integrity of these systems, improve water quality, and significantly improve the habitat provided for many aquatic SGCN, as well as the diversity of wildlife species that rely on riparian cover movement or other habitat functions. Species include both year-round residents and those that use the rivers and streams primarily for spawning, development of young, or feeding. Minnows, freshwater mussels and snails, benthic fishes, and mammals are among those that utilize the Lake Champlain tributaries year-round, and often require a variety of habitats. Lake sturgeon, mooneye, greater redhorse, and possibly common mudpuppy are among those that depend on these rivers seasonally for reproduction. Others, such as map turtle, spiny softshell, northern watersnake, wood turtle, and bats use these waters for foraging, winter shelter, or other seasonal purposes.

Gravel/cobble substrates that are free of loose silt are required by many of the riverine species that spawn here. Eggs in contact with excessive silt are not able to adequately absorb oxygen for development. The eastern sand darter requires silt-free sand for this purpose. Substrates also need to be stable in order to support many SGCN, particular benthic organisms like freshwater mussels, darters, hibernating spiny softshells, and nesting

mudpuppies. This is often affected by stream hydrodynamics; that is, streams that are hydrodynamically imbalanced can have substrates that shift frequently and do not provide a firm footing or shelter for aquatic organisms that occur there. Small invertebrates are less abundant in silted-in or unstable stream bottoms, thus providing a reduced food source for their predators. Woody debris is an important habitat component in lower Lake Champlain tributaries, especially for aquatic insects. Historically, people removed trees and branches that fell into streams. Unfortunately, this removed the structure and habitat needed for many invertebrates and their predators, as well as basking habitat for turtles.

Two aquatic SGCN, the American eel and the Atlantic salmon, were historically able to ascend the fall line from downstream. The American eel did so to reach smaller waters upstream where the young eels would grow for several years before migrating back out to sea to spawn. Atlantic Salmon jumped the falls to reach the clean, coarse gravel substrates located upstream where they would spawn their eggs. With the construction of dams at or below the falls on all the major Lake Champlain rivers, much of the habitat needed for these two species was made unavailable to them. Reconnection of these fishes with this habitat would likely be beneficial to their long-term survival. River otter is susceptible to heavy metals and PCB's.

Implementing the 2005 Wildlife Action Plan

In 2013, the Department completed the Vermont BioFinder project, a map and database identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. A notable outcome of the project was a map of all aquatic features and the riparian areas/valley bottoms in which rivers and streams occur and the identification of these areas as critical conservation components for wildlife habitat, rare species, aquatic system health, and wildlife/landscape connectivity. The project mapping results for aquatic features, valley bottoms, and riparian connectivity together provide a tool for prioritizing restoration of riparian areas, including floodplain forests.

Species of Greatest Conservation Need in Lake Champlain Tributaries

High Priority
Bald Eagle (Haliaeetus leucocephalus)
Lake Sturgeon (Acipenser fulvescens)
Eastern Sand Darter (Ammocrypta pellucida)
American Brook Lamprey (Lethenteron appendix)
Northern Brook Lamprey (Ichthyomyzon fossor)
Silver Redhorse (Moxostoma anisurum)
Greater Redhorse (Moxostoma valenciennesi)
Bridle Shiner (Notropis bifrenatus)
Blackchin Shiner (Notropis heterodon)
Blacknose Shiner (Notropis heterolepis)
Stonecat (Noturus flavus)
Channel Darter (Percina copelandi)
Sauger (Sander canadense)
Spiny Softshell (Turtle) (Apalone spinifera)
Common Mudpuppy (Necturus maculosus)
Wood Turtle (Glyptemys insculpta)
Silver-haired Bat (Lasionycteris noctivagans)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Tri-colored bat (Perimyotis subflavus)
Freshwater Mussels Group (13 species)
Freshwater Snails Group (15 species)

Odonates-River/Stream Group (17 species)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Pied-billed Grebe (Podilymbus podiceps)
Lesser Yellowlegs (Tringa flavipes)
Mottled Sculpin (Cottus bairdi)
Mooneye (Hiodon tergisus)
Silver Lamprey (Ichthyomyzon unicuspis)
Shorthead Redhorse (Moxostoma macrolepidotum)
Atlantic salmon (Lake Champlain & Memphremagog basins naturally reproducing populations) (Salmo salar)
Northern Water Snake (Nerodia sipedon)
Eastern Musk Turtle (Sternotherus odoratus)
Northern River Otter (Lontra canadensis)
Muskrat (Ondatra zibethicus)
Masked Shrew (Sorex cinereus)

SGCN Note: For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories used here

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Alteration	Input of sediments and nutrients from surface and stormwater runoff, and from small tributaries; caused by human land use nearby	High
Habitat Conversion	Loss of benthic habitat due to riprapping, bridge construction, boat access construction, etc. Loss of riverine environment due to impoundment.	High
Hydrologic Alteration	Changes in hydrologic and physicochemical regime due to dams and stormwater runoff. Direct loss of SGCN due to dewatering.	High
Habitat Fragmentation	Migration barriers created by dams	High
Pollution	Vulnerability to Catastrophic Spills: Bordering roadways, bridge crossings, adjacent industry, and manure pits are examples of high risk points of entry for large-scale contaminant spills	High
Invasion by exotic species	Zebra mussels are currently high risk threat to SGCN; other exotics may also be displacing native SGCN	High
Sedimentation	Alteration of habitat (e.g., spawning areas); fine sediments can embed of substrate and smother invertebrates, incubating eggs and the young of many fish species.	High
Pollution	Water quality degradation due to contaminants from agricultural fields, stormwater runoff, other point and non-point sources	High

Inventory	Inventory needed for many SGCN, particularly those for which distributional and abundance information is greatly lacking	High
Monitor	Detect SGCN population trends to help guide conservation actions and to track the effectiveness of current management	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories used here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Monitor known SGCN populations	Number of known SGCN sites monitored	USFWS, ANR, TNC, Universities, EPA	SWG, VFWD, VT Watershed Grants, EPA
Conduct inventories of rivers to detect and gather information on new SGCN populations	Number of sites/rivers with completed inventories	USFWS, ANR, TNC, Universities, EPA	SWG, VFWD, VT Watershed Grants, EPA
Protect and restore habitats on which SGCN are dependent through pollution abatement, substrate improvement, riparian buffer and, floodplain enhancement, flow regulation, etc.	Number of acres of floodplain and riparian habitat protected and/or restored	LCLT, VLT, Watershed groups, USFWS, ANR, Army Corps, EPA	EPA, SWG, LCLT, VLT, NRCS, EPA, Clean Water Fund
Restore migration corridors for SGCN by removal of artificial barriers or construction of effective fish passage facilities at dams	Number of artificial SGCN migration barriers removed or provided with passageways Number of adult fish passed migrating to upstream spawning habitat (e.g., lake sturgeon, greater redhorse)	Hydro operators, FERC, ANR, Municipalities, VNRC	USFWS, NRCS
Provide for the safe and expeditious out-migration of SGCN from upstream of dams	Number of artificial SGCN migration barriers removed or provided with out-migration passageways	Hydro operators, FERC, ANR, Municipalities, VNRC	ANR, Army Corps
Prevent the introduction and spread of invasive exotic species, particularly zebra mussels	Number of sites with control activities and/or invasive monitoring. Number sites where invasive species are eliminated or controlled	LCBP, ANR Municipalities, USFWS, EPA	VT Watershed Grants, LCBP, Clean Water Fund
Provide technical outreach and financial assistance to private landowners, watershed groups and other partners to maintain or enhance habitat and tributary functions for SGCN.	Number of actions implemented to maintain or enhance tributary function for SGCN.	USDA, USFWS, EPA, NRCS, VFWD, TNC, LCBP, LCI, RPC's. Municipalities, Watershed groups	EPA, USFWS, EQIP, CRP, CREP, VT Watershed Grants, LCBP, SWG, Clean Water Fund
Provide technical outreach to towns and regional planning commissions to maintain or enhance Lake Champlain tributary habitat and tributary functions for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of actions implemented to maintain or enhance tributary function for SGCN.	USDA, USFWS, EPA, NRCS, VFWD, TNC, LCBP, RPC's. Municipalities, Watershed groups	EPA, USFWS, EQIP, VT Watershed Grants, LCBP, SWG, Clean Water Fund
Acquire conservation easements for the protection of critical SGCN habitats and maintenance or restoration of ecological functions	Number of riparian habitat acres acquired/enrolled	LCLT, VLT, ANR, TNC, NRCS	LCLT, VLT, EPA, TNC, SWG, NRCS

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Enhance coordination between government agencies and partners to ensure consistency in respective program implementation and increased sensitivity to SGCN requirements and problems to SGCN		ANR, USFWS, COE, FEMA, FHWA, NRCS, LCI, Wildlife Services, VTrans	EQIP, USFWS, EPA, Clean Water Fund
Enhance substrate quality to benefit SGCN via research, technical and financial assistance and regulatory review.		DEC, USFWS, NRCS	EQIP, CREP, Clean Water Fund

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Lake Sturgeon Recovery Plan	Lake Sturgeon restoration	VFWD
Vermont's Clean Water Initiative	Water quality improvement	VDEC
Lake Champlain Basin Aquatic Nuisance Species Management Plan (2005).	Management and prevention of invasive exotic species in the basin	VTDEC, NYDEC
DEC Water Quality Division	Water quality and stream protection and restoration	DEC
Quebec Ministère de l'Environnement	Shared watershed for Missisquoi River	Quebec Ministère de l'Environnement
Conserving Lake Champlain's Biological Diversity 6/102005	Strategic plan focused on conserving Lake Champlain's biological diversity	TNC
Various watershed planning efforts	Watershed protection and restoration; river and lake restoration and protection	VTDEC; local/regional watershed groups
Riparian Management Guidelines for Agency of Natural Resources Lands (Draft 2015)	Informs the development of recommendations for Act 250-regulated projects	ANR
ANR Stream Geomorphic Assessments	Stream and riparian condition inventories	ANR

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Lower Connecticut River Summary

Characteristics and Location

The Lower Connecticut River encompasses approximately 130 miles of the main stem from the Massachusetts state line upstream to its confluence with the Wells River and occurs almost exclusively within the Southern Vermont Piedmont biophysical region. Additionally, this summary includes the lower sections of its Vermont tributaries that are directly influenced by or have physical and/or biological similarity to the Connecticut River. The presence of a readily identifiable geological feature, such as a fall line, is not evident on all tributaries. Where the fall line is apparent, typically within a short distance from the tributary mouth (e.g., as on the Williams, Black, Ottauquechee, Waits and Wells rivers), this feature delineates the upstream extent of the Lower Connecticut River. On other tributaries (e.g., the West and White rivers), artificial structures (e.g., the lowermost dam) are used to define the upstream limit. Rivers and streams located within the Connecticut River basin but upstream of the habitat boundary are covered under the Fluvial (Stream) Summary. To a limited degree the historic distribution of several anadromous fish species native to the Connecticut River basin, namely sea-run Atlantic salmon, American shad and sea lamprey, as well as current management goals for the restoration of these fishes to the basin also define the bounds of the Lower Connecticut River.

Lower Connecticut River Condition

Current Condition: Prior to European settlement and subsequent industrial development of the Connecticut River basin, rivers and streams were free-flowing systems subject to natural flow regimes and processes. Waters ran free of pollutants, and the landscape, including riparian lands, was predominantly forested. These conditions provided habitat for both aquatic and terrestrial plant and wildlife assemblages native to the Lower Connecticut River. However, over the past 200 plus years, the river and its tributaries have been altered extensively fragmenting historic migration routes, changing natural habitats and ecological functions, as well as the current composition of the plant and wildlife communities.

Dams constructed for waterpower and flood control have greatly altered river and streams throughout the Connecticut River basin. Historic migration corridors used by Atlantic salmon, American shad, blueback herring, and American eel to gain access to critical spawning and nursery habitats have been obstructed. Long sections of the main stem and tributaries have been transformed from free-flowing waters to impoundments; and natural flow regimes are now regulated in ways that are not compatible with the habitat requirements of many aquatic species, including SGCN. Impoundments and artificial flow regimes have significantly influenced sediment transport and deposition, which in turn have altered the character, quantity and quality of various habitat types found throughout the Lower Connecticut River. Waters above and below dams are managed in ways, which result in fluctuating impoundment levels and tail water discharges. Frequently, flows released from dams are not adequate in volume or fluctuate in magnitude and duration so as to create habitat conditions unsuitable for SGCN. While water management within impoundments and free-flowing river segments may benefit habitat for a few SGCN (e.g., expose mudflats and shorelines used by feeding lesser yellowlegs during migration), fluctuating water levels can be detrimental to strictly aquatic SGCN (e.g., Redbreast Sunfish, Dwarf Wedgemussel).

The extensive conversion of the Connecticut River from a free-flowing system to one dominated by impoundments has created habitats suitable to a variety of aquatic exotic plants and animals. Shorelines and wetlands associated with these impoundments have been invaded by phragmites, Eurasian milfoil and purple loosestrife, which have established dominant stands degrading nesting habitats needed by waterfowl, songbirds and muskrats. Water chestnut, an exotic aquatic plant has been a significant environmental problem on Lake Champlain demanding large expenditure of funds and labor to keep it under control. In recent years water chestnut was discovered in North Springfield Reservoir, which is on the Black River, a tributary of the Connecticut River. An early control-rapid response effort was able to eliminate water chestnut from this waterbody. Several fish species not indigenous to the Connecticut River, including predatory largemouth bass, northern pike, bluegill, crappie and rock bass, were introduced during the 1800s and early 1900s and have benefited from habitat formed within the impoundments. These species have altered the composition of the natural fish community of the river and have influenced ecological relationships at all trophic levels. At the present time, zebra mussels have not been found in the Connecticut River.

Prior to the federal Clean Water Act (amended in 1977) and subsequent implementation of water pollution abatement programs, a 1951 government report described the Connecticut River as the "best landscaped sewer in New England" (CRJC 2009). Over the past three decades water quality in the river and its tributaries has vastly improved habitats for aquatic SGCN. Nonetheless these waters continue to receive point and non-point source pollution (sediments, nutrients, toxic chemicals), which remain problems to aquatic habitats and the ability of the environment to support healthy, sustainable populations of SGCN, such as the Bald eagle, fishes, freshwater mussels, and other aquatic invertebrates. Healthy aquatic systems are important to maintaining food webs not only for aquatic SGCN but also terrestrial species (eagle, bats, otter).

Development and logging along the river and tributaries has had a significant impact on riparian areas functions and benefits to SGCN. The loss of naturally vegetated (forested) riparian areas have led to increased inputs of sediment and other pollutants to streams, increased water temperatures, channel instability, and loss of in-stream habitat structure created by the recruitment of large wood. Removal of living and dead trees (snags) from riparian lands has reduced sites for eagle nesting, roosting and perching.

Unique to the Lower Connecticut River is the existence of the Vermont Yankee Nuclear Power Station. While it ceased power generation at the end of 2014, it still uses the river as a source of reactor cooling water and by state permit is allowed to discharges waste heat within specified thermal limits to the river. Excessive heat discharged to the river can potentially limit the temperature regime of the river within vicinity of the power plant to the detriment of aquatic SGCN intolerant of warm water. On a larger scale is the effects of climate change on aquatic habitats critical to many SGCN.

Desired Conditions (SGCN Needs): Eventual restoration and maintenance of sustainable populations of migratory native fishes to the Connecticut River basin is dependent on eliminating or mitigating artificial barriers which currently do not allow fish access to critical habitats, whether freshwater spawning and nursery areas or seawater (e.g. American Shad, Sea Lamprey, American Eel). Dam removal would open river migration corridors, as well as restore natural flow regimes, sediment transport and other fluvial processes essential to creating and maintaining instream aquatic habitat. Where dam removal is not feasible, fish passage should be restored by retrofitting structures with fish ladders, lifts or similar devices. Existing fishways demand continued operation and

maintenance to assure their effectiveness. New dam construction should be avoided. Establishing flow regimes below dams and water level management within impoundments that mimic natural systems would benefit many of the aquatic SGCN.

The reduction of sediment inputs to the Lower Connecticut River from land development and chronic streambank erosion is important to maintaining SGCN populations, many of which depend on habitats consisting of coarse river bottom substrates (i.e., gravels and cobbles) that are not embedded by finer substrates. Riparian vegetation contributes to the reduction of these fine sediment inputs to surface waters by obstructing and slowing down overland runoff, while also reinforcing streambanks against the erosional forces of running water. Riparian areas also provide several habitat functions for species that inhabit them. Mature trees in the riparian zone provide necessary nesting sites for eagle. These trees eventually may be recruited to the river channel, creating instream habitat such as refuge cover required by the Redbreast Sunfish.

Allowing these rivers to meander freely within their natural floodplains and maintaining and/or restoring natural vegetation to all or a portion of the rivers' floodplains would significantly improve the ecological integrity of these systems, improve water quality, and significantly improve the habitat provided for many aquatic SGCN, as well as the diversity of wildlife species that rely on riparian cover movement or other habitat functions.

The potential for new non-indigenous invasive organisms (e.g., zebra mussel, Asiatic clam, hydrilla) becoming established in the Connecticut River is a persistent problem for the native biota and habitats.

Implementing the 2005 Wildlife Action Plan

In 2013, the Department completed the Vermont BioFinder project, a map and database identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. A notable outcome of the project was a map of all aquatic features and the riparian areas/valley bottoms in which rivers and streams occur and the identification of these areas as critical conservation components for wildlife habitat, rare species, aquatic system health, and wildlife/landscape connectivity. The project mapping results for aquatic features, valley bottoms, and riparian connectivity together provide a tool for prioritizing restoration of riparian areas, including floodplain forests.

Species of Greatest Conservation Need in Lower Connecticut River

High Priority
Bald Eagle (Haliaeetus leucocephalus)
Common Mudpuppy (Necturus maculosus)
Silver-haired Bat (Lasionycteris noctivagans)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Tri-colored bat (Perimyotis subflavus)
Freshwater Mussels Group (13 species)
Odonates-River/Stream Group (17 species)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Pied-billed Grebe (Podilymbus podiceps)
Lesser Yellowlegs (Tringa flavipes)
Blueback Herring (Alosa aestivalis)
American Shad (Alosa sapidissima)
American Eel (Anguilla rostrata)
Redbreast Sunfish (Lepomis auritus)
Northern River Otter (Lontra canadensis)
Muskrat (Ondatra zibethicus)
Masked Shrew (Sorex cinereus)

SGCN Note: For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories used here

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat conversion	Loss of riparian and in-stream habitats from land and water development projects and activities, including impoundments.	High
Habitat alteration	Alteration and degradation of riparian and in-stream habitats from land and water development projects, including streambank rip rapping.	High
Hydrologic alteration	Replacement of natural flow cycles and processes with regulated flow regimes (e.g., inadequate minimum flows, fluctuating flows) rendering riverine habitats unsuitable to certain SGCN.	High
Sedimentation	Habitat degradation resulting from land development and uses; dams disrupting natural sediment transport; flushing sediments from impoundments; excessive bank erosion from inadequate riparian vegetation.	High
Habitat fragmentation	Interruption of migration corridors to and from breeding/spawning/wintering habitats via alteration and conversion of home range; construction of dams and culverts.	High
Invasion by exotic species	Displacement or restructuring of native aquatic plant and animal communities by invasive organisms impacting habitat and community structure and processes.	Med
Pollution	Nutrient overloading and other pollutants.	High
Pollution	Vulnerability to catastrophic spills: Bordering roadways, bridge crossings, adjacent industry and urban centers pose high risk points of entry for large-scale contaminant spills.	High
Monitoring	Population and habitat monitoring: Improved data on known SGCN populations is needed to track changes in species abundance and habitat quantity and quality as may be affected by natural processes and anthropogenic factors; habitats with potential for having existing SGCN populations or SGCN restoration potential should be investigated.	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories used here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Monitor, protect and restore floodplains, riparian and in-stream habitats limited or impacted by development.	Number of SGCN sites (habitats) monitored; acres/miles of undisturbed habitats protected; acres/miles of disturbed habitats restored.	ANR, USFWS, NRCS, CRJC, TNC, Power Companies	EPA, NH Charitable Foundation
Monitor, protect and restore river and stream water quality from excessive nutrient and sediment loading and other pollutants.	Miles of SGCN habitat meeting water quality standards.	ANR, USFWS, NRCS, CRJC, TNC	EPA, NH Charitable Foundation
Monitor, protect and restore migration and travel corridors limited or impacted by dams, culverts and roads.	Number of identified artificial migration barriers removed or mitigated; miles of critical habitat restored by removal of barriers.	ANR, CRASC, USFWS, CRJC, VTrans, , Utilities	EPA, USACE
Monitor the Connecticut River and its tributaries for invasive species; prevent the introduction or spread of invasive species; implement control measures which take into account SGCN and their habitat requirements.	Number of SGCN habitats monitored for invasive species; number of SGCN habitats with plans in place designed to control invasive species and restore or enhance SGCN.	ANR, USFWS, CRJC, VY, TNC	EQUIP, USFWS Conte Grants, EPA
Support policies and programs designed to reduce climate change.	Number of climate change policies and programs established or supported.	ANR, EPA, Other NE States	EPA
Conduct inventories to detect and gather information on new SGCN populations and their habitats.	Number of potential SGCN habitats surveyed.	ANR, USFWS, TNC, USGS, EPA	EPA

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Provide technical and financial assistance to private landowners, towns, watershed and lake associations, regional planning commissions, and other partners to increase their awareness of problems to SGCN.	Number of actions implemented to maintain or enhance river function for SGCN.	ANR, USFWS, NRCS, CRJC, TNC	Farm Bill, Conte Grants, EPA, NH Charitable Foundation
Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004) to town and Regional Planning Commissions.	Number of towns and RPC considering SGCN in their planning. Number of actions implemented to maintain or enhance river function for SGCN.	AVCC	SWG, VFWD
Acquire conservation easements for the protection of SGCN sites and maintenance or restoration of their ecological functions.	Number of SGCN habitats acquired or enrolled in land conservation easement programs.	ANR, USFWS, TNC	EPA
Enhance coordination between government agencies/partners to ensure consistency in respective program implementation and increase sensitivity to problems and requirements for SGCN.	Number of agencies and private conservation organization, which recognize and address problems to SGCN.	ANR, USFWS, USFS, NRCS, USACE, VTrans, CRJC, TNC	EPA, NH Charitable Foundation

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Connecticut River Corridor Plan	"That plants, migratory birds, anadromous fish, and other native birds, fish, and wildlife continue to find the Connecticut River corridor and watershed hospitable to their unique needs for clean water and connected, protected open lands and forests;"	CRJC
A Plan to Restore the Aquatic Ecosystem in the Connecticut River Watershed	"Restore aquatic ecosystem so as to recover and support migratory and native fish populations and promote natural reproduction in the Connecticut River and its tributaries."	NRCS
Strategic Plan for the Restoration of Atlantic Salmon to the Connecticut River.	"Protect, conserve, restore and enhance the Atlantic salmon population in the Connecticut River for the public benefit, including recreational fishing."	CRASC
A Management for American Shad in the Connecticut River Basin.	"Restore and maintain a spawning shad population to its historic range in the Connecticut River Basin and to…"	CRASC
Management Plan for Blueback Herring in the Connecticut River Basin.	"Restore and maintain a spawning blueback herring population within its historic range in the Connecticut River basin."	CRASC
Plan for the Restoration of Migratory Fishes to the Ashuelot River Basin, New Hampshire.	"Protect, conserve, restore, and enhance the migratory fish populations in the Ashuelot River system for both public and ecological benefits."	NHFG

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

CRJC (Connecticut River Joint Commissions). 2009. Connecticut River Water Resources Management Plan. CRJC, Charlestown, NH.

Lake Champlain Summary

Lake Champlain includes the main body of the lake and its bays and river deltas. These waters are shared with New York and Quebec. At about 120 miles in length and a maximum depth over 400 feet, this is Vermont's largest waterbody. Aquatic habitats found here are many and extensive. Among these are expansive sand-bottomed shallows, shale/cobble littoral shorelines and bays, and deep limnetic environments. Other natural communities, such as large tributaries, emergent marshes, and floodplain forests, are integral to Lake Champlain and provide a critical habitat component for many SGCN found here. This is, in general, an oligo-mesotrophic lake, with nutrient levels in different parts of the lake dependent on local soil and bedrock types, as well as the type and extent of human land use within the surrounding watershed. This lake supports the highest lacustrine diversity of any of our lakes, which is due mainly to its large size and connections (current and historical) with the Great Lakes-St. Lawrence River and the Hudson River.

Lake Champlain Condition

Current Condition: The most outstanding concerns facing this large system are water quality and habitat degradation, and invasive exotic species. The lake is within the largest watershed in Vermont and is fed by many large tributaries that drain extensive agricultural and developed lands. A significant portion of the excessive nutrients, contaminants, and fine sediments that enter streams and rivers eventually reach Lake Champlain. Water and benthic habitat quality are affected, particularly in delta areas and along the shoreline, but also within the open and deeper waters over time. SGCN that are sensitive to contaminants and those that depend on consolidated (firmly-packed) substrates may be impacted by these changes to their habitat. Development along Lake Champlain's shoreline and within smaller watersheds immediate to the lake is ever-increasing, and with it the amount of contaminants entering directly into the lake. Excessive nutrients that reach the lake from various land uses within the watershed can cause eutrophication, reducing water quality and altering food webs. Zebra mussels have had a dramatic and devastating impact on the biotic community of Lake Champlain, including populations of many SGCN. These exotic pests foul the shells of native freshwater mussels, decreasing their ability to move about and obtain food and oxygen, resulting in a slow death. Populations of native mussels have been eliminated from large areas, a scenario that has repeated itself throughout most of the lake. The only areas where native mussels have not been seriously impacted by zebra mussels are Mallets Bay, the Inland Sea, and Missisquoi Bay. Water chestnut is an invasive that has impacted aquatic communities in the lake by forming huge, dense masses that cover the water surface and crowd out species. The exotic faucet snail *Bithynia tentaculata* now dominates much of the shale/cobble habitat in Lake Champlain, likely reducing native snail populations and altering the food web. Other invasive exotics in Lake Champlain include the alewife, and rusty crayfish. In 2014 the Spiny waterflea (*Bythotrephes longimanus*) was found in the lake. On the horizon are the round goby, quagga mussel. Additional problems to Lake Champlain include habitat conversion and vulnerability to catastrophic contaminant spills.

Desired Condition (SGCN Needs): These waters, along with Lake Champlain tributaries, support the greatest diversity of aquatic species found in the state. SGCN supported by Lake Champlain include mid- to deep-water species like cisco and lake whitefish that require cold, well-oxygenated waters. Shallow-water species such as mooneye and sauger utilize upper portions of the lake where temperatures are often much warmer. Near-shore and benthic species like bridle shiner, pink heelsplitter, giant floater, and spiny softshell are often found in bays or in the shallows of deltas.

The lake offers a variety of habitats that provide for the many needs of aquatic species, such as refuge, food, thermal protection, and spawning substrate. The great majority of freshwater mussel species remain buried in the substrate most of their lives, where they grow, feed, produce offspring, and seek refuge from the elements. Lake sturgeon feed on lake-bottom invertebrates, only entering rivers for brief periods to spawn. Different fishes can be found occupying different strata of the lake where they find the temperatures and oxygen levels they prefer. Degradation of water quality through nutrient input, thermal shifts, or other changes can cause significant alterations in food webs and habitat availability. Similarly, excessive fine sediments entering the lake from the shoreline and tributaries blankets and degrades the benthic substrate used by many SGCN. Improvement and protection of Lake Champlain's water quality, including reduction of nutrient and fine sediment inputs, is paramount to ensure that the SGCN populations found here remain viable. Control of exotic species, including preventing new species from invading, is also of great importance to the survival of these native species.

Many SGCN utilizing Lake Champlain depend on closely associated aquatic, wetland, and terrestrial habitats to complete their life cycles. Many fish, such as lake sturgeon, greater redhorse, and mooneye are found in the lake most of the year, but spawn over rocky substrates in Champlain tributaries. Bald eagle feed in the lake but need nearby suitable nesting trees or structures to raise their young. Spiny softshells occupy the lake much of the year for basking, feeding, and over-wintering, but require adjacent beaches of sand or gravel/cobble for egg-laying. Bats feed on emerging aquatic insects over the lake, while utilizing upland roosting and nursery sites. Muskrat, river otter and mink find a rich aquatic food source within Lake Champlain and its associated wetlands, but must den above the waterline. Maintaining these connections to critical wetland, aquatic, and terrestrial habitat is key to ensuring the continuation of these SGCN in the lake.

Species of Greatest Conservation Need in Lake Champlain

High Priority
Bald Eagle (Haliaeetus leucocephalus)
Lake Sturgeon (Acipenser fulvescens)
Silver Redhorse (Moxostoma anisurum)
Greater Redhorse (Moxostoma valenciennesi)
Sauger (Sander canadense)
Blackchin Shiner (Notropis heterodon)
Bridle Shiner (Notropis bifrenatus)
Crustaceans Group
Freshwater Mussels Group
Freshwater Snails Group
Spiny Softshell (Apalone spinifera)
Silver-haired Bat (Lasionycteris noctivagans)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Tri-colored bat (Perimyotis subflavus)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Cisco or Lake Herring (Coregonus artedi)
Lake Whitefish (Coregonus clupeaformis)
Mooneye (Hiodon tergisus)
Silver Lamprey (Ichthyomyzon unicuspis)
Shorthead Redhorse (Moxostoma macrolepidotum)
American Eel (Anguilla rostrata)
Atlantic Salmon (Salmo salar)
Lake Trout (naturally reproducing populations) (Salvelinus namaycush)
Muskrat (Ondatra zibethicus)
Northern River Otter (Lontra canadensis)

SGCN Note: Vascular plant SGCN not listed here: 38 (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories used here

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Alteration	Input of excessive sediments and nutrients from surface runoff and tributaries; caused by human land use nearby	High
Habitat Conversion	Loss of benthic habitat due to riprapping, bridge construction, boat access construction, etc.	High
Pollution	Vulnerability to Catastrophic Spills: Bordering roadways, bridge crossings, adjacent industry, and manure pits are examples of high risk points of entry for large-scale contaminant spills	High
Invasion by exotic species	Zebra mussels and water chestnut are currently impacting SGCN; other exotics may also be displacing native SGCN	High
Pollution	Water quality degradation due to contaminants from agricultural fields, stormwater runoff, other point and non-point sources	High
Inventory	Inventory needed for many SGCN, particularly those for which distributional and abundance information is greatly lacking	High
Monitor	Detect SGCN population trends to help guide conservation actions and to track the effectiveness of current management	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories used here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Monitor known SGCN populations	Number of known SGCN sites monitored	USFWS, ANR, TNC, Universities	SWG, VFWD, VT Watershed Grants
Conduct inventories to detect and gather information on new SGCN populations	Number of completed species or species-group inventories	USFWS, ANR, TNC, Universities	SWG, VFWD, VT Watershed Grants
Protect and restore habitats on which SGCN are dependent through pollution abatement, riparian buffers, floodplains, etc.	Number of acres of riparian and lakeshore natural vegetation protected and/or restored Number of acres of lake habitat restored/protected	LCLT, VLT, Watershed groups, USFWS, ANR, EPA	SWG, LCLT, VLT, NRCS, EPA, Clean Water Fund
Restore migration corridors for SGCN by removal of artificial barriers to spawning habitat or construction of effective fish passage facilities at dams	Number of artificial SGCN migration barriers removed or provided with passageways Number of adult SGCN fish passed migrating to upstream spawning habitat (e.g., lake sturgeon, greater redhorse)	USFWS, Hydro operators, FERC, ANR, Municipalities, VNRC, EPA	NRCS, USFWS, Clean Water Fund, EPA
Implement an invasive species monitoring program to prevent the introduction and spread of invasive exotic species. Manage, mitigate, and/or eliminate invasive species that are detected.	Number of acres controlled/year. Number of sites with control activities and/or invasive monitoring. Acres protected from invasives.	LCBP, ANR, Municipalities, USFWS, EPA, NRCS	USFWS, VT Watershed Grants, LCBP, EPA, Clean Water Fund
Provide technical outreach and financial assistance to private landowners, watershed groups, and other partners to maintain and enhance Lake Champlain for SGCN.	Number of actions implemented to maintain or enhance lake suitability for SGCN	EPA, VFWD, TNC, LCBP, VLCT, LCI, Watershed groups,	VT Watershed Grants, LCBP, EPA, Clean Water Fund

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Provide technical outreach to towns and regional planning commissions to maintain and enhance Lake Champlain for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns considering SGCN in their planning. Number of actions implemented to maintain or enhance lake suitability for SGCN	EPA, AVCC, LCBP, RPC's Municipalities,	EPA, SWG
Acquire conservation easements for the protection of SGCN sites and maintenance or restoration of ecological functions	Number of riparian habitat acres acquired/enrolled	LCLT, VLT, ANR, TNC, NRCS, EPA	LCLT, VLT, TNC, SWG, NRCS, EPA, Clean Water Fund
Enhance coordination between government agencies and partners to ensure consistency in respective program implementation and increased sensitivity to SGCN requirements and problems to SGCN	Number of programs that incorporate SGCN conservation.	ANR, USFWS, COE, FEMA, FHWA, NRCS, LCI, Wildlife Services, VTrans	USFWS, EPA, Clean Water Fund
Update Vermont's baitfish rules as necessary and expand to include non-fish invasive bait species.	Baitfish rules are reviewed and amended as needed.	ANR	ANR

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Lake Sturgeon Recovery Plan	Lake Sturgeon restoration	VFWD
Vermont's Clean Water Initiative	Water quality improvement	VDEC
Vermont Lake Champlain Phosphorus TMDL Implementation Plan (Phase 1)	Reduction of phosphorous inputs to Lake Champlain	VDEC, AAFM
The Vermont Shoreland Protection Act: A Handbook for Shoreland Development (Version 1.2, April 2015). http://www.anr.state.vt.us/dec/waterq/lakes/docs/shoreland/lp_ShorelandHandbook.pdf#zoom=100	To allow reasonable development of shoreland along lakes and ponds while protecting aquatic habitat, water quality, and maintaining the natural stability of shorelines.	ANR
Lake Champlain Basin Aquatic Nuisance Species Management Plan (2005).	Management and prevention of invasive exotic species in the basin	VTDEC, NYDEC
VTDEC Water Quality Division	Lake protection and restoration programs	VTDEC
NYDEC	Lake protection and restoration programs	NYDEC
Quebec Ministère de l'Environnement	Protection of Québec's ecosystems and biodiversity; prevention, reduction or elimination of water contamination	Quebec Ministère de l'Environnement
Vermont Osprey Recovery Plan	Recovery and management of osprey within VT	VFWD
Conserving Lake Champlain's Biological Diversity 6/102005	Strategic plan focused on conserving Lake Champlain's biological diversity	TNC
Various watershed planning efforts	Watershed protection and restoration; river and lake restoration and protection	VTDEC; local/regional watershed groups

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Lakes Summary (excluding Lake Champlain)

Characteristics and Location

Lakes or lacustrine areas include natural lakes and ponds throughout Vermont, which can be classified on the basis of their productivity and associated physio-chemical characteristics. Lake types discussed here include oligotrophic lakes, mesotrophic lakes, eutrophic lakes, high elevation acidic lakes, and dystrophic lakes. Lake Champlain, representing oligotrophic, mesotrophic and eutrophic habitat types, is not included in this summary due to its large size and unique species assemblages (see Lake Champlain Summary). The following descriptions of Vermont lake types are based in part on parameters provided by the Vermont Department of Environmental Conservation, Water Quality Division, Lakes and Ponds Section.

Types of Lake Communities:

Oligotrophic Lakes: These lakes are typically deep with clear, cold water; low in dissolved nutrients, such as phosphorus and nitrogen; and experience seasonal periods of temperature and oxygen stratification and de-stratification (mixing). Biochemical parameters generally characterizing this lake type are: (1) total phosphorus concentration in the summer photic zone, <10 μg/L; total nitrogen concentration, <0.35 mg/L; average summer chlorophyll-a concentration, ≤3.5 μg/L; and average summer Secchi disc depth, ≥5.5 m. Another general feature of oligotrophic lakes is the lack of an extensive littoral zone. Littoral plants are scarce and plankton density is low. Several SGCN uniquely associated with this lacustrine waters are landlocked Atlantic salmon, lake trout, and round whitefish. In Vermont, lakes of this type are predominantly located in the Northeast Highlands biophysical region.

Mesotrophic Lakes: Lakes of this type are intermediary between oligotrophic (nutrient poor) and eutrophic (nutrient rich) systems. Mesotrophic lakes are shallower than oligotrophic lakes, have a well-established littoral zone supporting aquatic vegetation, and are moderately rich in dissolved nutrients. Consequently, primary productivity and plankton densities are greater than in oligotrophic systems but less than in eutrophic waters. Biochemical parameters generally characterizing this lake type are: (1) total phosphorus concentration in the summer photic zone, 10 to 24 μg/L; total nitrogen concentration, 0.35 to <0.65 mg/L; average summer chlorophyll-a concentration, >3.5 to 7.0 μg/L; and average summer Secchi disc depth, 3.0 to 5.5 m. Several SGCN uniquely associated with meso-eutrophic lakes are bridle shiner, blackchin shiner, redfin pickerel, redbreast sunfish, Eastern Musk Turtle, and northern water snake. Lakes of this type are distributed throughout Vermont; however, those supporting one or more populations of SGCN tend to be represented in greater frequency in the Champlain Valley and Connecticut River biophysical regions.

Eutrophic Lakes: Lakes of this type are generally characterized as nutrient mature systems. They are richer in dissolved nutrients and generally shallower than oligotrophic and mesotrophic lakes with extensive littoral areas supporting prolific growths of aquatic vegetation. Primary productivity and plankton densities are greater than in mesotrophic lakes. Eutrophic lakes that thermally stratify are likely to experience oxygen depletion below the thermocline during summer and/or winter stratification periods. Oxygen depletion during winter can occur when ice cover prohibits atmospheric exchange of

oxygen resulting in "winter-kill" conditions. Biochemical parameters generally characterizing this lake type are: (1) total phosphorus concentration in the summer photic zone, >24 μg/L; total nitrogen concentration, >0.65 mg/L; average summer chlorophyll-a concentration, ≥7.0 μg/L; and average summer Secchi disc depth, 0 to 3.0 m. SGCN associated with eutrophic lakes are like mesotrophic lakes with decreasing occurrence in lakes of more advanced eutrophication. Though advanced eutrophication may make unsuitable habitat for purely aquatic SGCN, the productivity of these waters may be important to terrestrial and semi-aquatic species (e.g., bald eagle, bats and northern water snake) due to the abundance of food organisms these waters are capable of producing. Lakes of this type are distributed throughout Vermont but are more likely to be at low elevations and in disturbed landscapes.

High Elevation Acidic Lakes: These are clear-water lakes generally located at elevations over 1500 feet with neutralizing capacity (ANC) less than 25 mg/L and more typically within the range of 0 to 5 mg/L. Lakes of this type are vulnerable to and in some cases are known to be adversely affected by acid deposition. These lakes are usually small and shallow, with rocky or gravelly bottoms, and little accumulated organic material. Dissolved nutrient concentrations and primary production are generally low. Relatively few SGCN are associated with high elevation acidic lakes. One possible associate is brook trout. In Vermont lakes of this type are generally distributed within the Northern and Southern Green Mountain biophysical regions.

Dystrophic Lakes: Lakes of this type are usually associated with bogs. These are characterized by brown stained water (color >50 Pt Co) and are high in nutrients and humic materials. Dystrophic lakes are often acidic and may be anoxic or nearly so in the deeper waters. Relatively few SGCN are associated with dystrophic lakes with the possible exception of brook trout. Although examples of dystrophic lakes may be found statewide, generally they are more abundant in the Northern Green Mountains, Southern Green Mountains and Northeast Highlands biophysical regions.

Lake Condition

Current Condition: The lake waters represented here have notably different physio-chemical characteristics, therefore problems and changes to their water quality and chemistry may affect each lake type and species assemblages in different ways. Most oligotrophic and mesotrophic lakes in Vermont have experienced abundant lakeshore development, both historically and currently, such as seasonal and permanent residences, marinas and docks, and public and private beaches. Cumulatively, Vermont's lakes and ponds have lost more than 45% of their intact healthy shoreline. In many instances these developments have altered natural lakeshore and littoral habitats through the addition of fill materials (e.g., sand, bottom barriers), removal of large woody debris, and removal of native aquatic vegetation for beach construction and maintenance, resulting in the direct loss of habitats for SGCN. Additionally, development has increased stormwater runoff to lakes and has elevated the input of pollutants, including sediments, nutrients, and toxic chemicals. Nutrient loading can accelerate the eutrophication process causing excessive growth of phytoplankton and other aquatic vegetation, reduced water clarity, and increased biological oxygen demand. Such water quality and habitat changes may be detrimental to certain SGCN associated with specific lakes. Many SGCN species are heavily dependent on healthy aquatic systems for food sources, such as abundant fish and/or invertebrate populations utilized by eagles, river otter, muskrat and bats.

Development of shorelands may alter habitat required by terrestrial SGCN that are associated with lacustrine areas, such as bald eagle and osprey. As an example, the reduction of mature trees by clearing within the riparian area may eliminate eagle and osprey nesting sites and reduce recruitment of woody debris into the littoral zone.

The invasion of lacustrine waters by habitat-altering exotic species and the subsequent control of these exotics may have degraded habitat for some aquatic SGCN. For example, the establishment of Eurasian milfoil in several mesotrophic lakes where blackchin shiners are known to occur has likely displaced native aquatic plant communities on which this fish species is dependent for spawning and refuge. While milfoil control activities, such as herbicide treatment, are conducted to restore lake conditions conducive to water-based recreational pursuits (boating, swimming, sport fishing), the result is loss of vegetative cover now provided by milfoil stands, increased predation on shiners by other resident fishes (e.g., bass, sunfish, pike), as well as the loss of spawning habitat. These pressures on blackchin shiner populations continue until littoral areas are adequately revegetated with native plant species, a process that may take many years if at all.

The deliberate and accidental introduction of plant and animal species to Vermont's lakes and ponds over the past 200 years has greatly changed natural communities and their ecological functions. Many fish species, including those native to the state as well as those brought from outside, have established in waters where they did not naturally occur. For example, largemouth bass, bluegill and northern pike, all native in Vermont to Lake Champlain only, now have transplanted populations in habitats nearly statewide. Rainbow and brown trout originated from the western United States and Europe, respectively, and now are established in many lakes within the state. The distribution of these species was expanded beyond their natural range for the primary purpose of increasing sport fishing opportunities; however, in the past little consideration was given to the negative effects these species have on native ecosystems. More recently, 1997, the exotic alewife was discovered in Lake St. Catherine where previously the species did not exist. This was the first recorded occurrence of alewife in the state. The impacts this species has on native fish communities are well documented, including: (1) out-competing other planktivores for food and causing shifts in zooplankton species composition and size structure; (2) preying on the eggs and larvae of native fishes; and (3) causing significant mortality syndrome in salmon and trout fry (Good 2001). The trans-state movement and introduction of exotic species into natural habitats has become an environmental problem of national scale. Past species introductions changed the current character of many Vermont lacustrine areas, and the problem is a persistent problem for maintaining lakes and ponds in a desired condition well into the future.

Currently dystrophic and high elevation acidic lakes are somewhat less limited by direct development pressures that other lake types are experiencing. On the other hand, these lakes are particularly vulnerable to habitat alteration through the effects of acid deposition.

Desired Condition (SGCN Needs): Lacustrine areas directly and indirectly support a host of species, including aquatic invertebrates (insects, crustaceans, mollusks), fishes, reptiles, amphibians, mammals, birds and plants.

Obligate SGCN associated with oligotrophic lakes (e.g., landlocked Atlantic salmon, lake trout, round whitefish) require deep, clear, well-oxygenated water for their survival. Potential

increases in lake water temperatures due to climate change represent a problem for these oligotrophic lakes and the associated cold-water SGCN.

In contrast, species associated with mesotrophic and eutrophic lakes are more dependent on the high productivity of these lake systems to produce needed food sources and habitat complexity, such as well-established littoral communities for feeding, reproduction and refuge cover.

A number of SGCN, notably the reptiles and amphibians, have home ranges that encompass both lacustrine and terrestrial areas at particular times of the year. For example, spotted and musk turtles, which reside most of the year in lakes and ponds, leave these waters briefly for upland areas to lay eggs. Similarly, lake residing brook trout may seasonally ascend tributary streams to spawn. In contrast, Fowler's toads travel from their usual terrestrial haunts to aquatic habitats to deposit eggs along the shoreline. Forested riparian zones provide nesting and feeding perches for bald eagle and osprey. Mature trees that eventually die and are recruited into the littoral area contribute to forming refuge and basking habitats. Maintenance of water quality conditions characteristic of specific lake types is a requirement of SGCN associated and dependent on those habitats.

The desired condition for all lacustrine communities would include: 1) the existence of intact riparian conditions; 2) the existence of minimally disturbed littoral zones; 3) evolutionary (e.g. trophic) processes occurring at rates not accelerated by disturbance; 4) pollutant levels (e.g. sediment and toxics, including acid deposition) below concentrations that would adversely affect SGCN; 5) absence of exotic species that adversely affect SGCN; 6) unimpeded access by SGCN to habitats required for the maintenance of life cycle functions; and 7) unaltered hydrological and temperature regimes.

Implementing the 2005 Wildlife Action Plan

Shoreline and Development Surveys for Vermont's Lakes (2006-2008) led by VDEC's Lakes & Ponds Management and Protection Program compared the SGCN present in undeveloped and developed lakeshore areas, finding that with the exception of aquatic plants, there were significantly fewer SGCN species present at the developed sites than the undeveloped shorelines. The study then used reserve design methods to identify lakeshore areas that are most likely to support SGCN, producing a map that could be used to help prioritize lakeshore conservation efforts. Project findings also aided in efforts to enact the Shoreland Protection Act of 2014 which will help protect lakeshores from further degradation. The Shoreline Protection Act, however, does not provide for restoration of already degraded and developed shorelines.

In 2011, the VTDEC Lakes and Ponds Management and Protection Section identified 13 reference lakes across a gradient of lake sizes for a Sentinel Lakes Program Monitoring program to track the effects of climate change on Vermont's inland lakes. Annual monitoring at spring turnover helps tease out trends related to climate change from trends related to land use and acid precipitation. Selected lakes have the least amount of known stressors possible. Over time, and if funding permits, quantitative macrophyte surveys, continuous temperature chains, and dissolved oxygen sensors and continuous water level monitoring devices will be deployed. Temperature, frequency of lake mixing and water levels are expected to change as a result of climate change. Understanding the magnitude and frequency of these changes due to climate change will be important for the management of

these and other lakes in the state and will contribute to our understanding of how Vermont's inland lakes are changing due to climate change.

In 2013, the Department completed the Vermont BioFinder project, a map and database identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. A notable outcome of the project was a classification of lakes and ponds based on alkalinity and trophic status and identification of best examples of each type. Follow-up efforts

The 115 lakes and ponds selected (table 1) are classified based on alkalinity and trophic status into 30 types, with Lake Champlain treated separately. Lakes and ponds were selected based on condition criteria, including naturalness of the outlet, water quality, milfoil abundance, degree of acid impairment, and lack of seasonal drawdown. Three additional lakes with special physical features were also added to the selection. Lily Pond, in Vernon, is included because of its similarity to ponds in the coastal plain. Lakes Champlain and Memphremagog are included because of their size and the extensive fisheries they support despite not meeting three other standards.

Bold: Lake/Pond name, *Italic*: location (town)

These are a subset of all lakes and ponds that occur in Vermont that represents most of lake types and examples of each type that are in the best condition for that type. The lakes and ponds are classified based on their trophic status, depth, and alkalinity, which are generally the main factors that shape biological communities in lakes (Wetzel 2001)

Table 1: Representative Lakes and Ponds

	Low Alkalinity		Moderate Alkalinity		High Alkalinity	
	Lake	***Pond***	***Lake***	***Pond***	***Lake***	***Pond***
Dystrophic	**Wheeler*** *Brunswick,* **Turtle*** *Holland,* **Branch*** *Sunderland*	**McConnell*** *Brighton,* **Dennis*** *Brunswick,* **Notch** & **S. American** *Ferdinand,* **Cow Mtn*** *Granby,* **West Mtn*** *Maidstone,* **Wolcott** *Wolcott*				
Ultra-Oligotrophic			**Crystal*** Barton, **Willoughby*** *Westmore*			
Oligotrophic	**Great Averill*** & **Little Averill*** *Averill,* Sunset* *Marlboro*	**Norford*** *Thetford*	**Echo*** *Plymouth*, **Woodward Res*** *Plymouth*, **Miller*** *Strafford*		**Caspian*** Greensboro	
Mesotrophic	**May** *Barton,* **Ricker** *Groton,* **Beaver*** & **Holland*** *Holland,* **Grout*** *Stratton*	**Athens** *Athens*, **Lakota** *Barnard*, **Nulhegan** *Brighton*, **Paul Stream** *Brunswick*, **Little Elmore** *Elmore*, **Pigeon** *Groton*, **Schofield*** *Hyde Park*, **Lewis*** *Lewis*, Lily & **Lowell** *Londonderry*, **McAllister** *Lowell*, **Kettle*** & **Turtlehead** *Marshfield*, **Ninevah** & **Tiny*** *Mt Holly*, **Kenny** *Newfane*, **Osmore** *Peacham*, **Gillett** *Richmond*, **Hancock** *Stamford*, **Stratton** *Stratton*, **Lily** *Vernon*, **Gates** & **Shippee** *Whitingham*	**Perch** *Benson*, **Long*** *Greensboro*, **Center** *Newark*, **Long*** & **Round*** *Sheffield*, **Hinkum*** *Sudbury*, **Bald Hill*** & **Mud*** *Westmore*, **Buck*** *Woodbury*	**Old Marsh** *Fair Haven*, **Daniels** *Glover*, **Horse** *Greensboro*, **Mudd** *Hubbardton*, **Milton*** *Milton*, **Fosters*** & **Mud** *Peacham*, **McLam*** *Ryegate*, **Bruce*** *Sheffield*, **Stannard*** *Stannard*, **Blake*** *Sutton*, **Abenaki** *Thetford*, **Flagg*** *Wheelock*	**Wardens*** *Barnet*, **Berlin** *Berlin*, **Emerald** *Dorset*, **Black*** *Hubbardton*, **Ewell** *Peacham*, **Rood*** *Williamstown*	**South** *Brookfield*, Coits *Cabot*, **Little Hosmer*** *Craftsbury*, **Keiser** *Danville*, **Mud*** *Leicester*, **Bean** *Lyndon*, **Johnson*** *Orwell*, **Jobs*** *Westmore*, **Chandler** *Wheelock*
Eutrophic	**Lefferts*** *Chittenden*, **Silver*** *Fairfax,* **Minards*** *Rockingham*	**Mile*** *Ferdinand*, **Little*** *Franklin,* **Spruce*** *Orwell*	**Colchester** *Colchester*, **Glen*** *Fair Haven*, **Harriman** *Newbury*, **Spring*** *Shrewsbury,* **High*** *Sudbury*	**Mollys*** *Cabot,* **Toad*** *Charleston,* **Mud*** *Morgan,* **Burr** *Pittsford*	**Great Hosmer*** *Albany*, **Memphremagog*** *Derby*, **Inman*** *Fair Haven*, **Zack Woods*** *Hyde Park*, **Long** *Milton*, **Round** *Milton*, **Huff** *Sudbury*, **Vail*** *Sutton*, **Valley** *Woodbury*	**Winona** *Bristol*, **Bliss** *Calais,* **Clarks*** *Glover,* **Little*** *Wells*
Lake Champlain*	Lake Champlain spans multiple trophic levels.					

****Highest Priority*** = lake and ponds followed by an '*'. A total of 65 lakes and ponds.

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SGCN in Lacustrine Communities (excluding Lake Champlain)

High Priority
Bald Eagle (Haliaeetus leucocephalus)
Bridle Shiner (Notropis bifrenatus)
Blackchin Shiner (Notropis heterodon)
Fowler's Toad (Anaxyrus fowleri)
Common Mudpuppy (Necturus maculosus)
Crustaceans Group (3 species)
Freshwater Snails Group (15 species)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Odonates-Lakes/Ponds Group (7 species)
Odonates-River/Stream Group (17 species
Silver-haired Bat (Lasionycteris noctivagans)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Tri-colored bat (Perimyotis subflavus)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Redfin Pickerel (Esox americanus)
Redbreast Sunfish (Lepomis auritus)
Round Whitefish (Prosopium cylindraceum)
American eel (Anguilla rostrata)
Atlantic salmon (Salmo salar) naturally reproducing populations in Lake Champlain & Memphremagog
Brook Trout-naturally reproducing populations (Salvelinus fontinalis
Lake Trout-naturally reproducing populations (Salvelinus namaycush)
Northern Water Snake (Nerodia sipedon)
Eastern Musk Turtle (Sternotherus odoratus)
Muskrat (Ondatra zibethicus)

SGCN Note: Vascular plant SGCN not listed here 38 species (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories used here

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Loss of riparian, shoreline and littoral habitats from land and water development projects and activities.	High
Habitat Alteration	Alteration and degradation of riparian, shoreline and littoral habitats from development, invasive species, and aquatic vegetation control; water level regulation; loss and inadequate recruitment of large woody debris.	High
Sedimentation	Alteration and degradation of habitat (e.g., spawning areas); smothering of organisms.	High
Habitat Fragmentation	Interruption of migration and travel corridors to and from breeding/spawning/wintering habitats via alteration and conversion home range; construction of roads, dams and culverts.	High
Invasion by Exotic Species	Alteration and conversion of native littoral plant communities; inter-species competition for habitat and food; predation on native species; impacts resulting from invasive species control programs and activities.	High
Climate change	Alteration of water and temperature regimes.	High
Pollution	Nutrient and sediment overloading, acid deposition and other pollutants.	High
Pollution	Nutrient input to lakes accelerates the eutrophication process altering normal trophic succession.	High
Monitoring	Population and habitat monitoring: improved data on known SGCN populations is needed to track changes in species abundance and habitat quantity and quality as may be affected by natural processes and anthropogenic factors; habitats with potential for having existing SGCN populations or SGCN restoration potential should be investigated.	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories used here

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Monitor, protect and restore riparian, shoreline and littoral habitats limited or impacted by development.	Number of SGCN sites (habitats) monitored; acres of undisturbed habitats protected; acres of disturbed habitats restored.	ANR, USFWS, NRCS, USFS, Lake and Watershed Associations	USFWS, EPA, Clean Water Fund, ANR
Monitor, protect and restore lake and pond water quality from excessive nutrient and sediment loading, other pollutants, and acid deposition.	Acres of SGCN habitat meeting water quality standards.	ANR, USFWS, NRCS, USFS, Lake and Watershed Associations	ANR. Clean Water Fund
Monitor, protect and restore migration and travel corridors limited or impacted by roads, dams, culverts, etc.	Number of identified artificial migration barriers removed or mitigated; number of migration corridors protected.	ANR, USFWS, NRCS, USFS, VTrans	USFWS, EPA
Monitor, protect and maintain known softshell turtle nesting sites; restore and protect additional nest sites.	Number of nest sites monitored, managed and protected; nest sites restored.	ANR, USDA, Wildlife Services, EPA	USFWS, EPA
Monitor lakes and ponds for invasive species; implement programs to prevent the introduction or spread of invasive species; implement control measures which take into account SGCN and their habitat requirements.	Numbers of SGCN habitats monitored for invasive species; number of SGCN habitats with plans in place designed to control invasive species and restore or enhance SGCN; incorporation of SGCN.	ANR, Lake and Watershed Associations	
Support policies and programs designed to reduce climate change.	Number of climate change policies and programs established or supported.	ANR, EPA, Other NE States	
Conduct inventories to detect and gather information on new SGCN populations and their habitats.	Number of potential SGCN habitats surveyed.	ANR, USFWS, USFS, EPA, USGS	USFWS
Provide technical outreach and financial assistance to private landowners, towns, watershed and lake associations, regional planning commissions, and other partners to increase their awareness of problems to SGCN.	Number of actions implemented to maintain or enhance lake function for SGCN.	ANR, USFWS, NRCS, TNC	USFWS
Acquire conservation easements for the protection of SGCN sites and maintenance or restoration of their ecological functions.	Number of SGCN habitats acquired or enrolled in land conservation easement programs.	ANR, TNC, USFS	USFWS
Enhance coordination between government agencies/partners to ensure consistency in respective program implementation and increase sensitivity to SGCN requirements and problems to SGCN.	Number of agencies and private conservation organization, which recognize and address problems to SGCN.	ANR, USFWS, USFS, NRCS, VTrans, TNC, Lake and Watershed Associations	

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Implement Vermont Sentinel Lakes Program.	Trends in spring turnover water chemistry attributable to climate change. Changes in community structure of diatom, macrophyte and littoral macroinvertebrate communities due to climate change.	ANR, EPA, UVM EPSCoR Program, Maine DEP, NH DES	Northeastern States Research Cooperative, EPA 106 monitoring fund, EPA 319 funding
Pursue funding to enable lake shore restoration and enhanced protection.	Necessary funding provided.	ANR, USFWS, USFS, NRCS, VTrans, TNC, Lake and Watershed Associations	Vermont legislature
Update Vermont's baitfish rules as necessary and expand to include non-fish invasive bait species.	Baitfish rules are reviewed and amended as needed.	ANR	ANR

Coordination with other plans

Plan or planning entity	Goal/Scope of plan	Lead
Clean Water Initiative Program	Water quality improvement	VDEC
The Vermont Shoreland Protection Act: A Handbook for Shoreland Development (V 1.2, April 2015).	To allow reasonable development of shorelands along lakes and ponds while protecting aquatic habitat, water quality, and maintaining the natural stability of shorelines.	ANR
Vermont Lake Champlain Phosphorus TMDL Implementation Plan (Phase 1)	Vermont Lake Champlain Phosphorus TMDL Implementation Plan (Phase 1)	Lake Champlain TMDL Plan
Lake Champlain Basin Aquatic Nuisance Species Management Plan (2005).	Management and prevention of invasive exotic species in the basin	VTDEC, NYDEC
VTDEC Water Quality Division	Lake protection and restoration programs	VTDEC

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