U.S. Fish and Wildlife Service

Silvio O. Conte National Fish and Wildlife Refuge
Nulhegan Basin Division
Habitat Management Plan

Habitat Management Plan
Silvio O. Conte National Fish and Wildlife Refuge
Nulhegan Basin Division
September 2018

Action	Signature/Name	Date
Submitted by:	Andrew C. French Project Leader	9/24/2018
Reviewed by:	DNRCP Chief (Acting)	10/12/2018
Reviewed by:	Refuge Supervisor, North Zone	10/22/2018
Approved by:	Region 5 Refuge Chief	10/26/2018

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Executive Summary

This 15-year plan highlights the U.S. Fish and Wildlife Service's goal of actively managing the Nulhegan Basin Division (Division) of the Silvio O. Conte National Fish and Wildlife Refuge to improve habitat for fish and wildlife species. The Division provides breeding and migratory habitat for a variety of bird species, and habitat essential for brook trout and other cold-water dependent species. The Division encompasses more than 26,000 acres of wetland, riparian and forested upland habitat, including rare plant communities such as black spruce woodland bog, mixed northern floodplain forest, and 9,000 acres of regionally significant lowland boreal habitat.

Proposed active habitat management is designed to improve habitat characteristics essential for focal species. Focal species for the upland and lowland forests of the Nulhegan include: rusty blackbird, Canada warbler, blackburnian warbler, American woodcock, black-throated blue warbler, northern long-eared and tri-colored bats. Restoration of the Division's cold-water streams and pond habitats is intended to benefit Eastern brook trout.

Currently, the Division forests are young and homogeneous, and the streams show a history of alteration. This plan outlines a combination of active and passive habitat management that aims to restore a diversity of forest successional stages, improve tree species composition, and continue improvements to stream function and connectivity.

Management will also benefit numerous Vermont Fish and Wildlife Department species of conservation concern such as:

- Wintering deer
- Spruce grouse
- Snowshoe hare
- American marten
- Rare plants

Implementation of the management strategies outlined in this planning document will necessarily include working with stakeholders, conservation partners, State agencies, and industry. In part, this plan identifies forest management strategies that may generate saleable wood products. In these areas, realizing our conservation goals will depend upon the expertise and availability of local contractors, robust timber markets, and operational flexibility.

Finding of No Significant Impact
Habitat Management Plan

SILVIO O. CONTE NATIONAL FISH & WILDLIFE REFUGE
Nulhegan Basin Division

The U.S. Fish and Wildlife Service (Service; we; our) has completed a final habitat management plan (HMP) for the Nulhegan Basin Division (division) of the Silvio O. Conte National Fish and Wildlife Refuge (refuge). The HMP, and its associated actions, is consistent with the refuge's 2017 comprehensive conservation plan (CCP). The 26,605-acre division is located in Essex County, Vermont within the watersheds of the Nulhegan and Connecticut rivers. The division was established to provide long-term protection for migratory birds, rare species and associated plant communities, fisheries habitat, and valuable wetlands.

We prepared a draft HMP and environmental assessment (EA) and distributed them to state agencies and the public for review and comment. The EA evaluated two alternatives: Alternative 1–No Action; and, Alternative 2–Expanded Habitat Management. Alternative 2, which incorporates the draft HMP, was identified in the EA as the Service-preferred alternative for implementation.

Description of Alternatives Analyzed

Alternative 1- No Action Alternative
Under alternative 1, early successional woodcock habitat management would continue in three demonstration areas totaling approximately 287 acres. No additional forest management would occur on the remainder of the division. Restoration efforts on the division's stream habitats would continue in order to improve stream function and connectivity for aquatic species. Both culvert replacements and placing woody structures in-stream to enhance aquatic species habitat would occur. Approximately 2.3 miles has been restored since 2014. Treatment of invasive species, primarily herbicide treatment of Japanese knotweed and common reed, would continue as well.

Alternative 2: Expanded Habitat Management Plan
Under alternative 2, we would implement the HMP over the next 15 years. The HMP provides detailed management objectives, and specific management strategies and prescriptions, to meet the goals and objectives in the CCP. The HMP is based on an evaluation of the suitability of division lands to support active management treatments and the desirability/opportunity to enhance and restore habitat for priority refuge resources of concern (PRRC). The HMP's primary objectives focus on expanding forest management, stream restoration, and invasive species management.

Given the preponderance of forest cover at the division, the majority of active management would enhance forest habitat conditions. Approximately 4,500 acres would come under management. We would implement silvicultural prescriptions designed to achieve the desired species composition, age class, and structural attributes necessary for refuge PRRC species' needs, and to improve biological integrity, diversity, and environmental health in the landscape as identified in the CCP. Management includes mimicking natural disturbances to create openings for new generations of trees, while retaining some larger, older trees, and restore the forest structure and size classes important for PRRC. Contractors working under the direction of refuge staff would do most vegetation manipulation. Techniques would include single-tree and group selection harvesting, retention of snags and cavity trees, and patch cuts. Contractors may remove vegetation that can be processed into a merchantable product providing economic inputs into the local and regional economy.

We would continue stream habitat restoration to improve stream function and connectivity for aquatic PRRC species. Restoration efforts are dependent on partnership involvement and funding availability, and we would pursue additional projects to the extent resources are available. Approximately 25+ miles of stream habitat are in need of restoration on the division.

We would continue to manage invasive plants, insects, or diseases using an integrated pest management strategy that incorporates pest ecology, the size and distribution of the population, and site-specific conditions. We would use best management practices to reduce potential effects on non-target species, sensitive habitats, soils and quality of surface, and groundwater. We would increase monitoring of sensitive habitats (e.g. wetlands) and high public use areas (e.g. hiking trails) as a priority to identify and treat quickly any new invasive species.

Decision

We have selected alternative 2, the HMP, for implementation over the next 15 years due to the long-term benefits predicted from expanded active management. The HMP supports the management goals, objectives and strategies set forth in the CCP. It also contributes to the purposes of the refuge and the National Wildlife Refuge System mission, and is consistent with applicable laws and policies. Further, the HMP is based on our evaluation of the suitability of refuge lands to support active management and the desirability/opportunity to enhance and restore habitat for PRRC.

Most active management will occur in degraded forested habitats that are in need of ecologically based forest management intervention. It will enhance approximately 4,500 acres by accelerating and improving forest development towards historic conditions and species composition. All forest management will use best management practices and silvicultural treatments designed to achieve the desired composition, age class, and structural attributes to benefit PRRC and to improve biological integrity, diversity, and environmental health in the landscape as identified in the CCP.

In addition to forest management, active management will include a stream restoration program to improve aquatic connectivity across additional miles for aquatic PRRC species. We will implement new projects in the 25 miles of stream identified for restoration, to the extent funding and other resources allow. We will also continue our invasive species treatment program, and expand our monitoring and early detection of invasive species to insure no new infestations.

Alternative 1 was not selected because, without active management, the vast majority of the division's degraded forest habitats will require a much longer timeframe, or fail entirely, to develop the desired level of structural diversity, resiliency, and composition important to PRRC dependent on later successional stages.

Summary of Effects of Selected Alternative

The EA was prepared in compliance with the National Environmental Policy Act (NEPA) to provide a decision-making framework that: (1) explores a reasonable range of alternatives to meet project objectives; (2) evaluates potential issues and impacts to the refuge, resources and values; and, (3) identifies mitigation measures to lessen the degree or extent of these impacts. The EA evaluated the effects associated with both alternatives.

Implementation of alternative 2, the HMP, is expected to result in the following environmental, social, and economic effects:

- The use of commercial harvest equipment to remove vegetation increases the potential for disturbance to moist/soft ground.
- Ground disturbing activities may adversely impact wildlife habitat.

- Heavy machinery used to conduct forest management may adversely affect archaeological or cultural resources.
- The use of commercial harvest equipment may cause the short-term displacement of wildlife.
- Stream restoration efforts may briefly cause disturbances to riparian habitats and aquatic species.
- Invasive species management has the potential to impact non-target species.

Measures to mitigate and/or minimize adverse effects are incorporated into alternative 2. These measures include:

- Recognized silvicultural best management practices will be implemented in all forest management activities (e.g. operating on frozen ground, establishing stream and wetland buffers, and avoiding vernal pools and sensitive habitats).
- Timber operations will be conducted when the ground is frozen to decrease the level of ground disturbance and ensure that rutting is avoided or minimized. Using tracked harvesting equipment on frozen ground is not expected to cause ground disturbance or impact potential archaeological or cultural resources.
- A Service employee will be responsible for monitoring temperature and ground condition to ensure site conditions are suitable for operations.
- Timber operations will occur outside of the peak songbird nesting season (May 15 to August 15), and scheduling most harvests for the winter months when migrant songbirds have left for their wintering grounds will minimize adverse effects to migratory birds.
- Utilizing best management practices for herbicide applications (e.g. timing of herbicide applications and appropriate weather conditions) will limit the potential impact of herbicide on non-target species.
- We are currently consulting on a Programmatic Agreement (PA) with the Vermont State Historic Preservation Officer (SHPO) covering HMP undertakings subject to Section 106 of the National Historic Preservation Act. Individual undertakings proposed for implementation prior to signature on the PA will require consultation with the SHPO pursuant to 36 CFR 800.3.

Implementing the actions proposed under alternative 2, and the mitigating measures above, will not have a significant impact on refuge resources and uses for several reasons:

- The actions will result in beneficial impacts to the human environment, including the biodiversity and ecological integrity of the refuge, as well as the wildlife-dependent recreational opportunities and socioeconomics of the local economy, with only negligible adverse impacts to the human environment as discussed above.
- The adverse direct and indirect effects of the proposed actions on air, water, soil, habitat, wildlife and aesthetic/visual resources are expected to be minor and short-term. The benefits to long-term ecosystem health that these efforts will accomplish far outweigh any of the short-term adverse impacts discussed in this document.
- The actions, along with proposed mitigation measures, will ensure that there is low danger to the health and safety of refuge staff and visitors.
- The actions are not in an ecologically sensitive area.
- The actions will not impact any threatened or endangered species; or any federally designated critical habitat.
- Any negative impacts to hunters, wildlife observers/photographers, or trappers due to wildlife disturbance near treatment units will be minor and short term in duration.
- The actions will not impact any cultural or historical resources.
- There is no scientific controversy over the impacts of the actions and the impacts are relatively certain.
- The actions are not expected to have any significant adverse effects on wetlands and floodplains, pursuant to Executive Orders 11990 and 11988, because best management practices will be implemented in all forest management areas.

Public and State Agency Review

The draft HMP and EA has been coordinated with interested and/or affected parties. Parties contacted include:

Vermont Department of Fish and Wildlife
Vermont Department of Forests, Parks and Recreation
Vermont Department of Environmental Conservation
Vermont Division of Historic Preservation
Vermont Natural Resource Council
Trout Unlimited
Vermont Nature Conservancy
Vermont Audubon
Center for Biological Diversity
Vermont Fish & Wildlife Conservation Group
Vermont Traditions Association
Vermont Forest Products Association
Nulhegan Band of the Coosuk- Abenaki Nation
Backcountry Hunters and Anglers
Northwoods Stewardship Center

On February 12, 2018, we distributed the draft HMP and EA for a 60-day public review and comment period. We received public comments that focused on adaptive management, forest management, passive management, integrated pest management, wildlife management, climate change, historical context, planning process and road infrastructure. Evaluation of the public comments led to minor modifications to alternative 2. Modifications include additions, corrections and clarifications. None of the modifications were significant enough to warrant additional analysis or a new alternative. Our responses to the comments can be found in appendix 2 of the final HMP.

Conclusion

Based upon this review, we find that implementing alternative 2, the HMP does not constitute a major federal action significantly affecting the quality of the human environment under the meaning of section 102 (2) (c) of the NEPA of 1969 (as amended). Therefore, we have concluded that this Finding of No Significant Impact is appropriate and an environmental impact statement is not required.

Scott Kahan
Regional Chief, National Wildlife Refuge System

10/26/2018
Date

1. Introduction

1.1. Scope and Rationale

The mission of the National Wildlife Refuge System (Refuge System) is to *administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans*. The 1997 National Wildlife Refuge System Improvement Act outlined a renewed vision for the future of the Refuge System where

- wildlife comes first
- refuges are anchors for biodiversity and ecosystem-level conservation
- lands and waters of the System are biologically healthy
- national and international leaders in habitat management and wildlife conservation

The 26,605-acre Nulhegan Basin Division (Division) of the Silvio O. Conte National Fish and Wildlife Refuge (Conte Refuge, refuge) contains a mixture of northern Appalachian-like vegetation and northern boreal forest communities. Important biological features include: rare species, diverse and extensive wetlands, contiguous migratory bird habitat, and Vermont's largest deer wintering area. The crater-like basin is the primary watershed of the Nulhegan River, an important tributary of the Connecticut River; three of the four major tributaries of the Nulhegan River; the North, Yellow, and Black Branches run south through the refuge.

A habitat management plan (HMP), as required by Refuge System policy, provides long-term vision and specific management guidance for the Division's resources of concern identified within the refuge comprehensive conservation plan (CCP). The contributions of the Division to broader landscape-level wildlife and biodiversity conservation are incorporated in the HMP. As required by the National Environmental Policy Act (NEPA) of 1969, as amended, an Environmental Assessment (EA) was written to evaluate and compare the environmental impacts of implementing this HMP (Appendix A).

1.2. Legal Mandates

Congress passed the Silvio O. Conte National Fish and Wildlife Refuge Act (Act) (P.L. 102-212) in 1991, authorizing the U.S. Fish and Wildlife Service (Service) to establish a national fish and wildlife refuge to protect the diversity and abundance of native species within the Connecticut River watershed. The purposes for the Conte Refuge, as stated in the Act are:

- *to conserve, protect and enhance the Connecticut River populations of Atlantic salmon, American shad, river herring, shortnose sturgeon, bald eagles, peregrine falcons, osprey, black ducks, and other native species of plants, fish, and wildlife;*
- *to conserve, protect and enhance the natural diversity and abundance of plant, fish and wildlife species and the ecosystem upon which these species depend within the refuge;*
- *to protect species listed as endangered or threatened, or identified as candidates for listing, pursuant to the Endangered Species Act of 1973 as amended (16 U.S. 1531 et seq.);*
- *to restore and maintain the chemical, physical and biological integrity of wetland and other waters within the refuge;*
- *to fulfill the international treaty obligations of the United States relating to fish and wildlife and wetlands; and*
- *to provide opportunities for scientific research, environmental education, and fish and wildlife-oriented recreation and access to the extent compatible with the other purposes stated in this section.*

1.3. Links to Other Plans

1.3.1. Refuge Plans

Comprehensive Conservation Plan (CCP)
The Refuge CCP was finalized in January 2017. The CCP guides management decisions and actions for a 15-year period. The HMP is a step-down plan of the CCP. Habitat goals and objectives developed in the CCP are carried forward to the HMP.

Inventory and Monitoring Plan (IMP)
The IMP is also a step-down plan from the CCP and HMP and will be completed within 2 years of the finalized HMP.

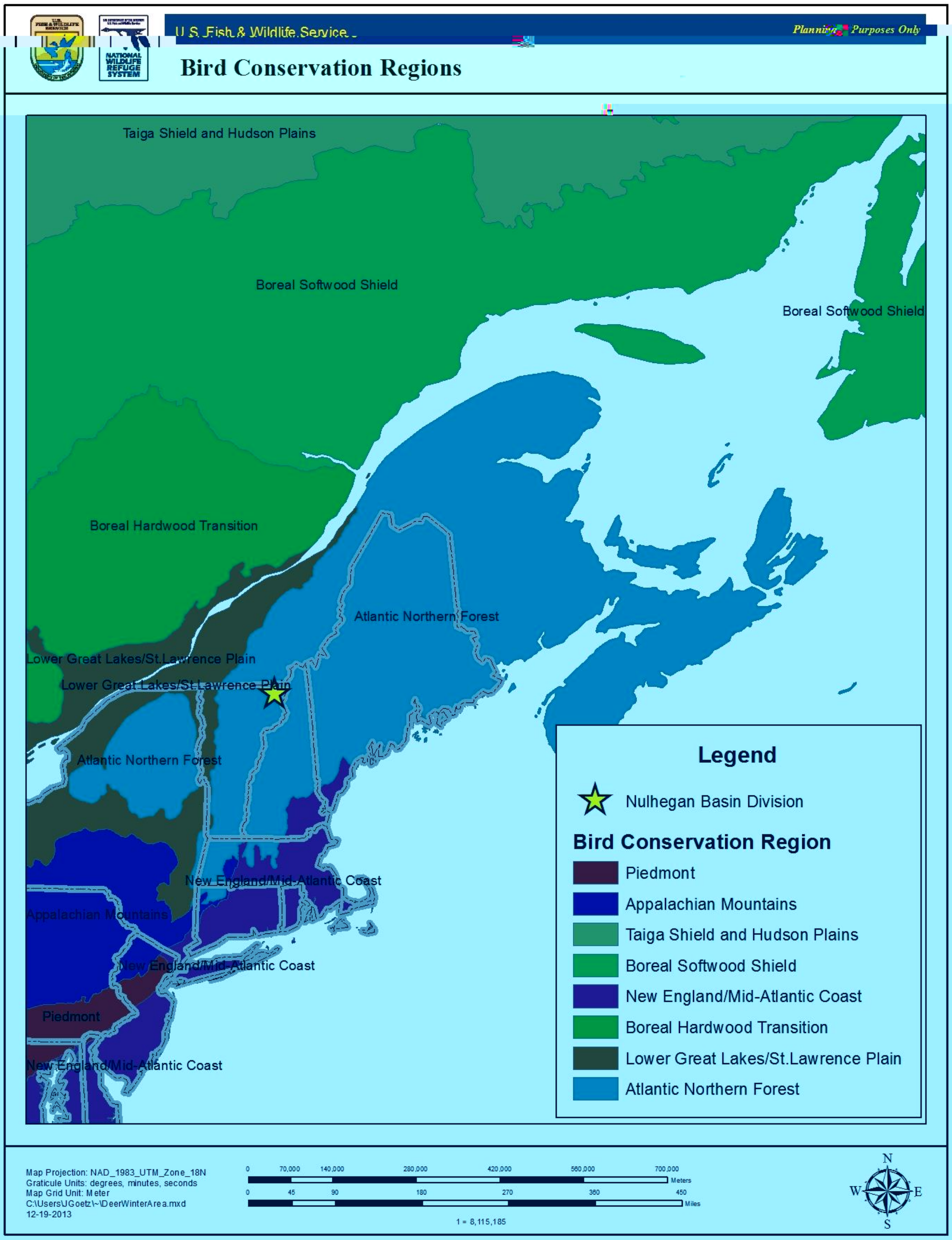
Fire Management Plan
A FMP is mandated by Service policy for any refuges that have "vegetation capable of sustaining fire." The fire plan addresses wildland and prescribed fire events with guidelines on the level of protection needed to ensure safety, protect facilities and resources, and restore and perpetuate natural processes. The FMP will be consistent with the goals and objectives in the HMP.

1.3.2. Service's Regional Plans and State Plans

Service's Migratory Bird Program Strategic Plan
The Service's Migratory Bird Program (MBP) completed a 10-year strategic plan in January 2004 (U.S Fish and Wildlife Service, 2004a). Refuges provide high quality habitat for many species of migratory birds. The MBP Strategic Plan seeks to conserve and manage migratory bird populations and their habitats. Two strategies to achieve these goals are bird population monitoring and habitat management. Refuges are currently conducting biological surveys and managing habitat. The HMP recognizes the opportunity for using standardized monitoring protocols and habitat assessments on refuges, contributing to region-wide assessments of population trends and effects of habitat management on migratory birds.

North American Bird Conservation Initiative (NABCI)
The NABCI brings together the Partners in Flight (PIF) landbird, shorebird, waterbird, and waterfowl plans into a coordinated effort to protect and restore all native bird populations and their habitats within North America. Conservation partnerships reduce redundancy in the structure, planning and implementation of conservation projects. The initiative uses Bird Conservation Regions (BCRs) to guide landscape scale, science-based approaches to conserving birds and their habitats (Figure 1.3.1 Bird Conservation Regions). The Nulhegan Basin is in BCR 14 – the Atlantic northern forest.

Figure 1.3.1 Bird Conservation Regions



2011 Technical Paper of Representative Species
Representative species are “species whose habitat needs, ecosystem functions, or management responses are similar to a group of other species.” These species were selected for the North Atlantic Landscape Conservation Cooperative (NALCC) by the USFWS and partners as a tool for designing conservation and management strategies for fish and wildlife populations at the landscape scale (U.S Fish and Wildlife Service, 2010). The Conte Refuge is one of three pilot landscapes where selected representative species and landscape design tools will be tested and refined before they are implemented across the Northeast Region.

2009-2013 Service’s Northeast Region Fisheries Program Strategic Plan
The Service’s Northeast Region Fisheries Program works with partners to “restore, recover, and maintain healthy populations of coastal and diadromous fish, fish species that cross state or national boundaries, and endangered aquatic animals and their habitats” (U.S Fish and Wildlife Service, 2009). This plan focuses on landscape level conservation and outlines goals for the Fisheries Program. These goals complement and support State Wildlife Action Plans, coordinate with other Service programs, and seek opportunities to involve refuges in strategic conservation of aquatic resources of concern.

State Wildlife Action Plans
In 2001, Congress established a new State Wildlife Grants (SWG) program that provided funds to state wildlife agencies for the conservation of fish and wildlife and their habitats. Each state was charged with developing a Wildlife Action Plan by 2005. These plans were updated in 2015. The Conte Refuge staff consulted the Vermont Fish and Wildlife Department (VFWD) Wildlife Action Plan in formulating the Conte Refuge Final CCP.

2010 Service’s Rising to the Urgent Challenge Strategic Plan for Responding to Accelerating Climate Change
This document establishes a basic framework within which the Service will work as part of the larger conservation community to help ensure the sustainability of fish, wildlife, plants and habitats in the face of accelerating climate change.

A complete list of plans that were considered in the formulation of the Conte Refuge CCP may be found in Appendix M of the final plan (U.S. Fish and Wildlife Service, 2017).

2. Background

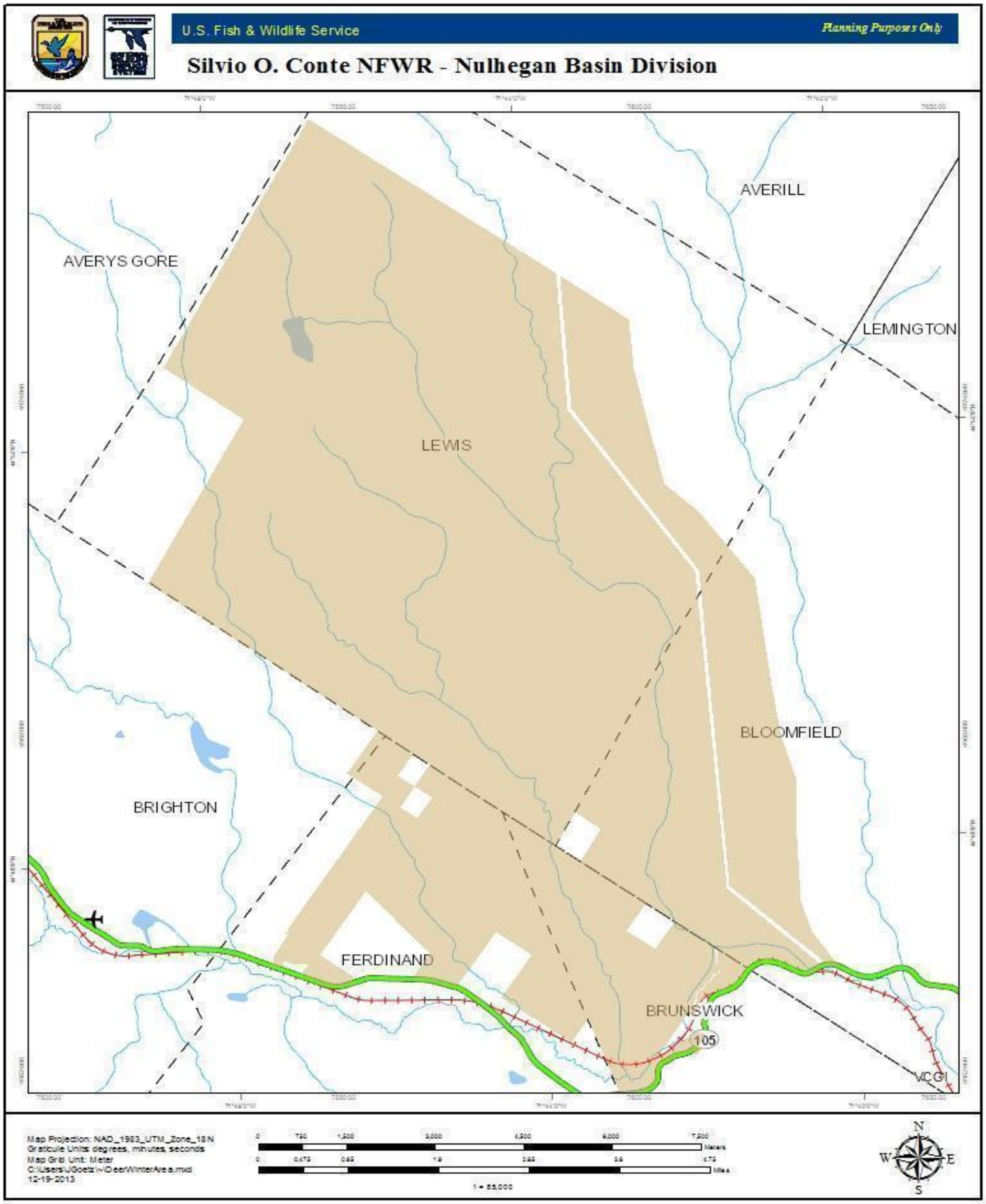
2.1. Refuge Location and General Description

The Nulhegan Basin Division in Essex County, Vermont (Figure 2.1.1 Nulhegan Basin Locator Map) lies in the crater-like Nulhegan Basin within the watersheds of the Nulhegan and Connecticut Rivers. The main stem of the Nulhegan River runs adjacent to the south boundary of the Refuge. Three of the four major tributaries of the Nulhegan River–North, Yellow, and Black Branches–drain south through the refuge. The 68-acre Lewis Pond is in the northwest portion of the refuge.

Twenty-three natural communities are mapped on the Division, and will inform habitat management. These include the most significant mosaic of lowland conifer natural communities in the state, including spruce-fir-tamarack swamp, black spruce swamp, northern white cedar swamp, and peatlands. Six of the natural communities have a Vermont Natural Heritage classification of S2 (rare) and 10 are classified as S3 (uncommon). Wetland and aquatic natural communities support the majority of identified rare plants.

Riparian habitats and wetlands are generally in good condition; however improvements to stream habitats following restoration work by the Vermont Department of Fish and Wildlife and Trout Unlimited demonstrate a continuing need for intervention. Historically, dams and log drives impacted the area's streams. Forested habitats in the Division have long supported the timber industry, dating back 150 years. The species removed and the intensity of harvesting varied over time as technologies and markets changed.

Figure 2.1.1 Nulhegan Basin Locator Map



2.2. Geographical Setting

Ecoregion

The Nature Conservancy (TNC) has divided the continental United States into 63 ecoregions – large geographic areas that share similar geologic, topographic, ecological, and climatic characteristics. The Division is in the Northern Appalachian/Boreal Ecoregion (Figure 1), which extends from Tug Hill and the Adirondacks in New York, across the Green and White Mountains, and stretches north through most of Maine, and into Canada. This region is characterized by expansive forest dominated by spruce-fir and northern hardwoods, diverse topography from sea level to over 5,000 feet in elevation, thousands of lakes, ponds, rivers and wetlands, and rugged coastline. Warm summers and long, cold winters typify the climate.

BCR and PIF Physiographic Area

The Division lies within BCR 14 – the Atlantic Northern Forest. BCR 14 is characterized by nutrient-poor soils that support spruce-fir forests in the northern reaches of the region and at higher elevations, and northern hardwood forests on lower slopes and elevations (Dettmers, 2006). The refuge is within PIF Area 28 (Eastern Spruce-Hardwood), a sub-region of BCR 14 (Figure 3).

Atlantic Coast Flyway

In North America, flyways are used in the management of waterfowl populations because they allow managers to link migratory bird conservation efforts across breeding, migration, and wintering grounds. The Division is within the Atlantic Coast Flyway. The U.S. portion of the Atlantic Flyway–the Atlantic Coast Joint Venture Area–includes the entire U.S. Atlantic coast. Joint Venture partners work together to assess the status, trends, and needs of bird populations and their habitats. Land managers use this information to guide the distribution of resources to the issues of highest priority.

Broad Vegetation Zones

Land cover data (e.g., NLCD, cover type maps) describe a habitat condition at a specific point in time and do not necessarily describe potential vegetation or successional trajectories.(Küchler, 1964; Westveld, 1956) depict broad vegetation zones for New England. The Division spans two broad vegetation zones: spruce-fir and northern hardwoods-spruce forests.

Connecticut River Watershed

The Nulhegan Basin is the primary watershed of the Nulhegan River, an important tributary of the Connecticut River. The main course of the Nulhegan River runs adjacent to the southern boundary of the Division. Three of the four major tributaries of the Nulhegan River; the North, Yellow, and Black Branches, run south through the Division. A network of smaller streams feed these branches. The 68-acre Lewis Pond is located in the northwest portion of the Division. Elevations in the Division range from approximately 1,000 feet to 2,800 feet above sea level.

The Nulhegan Basin was identified as a high priority terrestrial core area or "Terrestrial Tier 1 Core" from the *Connect the Connecticut* project; a collaborative effort by a variety of partners to prioritize conservation efforts within the Connecticut River watershed. Terrestrial Tier 1 Core areas represent areas with one or more of the following attributes: high potential ecological integrity, high habitat value for a suite of 14 representative species, high potential for floodplain forest restoration, and rare terrestrial natural communities that support unique biodiversity. The Division also contains priority aquatic core areas identified to have the potential for quality fish habitat – including ecological integrity and headwater streams with habitat value for brook trout.

Regional Conservation Context
The Division was acquired in 1999 as part of the largest conservation project in Vermont – more than 132,000 acres of forestland were conserved by a coalition of state, federal, and private organizations. The economy of the region is heavily dependent on forestry and seasonal recreation. Forest products (timber and pulp) companies are the major landowners in the region. In 1990 Maine, Vermont, and New Hampshire created the Northern Forest Lands Council to seek ways to maintain the traditional patterns of land ownership and use (Northern Forest Lands Council, 1994). Of concern was the potential for major shifts in land ownership and traditional uses.

The population of Essex County declined 1.3 percent from 2010 to 2012 (US Census), and remains the county with the lowest personal income per capita of the Connecticut River watershed counties, and in the State of Vermont. The number of visits to the Nulhegan Basin Division is estimated to be 15,000 to 20,000 per year.

The Division is part of a larger forested landscape largely protected via public ownership or working forest easements. Today the forestland supports the local timber economy, provides recreational opportunities, and supports wildlife. The largest conservation project in Vermont drew upon a partnership of public and private entities including: the Conservation Fund, the U.S. Fish and Wildlife Service, the Vermont Land Trust, the Vermont Housing and Conservation Board, the Vermont Agency of Natural Resources, and The Nature Conservancy of Vermont. The land had been previously owned and managed by Champion International Paper Company and was heavily harvested prior to being protected.

2.3. Historical Perspective

Pre-historic and Historic Native Americans

Throughout the Northeast in general and the north woods region of New England in particular, the archaeological record of Native American occupation is variably known. Like other remote forest lands in Northern New England, little archaeological research has been conducted to date at the Division, thus a detailed view of the changing Native American landscape is limited when compared to more densely populated areas.

Despite there being a few studies in the Division proper, a broad outline of human occupation in the basin can be described. The first human entrants into the region are believed to have come during the Paleoindian period (approximately 9,000 to 7,000 BC). These populations were believed to be small groups of semi-nomadic hunter-gatherers, who were adapted to residence and subsistence in tundra and tundra-woodland environments. Little evidence of the Paleoindian period is known for the northern Connecticut River drainage. The Archaic and Woodland period, from 7000 to 1000 BC and 1000 BC to AD 1600 respectively, are also poorly represented within the Division and surrounding environs. At the time of European contact, a number of autonomous Western Abenaki groups inhabited the upper Connecticut River valley including the Sokokis and Cowasucks. The Nulhegan Basin and Nulhegan River were named after the Nulhegan Band of the Coosuk; the Abenaki Nation Indians who have occupied, what they call N'Dakinna "our land" since time immemorial. Nulhegan means "Place of the Fish Traps" in the Abenaki Language which gives identity, roots, and territorial location to the Abenaki community who live there. The environs of the Nulhegan Basin offers important hunting, fishing and trapping territories for the Cowasucks which was affirmed in the Philip's Grant in 1796. A wide variety of foods are still harvested in the region by the Nulhegan Abenaki people today

Historic Period Euro-Americans
Little archaeological work concentrating on Euro-American archaeological sites has been done in the Northeast Kingdom, even less in the Nulhegan Basin. The current inventory of historic sites and cultural features known to exist within the Division boundary cannot be considered complete until additional research is done. The frontier created by the American wars with the French, English, and Native Americans delayed Euro-American settlement until sometime after the Revolution. The earliest Euro-American presence in the general vicinity of the Division was likely during the mid-17th century 70 miles to the south in Newbury, Vermont. Mission des Loupes (Mission of the Wolves) was a mission established in the Coos region around Newbury, Vermont by the Jesuit priest, Father Sebastian Râle sometime. The mission was to Christianize Abenaki Indians traveling along the Connecticut River. This is the earliest record of a Catholic Mission in Vermont which attracted Euro American to settle in the area. Small, diversified crop and livestock farms accompanied by water powered grist and sawmill; together with other small-scale industries represent the agents of landscape change during this period.

By the 1850's a landscape dominated by logging and lumbering began to emerge. This period saw the introduction of the railroad and a simultaneous rise in local wood-manufacturing mills, with extensive holdings in timberland, agricultural fields, housing and the mercantile trade. By the turn of the century, wood manufacturing and sawmills had given way almost completely to large-scale timber harvesting and associated river drives. The scale of production reached its zenith with George Van Dyke and the Connecticut Valley Lumber Company (CVL). CVL controlled nearly the entire upper drainage of the Connecticut River, including the current Division lands.

2.4. Natural and Anthropogenic Disturbances

Natural
Questions concerning the historical role of natural disturbance in forests of northern New England and the long-term stability of these ecosystems have prompted vigorous discussion (Bormann and Likens, 1979; M.B. Davis, 1981; Raup, 1964; Russell, 1983; Siccama, 1974; Stephens, 1955) but surprisingly little consensus. Consequently, despite evidence from palaeoecological, historical, and vegetational studies suggesting that many of the forests of northern New England have been repeatedly affected by windstorms (Henry and Swan, 1974; Reiners and Lang, 1979; Stephens, 1955), ice storms (Lorimer and White, 2003), pathogens (M.B. Davis, 1981, 1984), and short-term climate change (Margaret B. Davis, Spear, and Shane, 1980), other investigations have concluded that large areas can remain undisturbed for centuries (Bormann and Likens, 1979; Leak, 1970). The result has been the formulation of divergent views of community organization in New England. One view stresses stochasticity, vegetation dynamics and the natural role of periodic, broad-scale disturbance (Raup, 1956), whereas the other emphasizes community-level stability, steady-state ecosystem properties and endogenous gap formation (Bormann and Likens, 1979).

Much of this difference in perspective results from real differences among the forests investigated. A gradient of decreasing natural disturbance has been described latitudinally northward and inland from the coast in New England that is interdependent with the zonation of forest vegetation. Historical sources and geographic patterns of vegetation, climate and aboriginal populations have led to the general view that fire (ignited by lightning and by humans) was historically important in coastal areas (Pitch pine-Scrub oak forest) and in southern New England (central hardwoods forest), decreasing through the region of transition and northern Hardwood Forest in central and northern New England (Cronon, 1983; Day, 1953). Likewise, the incursion of hurricanes into New England similarly exhibits a decreasing frequency inland and to the north (Neumann, Cry, Caso, and Jarvinen, 1985).

The northern hardwood and Acadian forests with a substantial admixture of spruce found within the Division are best discussed separately from other forests because of differences in both physical environment and disturbance regime. Spruce and fir in particular are much more vulnerable to windthrow, insect epidemics, and crown fires than most of the associated species. Four distinct habitats are often recognized, each of which probably has a different disturbance regime: (1) spruce swamps, (2) “spruce flats” on relatively level and often stony soils near lakes and streams; (3) mixed forests of spruce and northern hardwood species on the better soils of lower slopes and low ridges, and (4) the “spruce slope” type on high mountain slopes or on ridges with thin, rocky soil.

Spruce and fir are susceptible to windthrow because of their shallow root systems and the tendency to predominate in swamps, on upland sites with thin and stony soils, and on mountain slopes exposed to severe winds. As early as 1899, (Graves, 1899) recognized that on these extreme habitats, windfall was common and that trees were usually blown down before reaching (biological) maturity. (Graves, 1899) also indicated that spruce forests in the swamp flats, and high mountain slopes facing the prevailing winds were often relatively even-aged. In contrast, on deeper soils where hardwoods compete more strongly, extensive tracts of mixed spruce-northern hardwoods were seldom destroyed by natural forces, but individual trees were continually dying and being replaced, resulting in a forest that included trees of all sizes and ages (Graves, 1899).

Pre-settlement land surveys provide the best evidence of disturbance rates and rotation periods at the landscape level. Windfalls and burned areas recorded by surveyors in New Hampshire, Vermont, and northern New York occupied about 0.5% of the landscape, and suggest long rotation periods. There was clearly a difference in windthrow frequency, however, between spruce-dominated forests in lowlands and mixed spruce-hardwood forests on the uplands, with most of the blowdown area located in conifer-dominated forests in swamps and stony flats of the type commonly found on the Division.

Many insects are capable of killing trees in spruce-northern hardwood forests. Only a few native insects, however, are known to cause widespread mortality. These include the spruce budworm, spruce beetle, and larch sawfly. Because these insects are reasonably host-specific, in mixed forests they normally kill scattered trees or small groups. However, in stands heavily dominated by spruce, fir, or larch, they can kill most of the stand.

Anthropogenic

Wood and its byproducts have always been a basic ingredient of North America’s commerce. As (Thoreau, 1862) once noted: ‘In wildness is the preservation of the world. The cities import it at any price. Men plow and sail for it. From the forest and wilderness come the tonics and barks which brace mankind.’ Wood was New England’s first crop. Clapboards were included in the first boat-load of goods shipped from Plymouth to the Old World in 1622 (B. M. Forman, 1970).

The commercial importance and particularly the magnitude of these early wood-related trades, however, should not be overemphasized. Sawmills were typically small-scale, family affairs oriented to local markets. Even the much publicized mast trade barely dented New England’s forests of white pine. Joseph Malone (Malone, 1964), for instance, has shown that at the most only 4,500 masts were shipped to the Royal Navy from 1694 to 1775. Large-scale commercial exploitation of North America’s–and the Division’s–forests awaited the second half of the 19th century (Williams, 1992).

Settlement had engulfed most of the Northeast by the mid-1800s, and included widespread clearing of forests for agricultural expansion. The Northeast, however, still possessed a number of sparsely populated areas which were marginal from an agricultural standpoint. The climate and the remoteness of the Nulhegan Basin limited the realization of a strong, agriculturally based economy. In the early days of lumbering in the Division, only the larger white pine and red spruce were cut from the woods. With the rise of pulp operations, the smaller red spruce were cut – spruce being favored for its longer wood fiber, which made for strong paper. Later balsam fir and, in many areas, hardwoods were added to the list of pulp species. Cutting practices largely followed the dictates of the pulpwood industry; as smaller diameters became more profitable, more extensive and thorough cutting became the norm. The development of mechanized harvesting systems, i.e., skidders and feller-bunchers, and lower product requirements in more recent decades encouraged a shift toward even-aged silvicultural management. Clearcutting, or at least cutting all the softwoods to a minimum diameter limit, became the prevailing form of management of the spruce-fir on the Division. This was particularly true during a well-documented spruce-budworm outbreak on the Division beginning the late 1970s into the early 1980s. This often resulted in salvaging of balsam-fir dominated stands with little regard for advance regeneration.

Hardwood harvesting began in earnest in 1920 to 1927 with the formation of the New Hampshire Stave & Heading Company (NHSHC). The primary aim of the NHSHC was the harvest of maple boltwood and manufacture of staves and headings for barrels destined for the West Indies sugar trade (Gove, 2003). A railroad was built to the east of the Division lands along the East Branch of the Nulhegan to allow transport of logs to a mill in North Stratford, New Hampshire. The most recent owner of Division lands–Champion International–regenerated many hardwood stands as late as the mid-1990s. Champion's management also followed yellow birch markets and others, leading to widespread irregular harvesting within hardwood and mixedwood stands.

2.5. Refuge Resources: Current Condition

Current Climate
The Division is within the Northeast Highlands biophysical region of Vermont. The region is characterized by some of the coldest temperatures in the state; average January temperature 14F. The growing season ranges from 90 to 115 days. Mean annual precipitation ranges from 38 to 54 inches, although snow falls earlier and stays later than in other regions of Vermont (Thompson and Sorenson, 2000).

Soils and Geology
Most of the Division is composed of two types of bedrock – granitic plutonic rocks and Gile Mountain formation phyllite, schist and quartzite, both of Devonian age (Doll, Stewart, and MacClintock, 1970). The granitic rocks are divided into two distinct plutons; the Nulhegan Pluton comprises the majority of the granite, and a small area of the Averill Pluton extends into the northern extremity of the Division.

Surficial deposits are of glacial, peri-glacial, and post-glacial alluvial origin. Coarse-loamy tills that are probably best described as washed tills are extensive in the Nulhegan Basin. This area was a "stagnant-ice" landscape during late Wisconsinan glacial ablation. Glacio-fluvial glacio-lacustrine deposits comprise a significant portion of the surficial deposits; these are predominantly either sandy or cobbly and sandy, and limited areas are extremely bouldery. The Division includes kame moraine. Part of what is mapped as kame moraine along the Nulhegan River appears to be a narrow outwash plain deposit. The Yellow Bogs portion of the Division is dominated by a cobbly sandy deposit, the origin of which has not been sufficiently investigated. It appears to be a very coarse-loamy washed till with cobble-boulder veneer, which occasionally is seen in situations where till meets glacial outwash. Finer tills more typical of the surficial deposits found throughout Vermont's mountainous regions cover the mountain slopes.

Inventories/Surveys
- 2001 Natural Community Mapping following Vermont Natural Heritage Inventory methodology
- 2006-2007 Nulhegan Basin Division Habitat Inventory

- 2005 James W. Sewall Company Aerial Photo Interpretation
- 2000-2006 breeding landbird survey
- 2003-2012 a Monitoring Avian Productivity and Survivorship (MAPS) banding station collected data on landbird populations
- 2001-2005 Canada warblers were monitored on the Nulhegan Basin Division, as part of a larger study effort, to obtain and model habitat-specific estimates of productivity, survivorship, dispersal, and site fidelity for northeast Vermont.
- 2000, and 2001 to 2005 Owls were surveyed.
- Since 1991 Spruce grouse breeding surveys have been conducted by Vermont Fish and Wildlife to determine presence, abundance and distribution.
- 2000-2014 American woodcock spring singing ground surveys
- 2009 and 2010 American woodcock roosting surveys within the roosting areas of woodcock units.
- 2000 a biological survey of fish and macroinvertebrates was conducted as part of a biological diversity survey effort conducted on the former Champion International Lands.
- 2009-2014 aquatic habitat assessments investigating fish passage and in-stream features.
- 2012-2015 snow tracking surveys were conducted to better understand lynx distribution in Vermont. Other species were also documented during the survey effort including bobcat and fisher. A remote camera station was set-up in 2013 in an area that was being heavily used by lynx.
- 2000 small mammal inventory was conducted as part of a biological diversity survey effort conducted on the former Champion International Lands.
- 2000 and 2008 waterfowl brood surveys were conducted as part of a biological diversity survey effort.
- 2000 marsh bird surveys were conducted as part of a biological diversity survey effort
- 2001-2005 reptile and amphibian breeding surveys were conducted to document species presence and abundance. Data was also collected on vernal pools including spatial data, productivity level, and pool measurements (length, width, and depth).
- In 2005, an inventory of invasive plant species was conducted.

Habitat Types

Within Vermont, the Nulhegan Basin is a unique landform with a correspondingly unique natural community composition. The basin, a granitic pluton that is lowland rather than mountain, is an unusual landform. Unlike lowlands in most of the State, the basin is dominated by lowland spruce-fir forest. In Vermont, only Victory Basin, a much small area 18 miles to the south, bears any resemblance to the Nulhegan in landform and vegetation characteristics.

Located a few miles south of the Canadian border, the Nulhegan Basin's vegetation most closely resembles that of the northern Appalachian Mountains, interspersed with elements of the boreal forest to the north. The Division is predominantly forested; natural openings are small and frequently associated with wetlands (e.g., bogs and beaver flowages). Windthrow events have created scattered, larger openings. The most conspicuous openings in the landscape are clearcuts, ranging in size from 10 to more than 200 acres. Shrublands, primarily dominated by speckled alder, are restricted to poorly drained areas, small seepage zones, and wide alluvial stretches of the Nulhegan River and its tributaries.

Northern hardwood forest–characterized by a mixture of sugar and red maple, yellow and paper birch, and beech–cloak the mountains of the Nulhegan Basin rim and the larger hills of the interior. Spruce-fir forest (primarily red and black spruce and balsam fir) covers large areas of the Nulhegan Basin bottom. White spruce occurs sparingly in floodplains and some swamps. In upland areas, successional stages of spruce-fir forests are often dominated by quaking and bigtooth aspen, red maple, and paper birch. tamarack, northern white cedar, and black ash occur in the Division, often restricted to wetlands more heavily influenced by groundwater.

Lowland spruce-fir forest forms the forested matrix in the Nulhegan Basin lands in the Division. Approximately 6,800 acres or 26 percent of the Division supports softwood vegetation. Except for scattered patches, the lowland forests have been heavily logged over the past 40 years. It is not a gross overgeneralization to say that every acre of lowland spruce-fir forest in the refuge is younger than 90 years old, and nearly 45 percent of the forest is likely younger than 25 to 30 years old (Lapin and Engstrom, 2002b). There is, however, some heterogeneity in the age and structure of the forest, both as a result of natural processes (particularly spruce budworm mortality and natural blowdown) and logging history. The present forest age and structure pattern is not, however, representative of the heterogeneity that would develop under a natural disturbance regime (Cogbill, 2000; Lorimer, 1977).

(Lapin and Engstrom, 2002b) documented 189 patches of older forest (closed canopy with trees at least 40 years old). These parcels total 2,965 acres or 18 percent of the land in the Division. A single patch was mapped as greater than 200 acres. Of the remaining areas, 50 percent were less than 5 acres. Forest cover data from Champion International indicated 34 percent of the area in the Division was conifer cover, however, natural community mapping suggests 60 percent as conifer community types. Thus, 26 percent of the area mapped as a conifer natural community type does not currently support conifer cover.

As you move up in elevation, the Division's lowland spruce-fir forests transition into northern hardwood-spruce-fir forest. These forests are often typically found at intermediate elevations in cool, mesic settings on shallow, rocky, nutrient-poor till or boulder substrates. Stands of this type in the Nulhegan Basin show signs of over-browsing by moose and extensive diameter-limit cutting. Mapping of the Division's natural communities suggest that previous disturbance has shifted the species composition of these stands – increasing the representation of hardwood species at the expense of red spruce and balsam fir. The diameter-limit harvesting so common in these stands generally removed the largest trees, opportunistically capitalizing on the volume and value the landowner could extract from a forest without concern for the future, and leaving the small trees as residuals. This cutting did not control stocking or regeneration, adjust spacing among residual trees, or deliberately upgrade the growing stock quality. Long-term effects differ between even and uneven-aged stands, but remain largely unpredictable.

Four to 5 percent of the Division is naturally open. As Table 2.1 illustrates, wetlands, including beaver impoundments and riverine natural communities, account for nearly all of the naturally open areas. Ecological research in northern forests from northern New England to the northern Midwest, including site specific work of (Cogbill and Royte, 2001), indicate that the natural disturbance regime of forest communities is likely to create openings in roughly 1 percent of the forested land annually(Lorimer and White, 2003). Thus, if the landscape were left to natural dynamics, it is estimated that upland and wetland natural openings would cover 5 to 6 percent of the land, with approximately four-fifths of that comprised of open wetland natural communities and one-fifth comprised of openings created by forest disturbance.

Table 2.1 Percent of Nulhegan Division Terrestrial Acreage Comprised of Uplands, Wetlands, Dominant Forest Natural Communities, and Naturally Open Communities (Lapin and Engstrom, 2002a)

LAND TYPE	PERCENT COVERAGE
Upland	86%
Wetland	12%

Riverine (non-aquatic)	2%
Vegetation Type	Percent
Lowland spruce-fir	31%
Red spruce-Hardwood	27%
Northern Hardwood	25%
Montane communities	3%
Beaver wetlands	1%
Other open wetlands	2%
Open riverine	1%
Forested riverine	<1%

Single cohort versus multi-cohort
Canopy structure is an important habitat consideration for our resources of concern (R.M. DeGraaf and Yamasaki, 2001), and represents an attribute of forests that is easily manipulated through management. Stands were classified by structural maturity (Table 2.2) to assist in biodiversity and refuge resources of concern habitat evaluation. Vertical structure was described (i.e., one story, two stories, more than two stories) as recommended by Maine Council on Sustainable Forest Management (MCSFM) and adopted by the Maine Forest Service for statewide biodiversity benchmarks (Maine Council on Sustainable Forest Management, 1996). We analyzed our aerial photo interpretation data using the following assumption: stands where interpreters identified a single tree canopy layer (of any height) may be considered to have a single-cohort structure; stands where interpreters identified two tree canopy layers (an overstory and an understory), regardless of the distribution of these layers in space, may be considered to have a multi-cohort structure. This is an oversimplification of an attribute that is inherently variable over space, but allows discussion of canopy structure at the scale for administrative planning.

Table 2.2 Acres by Canopy Structure

	HARDWOOD	% ALL HARDWOOD	MIXEDWOOD	% ALL MIXEDWOOD	SOFTWOOD	% ALL SOFTWOOD
SINGLE-COHORT	3,313	44.5%	5,777	73.7%	7,693	71%
MULTI-COHORT	4,117	55.4%	2,052	26.2%	3,141	28.9%

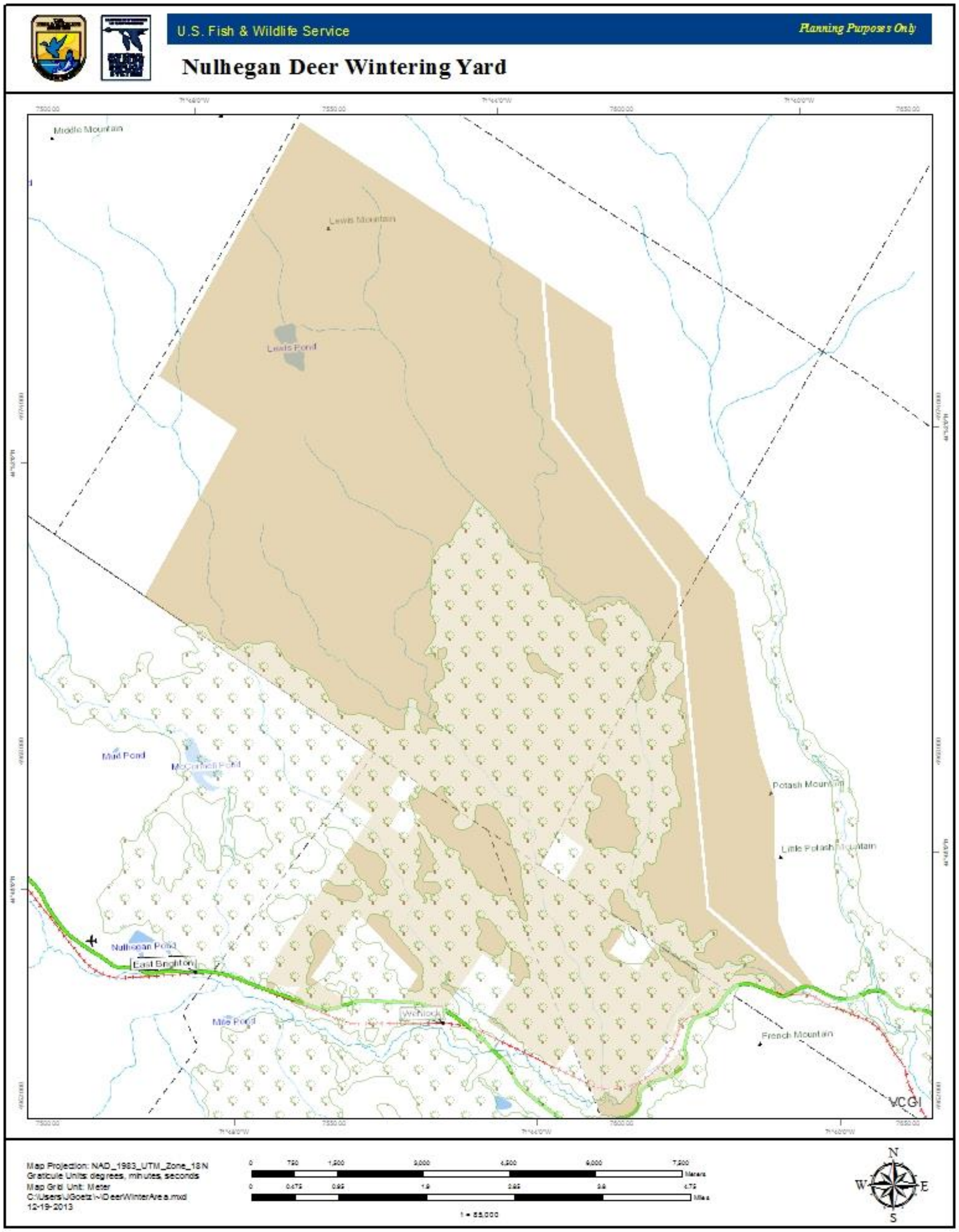
By assigning stands to one of two categories, we may make inferences about the structure of the Division’s forests at both stand and landscape scales. Historically, the Division’s forest types should support a multi-cohort structure at the stand scale, with dispersed single-cohort stands where soils, natural community, topography, or aspect increase the probability of larger-scale disturbance events.
We estimate that more than 16,783 acres of the Division or approximately 62 percent of the landbase occurs in single-cohort structures. The nature of our GIS analysis includes natural communities one

would expect to occur in single-cohort structures naturally: a thousand acres of black spruce for example, or swamps, alluvial shrublands, alder swamps being further examples. However, our analysis identified more than 7,600 acres of lowland spruce-fir natural communities, 5,700 acres of red spruce-hardwood forests, and 3,300 acres of northern hardwood natural communities that currently occur in single-cohort stands. These numbers are outside of historical norms. The preponderance of these structurally simplified stands is likely the result of past large-scale, even-aged management and harvests.

Deer Wintering Area

The Division contains a portion of the state's largest deer wintering area. White-tailed deer use spruce-fir stands for shelter from deep snow conditions and use associated regenerating intolerant hardwoods as important winter browse. The deer wintering area was degraded in the 1980s, and current conditions are improving, but not ideal for wintering deer. We will maintain updated maps of critical deer wintering areas and manage these stands, to the extent compatible with management of Federal trust resources, to ensure long-term continuation of this habitat. The overall target would be to maintain a minimum of 50 percent of a deer wintering area as functional shelter at any point in time. Functional shelter includes softwood cover over 35 feet tall and 70 percent or higher crown closure (Reay, Blodgett, Burns, Weber, and Frey, 1990).

Figure 2.5.1 Nulhegan Deer Yard



Rare Plants, Animals, and Exemplary Natural Communities

Federally Listed Species
Canada lynx was confirmed breeding in northeastern Vermont in the winters of 2012 and 2013 when a family group was detected within the Nulhegan Basin. Since that time, individual lynx have been detected by winter track and camera trap monitoring in 2014 and 2017. Prior public records beginning in 1998 report nine confirmed lynx sightings within the northeast portion of Vermont, including Division lands (Chris Bernier, personal communication 2013). Preliminary data from on-going research evaluating snowshoe hare demographics in response to climate change in northern New England shows landscape-scale densities of 0.52 hare per hectare in the Division. Snowshoe hare are considered a keystone species in the boreal forest, and an important prey species for lynx. These densities are just above the threshold of lynx occurrence across its geographic range but below optimal foraging habitat (Sirén, 2017). These results may explain lynx occupancy trends in the Division.

Conservation efforts for this species need to be at the landscape scale. A coarse assessment conducted by the USFWS New England Field Office summarized that Division habitats are not capable of supporting a standalone lynx population (Tony Tur, personal communication 2013). It was further concluded that persistence of lynx in Vermont is reliant upon receiving periodic dispersal from larger source populations, such as those found in Maine. This assessment was based on landscape scale habitat requirements necessary to support persistent populations of breeding lynx, including abundant snowshoe hare, consistent deep snow pack and denning sites, and the average home range size of lynx in southern boreal forests.

The Division staff is currently working with conservation partners to research and monitor lynx occupancy at the landscape scale. Winter track surveys and camera trap monitoring occurs across northern Vermont, including the Division lands, and New Hampshire. This information, in combination with the on-going research mentioned above, will inform landscape scale lynx conservation planning.

The Division is within the range of the *northern long-eared bat,* a Federal threatened species, and *tricolored bat,* a species petitioned for listing under the Endangered Species Act (ESA). Bat acoustic surveys from 2012 to 2015 detected tricolored bats, and potential northern long-eared bats (calls were inconclusive). These bats forage on insects within wetlands and forested habitats, and roost in large diameter trees (Massachusetts Division of Fisheries and Wildlife, 2015; U.S. Fish and Wildlife Service, 2014). These roosting habitats also provide maternity sites where females will raise their young. Our management will protect current roost trees, and maintain large diameter trees for future roosting sites. The conservation measures laid out in the Intra-service Endangered Species Section 7 Consultation (Appendix X) will be used to minimize impacts our management may have on these bat species.

Wood turtles are a species petitioned for listing under the ESA and considered a species of special conservation concern in Vermont due to state-wide declines. This species winters and breeds within riparian habitats, and has been documented in the Nulhegan River portion of the Nulhegan Basin. They hibernate in the winter on stream bottoms, often burying themselves in the mud. Breeding occurs in the spring, and eggs are buried near streams in nests of sandy soil that are protected from flooding. Wood turtles are omnivores, often foraging for plant and animal life in forests, wetlands and grasslands, though they are rarely seen foraging far from a river or stream.

State Listed Species
A total of 46 *rare plant species* listed by the Vermont Non-game and Natural Heritage program as rare and uncommon in Vermont are known to occur on the Division. Two additional rare species were found on the Nulhegan floodplain in Wenlock Wildlife Management Area, immediately adjacent to the Division; these species are thought very likely to occur within the Division as well.

Three species discovered are listed as "state historical," meaning they have not been found in the State for at least 20 years. One of these species, Pickering's reed bent-grass was known in Vermont from a single specimen collected over a century ago by the well-known Vermont botanist, Cyrus Pringle. Likewise, Wiegand's sedge was another historical species found during the inventory that has not been seen in the State for nearly 100 years and was known from only two sites in Vermont. Shining rose, the third State historical species, was found at a number of locations in the Division.

In addition to the historical species, other species considered rare within the State include 12 very rare and 13 rare species. Seventeen of the 46 species are ranked as uncommon, and one species, rough cotton-grass, is thought to be rare, but the status is unknown.

Six plants found in the Division are protected by Vermont's Endangered Species Law (Protection of Endangered Species, 1981). Auricled twayblade is a State-endangered orchid, extant at only one other location in Vermont. Woodland cudweed is the second State-endangered plant species found; it is the fourth record of the species in Vermont. The State-threatened species include two emergent wetland species, pod-grass and northern yellow-eyed grass, one wetland species often found in cedar swamps, sweet coltsfoot, and an insectivorous aquatic plant, northeastern bladderwort.

Of the 46 species identified during natural community mapping, 30 species (65%) are wetland species, while 10 (22%) are aquatics. Only 6 plants (13%) are typically upland species. It is apparent that the natural communities that harbor the greatest number of rare plants are the open peatlands, particularly the dwarf shrub bogs and fens.

The *eastern pearlshell* is listed as threatened in Vermont. This species requires cold streams and rivers with moderate grade and a cobble/gravel/sand substrate. Salmonids are the host species for this mussel. The pearlshell was documented and reported as rare in the Nulhegan River drainage by Fichtel and Smith in 1995 (Christopher Fichtel and Douglas G. Smith, 1995). It was recently documented in 2000 by Langdon and Fiske in the Nulhegan River just below the Black Branch. This population was widely scattered, and described as rare (Rich Langdon and Steve Fiske, 2001).

Bogs, fens, shrub-dominated wetlands, and swamps, as well as lowland conifer, montane, and hardwood forests support a diversity of breeding birds. Six years of breeding landbird survey data, and countless observations made by expert birders have detected numerous species of high conservation concern. Several of these species are uncommon in the Northeast, occurring at the southern periphery of their range. These include *resident and migratory boreal species* including boreal chickadee, black-backed woodpecker, spruce grouse, gray jay, bay-breasted warbler, rusty blackbird, and olive-sided flycatcher.

Spruce grouse are listed as endangered in Vermont. A breeding population currently occupies the spruce-fir forests in the Division, and adjacent VFWD Wenlock Wildlife Management Area. This species requires softwood habitat with complex vertical structure including a low to moderate shrub or regenerating softwood cover, and forest openings for raising young (Alexander and Parren, 2012). Our management will increase structural and age diversity of the Division's spruce-fir forests which will benefit the state spruce grouse population. We will continue to work with VFWD to monitor populations that inhabit the Division.

American marten is State-endangered and has recently been documented in the Nulhegan Basin Division, and elsewhere in northeastern Vermont. American marten uses a variety of forest types with a preference towards large blocks of unfragmented mature forests that contain abundance of snags, coarse woody material, and within stand structural diversity (Aylward et al., 2018; Lambert J.D., Z.J. Curran, and L.R. Reitsma, 2017). Our management will increase mature forest conditions within large contiguous forest blocks, and therefore, we expect to continue to see a rise in occupancy by marten.

Exemplary Natural Communities
Although three major forest natural communities dominate the landscape, natural community diversity on the Division is substantial. The Nulhegan Basin is an area where hydrology and glacial deposits create a complex, fine-scale mosaic of upland and wetland natural communities. Twenty-six terrestrial and palustrine natural community types have been mapped on the Division. A number of these include several variants, for a total of 46 natural community types and their variants. Six of the communities are considered rare in Vermont, and one newly described type that is thought to be rare. An additional 10 natural communities are ranked as uncommon in the State.

Rare (S2) natural community types in the Division are:

- Black spruce swamp
- Dwarf shrub bog
- Black spruce woodland bog
- Poor fen
- River cobble shore
- Mixed northern seepage swamp forest/woodland
- Mixed northern floodplain forest

Uncommon (S3) natural community types in the Division are:

- Montane spruce-fir forest
- Lowland spruce-fir forest
- Montane yellow birch-red spruce forest
- Boreal talus woodland
- Northern hardwood talus woodland
- Northern white cedar swamp
- Spruce-fir-tamarack swamp
- Vernal pool
- River sand or gravel shore
- Sweet gale shoreline swamp

Invasive Species
The Service identifies an invasive species as one that is: (1) “non-native (or alien) to the ecosystem under consideration, and (2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health” (Clinton, 1999).

Invasive species are less of a problem in the Nulhegan Basin than in many places in Vermont and the rest of New England. The Division has remained continuously forested throughout the post-European settlement period. This contrasts with much of New England and southern divisions of the refuge, which has been cleared for pasture or plowed for agricultural fields; such conversions from the natural vegetation invite non-native plants, including many species that are invasive. In addition, because of the northern latitude and general remoteness of the lands the arrival and/or spread of many of the Eurasian species considered to be invasive have been recent.

Three non-native species that are considered invasive have been documented on the Division: common reed, Japanese knotweed and common buckthorn. Known populations have been systematically treated multiple times using herbicides, often in conjunction with mechanical treatments such as cutting, or covering with plastic. These management efforts are on-going. Common buckthorn is no longer a concern, though constant monitoring for this and other invasive species is a priority.

2.6. *Climate Change*

Vermont has experienced an increase in average temperatures (1.3 F) and precipitation (5.9”) over the past 50 years as a result of climate change (Galford, et al., 2014). Weather data shows temperatures warming twice as fast in winter than in summer, resulting in an earlier winter thaw and an extended growing season. Climate change models at the low emissions climate scenario, project a continued rise in temperatures (3 to 4 F) and precipitation over the next few decades. Much of the precipitation will fall as rain as average winter temperatures warm (Galford, et al., 2014). As Vermont’s climate changes, wildlife and ecosystems are adapting (Janowiak et al., 2018). It is unclear, however, how species will continue to adapt with projected climate scenarios. There are multiple non-climate stressors influencing how species respond to a changing climate such as land-use changes, land-cover modification, invasive species, pollution, and disease (Settele et al., 2014). There are various management actions or “adaptation strategies” that land managers can use to assist ecosystems and species adapt to the effects of a changing climate (Pfeiffer, n.d.; Settele et al., 2014).

The Nulhegan Basin Division is located in a top tier site for climate resilience, according to an analysis conducted by the Nature Conservancy (TNC) (Anderson et al., 2016). Top tier sites experience high landscape diversity and local connectedness. Conservation of these top tier sites is a priority by many conservation partners, including the USFWS (Anderson et al., 2016). The assumption is that sites will have the ability to adapt to climate change while maintaining diversity and ecological function. Land conservation is one of many climate change adaptation strategies supported by the Service (US Fish and Wildlife Service, 2012).

The USDA Forest Service “Forest Adaptation Resources: Climate Change Tools and Approaches for Land Managers” technical report (C. Swanston & Janowiak, 2012) and applied state climate science data was used to integrate adaptation strategies and approaches into the Habitat Management Plan. The management actions detailed in this 15-year plan are based on an adaptive management framework. Climate change impacts and ecosystem responses to those impacts are unpredictable, and this framework provides managers with the flexibility to make management decisions on an outcome basis and on updated climate science data.

According to C. Swanston and Janowiak (2012) the five-step process outlined below is one way managers can incorporate climate change into management planning.

1. Define area of interest (location, ecosystems, timeframe)
2. Assess climate change impacts for the area of interest
3. Evaluate management objectives given projected impacts
4. Identify and implement adaptation approaches and tactics for implementation
5. Monitor and evaluate effectiveness of implemented actions

We integrated this five-step process while drafting HMP management objectives and strategies for the Nulhegan Basin Division (our defined area of interest). Because accurate climate science data is not available for the Nulhegan Basin Division, we applied data from the Vermont Climate Assessment (Galford, et al., 2014). This assessment was developed for the State to communicate scientific knowledge of impacts, risks, and vulnerabilities associated with a changing climate to support decision-making in Vermont. The statements below are excerpts from this assessment with projection confidence levels after each statement.

- Temperatures in Vermont are increasing, with the greatest increases in winter temperatures (very high).

- Winter severity in Vermont has and will continue to decrease as overnight low temperatures steadily climb. Spring has started 2 to 3 days earlier per decade, and growing season has increased by 3.7 days per decade. Vermont has already transitioned from hardiness zone 3 to 5 to 4 and 5, as a result of warmer winter minimum temperatures (very high).

- One effect rising of temperatures is that Vermont's lakes are frozen 7 fewer days per decade. Because the natural climate of Vermont varies across the state, the impacts of human-induced climate change will not be smooth across the state or over-time (very high).

- More winter and spring precipitation is projected for Vermont over this century, initially increasing snowfall but, as temperatures rise, later increasing winter rainfall (very high).

- Certain types of extreme weather events have become more intense and frequent in Vermont, including floods, and high-energy storms (very high).

Based on the Vermont Climate Assessment projections and various species climate models, the division ecosystems may respond in the following manner ("Connect the Connecticut," n.d.; Janowiak et al., 2018; Romero-Lankao et al., 2014; Settele et al., 2014; C. Swanston and Janowiak, 2012):

- A change in forest composition:
    - A shift to more southern species such as northern red oak, chestnut oak, and white oak as suitable habitat for many tree species will shift northward.

    - Decline in species associated with boreal forests such as balsam fir, red spruce, white spruce, and black spruce.

    - A decline in sugar maple and an increase in red maple and black cherry.

- A change in forest succession (making future trajectories unclear).

- Interactions of multiple stressors will reduce forest productivity.

- Temperatures will increase in cold water stream habitats causing declines in native brook trout populations.

- Stream flow variabilities due to increase precipitation and/or increased chance of drought.

- Increase in the establishment, growth, spread and survival of non-native invasive species.

- Changes in phenology (earlier occurrence of spring events, such as breeding, bud burst, flowering, migration).

Our broad Comprehensive Conservation Plan goals and objectives for the Nulhegan Basin Division, which stepped down to this HMP, provided a solid foundation for climate change adaptation. They support landscape connectivity and biological diverse and resilient ecosystems. Our HMP management objectives and strategies step down from these goals and objectives to provide detailed implementation actions that incorporate climate change adaptation strategies. Many of these strategies were adapted from C. Swanston and Janowiak (2012), shown in table 2.3 below, as well as other resources which are explained in each objective's rationale.

(Table 2.3) provides climate change adaptation strategies, actions for each strategy and three broad adaptation options that each strategy falls under.

Table 2.3 Climate change adaptation strategies

Strategies and Approaches	Resistence	Resilience	Response
Sustain fundamental ecological functions *Maintain or restore soil quality and nutrient cycling* *Maintain or restore hydrology* *Maintain or restore riparian areas*	x	x	x
Reduce the impact of existing biological stressors *Maintain or improve the ability of forests to resist pests and pathogens* *Prevent the introduction and establishment of invasive plant species and remove existing invasives* *Manage herbivory to protect or promote regeneration*	x	x	x
Protect forests from severe fire and wind disturbance *Alter forest structure or composition to reduce risk or severity of fire* *Establish fuel breaks to slow the spread of catastrophic fire* *Alter forest structure to reduce severity of or extent of wind and ice damage*	x	x	
Maintain or create refugia *Prioritize and protect existing populations on unique sites* *Prioritize and protect sensitie or at risk species or communities* *Establish artificial reserves for at risk and diplaced species*	x		
Maintain and enhance species and structural diversity *Promote diverse age classes* *Maintain and restore diversity of native tree species* *Retain biological legacies* *Restore fire to fire-adapted ecosystems* *Establish reserves to protect ecosystem diversity*	x	x	
Increase ecosystem redundancy across the landscape		x	x

Manage habitats over a range of sites and conditions *Expand the boundaries of reserves to increase diversity*			
Promote landscape connectivity *Use landscape scale planning and partnerships to reduce fragmentation and enhance connectivity* *Establish and expand reserves and reserve networks to link habitats and protect key communities* *Maintain and create habitat corridors through reforestation or restoration*		**x**	**x**
Enhance genetic diversity *Use seeds, germplasm, and other genetic material from across a greater geographic range* *Favor existing genotypes that are better adapted to future conditions* *Increase diversity of nursery stock to provide those species or genotypes likely to succeed*		**x**	**x**
Facilitate community adjustments through species transitions *Anticipate and respond to species decline* *Favor or restore native species that are expected to be better adapted to future conditions* *Manage for species and genotypes with wide moisture and temperature tolerances* *Emphasize drought and heat tolerant species and populations* *Guide species composition at early stages of stand development* *Protect future adapted regeneration from herbivory* *Establish or encourage new mixes of native species* *Identify and move species to sites that are likely to provide future habitat*			**x**
Plan for and respond to disturbance *Prepare for more frequent and more severe disturbances* *Prepare to realign management of significantly altered ecosystems to meet expected future environmental conditions* *Promptly revegetate sites after disturbance* *Allow for areas of natural regeneration after disturbance* *Maintain seed or nursery stock of desired species for use following severe disturbance*			**x**

Remove or prevent establishment of invasives and other competitors following disturbance			

Many of the adaptation strategies in this HMP are based on the Division's current habitat conditions. We focus on strategies that will maintain and enhance species and structural diversity (e.g. increase structural diversity of the Division forested communities), sustain fundamental ecological functions (e.g. restoration of riparian habitats) and reduce the impact of existing biological stressors (e.g. invasive species management). These strategies will help to increase the adaptive capacity of the Division ecosystems as they face in an uncertain future with a changing climate.

3. Priority Refuge Resources of Concern

3.1. Introduction

Resources of concern or focal species are the primary focus of this HMP. The Service is entrusted by Congress to conserve and protect migratory birds, federally listed threatened and endangered species, inter-jurisdictional fishes, and certain marine mammals (i.e., "trust species"). In addition to this Service mission, each refuge has one or more purposes for which it was established that add to our "trust responsibilities" that guide HMP management goals and objectives. Further, refuges support other elements of biological diversity including invertebrates, rare plants, unique natural communities, and ecological processes that contribute to biological integrity and environmental health at the refuge, ecosystem, and broader scales (Pavelgio and Taylor, 2010).

The HMP policy (620 FW 1) defines "resources of concern" as "All plant and/or animal species, species groups, or communities specifically identified in refuge purpose(s), System mission, or international, national, regional, state, or ecosystem conservation plans or acts." For example, northern white cedar natural communities are of concern on the Division, given the refuge purpose: "conserve, protect and enhance the abundance and diversity of native plant, fish and wildlife species and the ecosystems on which they depend" (U.S Fish and Wildlife Service, 2002) Federal or state threatened and endangered species on the Division are also a resource of concern under terms of the respective endangered species acts.

Given the multitude of purposes, mandates, policies, regional and national plans that can apply to a refuge, there is a need to identify the resources of concern and then prioritize those resources that the refuge is best suited to focus on in its management objectives. A complete description of the refuge's process for determining biological priorities for refuge lands may be found in the 2017 Conte Refuge Final CCP, Appendix B (U.S. Fish and Wildlife Service, 2017). An overview of the process for the Nulhegan Basin Division is described below.

3.2. Resources of Concern

Refuge Purpose Species
As mentioned above, the refuge was established under the Silvio O. Conte National Fish and Wildlife Refuge Act of 1991 (U.S. Congress, 1991), which lists specific refuge establishment purposes. Species and habitats of importance are identified in these purposes as shown in Table 3.1.

Table 3.1 Summary of Species and Habitats Identified in the Silvio O. Conte National Fish and Wildlife Act Establishment Purposes

Species, Species Group, or Habitat	Life History Requirements and Supporting Habitat Type(s)
Atlantic salmon	*Migration and Spawning:* Connecticut River and tributaries
American shad	*Migration and Spawning:* Connecticut River and tributaries
River herring	*Migration and Spawning*: Fast moving, shallow water in the Connecticut River and tributaries
Shortnose sturgeon	*Migration and Spawning:* Connecticut River main stem
Bald eagle	*Nesting:* Mature forests adjacent to open water habitats *Foraging:* Open water, including Connecticut River main stem *Wintering:* Lower Connecticut River main stem and estuary
Peregrine falcon	*Nesting:* Cliff and talus systems *Foraging:* Open water habitats and associated herbaceous wetlands
Osprey	*Nesting:* Mature Forests or elevated platforms adjacent to open water *Foraging:* Open water including Connecticut River main stem
American black duck	*Breeding and Migrating:* Herbaceous and forested wetlands, shallow lakes with emergent vegetation, bogs in boreal forests *Wintering:* Open water, such as, estuaries, coves or bays with submerged aquatic vegetation, mollusks and crustaceans for foraging, as well as tidal wetlands
Federally listed and candidate species	**Current federally listed and candidate species:** Dwarf wedgemussel – *Year-round:* Connecticut River and tributaries Puritan tiger beetle – *Year-round:* Sandy beaches of the Connecticut River and tributaries New England cottontail – *Year-round:* Early successional forests, shrub-swamps Jessup's milkvetch – *Year-round:* Shoreline habitat of the Connecticut River and tributaries Northeastern bulrush – *Year-round:* Herbaceous wetlands Small-whorled pogonia – *Year-round:* Hardwood forests
Wetlands	**Wetland Habitat Types within the Refuge:** **Freshwater Marshes** – Dominated by herbaceous vegetation including jewel weed, common bulrush, narrow-leaved cattail, marsh fern, water lily, wild rice and sedges. **Peatlands** – Includes acidic and alkaline fens and acidic peatlands. These wetlands are dominated by sphagnum moss, as well as leather leaf, bog rosemary, sheep laurel, pitcher plant, cotton grass, and often scattered with stunted black spruce. **Conifer Swamps** – Includes swamps dominated by conifer trees such as northern white cedar, red spruce, balsam fir, eastern hemlock, and American larch. The herbaceous and shrub layer tends to be species poor, but depends on the soils, and may include red-osier dogwood, catberry, ferns, and ephemerals. **Hardwood Swamps** – Includes swamps dominated by deciduous trees such as red-maple, black ash, swamp white oak, and pin oak. Shrubs and herbaceous layer may include buttonbush, holly, ferns, and sedges. **Shrub Swamps and Floodplain Forests** – Shrub swamps are dominated by shrubs

	including alder, willow, meadowsweet, dogwood, sedges, and rushes. Floodplain forests are often dominated by silver maple mixed with red maple, ash, and oaks. Shrubs include black willow, viburnums, and silky dogwood. The herb layer includes ferns and spring ephemerals. **Saltmarsh** – Includes intertidal marshes where salinity levels are between 5 and 50 parts per thousand). Salt tolerant species occur such as cordgrass, glasswort, switchgrass, sedges, rushes, and eastern red cedar in the higher portions of the marsh.

American black duck and the freshwater wetland habitats occur within the Nulhegan Basin Division. These resources are therefore, considered a high priority for conservation and management within the Division.

Fisheries
Conte Refuge is one of very few refuges with "Fish" in the name, emphasizing the importance of these species in the Connecticut River watershed. Fish species were compiled from the refuge purposes (above) and the following conservation plans:

- 2009 to 2013 U.S. Fish and Wildlife Service's Northeast Region Fisheries Program Strategic Plan;
- 2015 Draft Vermont Wildlife Action Plan;

Service Trust Resources
Although the refuge purposes are the first obligation, managing for trust resources is also a priority. Trust resources are further defined as follows:

Migratory Birds
A list of all species of migratory birds protected by the Migratory Bird Treaty Act (16 U.S.C. 703-711) and subject to the regulations on migratory birds is contained in subchapter B of title 50 CFR § 10.13. The Migratory Bird Program also maintains subsets of this list that provide priorities at the national and regional scales. Migratory birds that are considered management priorities for the Nulhegan Basin Division are distilled from the abundant existing conservations plans, including:

- 2008 USFWS Birds of Conservation Concern for Bird Conservation Region 14.
- 2006 Blueprint for the Design and Delivery of Bird Conservation in the Atlantic Northern Forest (BCR 14);
- Continental and regional plans for landbirds, waterfowl, shorebirds and marshbirds;
- 2009 North Atlantic Landscape Conservation Cooperative Development and Operations Plan;
- 2011 Technical Paper of Representative Species;
- International Union for Conservation of Nature;
- 2015 Draft Vermont Wildlife Action Plan;
- Status and Trend information from Refuge bird surveys;

Interjurisdictional Fish
Interjurisdictional fish are those species that cross more than one political boundary (e.g. state boundaries), and are the collective management responsibility of multiple agencies. Brook trout and Atlantic salmon are interjurisdictional fish that are important for conservation and management within the Nulhegan Basin Division.

Wetlands
Wetlands are vital for sustaining populations of fish and wildlife and are one of the Service's conservation priorities. Wetlands provide habitat for approximately 1/3 of federally listed plants and animals, and nesting, migratory and wintering areas for more than 50 percent of the Nation's migratory

bird species (U.S Fish and Wildlife Service, 1996). The Emergency Wetlands Resources Act of 1986, Public Law 99-645 (100 Stat. 3582), authorized the purchase of wetlands using the Land and Water Conservation Fund. It required the Secretary to establish a National Wetlands Priority Conservation Plan and required the states to include wetlands in their Comprehensive Outdoor Recreation Plans (United States Congress, 1986).

Threatened and Endangered Species
The ESA (16 U.S.C. §§ 1531-1544, December 28, 1973, as amended 1976-1982, 1984 and 1988) designates the Service as the responsible agency through which the Authority of the ESA will be carried out. Section 7(a)(1) of the Act further requires all Federal agencies and departments to use their authority in furtherance of the purposes of this Act by carrying out conservation programs for the benefit of endangered and threatened species (United States Congress, 1973).

To identify federally threatened or endangered species, as well as species listed by the State of Vermont relevant to the Division the following were reviewed:

- 2016 Federal Threatened and Endangered Species including Candidate.
- 2016 Federal Elevated Concern species petitioned for Threatened and Endangered Species.
- Recovery plans for Federal-listed species in our region.
- Vermont Threatened and Endangered Species list.
- Vermont threatened and endangered natural heritage program's rare plants, animals, and community list.
- 2015 Draft Vermont Wildlife Action Plan.

3.3. Biological Integrity, Diversity and Environmental Health

The 1997 National Wildlife Refuge System Improvement Act (U.S. Congress, 1997) states that in administering the System, the USFWS shall "… ensure that the biological integrity, diversity, and environmental health of the System are maintained…". The Service defines these terms as:

- *Biological diversity:* The variety of life and its processes, including the variety of living organisms, the genetic differences between them, and the communities and ecosystems in which they occur;
- *Biological integrity:* Biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities;
- *Environmental Health:* Composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape the environment

In addition to providing habitat for trust species, refuges support other elements of biodiversity including invertebrates, rare plants, unique natural communities, and ecological processes (Pavelgio and Taylor, 2010). Where possible, refuge management restores or mimics natural ecosystem processes or functions and thereby maintains biological diversity, integrity, and environmental health. Given the continually changing environmental conditions and landscape patterns of the past and present (e.g., rapid development, climate change, sea level rise), relying on natural processes is not always feasible nor always the best management strategy for conserving wildlife resources. Uncertainty about the future requires the refuge to be managed within a natural range of variability rather than emulating an arbitrary point in time. This maintains mechanisms that allow species, genetic strains, and natural communities to evolve with changing conditions, rather than necessarily trying to maintain stability. Table 3.2 below, summarizes existing elements of biological integrity, diversity and environmental health (BIDEH) on the refuge.

Table 3.2 Summary of Nulhegan Basin Division Habitats Considered Under BIDEH

Habitats that Represent Existing BIDEH	**Habitat Attributes and Conservation Concern Species**	**Natural Processes Responsible for These Conditions**	**Limiting Factors**
Conifer swamp/Spruce-fir	Acadian sub-boreal spruce flat Laurentian-Acadian conifer-hardwood acidic swamp: bigger river floodplain Laurentian-Acadian conifer-hardwood acidic swamp: isolated Laurentian-Acadian conifer-hardwood acidic swamp: pond/lake Laurentian-Acadian conifer-hardwood acidic swamp: stream/river riparian Laurentian-Acadian alkaline conifer-hardwood swamp: bigger river floodplain Laurentian-Acadian alkaline conifer-hardwood swamp: isolated Laurentian-Acadian alkaline conifer-hardwood swamp: pond/lake Laurentian-Acadian alkaline conifer-hardwood swamp: stream/river riparian Acadian low elevation spruce-fir-hardwood forest Acadian-Appalachian montane spruce-fir-hardwood forest *Potential Conservation Species:* blackburnian warbler, rusty blackbird, Canada lynx, wintering deer, spruce grouse, rare plants	Primary natural drivers of the upland forest systems are soils, aspect, elevation, moisture gradients, landscape position, and disturbance regimes. Conifer swamps are generally found on saturated organic peat or muck soils with seasonal water fluctuations resulting from variation in upland runoff and/or seasonal groundwater flow (often seeps) Spruce-fir habitats are often found in cold 'pockets', with wet soils, frequently adjacent to and grading into wetlands; often on shallow, acidic, nutrient- poor soils, at lower elevations and on summits of larger hills.	Natural succession; also logging history has converted some spruce-fir stands to mixed stands, and mixed stands to hardwood stands. It has also altered the natural 'tree gap' disturbance regime in favor of larger and more frequent disturbances; climate change will also tend to favor more southern species, over time.

Hardwood forest (includes mixed wood)	Laurentian-Acadian northern hardwood forest: high conifer Laurentian-Acadian northern hardwood forest: moist-cool Laurentian-Acadian northern hardwood forest: typic *Potential Conservation Species:* *Mixed woods*: blackburnian warbler, black-throated green warbler. Canada warbler *Northern hardwood*: American woodcock; black-throated blue warbler, amphibians/reptiles where vernal pools are present	Mixed woods habitats are quite variable, but are generally persistent in areas with locally shallow soils or moister soils; generally on benches and plateaus, often on northern and western hillslopes occasionally on steeper slopes; soils generally intermediate between poorer softwood soils and better hardwood soils. Northern Hardwood habitat is usually found on lower to middle slopes on better soils, primarily on mesic loamy soils; often on east and southeast-facing slopes of hills	Natural succession; also logging history has converted some mixed stands to hardwood stands. It has also altered the natural 'tree gap' disturbance regime in favor of larger and more frequent disturbances; climate change will also tend to favor more southern species, over time.
Shrub swamp and floodplain forest	Laurentian-Acadian wet meadow-shrub swamp: isolated Laurentian-Acadian wet meadow-shrub swamp: pond/lake Laurentian-Acadian wet meadow-shrub swamp: stream/river riparian *Potential Conservation Species:* American woodcock, Canada warbler, beaver, American black duck, cavity-nesting and brood-rearing waterfowl, rusty blackbird, bats, rare plants	Seasonal flooding; beaver activity Primarily occur on mineral soils on periodically flooded bottomlands associated with river corridors. Flood disturbance, including flood frequency, duration and intensity, is the primary driver of the system. Underlying soils, geomorphology, and elevation also impact	Natural, human influenced (logging, dam controlled water level changes) or climate-influenced changes in hydrology Land use practices such as timber harvest and development that affect erosion, sedimentation, hydrologic regime/ flooding interval; increase habitat fragmentation; dam

		plant community composition and distribution	management that alters water levels, flow and timing of flood events and sediment loads.
Cliff and Talus	Laurentian-Acadian acidic cliff and talus Laurentian-Acadian calcareous cliff and talus *Potential Conservation Species:* bats	Occurs at low to mid elevations consisting of vertical or near-vertical cliffs and the associated accumulation of broken rocks at the base of slopes. Bedrock chemistry determines whether the system is acidic or calcareous.	Climate change, acidic rain
Freshwater marshes	Laurentian-Acadian freshwater marsh: isolated Laurentian-Acadian freshwater marsh: stream/river riparian *Potential Conservation Species:* American black duck, mink frog	Occur in closed or open basins that are generally flat and shallow. They are associated with ponds, slow-moving streams, and beaver impoundments. The herbaceous vegetation does not persist through the winter. Scattered shrubs are often present and usually total less than 25% cover. Trees are generally absent and, if present, are scattered. The substrate is typically muck over mineral soil.	changes in precipitation/ hydrological regime / timing, resulting from climate change
Peatland	Boreal-Laurentian-Acadian acidic basin fen	Wetland fed by mineral-rich surface water or groundwater;	Succession due to changes in amount of water flow, altered

	Potential Conservation Species: rare plant communities	they are characterized by their water chemistry, which is neutral or alkaline. The substrate is Sphagnum, and vegetation typically includes areas of dominance by grasses and dwarf-shrub dominance. Leatherleaf (*Chamaedaphne calyculata*) is usually present and often dominant.	flood regimes, nutrient inputs, or sediment build-up, caused by natural processes, human disturbance (logging, road-building) and/or climate change
Rocky outcrop	Northern Appalachian-Acadian rocky heath outcrop Laurentian-Acadian calcareous rocky outcrop	The acidity of the bedrock determines whether the system is calcareous or heath. The vegetation is patchy, often a mosaic of woodlands and open glades.	Climate change, acidic rain
Open water	Includes: open water of ponds, rivers, streams; floating –leaved and submerged aquatic vegetation, aquatic beds *Potential Conservation Species:* eastern brook trout, other native fish, common loon, other aquatic birds	Water quality, clarity/ light penetration, temperature nutrient loads; water depth and flow characteristics; timing/ seasonality of hydrologic regime	Introduced fish species; aquatic invasives, human disturbance, pollution from airborne and aquatic sources, land use practices (timber harvest, development) that influence sediment loads, water quality, shading; climate change that alters hydrologic and temperature regimes

3.4. Process for Prioritizing Resources of Concern

As mentioned above, resources of concern or focal species were compiled from various purposes, mandates, policies, and regional and national plans. This information was compiled for the entire Connecticut River watershed, and can be found in the 2017 Conte Refuge CCP, Appendix B (U.S. Fish and Wildlife Service, 2017). This list addresses a broad range and high number of conservation needs, but does not allow for focused and effective resource conservation. Priority refuge resources of concern for each Division, CFA and Unit were selected from this comprehensive list using a "focal resources" concept. Focal resources are associated with conditions that represent the needs of larger groups of species that have similar requirements and respond to management similarly (Pavelgio and Taylor, 2010). The species selected prioritize and focus management, and may be a species or a species group, habitat, or natural community type, such as migratory birds or floodplain forests.

We used existing wildlife inventory data and current information on habitat conditions to inform our selection of priority refuge resources of concern for the Nulhegan Basin Division. The following criterion was used in this selection process:

1. Is the species a federally threatened or endangered species, a Federal candidate species, a species petitioned for Federal listing or a species mentioned in the refuge purposes currently present in the Division (e.g., Puritan tiger beetle)? If yes, then the species is a priority.

2. For species whose core range is within the Division and management for them will benefit other priority species we pose the following questions. If yes to all of these questions, he species is a priority:
    - Is the species distributed throughout the Division, and/or is the Division within the core of their breeding/migratory/wintering range?
    - Does the Division provide the habitat to support this species?
    - Will this species respond well to management?
    - Does the species have the highest ranking, and will management for this species also benefit a suite of species that rely on similar habitat types and structure (e.g., wood thrush, American black duck)?

3. Does the species have habitat needs that will not be addressed through management of other chosen priority species, and is it currently present in the Division (e.g., blackburnian warbler)? If yes, then the species is a priority.

4. Is this a habitat type within the Division that is not necessarily being managed for a particular priority species of concern due to small patch size or location, but nonetheless, is important to conserve for its contribution to BIDEH or ecosystem processes and function? If yes, then the habitat is a priority.

Species that met the criteria above, but are also listed in the State Wildlife Action Plan, under the International Union for Conservation of Nature and/or are a North Atlantic Landscape Conservation Cooperative representative species, then the species were given additional emphasis.

Using the above process the following habitats and species were determined priority resources of concern for the Nulhegan Basin Division:

Table 3.3 Priority Resources of Concern for the Nulhegan Basin Division

Priority Refuge Resources of Concern[1]	Habitat Structure[2]	Associated Species[3]
Forested Uplands and Wetlands[4]		
Conifer Swamp/Spruce-fir Forest[5] - 18,549 acres		
Blackburnian Warbler[A]	Breeding habitat includes mature conifer, and conifer-deciduous forests (80+ years old) (R.M. DeGraaf & Yamasaki, 2001; Dunn & Garrett, 1997; Morse, 2004).	Cape May Warbler[A, J] Boreal Chickadee[A, J] Purple Finch[A, J] Black-throated Green Warbler[A, J] **Spruce Grouse [A, I]** **American Marten[I]** Canada Lynx[I, J] Gray Jay[A, I, J] Black-backed Woodpecker [A, I, J] Bay-breasted Warbler[A, I, J] **White-throated Sparrow** **Blackpoll Warbler[A, I]** Brown Creeper[J] Northern Saw-whet Owl[J] Olive-sided Flycatcher[A, I, J] Palm Warbler[A,J] Pine Grosbeak[A, J] Sharp-shinned Hawk[J] Yellow-bellied Flycatcher[J] Northern Parula[A]
Rusty Blackbird[A, C]	Breeding habitat includes conifer dominated forested wetlands interspersed with shrub swamps and peatlands. Young spruce and fir may be required for nesting (Greenberg & Droege, 1999; Greenberg & Matsuoka, 2010; Matsuoka et al., 2010; Powell, Hodgman, & Glanz, 2010).	
Canada Warbler[A, B, C]	Breeding habitat includes contiguous deciduous, mixedwood and coniferous forests interspersed with openings that provide an average over-story tree height of 55 ft within >30% canopy closure, a dense foliar mid-story and well developed shrub layer 7-20' in height, and moist soils (J.F. Chace, Faccio, & Chacko, 2009; Dunn & Garrett, 1997; Lambert & Faccio, 2005).	
Hardwood Forest[5] - 13,448 acres		
American Woodcock[A, B, C]	Breeding and roosting habitat includes young deciduous and mixed forests (1-20 years old) dominated by aspen and birch, and 3+ acre forest openings with 60% shrub cover, in proximity to alder wetlands and herbaceous openings (Kelley Jr., Williamson, & Cooper, 2008; Sepik, Owen Jr, Coulter, & Mendall, 1981).	**Ruffed Grouse[A, I]** Whip-poor-will[A, I, J] Smooth Green Snake[I] Canada Lynx[I] **Chestnut-sided Warbler[A, I]** Purple Finch[A, J] **Ovenbird[A]** **Eastern Red Bat[I]** Little Brown Bat[I] American Redstart[A, J] Black-and-white Warbler[J] Broad-winged hawk[J] Eastern Wood-pewee[A, J] Northern Flicker[A, J] Northern Goshawk[A, I, J] Red-shouldered Hawk[I, J] Rose-breasted Grosbeak[A,J] Canada Warbler[A,I] Yellow-bellied Sapsucker[A, J] Veery[A] Black-billed Cuckoo[A,I] Black-throated Green Warbler[A] Northern Parula[A] American Marten[I]
Black-throated Blue Warbler[A]	Breeding habitat includes mature deciduous and mixed deciduous-conifer forests with a shrubby understory ((R. M. DeGraaf & Yamasaki, 2001; Dobbs, Sillett, Rodenhouse, & Holmes, 2007; Dunn & Garrett, 1997; Rosenberg & Hodgman, 2000)	
Northern Long-eared Bat[D] Tricolored Bat[E]	Winter habitat includes high humidity under-ground caves or cave like structures; summer habitat includes roost trees that are typically $\geq$ 3 inches dbh, are alive, dead or dying, exhibits exfoliating bark, cavities, crevices, or cracks and located within a variety of forest types interspersed with non-forested habitats (Massachusetts Division of Fisheries and Wildlife, 2015; U.S. Fish and Wildlife Service, 2014).	

Blackburnian Warbler[A]	Breeding habitat includes mature conifer, and conifer-deciduous forests (80+ years old) (R.M. DeGraaf & Yamasaki, 2001; Dunn & Garrett, 1997; Morse, 2004).	
Forested Uplands and Wetlands[4]		
Shrub Swamp and Floodplain Forest[5] **- 348 acres**		
American Woodcock[A, B, C]	Foraging habitat includes alder dominated wetlands in proximity to early successional forests, shrublands, and herbaceous openings (Kelley Jr. et al., 2008; Sepik et al., 1981).	Chestnut-sided Warbler[A, I] Black Racer[I] Ruffed Grouse[A,I] **Warbling Vireo** **Willow Flycatcher** American Redstart[A, J] Eastern Kingbird[J] Gray Catbird[J] Wood Duck[A, J] Veery[A]
Wood Turtle[E]	Associated with slow-moving sections of clear, cold woodland mid-size streams with sand, gravel or rock substrate. Instream structural features important for basking, overwintering and cover include large root masses, log jams and woody material. A mosaic of upland habitats provide thermoregulation and food. Nesting habitat includes features such as sandy point bars, cut banks, and sand and gravel deposits in the stream channel (Northeast Wood Turtle Working Group, 2017)	
American Black Duck [A, B, C, G]	Breeding and migrating habitat includes herbaceous wetlands, and flooded meadows and shrub-swamps (R.M. DeGraaf & Yamasaki, 2001; Longcore, Mcauley, Hepp, & Rhymer, 2000).	
Non-Forested Uplands and Wetlands[4]		
Rocky Outcrop[5] **- 200 acres**		
Northern Appalachian-Acadian rocky heath outcrop[H] Laurentian-Acadian calcareous rocky outcrop[H]	*The Northern Appalachian-Acadian rocky heath outcrop system* occurs on ridges or summits of erosion-resistant acidic bedrock. The vegetation is patchy, often a mosaic of woodlands and open glades. Red oak and various conifers, including White pine and Red spruce, are characteristic trees. Low heath shrubs, including Sheep laurel, Low- bush blueberry, Black huckleberry, and Black chokeberry are typically present. Exposure and occasional fire are the major factors in keeping the vegetation relatively open. *Laurentian-Acadian calcareous rocky outcrop* occurs on ridges or summits of circumneutral to calcareous bedrock. Sites are often exposed and dry; however, there may be local areas of more moist conditions. The vegetation is often a mosaic of woodlands and open glades. This system may also occur on rocks that are primarily acidic but with a local influence of calcium through weathering (Gawler, 2008).	Uncommon plant community within the landscape that contributes to BIDEH*

Non-Forested Uplands and Wetlands[4]		
Freshwater Marshes[5] **- 4 acres**		
Laurentian-Acadian freshwater marsh[H]	These freshwater emergent and/or submergent marshes are dominated by herbaceous vegetation. They occur in closed or open basins that are generally flat and shallow. They are associated with lakes, ponds, slow-moving streams, and/or impoundments or ditches. The herbaceous vegetation does not persist through the winter. Scattered shrubs are often present and usually total less than 25% cover. Trees are generally absent and, if present, are scattered. The substrate is typically muck over mineral soil. Vegetation includes common bulrush, narrow-leaf cattail, marsh fern, common jewelweed and sedges (Gawler, 2008).	Uncommon plant community within the landscape that contributes to BIDEH*
Peatlands[5] **- 413 acres**		
American Black Duck[A, B, C, G]	Breeding and migrating habitat includes herbaceous wetlands, and flooded meadows and shrub-swamps (R.M. DeGraaf & Yamasaki, 2001; Longcore et al., 2000).	Olive-sided Flycatcher[A, I, J] Southern Bog Lemming[I, J] Mink Frog Palm Warbler[A] Black-backed Woodpecker[A, I, J] Eastern Kingbird[J] Northern Harrier[A, I, J]
Cliff and Talus[5] **– 40 Acres**		
Laurentian-Acadian acidic cliff and talus[H] Laurentian-Acadian calcareous cliff and talus[H]	These cliff systems occur at low to mid elevations, well below treeline. The vegetation within the *acidic cliff and talus system* is patchy and often sparse, punctuated with patches of small trees such as birches and spruce species. Species that prefer calcium rich soils are absent. In north-facing or other sheltered settings where cold air accumulates at the bottom of slopes, a shrubland of heaths and reindeer lichens can develop. The *calcareous cliff and talus system* has more nutrient rich soils, and the vegetation is often sparse, but may include patches of small trees including northern white cedar, which may be the dominate species. Ash species and basswood are woody indicators of the enriched setting (Gawler, 2008).	Uncommon plant community within the landscape that contributes to BIDEH*

Inland Aquatic Habitats[4]		
Open Water[5] - 163 acres		
Brook Trout[B, F]	Spawning habitat includes clear, well oxy-genated cold water lakes/ponds/streams with silt-free rocky substrate, abundant cover, vegetated banks, stable temperatures and stream flow (Vermont Wildlife Action Plan Team, 2015).	Eastern Pearlshell[I] Riffle Snaketail[I] Brook Snaketail[I] Maine Snaketail[I] Zebra Clubtail[I] **Wood Turtle[E]**
American Black Duck[A, B, C, G]	Breeding and migrating habitat includes her-baceous wetlands, fens, and flooded meadows and shrub-swamps (R.M. DeGraaf & Yamasaki, 2001; Longcore et al., 2000).	Canada Goose[A] Wood Duck[A] Hooded Merganser[J] Green-winged Teal[J] Mallard[J] Common Merganser Ring-necked Duck Common Loon[A,I]

Notes:

1 - These species of conservation concern and associated habitats, as well as under-represented and sensitive ecological systems constitute the management focus for the CFA, and recommended for the CPA. They were identified based on specific criteria, and are included in the following plans, databases and/or have Federal status.

A: 2008 Bird Conservation Region 14.

B: 2009 North Atlantic Landscape Conservation Cooperative Development and Operations Plan.

C: 2008 USFWS Birds of Conservation Concern.

D: Federal Threatened and Endangered status as of 2016, including Candidate Species

E: Federal Elevated Concern species or species petitioned for threatened and endangered listing as of 2016

F: 2009-2013 USFWS Northeast Region Fisheries Program Strategic Plan

G: Silvio O Conte Refuge Purpose Species.

H: 2008 North East Terrestrial Habitat Classification System.

2 - This habitat structure will benefit the listed priority refuge resources of concern, and is based on the most recent literature.

3 - These species are a compilation from the following plans, and are associated with the habitat type and/or will benefit from all or a portion of the habitat structure associated with the priority species. This is not a comprehensive list of species.

A:2008 Bird Conservation Region 14.

I: 2015 Draft Vermont Wildlife Action Plan (Species of Greatest Conservation Need)

J: 2012 Terrestrial and Wetland Representative Species of the North Atlantic: Species Selected, Considered, and Associated Habitats (Ecological Systems). These species were LCC candidate species and are represented by the selected LCC Representative Species.

4 - CCP Objectives from Silvio O. Conte NFWR Comprehensive Conservation Plan, Chapter 4, Service-preferred Alternative.

5 - These habitat types are based on the North Atlantic Landscape Conservation Cooperative (NALCC) habitat groupings for associated Representative Species, which were derived from The Northeastern Terrestrial Habitat Classification System (NETHCS). See table A.52 for a comparison of the NALCC habitat groupings and NETHCS.

BOLD - These species are LCC Representative Species, which is a species that, because of its habitat use, ecosystem function, or management response, typifies lifecycle or habitat requirements for a larger group of species.

* The Refuge Improvement Act directs the US Fish and Wildlife Service to maintain Biological Integrity, Diversity, and Environmental Health (BIDEH). Elements of BIDEH are represented by native fish, wildlife, plants and their habitats as well as those ecological processes that support them.

The Connect the Connecticut used species and ecosystem data to create the terrestrial and aquatic core networks mentioned above. Landscape capability and probability of occurrence models were created for representative species. We used the landscape capability models for blackburnian and American woodcock, and probability of occurrence model for brook trout to verify the Division's priority resources of concern. The capability models provide an index of relative habitat quality for the species in the watershed. Based on model outputs, the Division provides areas of high quality habitat for blackburnian warbler and American woodcock, as well as high occurrence probability for brook trout.

3.5. Priority Habitat Types and Associated Species

Refuge management will focus on restoring, managing, or maintaining habitats or certain habitat conditions that will benefit the Division's priority resources of concern and associated species, while maintaining the biological integrity, diversity and environmental health of the natural communities unique to the basin. Since all management activities cannot be undertaken at the same time, we have prioritized habitats based on the following ranking factors:

- Where would management actions provide the greatest conservation benefit to our refuge resources of concern;
- Current habitat condition and the urgency of the need for active management;
- Landscape level ranking of particular habitats;

Although a habitat may be ranked as priority II, this should not be interpreted to mean that this habitat type does not provide valuable habitat to a variety of species and contribute to the overall diversity of the refuge. In many cases, these habitats do not require active management by the Refuge or represent an area where we have little management capability. Table 3.4 provides information on the Division habitat priorities.

Table 3.4 Habitat Priorities at the Nulhegan Basin Division

Habitat Type Priority I Habitats	Reasons for Ranking	Limiting Factors/Threats
Conifer swamp/Spruce-fir	Supports resident, migratory, and breeding boreal species and species of conservation concern including rusty blackbird, blackburnian warbler, bay-breasted warbler, black-backed woodpecker, boreal chickadee, and Canada lynx; provides a forest buffer for numerous streams; contiguous forest; connectivity to other conservation lands.	Spruce-budworm outbreaks, climate change, infrastructure
Shrub swamps and floodplain forests/Freshwater marsh	Supports breeding waterfowl, including American black duck and wood duck; provides feeding habitat for American woodcock; supports rare plants; provides stop-over habitat for migrating landbirds	Invasive species, climate change, recreation (e.g. fishing access trails)
Hardwood Forest (includes mixed wood)	Provides contiguous breeding habitat for forest interior species, as well as species of conservation concern, such as black-throated blue warbler and Canada warbler; common in the landscape; provides connectivity to other conservation lands	Invasive insects (e.g., emerald ash borer, hemlock wooly adelgid), infrastructure, climate change
Priority II Habitats	**Reasons for Ranking**	**Limiting Factors/Threats**
Open Water	Supports cold water fisheries including brook trout and Atlantic salmon; limited management capability.	Climate change, non-native species (e.g., small-mouth bass)
Rocky Outcrop/Cliff and Talus	Uncommon habitat type in landscape; sensitive habitat; limited management capability	Remote and steep terrain, limited management capability,
Peatlands	Uncommon habitat type in landscape; sensitive habitat; unique plant species; black ducks; surrounds remote ponds, limited management capability.	Sensitive habitat, remote, limited management capability

3.5.1. **Habitat Suitability Modeling**

Successful biodiversity conservation hinges on our ability to understand wildlife-habitat relationships at multiple spatial scales (Grand & Cushman, 2003; Storch, 2002; Turner, O'Neill, Gardner, & Milne, 1989). The Connect the Connecticut LCD landscape capability species models were a valuable tool for verifying the Division's importance within the Connecticut River watershed to our identified priority resources of concern. Because patterns change depending on the scale at which they are measured (Bissonette & Storch, 2003; Levin, 1992; Turner et al., 1989; Wiens, 1989), spatial scale choices for habitat model development are critical. Recent work by (K. M. Smith, Keeton, Donovan, & Mitchell, 2008) in Vermont, noted past models of avian occurrence for one of the identified focal species(black-throated blue warbler) which may have underestimated the importance of stand-scale vegetation.

The Division's stand-scale vegetation datasets allowed development of simple habitat suitability models for each of the identified focal species excluding American woodcock, which are managed under the Woodcock Management Unit Plan. These models provide an estimated baseline metric of current habitat conditions for each species and will inform prioritization of habitat management efforts. Model outputs were generated using two different processes dependent upon variable characteristics for a species habitat needs: species models that relied upon categorical variables were constructed using a weighted overlay process in ArcGIS; species models that included continuous variables were developed mathematically in ArcGIS model builder. These efforts are representative of forest conditions at the time of *data acquisition* (which in many cases may be 10 years or more prior), rather than when this planning document was completed. Model assumptions and outputs may vary as our efforts improve over the life of this plan. Species models and associated assumptions are discussed below:

3.5.1.1. Model Assumptions

Black-throated Blue Warbler Model

Variable	Criteria
Natural Community Type	Forest where species composition trends toward hardwood species and away from softwood species are more favorable to Black-throated Blue Warbler occupancy (R. T. Holmes, 2005).
Elevation	Forest between 375m to 700m in elevation are more favorable than those at higher or lower elevations (R. T. Holmes, 2005).
Shrub density	Stands where shrub density is high are more favorable than stands with low shrub density (S. B. Holmes & Pitt, 2007; Kearns, Silverman, & Hall, 2006)
Understory crown closure	Forest with an understory of moderate to high crown closure (>60%) are more favorable to Black-throated blue warbler occupancy than forest with an understory with low canopy closure (Goetz et al., 2010)
Overstory crown closure	Forest with an overstory crown closure greater than 60% are more favorable to Black-throated blue warbler occupancy than forests with high or low canopy closure (Goetz et al., 2010)
Dominant shrub species	Stands identified qualitatively has having moderate or dense populations of hobblebush (R. T. Holmes, 2005)

Blackburnian Warbler Model

Variable	Criteria
Natural Community Type	Forest where species composition trends toward softwood species and away from hardwood species are more favorable to blackburnian warbler (Collins, James, & Risser, 1982; Dettmers, 2006; Morse, 2004).
Overstory height	Forest with taller canopy areas (greater than 36ft) are more favorable to blackburnian warbler occupancy than shorter canopies(Young, Betts, & Diamond, 2005).
Overstory crown closure	Forest stands with crown closure greater than 60% are more favorable to occupancy by blackburnian warbler than areas with lower canopy closure (Burris & Haney, 2005; King & DeGraaf, 2000).
Distance to cutover stand	Stands more distant (greater than 200m) from clearcuts are more suitable than those nearer to existing clearcuts (Kroodsma, 1984). .
Dominant overstory species	Stands with 50% or greater of the overstory stocking comprised of softwood species, excluding black spruce are more favorable than those dominated by hardwoods (Morse, 2004).

Canada Warbler Model

Variable	Criteria
Natural community type	Forest where species composition trends toward softwood species and away from hardwood species are more favorable to Canada warbler (Cliche, 2016).
Open water proximity	Forest in close proximity to riverine, freshwater forested or shrub wetlands are more favorable to occupancy by Canada warbler than those forests furthest from riverine, freshwater forested or shrub wetlands (Conway, 2009).
Hydric soils	Soils identified by U.S. Geological Survey soil surveys as hydric are more favorable than other soils (Conway, 2009).
Overstory crown closure	Forest with moderate to low overstory crown closure (less than 60%) are more favorable to occupancy by Canada warbler than forests with high overstory canopy closure (J. F. Chace et al., 2009; Hallworth, Ueland, Anderson, Lambert, & Reitsma, 2008; King & DeGraaf, 2000; Mitchell, 1999)
Low elevation preferred natural communities	At low elevations the following natural communities are more preferable: cedar swamps, red maple swamps, sphagnum bogs, spruce-tamarack bogs, aspen and moist spruce-birch forests, alder/willow stands along streams (Conway, 2009).
Understory height	Forest with an understory of woody stems between 0-15 ft tall are more

	favorable to Canada warbler occupancy (J. F. Chace et al., 2009; Hallworth et al., 2008; Lambert & Faccio, 2005) than those without.

Rusty Blackbird Model

Variable	**Criteria**
Natural Community Type	Forest where species composition trends toward softwood species and away from hardwood species are more favorable to rusty blackbird (Kennard, 1920; Matsuoka et al., 2010)
Proximity to NWI open water wetland	Areas nearest to an open water wetland greater than 0.5 hectacres are more favorable than those without (Powell, Hodgman, & Glanz, 2010)
Proximity to short softwood species	Cells surrounded by the greatest proportion of softwood species between 0-15 tall are more favorable to nesting Rusty blackbirds (Kennard, 1920; Luepold, Hodgman, McNulty, Cohen, & Foss, 2015; Powell, Hodgman, Glanz, Osenton, & Fisher, 2010).
Overstory crown closure	Forest with low overstory crown closure (between 5-25%) is more favorable to occupancy by Rusty blackbird than forests with high overstory canopy closure (Powell, Hodgman, Glanz, et al., 2010).
Hydric soils	Soils identified by U.S. Geological Survey soil surveys as hydric are more favorable than other soils (Foss, Reitsma, & Lambert, 2016).

Figure 3.5.1 Black-throated blue warbler

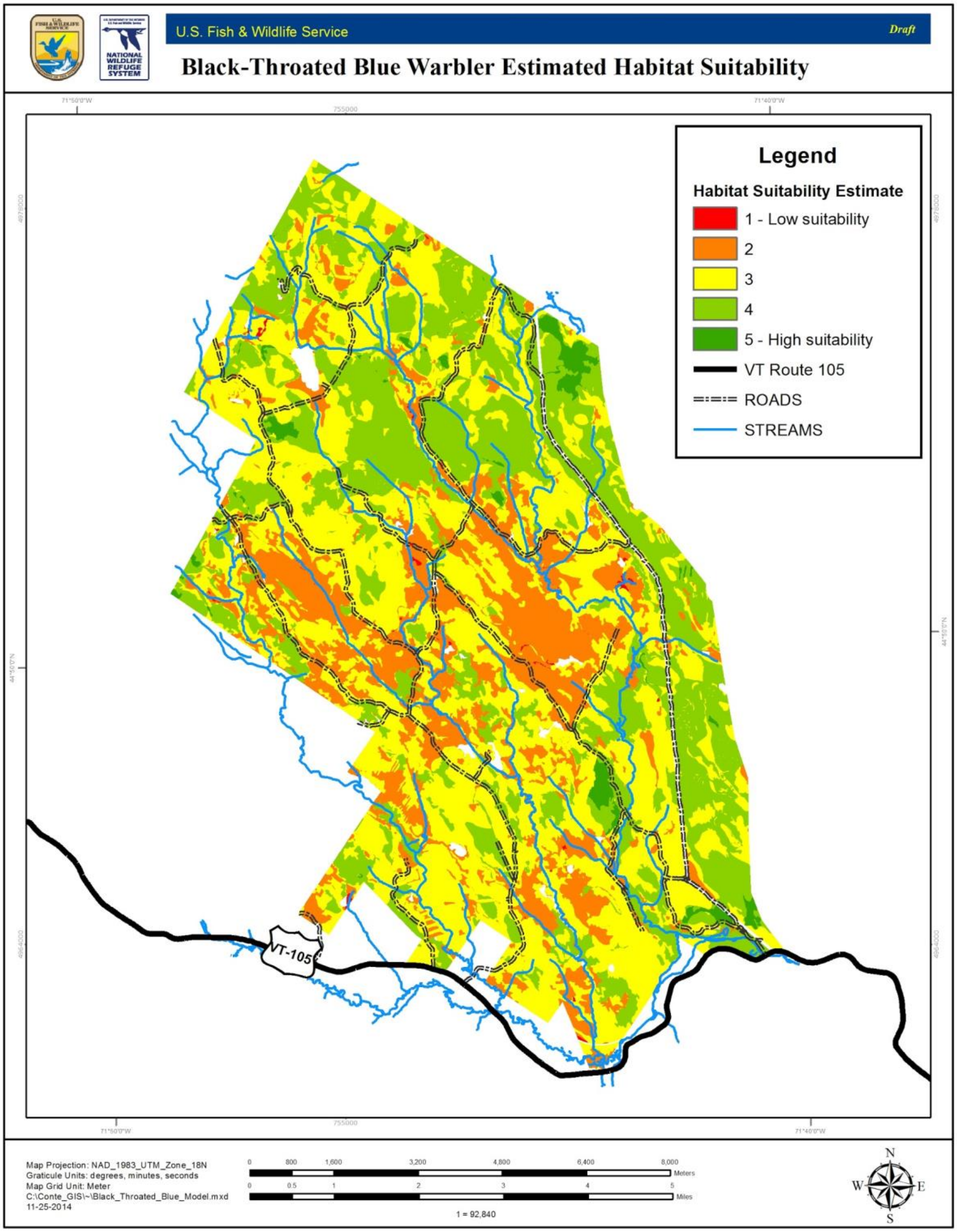


Figure 3.5.2 Blackburnian Warbler

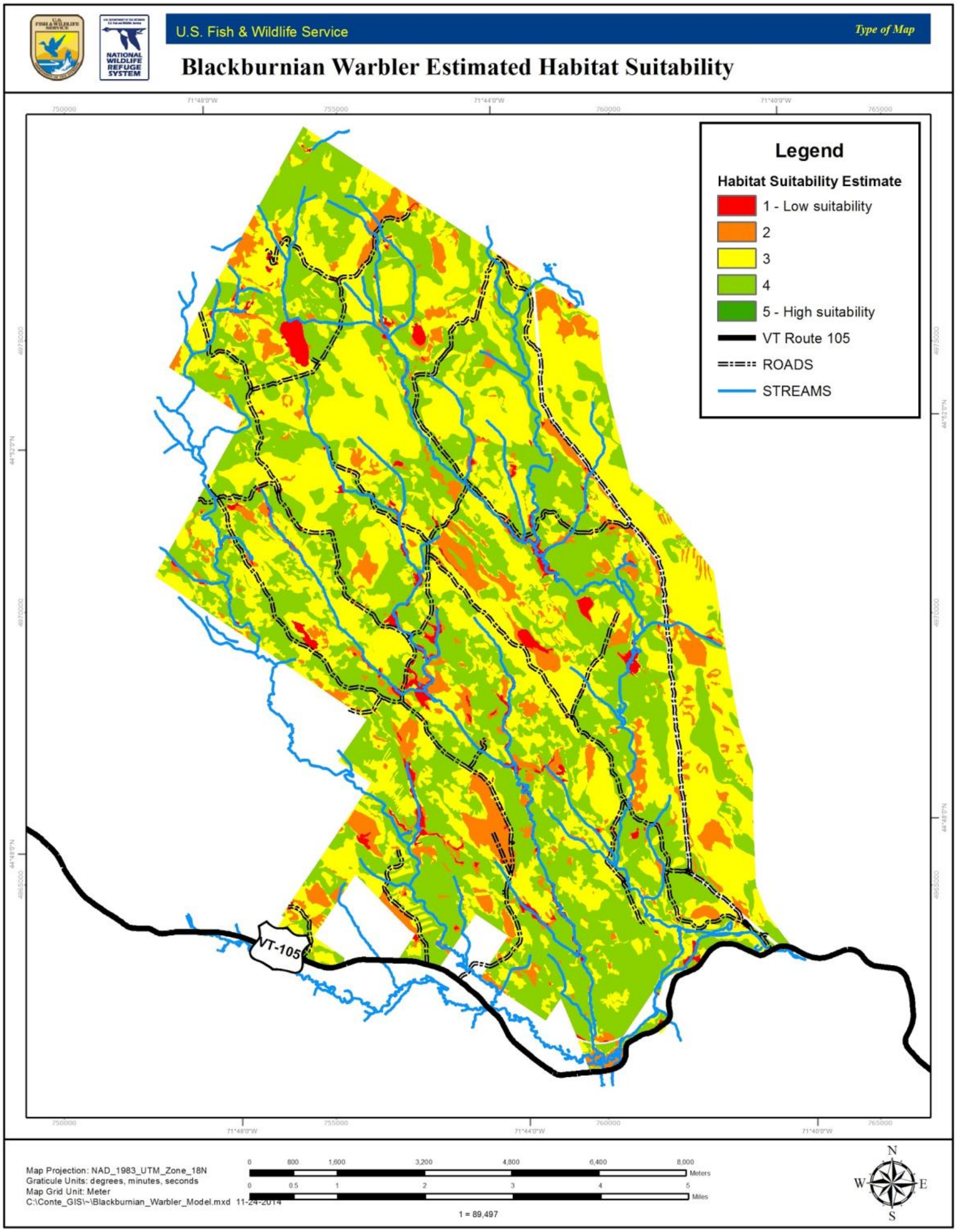

U.S. Fish & Wildlife Service
Type of Map
NATIONAL WILDLIFE REFUGE SYSTEM
Blackburnian Warbler Estimated Habitat Suitability
Legend
Habitat Suitability Estimate
1 - Low suitability
2
3
4
5 - High suitability
VT Route 105
ROADS
STREAMS
VT-105
Map Projection: NAD_1983_UTM_Zone_18N
Graticule Units: degrees, minutes, seconds
Map Grid Unit: Meter
C:\Conte_GIS\~\Blackburnian_Warbler_Model.mxd 11-24-2014
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Figure 3.5.3 Canada Warbler

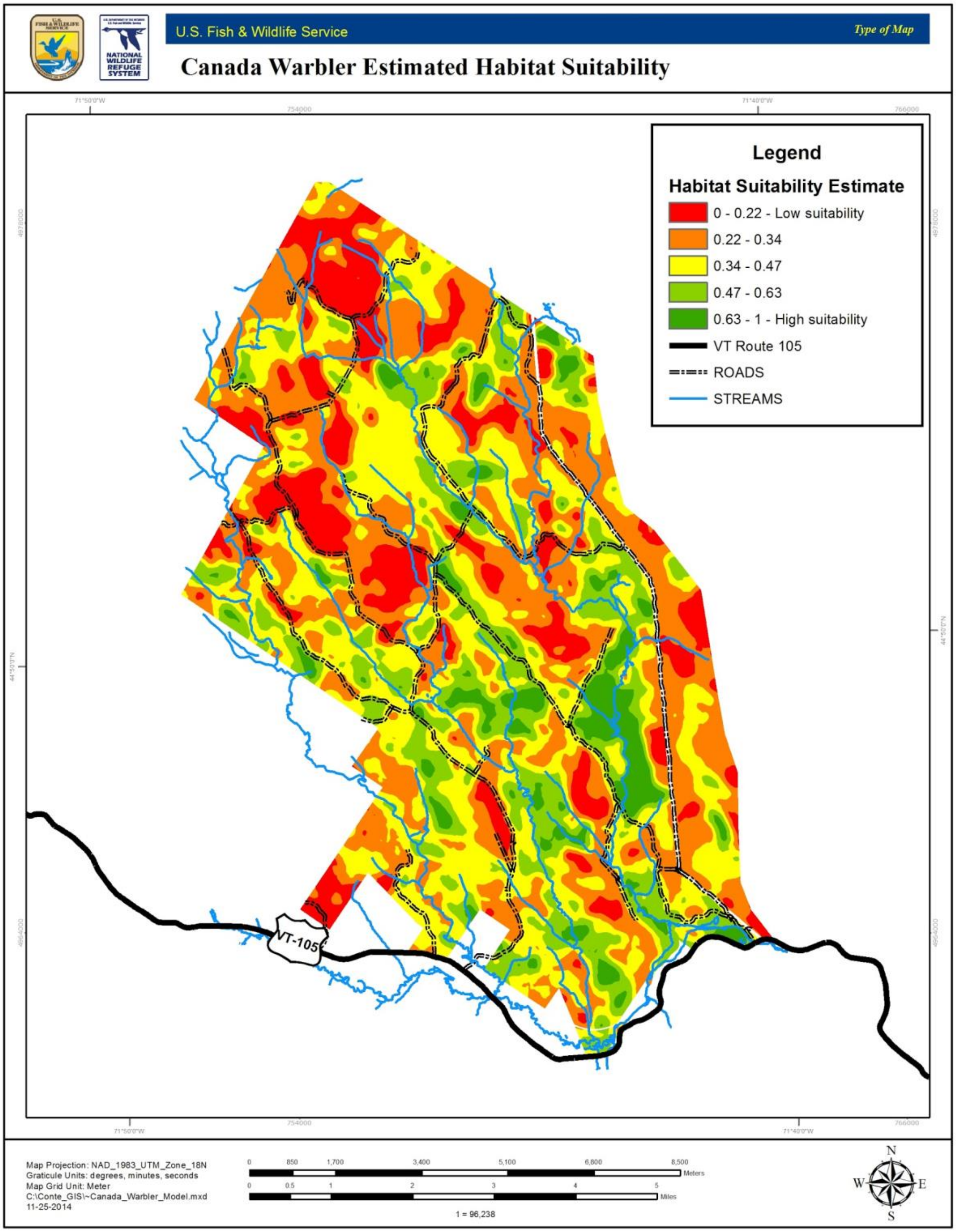
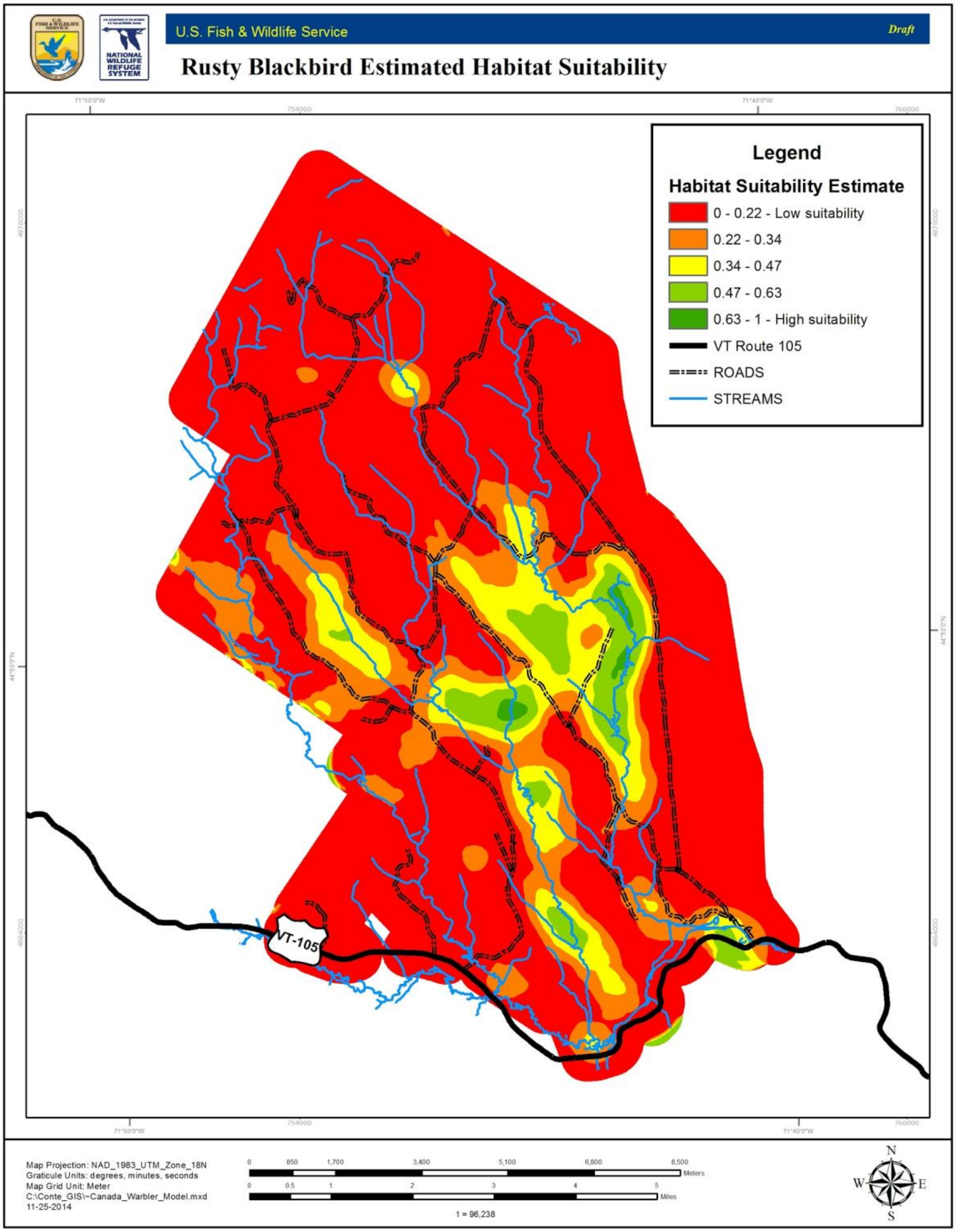


Figure 3.5.4 Rusty Blackbird



3.6. Conflicting Habitat Needs

Given the diversity of goals, purposes, mandates and conservation priorities for the Refuge System, it is common to have conflicting management priorities. Balancing the types and proportion of habitats (and their management) requires consideration of these conflicting priorities to determine an appropriate outcome that is partially based on an area's ability to desired priority outcomes as well as the overall importance of these outcomes with a specific geographic area.

The Division's habitat management efforts will provide a range of forest succession, establish persistent upland herbaceous openings, maintain wetland and scrub-shrub habitat, promote healthy aquatic ecosystems, protect sensitive habitat and rare plants, and establish a sustainable balance of habitats that benefit priority resources of concern.

Emphasis will be on restoring, rehabilitating, and maintaining natural communities ensuring the biological diversity associated with the Nulhegan Basin is preserved within the Northern Appalachian Forest, the Connecticut River watershed, and the local landscape. This is especially important in regards to the lowland spruce-fir and conifer matrix forest as identified by Lapin and Engstrom (Lapin & Engstrom, 2002b).

Where management favors focal species, American woodcock as an example, the restoration and maintenance of a site's natural community may be comprised. Woodcock require specific forest structural attributes which are best achieved through intensive forest management. This approach will likely mean forgoing the restoration of the northern hardwood-red spruce overstory component that would otherwise occupy the site of our woodcock demonstration areas.

Woodcock Habitat Management Demonstration Areas

In 2006, three separate areas on the Division were selected to be managed for woodcock. These Woodcock Habitat Management Demonstration Units (WMDU) total 287 acres and were identified based on habitat variables suitable for woodcock, proximity to roads for demonstration purposes and areas that did not conflict with other resources of concern. A Woodcock Habitat Management Plan was written in 2009 (Lapointe, 2009) to provide information on the establishment of these Units and management guidelines (Appendix **Error! Reference source not found.**). Commercial and/or non-commercial even-aged treatments will be used in a shifting mosaic to provide the full suite of habitat components within each WMU over the course of approximately 20 years. This management regime will result in a distribution of four age classes (~0-5 yrs, ~5-10 yrs, ~10-15 yrs, ~15-20 yrs). Once four age classes have been fully established, we will employ a 40 year rotation age with four age class distributions (~0-10 years, ~10-20 years, ~20-30 years, and ~30-40 years) to maximize the early successional component and practical application of an even-age management silvicultural system. These areas are opportune locations to meet woodcock management and demonstration goals, and provide early successional habitat to other dependent species.

3.7. Adaptive Management

The priority resources of concern and their known habitat attributes from the literature were used to develop habitat objectives. Over the 15 year life of this plan conditions will change. Budgets will ebb and flow; climate will likely warm; the forest product economy will fluctuate; all impacting our ability and need to perform habitat manipulations to support species populations. As conditions change, refuge staff will adapt their management as needed to successfully implement the goals and objectives outlined herein.

4. Habitat Goals, Objectives, and Strategies

4.1. Introduction and Definitions

This Habitat Management Plan is a step-down plan from the Silvio O. Conte Refuge CCP. The HMP sub-objectives and strategies provide direction and conservation actions that directly relate to and achieve CCP goals and objectives. The habitat goals and objectives written in this Chapter were taken from the CCP. Within the HMP, the CCP objectives became HMP goals. The objectives in the HMP are CCP Nulhegan Basin CFA sub-objectives, and provide details on how refuge staff plans to accomplish watershed conservation efforts on publically owned land under the stewardship of the Refuge. These CCP sub-objectives provide management guidance and resource priorities for current and proposed lands within the Nulhegan Basin CFA. The sub-objectives in this Chapter follow on from the associated CCP objectives and sub-objectives.

For patches of forest vegetation that are reasonably homogeneous in terms of species composition, age, and density, we will use the traditional forestry term, **stand** (D. M. Smith, Larson, Kelty, & Ashton, 1996). For the array of forest stands, grasslands, wetlands, bogs and fens, and so on that form heterogeneous mosaics across the Division we will use the term landscape (R. T. T. Forman, 1995). The distinction between forest stands and forest landscapes is the basis for delineating two major parts of our planning effort: the macro approach, managing forest landscapes; and the micro approach, managing forest stands.

Forest age is an expensive and time consuming metric to collect at large spatial scales like the Division. In forestry and wildlife literature tree size often serves as a proxy for age. In our discussions throughout the plan we simplify this further to take advantage of a detailed and comprehensive dataset acquired from aerial photo interpretation. Specifically, we categorize stands as single-cohort or multi-cohort. The Society of American Foresters (Helms, 1998) provides a silvicultural definition of a cohort: *a group of trees developing after a single disturbance, commonly consisting of trees of similar age, although it can include a considerable range of tree ages of seedling or sprout origin and trees that predate the disturbance*. We feel confident that a comparison of stands based upon the arrangement of cohorts is a valid proxy for forest structure at the landscape and stand scale, and has relevance when discussing wildlife habitat.

4.2. Goal 1 Forested Uplands and Wetlands

In cooperation with willing landowners and other partners, protect, manage, and restore forested habitats within the Connecticut River watershed. These forested habitats will sustain the biological diversity, integrity, and ecological and hydrologic function of the river ecosystem, provide habitat connections and wildlife travel corridors, accommodate anticipated shifts in species' ranges from climate change, and support forest-dependent species of conservation concern, including migratory birds and federally listed endangered and threatened species.

4.2.1. **Objective 1.1. Conifer Swamps/Spruce-fir forests**

Improve the diversity of seral stages (where and when possible), restore historic composition and structure, and improve landscape connectivity of spruce-fir habitat to support species of conservation concern and aid in climate change adaptation. Management will provide breeding and foraging habitat for priority refuge resources of concern, including blackburnian warbler, rusty blackbird, and Canada warbler. Management will also provide functional deer wintering shelter.

4.2.1.1. Sub-objective 1.1a Maintenance of landscape heterogeneity

Over the long-term (200-300 years), aim for a mosaic of spruce-fir stands of different age and structural classes at approximately the same seral distributions as occurred historically: ~15 percent early seral, ~35 percent mid seral and ~ 50 percent old single or old multilayer. Within 15 years, ensure approximately 500 acres of spruce-fir natural community acres function as young, single-cohort stands to benefit rusty blackbird, and 1,600 acres have been treated to establish a second age class.

The Spruce-fir natural community landscape will be managed to provide the following attributes:

- Diversity of stand ages across landscape
- Greater proportion of multi-cohort, older stands
- Reduced proportion of young, single-cohort stands
- Young, single-cohort stands occur adjacent to hydrologic features
- Where possible hemlock and white pine will be retained on the landscape.
- Restricted management areas distributed across the spruce-fir landscape and sited to protect unique examples, rare communities, or buffer hydrologic elements

Rationale:

Lindenmayer & Franklin (2002) list the maintenance of landscape heterogeneity as one of five core principles in developing a framework for conserving forest biodiversity. Forests of varied structures and succession stages provide habitat for different plant and animal species. Some species like rusty blackbirds, prefer young forest and some species, like blackburnian warbler, prefer older forest; some species prefer multi-aged or multi-cohort forest structures and other prefer single-aged or single-cohort canopies (R. M. DeGraaf, Yamasaki, & Leak, 1992). Maintaining healthy, well-distributed populations of the Division's native flora and fauna requires maintaining a complete and well-represented array of successional stages of different spruce-fir natural communities across the landscape.

Current forest inventory data suggests a spruce-fir landscape more homogeneous than natural disturbance patterns would suggest. Historical disturbance patterns and their influence on forest age structure prior to human activities allow insight into methods to support the Division's native biodiversity, including our focal species (Lorimer & White, 2003; Seymour, 1992). The major natural disturbance agents in the Division's spruce-fir forests prior to European settlement were small- and large wind events and insect infestations. Limited historical evidence suggests that major fires were relatively rare, about every 700 to 2,000 years, and large-scale windthrow events occurred about every 1,150 years (Lorimer, 1977). Insect outbreaks from spruce budworm and bark beetles recurred at intervals of several decades to over a century (Lorimer, 1977; Seymour, 1992), as did small gap-creating wind events. These events usually were not stand-replacing, although budworm infestation in stands dominated by balsam fir may result in stand-replacing mortality, and a wide-range of age classes developed across the landscape (Bouchard, Kneeshaw, & Messier, 2007; Seymour & Hunter Jr., 1992). This would suggest a highly heterogeneous landscape, particularly at finer scales.

In contrast, within the Nulhegan Basin Division, (Lapin & Engstrom, 2002b) identified 189 remnant patches of spruce-fir forest they defined as old (closed canopy of trees approximately 40 years old or more). The total area of 'old' spruce-fir forest on the Refuge was 2,965 acres, or 18 percent of total Refuge lands at the time of their survey. Only one patch, at 373 acres, was greater than 250 acres in size. Over one-half of the patches were less than five acres. The difference between mean patch size 15.6 acres, and the median patch size, four acres, is indicative of the preponderance of small patches. Aerial photo interpretation in 2005 identified 251 early successional patches whose mean size of 18 acres is well above what we would expect from historical norms. This includes the largest clearcut patches, many of which are greater than 100 acres in size, including a 271 acre clearcut.

Age structure within stands has also changed since European settlement. The relative proportion of even-and uneven-aged stands in the pre-settlement forest is uncertain (Seymour, 1992). However, (Lorimer, 1977) estimates that 59 percent of spruce-fir forests in northeastern Maine were in a primarily uneven-aged and all-aged condition in the late 18th and 19th centuries, and that these conditions were perpetuated through frequent small-scale windthrows and other natural disturbances. The shift seen in the Nulhegan Basin toward younger, more structurally homogeneous forests introduces several issues related to our focal species and biodiversity more broadly. Species like blackburnian warbler, which are associated with older, more-mature stages or conditions, need to have large enough stands that interior conditions prevail and are not influenced by edge effects. Further, species with preferred habitats that are associated with an older seral stages need to be able to move among representations of those habitats, thus stands of similar types and ages need to be close enough to allow movement and dispersal. Both these issues are relevant in the Nulhegan Basin given the lack of mature spruce-fir communities, and their relative small size.

Currently 504 of 664 stands typed as softwood-dominate occur as single-cohort or even-aged stands at scales ranging from a few acres to more than 250 acres. We hope to improve the heterogeneity of the spruce-fir landscape by reducing the proportion of single-cohort stands on the Division. Restoration will apply ecological forestry concepts to convert existing single-cohort stands towards a multi-cohort condition over time. Over time this will restore a matrix of multi-cohort stands, within which single-cohort stands may be created for focal species like rusty blackbirds. Moving a greater proportion of the Division's spruce-fir landscape into a multi-cohort condition will create important habitat conditions for a number of wildlife species. Research at the Division by Chace *et al.* (2009) showed Canada warblers nesting in regenerating patches dominated by softwood species. White-tailed deer are known to use the abundant spruce-fir stands of the Division to over-winter. A diverse canopy structure will ensure adequate snow interception and regenerating intolerant hardwoods (e.g. white birch and red maple) associated with spruce-fir landscapes will provide important winter browse. As single-cohort stands are regenerated in gaps, the resulting spruce-fir regeneration will enhance habitat for the State-endangered spruce grouse (Robinson 1969). Further, gap openings are known to be important to female spruce grouse and their broods, as they provide greater abundance of accessible food resources for chicks than dense, single-cohort stands (Allan 1985).

4.2.1.2. Sub-objective 1.1b Habitat patch size

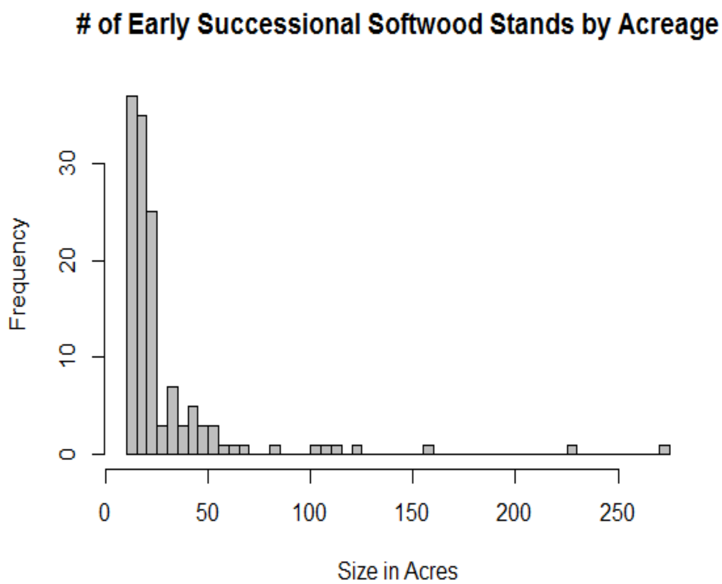
Maintain a variety of stand sizes and shapes, and design forest landscapes that are capable of supporting viable populations of species whose life-history requirements include large areas of contiguous forest. Over the long-term reduce mean early successional patch size through gap creation using historic ecological analogs (.001 to 0.1 ha openings over 10% of canopy per decade).

<u>Rationale</u>:

Large forest tracts like the Nulhegan Basin Division are more likely than small tracts to support wildlife species with large home ranges or special habitat needs, and those species that require large expanses of interior forest. Some wildlife species, particularly small carnivores, are area sensitive and require large territories to forage or range (Hunter Jr., 1990) making habitat patch size important. For example, American marten have recently been documented on the Division and research in Maine by (Chapin, Harrison, & Katnik, 1998) suggested the presence of large, contiguous stands was a prerequisite for resident American marten to occupy an area. Further, many of the 338 forest-dwelling vertebrate species occurring in New England have average home ranges greater than 50 acres, some as large as 12 sq. mi., and a few that exceed 1,000 sq. mi. These include most raptors, large-bodied woodpeckers, and medium- and large-size mammals (R. M. DeGraaf & Yamasaki, 2001). Within the Division, spruce grouse, black-backed woodpeckers, and gray jays all require home ranges greater than 50 acres. However, none of these species require the very large early successional spruce-fir stands currently dominating the Nulhegan Basin (Figure 4.2.1 Softwood Stands at Nulhegan). In fact, focal species like blackburnian warbler require mature spruce-fir forest patches between one to ten acres. Extensive, single-cohort stands were uncommon in the pre-settlement forest of the northeast; for example, (Lorimer, 1977) estimated that stands less than 75 years old occupied 16 percent of the landscape in northern Maine ca.1820. In the Nulhegan Basin, the widespread application of single-cohort silviculture on rotations less than 100 years has created a landscape that has no natural precedent - where all spruce-fir stands are less than 75 years old.

A 2005 Aerial photo interpretation of the Division's spruce-fir forests identified 244 stands totaling more than 4,500 acres considered 'cutover' or early successional. These stand shapes can vary from nearly linear in the case of previous strip clearcuts to circular. Stand size varies widely from less than an acre to more than 270 acres. Figure 4.2.1 shows the Division currently has seven clearcuts in spruce-fir habitats larger than 100 acres. While stand size is skewed toward openings less than 20 acres overall (IQR = 5.1, 10.7, 19.6), more than 3,900 acres of spruce-fir natural communities within the Nulhegan Basin occur in early successional openings larger than ten acres - the maximum home range size of our focal species blackburnian warbler.

Figure 4.2.1 Softwood Stands at Nulhegan



The Nulhegan Basin has many large clearcut areas in our spruce-fir natural community type. Restoring some of these areas using small group and patch cuts on the scale of historic norms (Fraver & White, 2005; Seymour, White, & deMaynadier, 2002) will benefit focal species like blackburnian warbler by moving spruce-fir communities toward a finer grain uneven-aged structure. Elsewhere on the landscape, the creation of larger areas of early successional spruce-fir along wetlands and waterways will benefit rusty blackbirds. By combining these two approaches we hope to maximize the horizontal diversity across our spruce-fir landscape. Further, providing forest stands of varying size throughout the spruce-fir landscape ensures both habitat specialists and habitat generalists are provided appropriate habitat.

4.2.1.3. Sub-objective 1.1c Diversity of vertical and horizontal structure

At stand level, within single-cohort stands, establish a successful new cohort of regeneration (defined as > 50 percent milacre plots stocked with spruce or fir on primary sites) under as intact an overstory as site conditions and stocking levels will allow to provide breeding and foraging habitat for blackburnian and Canada warblers, potential denning sites for Canada lynx, as well as habitat for uncommon resident boreal species, migrating landbirds and wintering deer.

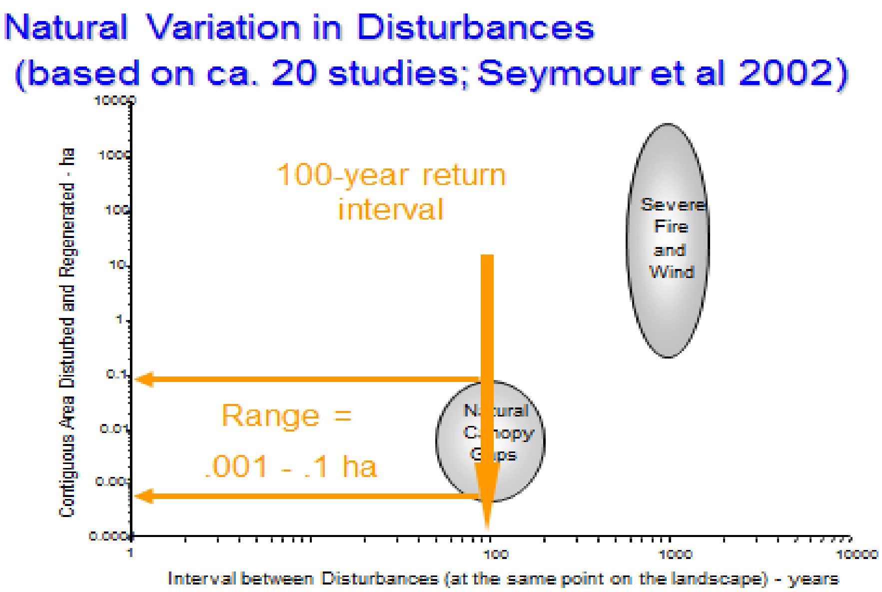
Spruce-fir natural communities at the stand scale will be managed to provide the following attributes:

- Primary softwood sites with >50 percent milacre plots stocked with spruce-fir regeneration
- Retention of existing snags and cavity trees
- An increase in foliage height diversity through addition of successful spruce-fir regeneration

Rationale:

Since the seminal work of (MacArthur & MacArthur, 1961), biologists have understood the height profile of foliage density (FHD) serves as an important predictor of bird species diversity. The relationship varies slightly within conifer forests. For, although deciduous forests vary principally with height above the ground and hence have a bird diversity predictable from the height profile, conifers (especially spruce) have a marked “inside” and “outside” for which species are specialized (MacArthur, 1958). Hence bird species diversity would be high in a mature spruce forest even if few layers were present. This sub-objective recognizes the importance of both the diversity of foliage layers above the ground and across horizontal space in providing the habitat conditions that support bird diversity generally, and those conditions required by our focal species blackburnian warbler, Canada warbler, and Rusty blackbird more specifically.

Figure 4.2.2 Natural Disturbance Frequency and Scale in the Acadian Forest (from Seymour *et al.* 2002)



The degree of development of vertical structure is a result of a stand’s stage of development, stand disturbance history, age structure, site productivity, and species composition. In the even-aged spruce-fir stands common to the Nulhegan Division, forest canopy forms approximately ten to 20 years following disturbance. As the canopy closes, vegetation on the forest floor begins to thin and die out and species composition changes. During the initial stages of crown closure, the canopy is dense and little light reaches the forest floor. After several decades, as subdominant trees in the crown die, more light reaches the forest floor and plants can survive in the understory. As the base of the living canopy rises, more light reaches the forest floor and plants can invade and survive. The Division’s spruce-fir forests over long time scales can be expected to develop several layers of foliage at the stand scale, to include an overstory, understory, shrub layer, and ground or herb layer.

As a general rule, single-cohort forests have little vertical structure and multi-cohort forests have more vertical structure (Bryan, 2003; Hunter Jr., 1990; Solomon & Gove, 1999). The challenge comes in converting the preponderance of single-cohort stands in the Nulhegan Basin toward a more multi-cohort condition (Nyland, 2003). Multi-cohort spruce-fir stands have several age classes of trees and consequently several layers of foliage. Much of the vertical diversity in multi-cohort spruce-fir forests results from horizontal patchiness of vegetation. And both the vertical and horizontal diversity of canopy layers has been shown to be critical to a number of forest interior nesting birds (R. M. DeGraaf &

Yamasaki, 2001). Historically, small to medium sized natural disturbances such as windthrow, ice damage, and mortality from insects and disease, created gaps in the canopy that fostered younger trees and increased the overall diversity of the stand.

Our forest management will restore these characteristics through some combination of partial cutting, maintaining elements of the original cohort while periodically regenerating new age classes underneath them (Ashton, 2004; Hawley, 1929; Nyland, 2005). This approach, where possible, will follow ecological forestry guidelines aimed at mimicking the natural disturbance regime endemic to spruce-fir natural communities. Small canopy gaps are a common form of disturbance in several forest types, ranging from spruce-fir (Battles & Fahey, 2000; Perkins, Klein, Badger, & Easter, 1992; Worrall & Harrington, 1988) to hardwood and hemlock-hardwood (James R. Runkle, 1990; James Reade Runkle, 1981, 1982; Tyrrell & Crow, 1994). As Figure 4.2.2 demonstrates, mean gap size is usually small with a return interval between 50-250 years. It's important to note this will vary considerably in spruce-fir communities dependent upon soils, topography, and other site conditions, which may make larger more frequent disturbances common (e.g. shallow soils can make stands prone to large windthrow events; stands with a high proportion of balsam fir are susceptible to spruce budworm outbreaks). In general our management may include (R. M. DeGraaf et al., 1992; Franklin, Mitchell, & Palik, 2007; Nyland, 2003, 2005; Seymour, 1992):

- regularly scheduled uniform partial cuttings similar to heavy thinning or light shelterwood seed cutting to establish new seedlings interspersed among other cohorts, allowing the eventual use of single-tree selection
- or more likely, periodic patch cutting with retention that mimic gap formation, to establish seedlings in small family groups or clusters, eventually supporting a group selection system.

Within spruce-fir natural communities, this translates into greater foliage-height diversity, more canopy gaps, and greater foliar biomass that provide a variety of habitats that are used extensively by birds, small mammals, epiphytes, and invertebrates. As canopy heights increase, vertical profiling and selective use of the canopy by birds increases (MacArthur & MacArthur, 1961). For example, blackburnian warblers use canopy dominant trees as nesting or feeding sites; Canada warblers rely on the shrubby understory that develops in canopy gaps for nesting. Raptors use trees above the canopy as nesting or roosting sites; hawking and sallying species favor open sites in the upper canopy where there is greater maneuverability; foliage gleaners focus their foraging on leaves recently exposed to sunlight; and trunk-gleaning species favor lower, older portions of the canopy where furrowed bark is more abundant (Sharpe, 1996). The live and dead branches and generally rougher bark of large trees host a myriad of invertebrates, epiphytes (mosses, lichens, and liverworts), and microbial organisms. And lastly, a shrub layer resulting from regenerating spruce-fir in small gaps enhances habitat for spruce grouse (Robinson 1969).

4.2.1.4. Sub-objective 1.1d Native tree species composition

Where possible, over the long-term (100-200 years) and dependent upon site and successional stage considerations, restore tree-species composition within spruce-fir stands to more closely match pre-settlement composition (improve abundance of *Picea* sp. to approximately > 35 percent stocking by volume).

Spruce-fir natural community types will be managed for the following attributes:

- Increased proportions of longer-lived species: red spruce, eastern hemlock, eastern white pine
- Decreased proportions of pioneer hardwood species: grey birch, white birch, aspen spp., red maple

<u>Rationale</u>:

Human intervention has altered the original spruce-fir forest. It is likely that certain commercially valuable species were more common in virgin forests. The well-documented waves of exploitation, first for white pine, second for red spruce, third for the valuable hardwoods, especially yellow birch are legendary. Examples of important changes in forest composition would include the former "spruce-yellow birch type," now - in the case of the Nulhegan Basin - dominated by red maple and balsam fir. This evidence, although limited and somewhat anecdotal, clearly suggests that the long history of use for forest product production has substantially altered the spruce-fir forest from its pre-settlement conditions (Lapin & Engstrom, 2002a; Seymour & Hunter Jr., 1992).

Tree species influence their environment in a number of ways, creating different habitat conditions for tree seedlings, understory plants, insects, and animals. Crown shape and foliage size, type (i.e., deciduous or coniferous), and orientation affect light infiltration and canopy interception of rain and snow, creating a variety of light and moisture conditions at the understory and ground levels. Chemical composition of litter also differs among tree species, and influences soil pH, organic-layer development, and nutrient availability. These factors not only have important effects on tree seedlings and herbaceous plants, but also on the distribution and abundance of forest-floor fauna, including invertebrates, amphibians, and small mammals. The dense shade and acidic litter under conifers are unsuitable for vernal herbs such as trout lily and spring beauty, but acceptable for goldthread and bunchberry. Although relatively few herbaceous and non-vascular plants are tightly associated with particular tree species in the Northeast, some close associations do exist. Three species of mycorrhizal *Lactarius* appear to be specifically associated with hemlock, birch, and black spruce, respectively (Phillips, 2010). In some situations, sugar maple seedlings grow best under yellow birch trees, and beech seedlings grow best under sugar maples (Forcier, 1975).

Tree-species distributions affect foraging and nesting opportunities for a number of bird species. Golden- and ruby-crowned kinglets nest almost exclusively in the tips of spruce branches, and pine warblers nest and forage in pines. Our focal species blackburnian warbler has been shown to favor a common spruce-fir associate in eastern hemlock (Tingley, Orwig, Field, & Motzkin, 2002). The presence of yellow birches in spruce-fir stands affects foraging distribution of a number of forest songbirds. (R. T. Holmes & Robinson, 1981) found that the ten most common foliage-gleaning bird species preferred yellow birches for foraging, possibly because this species supports a greater diversity of foliage insects than any other tree species in northern New England forests. Black-throated green warblers among other species have been shown to prefer red spruce to white spruce; this is largely thought to be related to tree architecture (Morse, 1976). Finally, spruce grouse have shown a preference for red spruce over balsam fir due the former's branch architecture

Although many foliage insects use a wide variety of hosts, some are limited to one or two species of food plant. Some bark beetles also are limited to one or a few tree species. Tree-species diversity within stands can reduce the effects of insect outbreaks. For example, spruce budworm outbreaks occur most severely in forests with relatively low species diversity (Mott, 1963). Lower diversity also may contribute to lower resistance to stress (Hunter 1990). Overstory inclusions, such as a patch of yellow birch in a spruce-fir stand, occur in some stands because of disturbance history (e.g., an intact patch within a large harvest area) or small-scale differences in soil or topography. Inclusions provide habitat features different from those in the surrounding stand, and can be important to many species of birds and mammals (R. M. DeGraaf et al., 1992). Finally, the ratio of conifer species to deciduous species is important – generally speaking, conifer forests support lower diversity.

Restoring the relative composition of overstory tree species will ensure the provision of the greatest habitat value for the plants, insects, and wildlife endemic to the Basin.

4.2.1.5. Sub-objective 1.1e Downed woody material, snags, and cavity trees

Over the long-term, maintain or restore a range of sizes and types of downed woody material, snags, and cavity trees and retain or provide downed woody material, snags, and cavity trees in sites where they are lacking. Within 15 years and where possible, forest management action should retain approximately three snags greater than 14” DBH and one greater than 24” DBH per acre

Spruce-fir natural community types will be managed for the following attributes:

- Old trees, especially inclusions of deciduous species (e.g. *aspen and birch species*)
- Broken, leaning, damaged and cavity trees where appropriate
- Trees with abundant epiphytic lichen flora
- Various sizes of fallen dead wood, especially large logs
- Standing dead trees (snags)

<u>Rationale</u>:
Downed woody material consists of a variety of residues that accumulate naturally or are deposited following a management action, including logs, large limbs, stumps, upturned tree roots, and slash. Woody material is an integral component of forest ecosystems, providing food, cover and nursery habitat for a diverse association of flora, fauna, and fungi (R. M. DeGraaf & Yamasaki, 2001; Harmon et al., 2004). Although large wood is the most visible material on land and in streams, fine wood also contributes substantially to energy flows and nutrient cycling throughout the course of secondary succession. In terms of availability, the nutrient pool provided by fine woody material is intermediate between that of leaf litter and coarse woody material . Fine woody material plays a distinct role in nutrient cycling on the forest floor, and often enhances water quality and conserves soil loss by limiting soil erosion.

Dead and downed woody material (DWM) is important in spruce-fir ecosystems. For example, in Maine, DWM, snags, and cavity trees are important habitat for 20 percent of bird, 50 percent of mammal, 44 percent of amphibian, and 58 percent of reptile species found there (Flatebo, Foss, & Pelletier, 1999). Animals that rely on DWM in spruce-fir forests include American marten and may include some saproxylic vertebrates (Majka & Pollock, 2006). Dead wood provides an important substrate for spruce and hemlock seedling development (Weaver, Kenefic, Seymour, & Brissette, 2009).

In general, the more even the overall distribution of downed woody material, snags, and cavity trees, the greater the habitat diversity and use. Conversely, a lack of downed woody material over large areas may reduce or eliminate species dependent upon woody material for some stage of their life cycle. A habitat inventory of the Nulhegan Basin Division identified 311 out of a total 504 stands where downed woody material was qualitatively ranked as “low.” These stands represent 19,000 acres of the Division’s forests. Generally moist conditions in the Nulhegan Basin lead to higher rates of decomposition. However, we suggest 150 years of forest products extraction has reduced the normal input of coarse woody material into spruce-fir communities. Further, the role of logs as habitat for forest flora and fauna depends on, and shifts with, the degree of decay. In the Nulhegan Basin, the species of the tree also plays a role because hardwood limbs and boles will typically decay more rapidly than those from conifers. Because of slower decay, softwood stands would be expected to accumulate more coarse woody material than hardwood stands. Large logs with hollow portions may be used as dens by large mammals like black bear and Canada lynx. Dens are used for many types of critical activities (e.g. rearing offspring, providing shelter), thus providing crucial microhabitat sites.

Finally, tree cavities are an important habitat component for many forest species. Cavities can be found in dead, dying, or live trees. Birds and mammals use larger trees extensively as nest and den sites, perches, and roosts (see table). The size (diameter and height), state of decay, species, and location of snags and cavity trees influences their use by cavity-dwellers (Hunter Jr., 1990). Many species have specific minimum-size requirements for the trees or snags they will use for cavities; they can use larger trees but are unable to nest in trees below a minimum size. Compared to smaller trees, larger trees provide more thermal insulation, protection from predators, perches, and room to house large clutches, and will persist longer in the stand. The shortage of large trees within spruce-fir habitats in the Nulhegan Basin may affect nesting success and result in reduced populations or the complete loss of some species. Previous analyses (see (Lapin & Engstrom, 2002b))) noted that only 18 percent of the Division's spruce-fir forests were greater than 40 years old. Our habitat inventory data show 217 out of 504 stands had no tallied snag trees. This represents more than 4,900 acres with little to no snag density.

4.2.1.6. Sub-objective 1.1f Maintenance of single-cohort stands (Early Successional)

Over the next 15 years, create or maintain approximately 500 acres of spruce-fir forests in early successional, single-cohort stands in patch sizes of varying shapes to provide breeding habitat for Canada warbler, rusty blackbirds, and foraging habitat for Canada lynx.

Spruce-fir natural community types will be managed for the following attributes:

- Dense native tree saplings between 1-20 years old dominate regeneration - red spruce, with balsam fir, northern white cedar, tamarack, and white spruce as associates
- Shrub species may include speckled alder, blueberry and pin cherry
- Stands will be located within the vicinity of alder wetlands, forested wetlands or floodplains

<u>Rationale</u>:

Managing forest landscapes for diversity involves managing patterns of succession for two reasons: (1) some successional stages have more species than others; and (2) each stage has a different, although not usually unique, set of species. In short, a forest landscape with many successional stages is more diverse than one at a single stage of succession (Bormann & Likens, 1979; R. DeGraaf, Yamasaki, Leak, & Lester, 2006; Hunter Jr., 1990). We define early successional stands as those areas having been disturbed within the last 20 years and which support a single regenerating cohort of trees. Stands that have matured beyond an average tree age of 20 years no longer provide the conditions required by early successional dependent species.

This sub-objective provides greater detail on those forest management actions that deviate from our overall goal of natural disturbance mimicry. Large, stand-replacing disturbances of the type known to create single-cohort, early successional stands are thought to be uncommon in the Nulhegan Basin (Cogbill, 1985, 2001; Lapin & Engstrom, 2002a; Lorimer, 1977; Lorimer & White, 2003). The focal species driving much of our forest management, however, are known to utilize habitat conditions that may only arise from these types of disturbances.

Canada warbler is a PIF Watch List species (Rich et al., 2004) that breeds in a range of habitat types including deciduous forested swamps, cool, moist, mature forest or streams and swamps with dense undergrowth, and cedar bogs. Small openings created by timber harvest, like those proposed above for structural restoration have been shown to improve Canada warbler habitat, particularly 5-20 years following harvest operations, especially in areas where some overstory trees are retained (Faccio, 2003; Lambert & Faccio, 2005). (Hagan & Meehan, 2002) found Canada warbler presence at a site was best predicted by dead tree basal area (positive relationship) and understory stems 2–4 m tall (positive); further goals of the restorative silviculture outlined above. On the White Mountain National Forest in New Hampshire and Maine they occur in northern hardwoods with a softwood understory. In central Maine, (Collins, 1983) found the Canada warbler in forests with a high percent shrub cover (70%), moderate canopy cover (64%), and a minor component of conifers in the canopy. Forests with dense understory particularly along streams, swamps, bogs, or other moist areas are important to Canada warblers (R. M. DeGraaf & Yamasaki, 2001). The Vermont Institute of Natural Sciences (VINS) has detected a 13.2 percent population decline in Canada warblers in Vermont since 1989. Jim Chace from Villanova University conducted a multi-year (2002-2004) study in the Division to examine the pairing success and site fidelity of Canada warblers across a gradient of forest disturbance patterns (Jameson F. Chace, 2005).

His research recommended further study of a range of forest management efforts aimed at perpetuating or increasing the availability of shrubby softwood regeneration.

Our management for rusty blackbirds and Canada warblers may in some cases reduce within stand structural complexity while increasing between stand diversity at the landscape scale. Specifically our forest management activities will create single-cohort regenerating openings larger than ½ acre and will locate them adjacent to wetlands and streams (J. F. Chace et al., 2009; Foss et al., 2016; Hallworth et al., 2008; Lambert & Faccio, 2005). Work on habitat use by Canada warblers on the Division has found them in regenerating softwood clearcuts. The literature on rusty blackbirds is less clear (Foss et al., 2016; Greenberg & Matsuoka, 2010; Kennard, 1920; Matsuoka et al., 2010; Powell, Hodgman, & Glanz, 2010; Powell, Hodgman, Glanz, et al., 2010). What is understood is the rusty blackbirds have experienced one of the most significant declines ever documented among North American birds in recent times. Data from long-term surveys such as the North American Breeding Bird Survey suggest rusty blackbird numbers have fallen a staggering 85-95 percent since the mid-1900's (Greenberg & Droege, 1999). Several hypotheses have been suggested to explain the decline. Loss of wooded wetlands in southeastern wintering grounds is a likely contributor, as over 80 percent of this habitat has been converted to agriculture and other land uses. Rusty blackbirds documented at the Nulhegan Basin depend upon shallow flooded boreal wetlands while breeding and raising young (Foss, unpublished) with adjacent young conifer forests. Forest management on the Division aimed at perpetuating these young forests will allow us to study rusty blackbird response. The International Rusty Blackbird Working Group has called for research into habitat management recommendations for the rusty blackbird and the Nulhegan Basin is in a unique location to aid in that effort. The proportion of the Division landscape maintained in each of our three broad categories is likely to change over time as research into the efficacy of our management efforts informs future planning.

4.2.2. **Objective 2.1. Hardwood forests**

Improve the diversity of seral stages and (where and when possible) restore historic composition and structure for the diversity of species present, including American woodcock, black-throated blue warbler blackburnian warbler and, northern long-eared bat and tricolored bat.

4.2.2.1. Sub-objective 2.1a Maintenance of landscape heterogeneity

Restore a range of successional stages within hardwood and mixedwood communities informed by the habitat needs of focal species, and whose proportions are more closely aligned with historical disturbance regimes. Within 15 years, increase ratio of multi-cohort stands to single-cohort stands by rehabilitating approximately 2,100 acres with silviculture treatments designed to move stands toward an all-aged condition.

The hardwood/mixedwood natural community landscape will be managed to provide the following attributes:

- Diversity of stand ages across landscape
- Greater proportion of multi-cohort, older stands
- Reduced proportion of young, single-cohort stands on landscape
- Young, single-cohort stands are sited based upon focal species habitat needs
- Where possible retain softwood inclusions within hardwood stands on the landscape.
- Restricted management areas distributed across the hardwood landscape and sited to protect unique examples, rare communities, or buffer hydrologic elements

Rationale:

(Lindenmayer & Franklin, 2002) list the maintenance of landscape heterogeneity as one of five core principles in developing a framework for conserving forest biodiversity. The simple assumption is the most efficient way to maintain biological diversity in a forested landscape like that in the Nulhegan Basin, is to have a diverse array of stands and thus a diverse array of ecosystems and their constituent species. Organisms vary in the extent to which they need a diverse environment, and this is often discussed in terms of habitat specialists and habitat generalists. A focal species of the Nulhegan Basin, the American woodcock, is a habitat specialist that requires a diverse habitat. It needs forest openings in which to roost and display, alder swamps in which to forage, and 15-30 year old hardwood stands for nesting and brood rearing (Sepik et al., 1981) in close proximity. In contrast, some of the large mammals common to the Nulhegan Basin, such as bobcats, coyotes, raccoons, and white-tailed deer, are examples of habitat generalists. If we assume two ideas as premises:

1.) The diversity of a forest depends on the scale at which it is viewed by individual species;
2.) Some species can live in a variety of habitats, some require a diverse habitat, and some require a fairly uniform habitat;

We can make three general predictions. First, on a very small scale, where a single tree could constitute a habitat, diversity is probably greatest in an old forest of mixed species composition in which some of the largest trees are starting to die, thus breaking up the canopy and allowing small groups of young trees to prosper. Second, on a larger scale, one measured in hundreds of acres, a mosaic of small stands of different ages and species compositions would have the richest diversity. Finally, on the largest scale, the scale of this document, forest diversity would be greatest if the landscape were covered by stands of many different sizes, ages, and species compositions.

To define an appropriate forest diversity target for the Nulhegan we assume that manipulation of a forest ecosystem should work within the limits established by natural disturbance patterns prior to extensive human alteration of the landscape. The key assumption being that native species evolved under these circumstances, and thus maintaining a full range of similar conditions under management offers the best assurance against losses of biodiversity. In the case of hardwood and mixedwood communities in the Nulhegan, traditionally partial disturbances would have dominated. Only a small portion of the landscape would naturally occur in single-cohort stands to which a single age can be easily assigned. Rather than think of the forest as a distribution of clearly defined age classes, managers should imagine a matrix of multi-cohort stands, each of which is continually regenerating in relatively small patches(Dahir & Lorimer, 1996; Frelich & Graumlich, 1994; Frelich & Lorimer, 1991; James Reade Runkle, 1982); so called gap dynamics. Such a multi-cohort condition has historical precedent, but more importantly it's the habitat structure required by some of the focal species detailed in this plan: blackburnian warbler, black-throated blue warbler, and Canada warbler.

Forest inventory data of the hardwood and mixedwood stands on the Division suggest approximately 8,900 acres of a total 15,000 acres within these natural communities occur as single-cohort stands. Stand sizes range from less than an acre to more than 300 acres. Large, single cohort stands are without historical precedent and our management will move these stands toward a multi-cohort condition over time. Remaining stands are almost exclusively two-aged; they have often been diameter-limit harvested multiple times and currently support very low densities of overstory trees. To improve the both within stand (alpha) and between stand diversity (beta) we hope to reduce the proportion of even-aged stands on the landscape over time.

4.2.2.2. Sub-objective 2.1b Rehabilitation of degraded stands

Restore full site occupancy on 1,600 acres of hardwood and mixedwood stands through retention of the highest quality trees while securing regeneration beneath the retained overstory, creating understory conditions that benefit black-throated blue warbler, Canada warbler, and American woodcock.

Degraded stand within hardwood/mixedwood natural communities will be managed to provide the *following attributes:*

- Retention of the greatest canopy closure as is possible with stocking and regeneration goals
- Retention of snags, cavities, and dead and downed wood
- Establishment of new cohorts of regeneration that fully occupy a site
- Establishment of regeneration not negatively impacted by ungulate browse
- Control of interfering understory plants

<u>Rationale</u>:

Hardwood and mixedwood stands in the Nulhegan have a long history of partial harvesting, in which large trees with desirable attributes have been selectively removed without any specific measures to ensure proper stand regeneration and long-term sustained forest health. Repeated selective cuttings, such as diameter-limit cutting, have long been used within Division forests (Kelty & D'Amato, 2005; Kenefic & Nyland, 2005; Nyland, 2005). These cuttings exploit high-value trees for short-term financial gain without consideration for future renewal. Residual stand quality, composition, and structure are unpredictably modified, particularly in the case of the Nulhegan Basin Division where repetitive selective cuttings removed the largest, most vigorous, and best quality trees. The resulting stands tend to have few large-diameter trees, even fewer with high quality, and fewer seed sources for desired species (Fajvan, Grushecky, & Hassler, 1998). Because removal depends upon pre-harvest diameter and species distributions, diameter-limit cutting in the Division's hardwood and mixedwood communities has left spatially irregular conditions that range from dense overstory in some places to completely open areas in others. While this spatial irregularity can create a variety of light conditions suitable for various species with different shade tolerances, when coupled with the intensive moose browsing in the Division it can lead to regeneration difficulties.

The heavy partial cutting common to the Division's hardwood and mixedwood stands was compounded by the return of moose to Vermont beginning in the early 1980s. Adult moose require substantial browse to maintain their characteristically large body size (2.8 kg/moose/day in January in New Hampshire; (Pruss & Pekins, 1992)), thus have the potential to impact plant communities considerably (Bowyer, Ballenberghe, & Kie, 1997; Peek, 1998), particularly in commercially managed forests that create preferred habitat and forage that attract moose (Andreozzi, Pekins, & Langlais, 2014; Bergeron, Pekins, Jones, & Leak, 2011; Scarpitti, Habeck, Musante, & Pekins, 2005). As an example, moose on Isle Royale, Michigan prevented aspen, birch, and balsam fir from reaching the overstory, whereas spruce was little affected (McInnes, Naiman, Pastor, & Cohen, 1992). In 2013, a University of New Hampshire graduate student established a series of plots on the Division and surrounding landscape to evaluate the impact to forest regeneration by moose. That work has shown moose browsing may be shifting species composition within mixedwood stands (Andreozzi et al., 2014).

The majority of the focal species identified for hardwood and mixedwood natural community types in the Nulhegan Basin rely upon some form of interior forest condition. Restoration of forest interior conditions in degraded stands must begin by establishing regeneration that fully occupies a site while simultaneously retaining as much canopy cover as possible. Recent research has shown application of irregular shelterwoods may be an option to rehabilitate impoverished hardwood and mixedwood stands (Bedard et al., 2014; Lussier & Meek, 2014). Variants of the irregular shelterwood should allow regeneration of shade-tolerant and mid-tolerant species under an overstory canopy. Securing regeneration under the shelter of an overstory will retain important structure for forest interior nesting focal species, particularly black-throated blue warbler and Canada warbler that nest in the shrubby regeneration. This level of regeneration will establish new cohorts of trees that fully occupy the growing space.

4.2.2.3. Sub-objective 2.1c Native tree species composition

Where possible, over the long-term (100-200 years) and dependent upon site and successional stage considerations, restore/maintain tree-species composition within hardwood and mixedwood stands to more closely match pre-settlement composition (increase percent basal area of long-lived species to include red spruce, yellow birch, white pine, and disease-free American beech*)*.

Species composition of hardwood/mixedwood natural communities will be managed to provide the following attributes:

- Reduced proportion of intolerant species in overstory
- Increased proportion of long-lived species like white pine and red spruce
- Free from invasive plant species
- Examples of disease-free American beech

<u>Rationale</u>:
Trees determine the character of forest stands. As the largest plants in the forest, they dominate the vegetation and provide the structure on which many other forms of life depend. Several tree species within the Division's mixedwood and hardwood natural communities have declined in abundance or distribution in the past century. Within mixedwood stands species like white pine and red spruce have become uncommon in particular stands from past harvesting practices (Cogbill, 2000; Lapin & Engstrom, 2002a; Seymour & Hunter Jr., 1992).

Tree species influence their environment in a number of ways, creating different habitat conditions for tree seedlings, understory plants, and animals. Crown shape and foliage size, type (i.e., deciduous or coniferous), and orientation affect light infiltration and canopy interception of rain and snow, creating a variety of light and moisture conditions at the understory and ground levels. Chemical composition of litter also differs among tree species, and influences soil pH, organic-layer development, and nutrient availability. These factors not only have important effects on tree seedlings and herbaceous plants, but also on the distribution and abundance of forest-floor fauna, including invertebrates, amphibians, and small mammals. The dense shade and acidic litter under conifers are unsuitable for vernal herbs such as trout lily and spring beauty, but acceptable for goldthread and bunchberry. Although relatively few herbaceous and non-vascular plants are tightly associated with particular tree species in the Northeast, some close associations do exist. Three species of mycorrhizal *Lactarius* appear to be specifically associated with hemlock, birch, and black spruce, respectively (Phillips, 2010). In some situations, sugar maple seedlings grow best under yellow birch trees, and beech seedlings grow best under sugar maples (Forcier, 1975).

Tree-species distributions affect foraging and nesting opportunities for a number of bird species. Golden- and ruby-crowned kinglets nest almost exclusively in the tips of spruce branches, and pine warblers nest and forage in pines. Our focal species blackburnian warbler has been shown to favor a common mixedwood associate in eastern hemlock (Tingley et al., 2002). The presence of yellow birches in mixedwood and hardwood stands affects foraging distribution of a number of forest songbirds. (R. T. Holmes & Robinson, 1981) found that the ten most common foliage-gleaning bird species preferred yellow birches for foraging, possibly because this species supports a greater diversity of foliage insects than any other tree species in northern New England forests.

This sub-objective must recognize that certain species composition goals are unrealistic due to introduced pathogens. American beech has suffered from beech bark disease for the last hundred years, restricting its ability to grow to maturity and provide all of the ecological benefits to wildlife it otherwise might in the absence of disease. Further, with changes to the climate, insects previously excluded by the Division's extremely cold winter temperatures may impact species composition goals.

4.2.2.4. Sub-objective 2.1d Diversity of vertical structure

Over 15 years across 2,100 acres, establish a successful new cohort of regeneration of shade-tolerant and mid-tolerant species (defined as >50% milacre plots stocked with at least one stem between 3 feet tall and

1.5 inches dbh) under as closed a canopy as site conditions and stocking will allow to provide breeding and foraging habitat for blackburnian, Canada, and black-throated blue warblers.

Hardwood natural communities at the stand scale will be managed to provide the following attributes:

- Old trees
- Well-developed overstory, mid-story, understory, and shrub layers
- Full site occupancy by viable advanced regeneration
- Multiple cohorts of trees spatially distributed

<u>Rationale</u>*:*
In contrast to the clearcut spruce-fir stands characteristic of the Nulhegan Basin, hardwood forests in the Division have a long history of partial harvesting, in which large trees with desirable attributes have been selectively removed without any specific measures to ensure proper stand regeneration and long-term sustained ecosystem health. This has left a legacy of highly heterogeneous stands in terms of basal area, stocking of desirable regeneration, and quality of residual growing stock (Nyland, 2010). These stands have a mosaic of condition classes. They have patches with abundant saplings or poles, others with little to no regeneration due to interfering plants, moose browse, or a closed canopy of dominant trees, and others having two strata with desirable regeneration overtopped by a partial canopy of poorly formed or diseased larger trees. Even 20-30 years after this type of harvest, the residual basal area and canopy cover are often very low (the mixedwood and hardwood stands within the Division *average* less than 62 ft^2/acre and more than 3,500 acres have an overstory crown closure of less than 60%).

Traditionally hardwood and mixedwood forests would be expected to support multiple canopy layers: an herbaceous ground layer, a shrub layer, a mid-story, an overstory, and individual super canopy trees. This partitioning of the vertical growing space by maturing trees provides a diverse assemblage of habitat niches for wildlife. Our focal species require these different vegetation layers for foraging and nesting. Canada warblers and black-throated blue warblers are well known to nest in the shrubby understory of hardwood and mixedwood stands. And blackburnian warblers forage and nest high in the canopy, seeking out mature softwood species to nest within. Currently, much of the Division's stands lack a well-developed shrub layer, are completely absent a mid-story layer, and have a sparsely stocked or diseased overstory.

Much of the silviculture and forest restoration literature suggests improvements to vertical structure diversity and increases in canopy closure may be realized by moving even-aged stands toward a more uneven-aged structure through application of a selection system over many years (Kelty, Kittredge Jr., Kyker-Snowman, & Leighton, 2003; Ministère des Forêts, de la Faune et des Parcs and New England Society of American Foresters Silviculture Working Group, 2016; Nyland, 2003; Sloan, 2003). However, after one or more diameter-limit cuttings in even-aged stands (of the sort common in the Nulhegan Basin), previously harvested stands are often not suited to the application of the selection system in its classic sense, either because of the low basal area or lack of sufficient quality in the growing stock (Nyland, 2003) (e.g. Nulhegan Basin hardwood and mixedwood stands average 33 ft^2/acre in acceptable basal area). In this case, foresters are often tempted to start over with a new stand, using uniform shelterwood or other even-aged regeneration systems, such as clearcutting. However, these are often unsatisfactory alternatives, as the natural disturbance regime in these forests and our focal species favor structures more common to multi-cohort stands. Rehabilitation using traditional even-aged silvicultural systems will probably modify the structural and species diversity of the forest in a way that may be incompatible with our management objectives; the provisioning of focal species habitat and the emulation of ecological processes. As such, restoration efforts will rely more heavily on developing an irregular structure through a combination of approaches (Bedard et al., 2014; D'Amato & Catanzaro, 2009; Maguire & Kenefic, 2004; Nyland, 2005; Raymond, Bédard, Roy, Larouche, & Tremblay, 2009)

4.2.2.5. Sub-objective 2.1e Downed woody material, snags, and cavity trees

Over the long-term, maintain or restore a range of sizes and types of downed woody material, snags, and cavity trees and retain or provide downed woody material (DWM), snags, and cavity trees in sites where they are lacking. Within 15 years and where possible, forest management action should retain approximately three snags greater than 14" DBH and one greater than 24" DBH per acre.

DWM within hardwood/mixedwood natural communities will be managed to provide the following attributes:

- Increased volume of DWM across all hardwood and mixedwood communities
- Increase in mean diameter of DWM
- Retention of snags and cavity trees

Rationale:

Downed woody material (DWM) is a central element of wildlife habitat in forests (Freedman et al., 1996). In New England, DeGraaf *et al.* (1989) catalogued at least 40 species that depend upon DWM. Further examples include: low densities of highly decayed logs (less than one log/ha) have a negative impact on red-back voles in a northern hardwood forest in New Brunswick, Canada (Bowman, Sleep, Forbes, & Edwards, 2000); and a Maine study that showed increased retention of DWM increased spotted salamander populations (Patrick, Hunter, & Calhoun, 2006).

The long history of wood utilization on the Division's lands has created a dearth of DWM as individual trees were largely harvested before they died, rotted, and fell to the ground. A habitat inventory of the Division identified 311 out of a total 504 stands where the amount of downed woody material was considered to be "low." The role of downed woody material in providing habitat for wildlife is dependent upon the physical distribution, size, amount, degree of decay, stage of decay, and orientation of the debris relative to slope and exposure (Chandler, 1987; Hunter Jr., 1990; Triska & Cromack Jr., 1980). In general, the more even the overall distribution of downed woody material, snags, and cavity trees, the greater the habitat diversity and use. Conversely, a lack of downed woody material over large areas may reduce or eliminate species dependent upon woody material for some stage of their life cycle. These 311 stands represent 19,000 acres of the Division's forests.

Downed woody material is used for nesting and cover; as thermal and drought refuges; as a source of and place to store food; as lookout, drumming, sunning, and preening sites; and as natural bridges across openings and streams. Vertebrates and various macro- and microorganisms that use downed woody material are important links in the forest food chain and in nutrient cycling. Logs oriented along contours are more likely to serve as runways for small mammals (Olszewski, 1968) and will also capture soil and organic material , slowing erosion and increasing nutrient retention (Triska & Cromack Jr., 1980). Large (>16" diameter) logs are a particularly valuable forest component; they are more-persistent landscape features and decay slowly because of their low surface to volume ratio.

Tree cavities are also an important habitat component for many forest species. Cavities can be found in dead, dying, or live trees. Birds and mammals use larger trees extensively as nest and den sites, perches, and roosts (see table). The size (diameter and height), state of decay, species, and location of snags and cavity trees influences their use by cavity-dwellers (Hunter Jr., 1990). Many of the animals have very specific minimum-size requirements for the trees or snags they will use for cavities; they can use larger trees but are unable to nest in trees below a minimum size. The northern long-eared bat, for example, prefers to roost under peeling bark or in cavities of large diameter trees often found in mature forest stands. When used as maternity sites, these roosts are essential for the growth and development of pups (Caceres & Pybus, 1997). Compared to smaller trees, larger trees provide more thermal insulation, protection from predators, perches, and room to house large clutches, and will persist longer in the stand. The shortage of large trees within hardwood and mixedwood habitats on the Division may affect nesting success and result in reduced populations or potentially the complete loss of some species. Our habitat inventory data show 217 out of 504 stands had no tallied snag trees. This represents more than 4,900 acres with little to no snag density.

4.2.2.6. Sub-objective 2.1f Maintenance of single-cohort stands (Early Successional)

Over the next 15 years, manage approximately 287 acres of hardwood forest types in early successional stands in patch sizes of varying shapes, between 5 to 20 acres to provide breeding habitat for American woodcock.

Hardwood natural community types will be managed for the following attributes:

- Dense native tree saplings between 1-40 years old dominate regeneration - red maple, aspen, paper birch, yellow birch, and balsam fir
- Shrub species may include speckled alder and pin cherry
- Herbaceous cover may include raspberry, blackberry, goldenrod, ferns, and spirea
- Stands will be located within the vicinity of alder wetlands or floodplains

Rationale:

Forest communities are dynamic creating variability in species composition and successional stages following a disturbance. This variability provides valuable wildlife habitat for species that have adapted to vegetative communities and age classes that result from a disturbance. One of our focal species, American woodcock, requires young regenerating hardwood and mixedwood forests interspersed with forest openings for breeding. Large scale natural disturbances required to create these conditions are thought to be uncommon in the Nulhegan Basin, and since these habitats are not permanent features in the landscape, conditions will need to be created over a period of time using even aged forest management.

The American woodcock has experienced population declines of about one percent since the 1960s (Dettmers, 2003). As with many early successional dependent species, the primary reason for this decline is loss and degradation of habitat (Kelley Jr., 2003). Due to their high conservation status, the USFWS and many other conservation agencies are taking steps to provide the habitat conditions required by woodcock, and other early successional dependent species.

In 2006, refuge staff and partners established Woodcock Habitat Management Demonstration Units (WMDU) within the Nulhegan Basin Division. These units total approximately 287 acres, and are strategically located to provide the most suitable habitat for woodcock and to serve as public demonstration areas. A Woodcock Habitat Management Plan was written in 2009 (Lapointe, 2009) to provide information on the establishment of these Units and management guidelines (Appendix **Error! Reference source not found.**). Commercial and/or non-commercial even-aged treatments are being used in a shifting mosaic to provide the full suite of habitat components within each WMU over the course of approximately 20 years. This management regime will result in a distribution of four age classes (~0-5 yrs, ~5-10 yrs, ~10-15 yrs, ~15-20 yrs). Once four age classes have been fully established, we will employ a 40 year rotation age with four age class distributions (~0-10 years, ~10-20 years, ~20-30 years, and ~30-40 years) to maximize the early successional component and practical application of an even-age management silvicultural system. The habitats created within these units are benefiting numerous early successional dependent species including chestnut-sided warbler, mourning warbler, moose, turkey, grouse, black bear, and various species of bats.

4.2.3. Objective 3.1 Shrub Swamps and Floodplain Forest

Manage shrub swamp and floodplain forest communities to support natural and rare ecological communities, and provide foraging habitat for priority refuge resources of concern including American woodcock and American black duck. Priority will be to maintain the alder-dominated shrub swamps within the Woodcock Management Units.

4.2.3.1. Sub-objective 3.1a Diverse Floodplain Communities

Perpetuate approximately 414 acres of floodplain natural communities to provide habitat for American woodcock, American black duck, cavity nesting waterfowl, and other species of conservation concern such as wood turtle.

Floodplain natural communities will be managed for the following attributes:

- Native tree species, including, where appropriate, black ash, white spruce, balsam fir, paper and yellow birches, and northern white cedar
- Native shrubs including, where appropriate, speckled alder, beaked hazel, mountain maple, black elderberry, highbush cranberry and red-osier dogwood
- Herbaceous species such as sedges and grasses, goldenrod, tall meadow-rue, sensitive fern, lady fern, mountain wood-sorrel, and virgin's-bower
- Moderate to closed canopy in forested communities
- Natural hydrologic function

Rationale:

Floodplain natural communities in the Division include mixed northern hardwood floodplain forest, alluvial grassland/meadows, alluvial shrubland, and oxbow marshes. These communities occur within the riparian areas of the Nulhegan River, and its tributaries including the Yellow, Logger, North and Black branches. They are often located within mostly intact riparian buffers adjacent to logged forest communities. These floodplain communities are unaltered for the most part, except for the presence of a few non-native invasive plant species such as coltsfoot, hemp-nettle, self-heal, and glossy buckthorn, which, with the exception of buckthorn, are not considered highly invasive.

According to (Lapin & Engstrom, 2002a) the Nulhegan River floodplain, specifically at the confluence of Yellow Branch and North Branch, is the most diverse and intact floodplain in the Nulhegan Basin. The species-diverse natural community complex provides habitat for a variety of butterflies, odonates, amphibians and reptiles, including wood turtle, a species petitioned for federal listing. Wood turtles require both aquatic and terrestrial habitats. They use slow moving sections of clear, cold, woodland streams for mating and overwintering, and occupy adjacent upland and floodplain habitats from late spring to fall for feeding and thermoregulation. The alluvial shrublands also have the greatest diversity of bird species of all non-forested wetland types in the Nulhegan Basin. (Lapin & Engstrom, 2002a) also note that the Nulhegan River floodplain appears to be in its "natural condition" based on lack of evidence of the presence of man-made dams that may have impounded the area.

The Division floodplain natural communities provide habitat for regional species of conservation concern. American woodcock, for example, feed on earthworms in the moist soils of floodplain habitats, while American black ducks and cavity nesting waterfowl take advantage of flooded meadows and alluvial shrublands to reach areas rich in invertebrates. Other species such as Canada warbler, northern parula, and rusty blackbird will also use floodplain habitats when appropriate breeding or foraging conditions are present.

Division floodplain communities are mostly intact and unaltered. Management of these communities will include monitoring non-native invasive species presence and managing invasive populations as needed, as well as maintaining "restricted management" forest riparian buffers.

4.2.3.2. Sub-objective 3.1b Diverse Shrub Swamp Communities

Perpetuate approximately 290 acres of shrub- swamp natural communities as foraging habitat for American woodcock, rusty blackbird, and American black duck.

Shrub swamp natural communities will be managed for the following attributes:

- Native shrubs including speckled alder, wild raisin, *Spirea* and willow
- Native grasses, rushes and sedges
- Seasonal to permanent shallow water inundation
- Often adjacent to emergent marsh and sedge meadows

<u>*Rationale:*</u>
Seasonal and permanent shallow flooded soils dominated by speckled alder characterize shrub swamp communities in the Division. These communities are not part of a floodplain system, like alluvial shrublands, but are often part of the dynamic systems caused by beaver activity. These shrub-swamps are associated with black-spruce swamps, lowland spruce-fir forests, slow moving streams, backwater areas of low gradient large streams, and beaver flowages (Lapin & Engstrom, 2002a).

Shrub swamp communities provide habitat for many species of regional conservation concern. American woodcock feed within the moist soils of shrub swamp communities for earthworms. Alder swamps are an important habitat component in the Division WDM Units (see discussion under 3.6 Conflicting Habitat Needs and sub-objective 2.1f. for details). American black duck also forage within shrub swamp communities, but in swamps that are flooded, and often associated with beaver ponds, slow moving streams or stream backwater areas. These areas are especially important for black duck broods as they provide cover and are often high in invertebrates (Ringelman & Longcore, 1982). Rusty blackbirds will also feed on invertebrates, as well as tadpoles, found in pockets of open water. These blackbirds nest in young spruce-fir, and require wetlands located within the vicinity of nesting habitat (Foss personal communication 2015).

Shrub-swamp communities are sensitive to changes in hydrology (Lapin & Engstrom, 2002a), and are impacted by non-native species, such as *Phragmites australis*, which has invaded shrub swamps in the Division. Maintaining the natural hydrological function of these communities (i.e., beaver activity), and continued monitoring and management of non-native species presence will perpetuate native species diversity and health of these communities.

4.3. Goal 2 Non-Forested Uplands and Wetlands

In cooperation with willing landowners and other partners, protect, manage, and restore non-forested wetlands and uplands within the Connecticut River watershed. These non-forested habitats will help sustain the biological diversity, integrity, and ecological and hydrologic function of the river ecosystem, provide habitat connections and wildlife travel corridors, accommodate anticipated shifts in species' ranges from climate and land use changes, and support dependent species of conservation concern- including migratory birds and federally listed endangered and threatened species.

4.3.1. **Objective 2.1 Peatlands**

Manage peatland communities to support natural and rare ecological communities, and provide breeding and foraging habitat for priority refuge resources of concern including American black duck.

4.3.1.1. Sub-objective 2.1a Maintain Peatland Community Diversity

Maintain the species composition, natural hydrologic and nutrient regimes, and the mosaic of vegetation structure within approximately 265 acres of peatland natural communities to provide habitat for a diversity of species including those that are rare or uncommon, regionally significant and species of conservation concern such as the American black duck.

Peatland natural communities will be managed for the following attributes:

- Stable water table at or near the soil surface.
- Sphagnum moss and liverworts are consistently abundant.
- Presence of low heath shrubs such as sheep and bog laurels, labrador tea, leatherleaf, *Rhodora*, bog rosemary, small cranberry and velvetleaf blueberry.
- Grasses and sedges include hare's tail cottongrass, three-seeded sedge, few-flowered sedge, and white beakrush.
- Presence of scattered to locally abundant stunted (<30 feet tall) black spruce and tamarack

Rationale: The peatland communities within the Nulhegan Basin Division occur at low elevations along slow moving streams, pond margins, drainages, and broad flats. They are permanently saturated wetlands that are dominated by grasses, sedges and shrubs, and scattered stunted black spruce and tamarack. The characteristic that distinguishes these wetlands from other wetlands is the presence of peat soils. Peat is the accumulation of partially decomposed organic material, which accumulates due to water levels being at or near the surface creating anaerobic conditions that slow or halt decomposition of plant material (Gawler, 2008; Thompson & Sorenson, 2000). The peatlands in the Division are often part of a larger wetland complex, transitioning to forested wetlands such as spruce-fir-tamarack, cedar and black spruce swamps.

Peatland communities are influenced by the source of water entering the system. A peatland that receives water from precipitation, for example, is highly acidic and has a low rate of peat decomposition. This type of peatland, known as a bog, is dominated by species of *Sphagnum* moss. Peatlands typed as fens, on the other hand, receive water and nutrients from groundwater, and tend to be less acidic with a higher rate of peat decomposition. Fens, depending on the acidity level, tend to be dominated by grasses, sedges, and non-sphagnum mosses (Thompson & Sorenson, 2000). A change in hydrology could have a significant impact on the physical and species composition of these wetlands.

The peatland communities within the Division, some of which are considered rare in the state, are an integral part of the landscape. They provide habitat for a diversity of species including state and regionally significant species of conservation concern (Lapin & Engstrom, 2002a). Species such as the state threatened pod-grass, and state rare bog sedge, white-fringed orchid, shining rose and Arctic jutta. State and regional species of conservation concern include black-backed woodpecker, rusty blackbird and American black duck.

To conserve the integrity of these habitats, it will be essential to maintain the local, natural processes inherent to peatland communities in the Division. Peatlands fall under a restricted management zone due to unique wetland plant communities, and therefore passive management will be employed. Areas that may have been impacted from past forest management practices will be evaluated by hydrologists and other experts to determine the best course of action. Best management practices will be used while engaged in habitat management activities; whether it is the careful placement of appropriately sized road culverts or employing silvicultural treatments in adjacent habitat types.

4.3.2. Objective 2.2 Biological Integrity, Biological Diversity, and Environmental Health

Where and when appropriate, protect or restore habitats absent an identified species of conservation concern, recognizing the importance of all habitats in contributing to the biological integrity, diversity, and environmental health of refuge lands and the Connecticut River watershed.

4.3.2.1. Sub-objective 2.2a. Diversity of Wetland Species

Protect water quality and natural hydrology, and maintain native species diversity within approximately 165 acres of freshwater emergent marshes found within the Division.

Freshwater emergent marsh natural communities will be managed for the following attributes:

- Mineral or shallow organic soils that are moist to saturated and inundated in the spring. Spring flooding with water depths around two feet. Summer water depths around two inches or exposed saturated soils.
- Grasses, sedges and herbs include bluejoint grass, rice cut-grass, bulrush, Joe-pye weed, white boneset, flat-topped aster, white turtlehead, sweet flag, narrow-leaf cattail and marsh fern.
- Less than 25 percent cover of scattered shrubs such as meadow-sweet, steeplebush, willows and speckled alder.

<u>*Rationale:*</u>

The freshwater emergent marshes in the Nulhegan Basin Division are associated with slow-moving streams and beaver impoundments. These habitats are most often small or isolated occurrences, but are important for providing additional structural and species diversity to the mostly forested landscape within the Division. Wildlife species that use emergent marshes include mammals such as moose, beaver, muskrat, mink; birds such as swamp sparrow and red-winged blackbird; reptiles such as common garter snake, leopard frog, green frog, and spring peeper; and many species of insects including dragonflies and butterflies.

Wildlife species rely on emergent marsh habitats that are intact and diverse with native plant species. Invasive plants, such as common reed, threaten marsh habitats by shifting the native diversity towards a monoculture. Common reed occurs on refuge lands in small, scattered patches. We will continue to monitor and manage this species where it occurs. We will also ensure that future management activities do not impact water quality or disrupt the natural hydrology of these systems. These management tactics will maintain the structural and native species diversity important to a large suite of species in the landscape.

4.3.2.2. Sub-objective 2.2b. Diversity within Montane Communities

Maintain native species diversity of rocky outcrops and cliff and talus habitats within approximately 442 acres of montane communities located within the Division.

Rocky outcrops and cliff and talus habitats within montane natural communities will be managed for the following attributes:

- Areas with bare rock and sparse vegetation on shallow, dry soils
- Presence of scattered, low trees such as pin cherry, paper birch, heart-leaved paper birch, balsam fir and red spruce.
- Presence of scattered shrubs such as American mountain-ash and mountain maple.

<u>*Rationale:*</u>

The montane communities in the Nulhegan Basin Division include montane spruce-fir forest and montane yellow birch-red spruce forest. Both these communities are subject to cold, icy and windy winters and short, dry and, at the higher elevations, foggy summers. The often shallow soils and windy conditions generate disturbance from downslope movement and windthrow. These events create natural open areas where rock is exposed and vegetation is stunted and sparse. These areas are the Division's rocky outcrop and cliff and talus habitats. The conditions within these habitats provide unique features and niches that are not found elsewhere in the Division including sunny, dry sites for reptiles to bask and nesting sites for ravens and turkey vultures.

These open and rocky habitats are most often small or isolated occurrences, but are important in maintaining connectivity within the larger forested matrix, and providing additional structural and species diversity in an otherwise mostly forested landscape. The major forces that influence these habitats are related to climate and geological processes. These factors will continue to occur and drive natural community dynamics. We will monitor these habitats to ensure that native species diversity is present, but otherwise will let nature effect the changes on the vegetation and maintain these habitats in the landscape.

4.4. Goal 3 Inland Aquatic Habitats

In cooperation with willing landowners and other partners, protect and restore in-stream and riparian habitat structure and function, and restore aquatic species passage and water quality within the Connecticut River watershed to improve the ecological integrity and environmental health of the river ecosystem and enhance habitat for migratory and inter-jurisdictional fish, mussels, and other native aquatic species of conservation concern.

4.4.1. **Objective 3.1** Open Water Habitat

In collaboration with the State and other partners, manage water resources and riparian areas to provide cold temperature regimes where appropriate, substrate diversity, and unimpeded fish passage that benefit priority refuge resources of concern including eastern brook trout. Also provide undisturbed breeding and foraging habitat for American black duck, and other waterfowl species.

4.4.1.1. Sub-objective 3.1a Improve Stream Function

In collaboration with the Vermont Agency of Natural Resources and Trout Unlimited and increase brook trout populations by improving stream function through strategic wood additions within approximately 8 miles of stream habitat within the North Branch, Black Branch, Yellow Branch and Logger Branch of the Nulhegan River, as well as Tim Carroll Brook and Whisky Brook.

4.4.1.2. Sub-objective 3.1b Evaluate Additional Stream Restoration Sites

In collaboration with the Vermont Agency of Natural Resources and Trout Unlimited assess approximately 10 miles of stream within the North Branch and Black Branch of the Nulhegan River to evaluate the potential for additional brook trout habitat improvements using instream engineered structures.

4.4.1.3. Sub-objective 3.1c Restore Aquatic Organism Passage

In collaboration with the Vermont Agency of Natural Resources and Trout Unlimited restore aquatic organism access to over 17 miles of stream.

Stream habitats will be managed for the following attributes:

- Clear passage (i.e., lack of man-made physical barriers) for aquatic organisms moving upstream or downstream in search of spawning habitat, cover, forage, or appropriate water temperatures.
- Stream corridors that meet State Aquatic Organism Passage standards and guidelines (i.e., culverts and bridges do not adversely affect the upstream passage of fish, mammals, amphibians, and reptiles).
- Establish and/or maintain equilibrium conditions and stable morphology in flowing waters.
- Presence of at least 150 pieces of at least 10 cm diameter woody material per hectare of stream to provide channel roughness and cover for fish (Kratzer & Warren, 2013).
- Vegetated stream bank and maximum canopy coverage.
- Native riparian trees along stream banks to provide shade and natural recruitment of wood and leaves that will ultimately feed aquatic invertebrates.

Rationale:

The Nulhegan River and three of its four major tributaries— the North, Yellow, and Black branches—flow through the Nulhegan Basin Division. These rivers provide important habitat for brook trout; the trout species native to flowing waters in Vermont, and a regional species of conservation concern.

Since the late 1800s, timber harvesting and associated activities have impacted riparian habitats within the Nulhegan Basin. In the days of the log drives, rivers were reshaped, boulders and large wood were removed from the channels, and trees were removed from river banks. A change in stream habitat characteristics resulted, impacting fish populations. When trucks began hauling the logs, undersized culverts on the constructed logging roads impeded fish passage, inhibiting or preventing the ability of fish to move upstream in order to fulfill portions of their life cycle. Restoring these aquatic habitats is a priority for refuge staff, Trout Unlimited, and the Vermont Agency of Natural Resources, and will benefit brook trout populations.

Stream assessments and fish inventories were conducted on the North, Yellow and Black branches, including feeder streams, by the Vermont Agency of Natural Resources and Trout Unlimited fisheries biologists from 2010 to 2012. During the summer and fall of 2013, large woody material was added to high priority areas on the Black and North branches, and culverts were replaced on refuge roads. By the spring of 2014, deep pools, large woody material and changes in the stream channel provided preliminary evidence of successful stream restorations (J. Norton pers. comm. 2014). Evaluation is ongoing. Restoration efforts in other impacted stream habitats in the Division will continue as funding is made available for these purposes. Recent strategic wood additions on the East Branch of the Nulhegan River has increased the brook trout biomass on average 150% at sites treated with strategic wood additions (Kratzer & Warren, 2013)

Connect the Connecticut models - including the index of aquatic ecological integrity, stream temperature tolerance and current brook trout probability of occurrence - provide further data on the importance of the Nulhegan River tributaries to the conservation of brook trout. The index of ecological integrity model, for example, shows these tributaries to have a range of high to medium relative intactness (level of human modification) and resiliency to environmental change (ability to remain intact). This data, along with the stream temperature tolerance model which shows persistence of cold water habitat despite increases in air temperature due to climate change, supports the need for restoration efforts.

4.4.1.4. Sub-objective 3.1d Restore Lewis Pond Water Quality and Native Fisheries

In collaboration with the Vermont Agency of Natural Resources and Trout Unlimited restore water quality and the native brook trout population in Lewis Pond within 15 years.

Lewis Pond aquatic communities will be managed for the following attributes:

- Self-sustaining native brook trout and other native aquatic species populations
- Native aquatic vegetation including water lilies
- Sandy/rocky bottom
- Intact natural communities within 1,000’ buffer along the shoreline

Rationale:

Lewis Pond is a 69-acre dystrophic pond, and is currently the only pond in the Division. Logger Brook, a potentially high quality aquatic natural community, empties into Lewis Pond on the north shore. The natural communities that surround Lewis Pond are generally intact (Lapin & Engstrom, 2002a) providing a buffer from outside influences that may impact water quality and the health of aquatic communities.

According VT Agency of Natural Resources (VTANR), the historic native fish community in Lewis Pond likely consisted of very few species, including brook trout. Brook trout are the only native trout in flowing water and small pond habitats in Vermont, and are a species of regional conservation concern. Currently, the fish community in Lewis Pond has been altered with the introduction and establishment of fathead minnows and smallmouth bass. These non-native species were likely introduced by anglers, and may limit the natural reproduction of brook trout populations in the pond (J. Kratzer pers. comm. 2011).

Lewis Pond and the surrounding wetland habitats are also important breeding and foraging areas for waterfowl species. Mergansers, wood ducks, mallards and black ducks forage on invertebrates and aquatic vegetation in backwater areas, and adjacent wetlands. Common loons are annually found feeding on fish in Lewis Pond, though breeding has not been confirmed.

According to VTANR, the substrate of Lewis Pond should be a sandy/rocky bottom, which is currently covered over with silt. We will work with VTANR to assess, and if feasible, restore water quality and the native fish community in Lewis Pond.

5. Management Strategies

In forging a strategy to restore forests and manage them sustainably, it is helpful to identify the specific structural and functional changes that have led to unacceptable conditions. The forest landscape of the Nulhegan Basin has experienced several degenerative trends: old forests have been replaced by younger forests; structurally complex forests of all ages have been replaced by simplified stands; species compositions at a given site have shifted from late successional species to early successional species. Many forest stands in the Nulhegan Basin have experienced these kinds of changes, with a concomitant loss of ecological integrity (Noss & Cooperrider, 1994). These trends can, to some extent, be reversed through a combined strategy of protection, restoration, and management of forests.

Since we do not know precisely how to achieve recovery of any forest, an adaptive approach is warranted. Prescribing a desired future condition in specific terms is always problematic - especially given uncertainties about future background conditions (e.g. global climate) and species responses - but in most cases we can define a desired future direction for forest management, for example, reversing trends that we know have been associated with biotic impoverishment.

5.1. Development of management strategies

5.1.1. Management zones

Management zones are areas that govern the type of resource management that can be used. Management zones provide protection for a variety of forest and non-forest resources identified and discussed further in the Silvio O. Conte Refuge CCP and refuge inventory and study documents. We consider them under three categories as they relate to forest management at the Nulhegan Basin Division: General Management, Special Management, and Restricted Management.

1. General Management: Forest management may occur, following best management practices (BMP) for the State of Vermont. Where general management areas surround or abut sensitive areas, general management prescriptions may be modified to protect or enhance the value of sensitive areas.

2. Special Management: Forest management may occur, but must consider limitations of heavy equipment, areas deemed important for species of concern, and areas otherwise considered unique or exemplary. This includes deer wintering areas and sensitive resource outer management buffers.

3. Restricted Management: Generally no heavy equipment or harvest may occur, although individual trees may be felled, girdled or otherwise treated for the benefit of fish and wildlife. This includes sensitive resource inner management buffers, and those otherwise considered unique, exemplary, or inoperable with heavy equipment.

Table 5.1 Management Zone Descriptors

Special Management	Restricted Management
Within a 100 foot buffer of National Wetland Inventory freshwater ponds, freshwater emergent wetlands, and riverine wetlands	Within a 50 foot buffer of National Wetland Inventory freshwater ponds, freshwater emergent wetlands, and riverine wetlands
Within a 100 foot buffer of sensitive natural communities including, but not limited to:	Within a 50 foot buffer of unique and sensitive natural communities including, but not limited to:

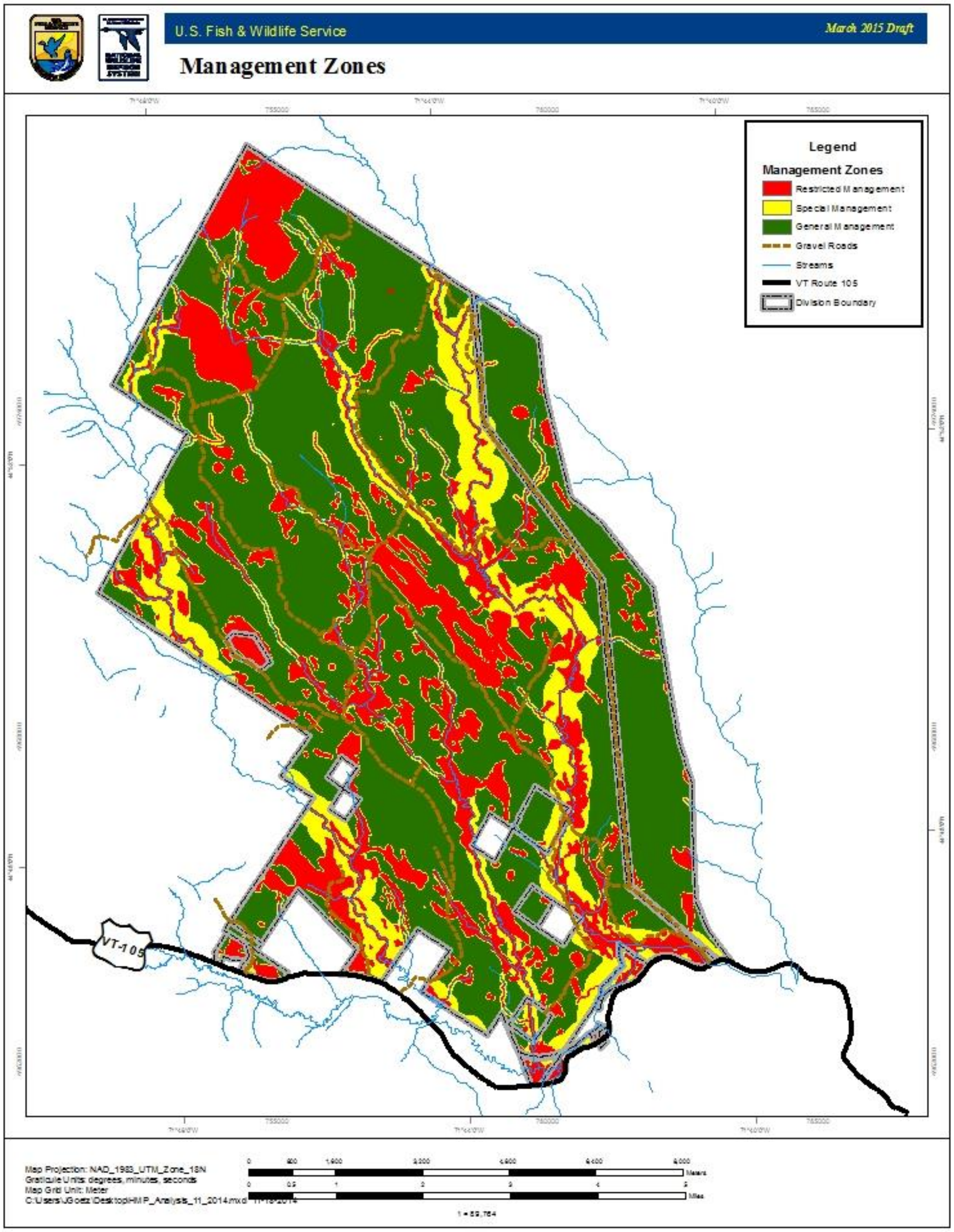
• Northern hardwood talus woodland • erosional river bluff • red maple-black ash swamp • northern white cedar swamp • northern white cedar sloping seepage forest • boreal acidic northern white cedar swamp • black spruce swamp • seeps • vernal pools • dwarf shrub bog • black spruce woodland bog • poor fen • shallow emergent marsh; beaver meadow • shallow emergent marsh; beaver pond • shallow emergent marsh; beaver wetland undifferentiated • river sand or gravel shore • river cobble shore • alluvial shrubland • alder swamp • alder swamp - deep peat • sweet gale shoreline swamp • mixed northern seepage swamp forest • alluvial meadow • mixed northern floodplain forest • oxbow marsh • pond • open water • northern hardwood talus woodland • montane spruce-fir forest • spruce-fir ledge • montane yellow birch-red spruce forest • montane yellow birch-red spruce-sugar maple forest • montane yellow birch-red spruce-paper birch forest • spruce-fir-tamarack swamp • red spruce-hardwood swamp • boreal talus woodland • high-elevation northern hardwood forest	• Northern hardwood talus woodland • erosional river bluff • red maple-black ash swamp • northern white cedar swamp • northern white cedar sloping seepage forest • boreal acidic northern white cedar swamp • black spruce swamp • seeps • vernal pools • dwarf shrub bog • black spruce woodland bog • poor fen • shallow emergent marsh; beaver meadow • shallow emergent marsh; beaver pond • shallow emergent marsh; beaver wetland undifferentiated • river sand or gravel shore • river cobble shore • alluvial shrubland • alder swamp • alder swamp - deep peat • sweet gale shoreline swamp • mixed northern seepage swamp forest • alluvial meadow • mixed northern floodplain forest • oxbow marsh • pond • open water • northern hardwood talus woodland • montane spruce-fir forest • spruce-fir ledge • montane yellow birch-red spruce forest • montane yellow birch-red spruce-sugar maple forest • montane yellow birch-red spruce-paper birch forest • spruce-fir-tamarack swamp • red spruce-hardwood swamp • boreal talus woodland • high-elevation northern hardwood forest
Riparian areas (buffers vary with stream order)	Slopes greater than 25% (NH BMP)
Rare plant locations (+100 ft from known site)	Riparian areas (buffers vary with stream order)
	Mature forest structure

Table 5.2 Values Informing Restriction Model

Sensitive Area Type	Outer Management Buffer (Special Management Zone)	Inner Management Buffer (Restricted Management Zone)
Vernal pools		100 ft from pool edge
Rare or Sensitive natural community	100 ft from community edge	50 ft from community edge
Rare or threatened plant locations	100 ft from GIS point location	50 ft from GIS point location
1st & 2nd order streams	150 ft from streambank	50 ft from streambank
3rd order streams	400 ft from streambank	100 ft from streambank
4th and 5th order streams	1,000 ft from streambank	100 ft from streambank
NWI non-forested wetlands or ponds	100 ft from wetland edge	50 ft from wetland edge

Applying the above criteria to the whole of the Division's natural communities identified approximately 15,702 acres (58.6%) as appropriate for inclusion in our General management category. Approximately 4,475 acres (16.7%) fell within our Special category and 6,588 acres (24.6%) within our Restricted category.

Figure 5.1.1 Management Zones Within the Nulhegan Basin



5.1.2. Commercial vs. Non-commercial

5.1.2.1. Commercial

Part of prioritizing our habitat management efforts required identifying which treatments would necessitate a cost to the Refuge (e.g. pre-commercial thinning or planting) and which treatments could be offset through the sale of commercial wood products. We used a simple GIS query identical to that used by Umbagog National Wildlife Refuge to identify stands we felt could support a commercial habitat management project. Improving habitats at no-cost, or potentially at a profit to the Refuge makes projects more likely to proceed. Using Umbagog Refuge's criteria of an overstory greater than 36 feet and a canopy closure greater than 60 percent we identified approximately 9,106 acres of merchantable stands that fall within our general management zone and about 2,637 acres within our special management zone. If the Division hopes to improve the entirety of these stands in the 15 year window of the HMP, this would mean treating almost 800 acres per year. We view this as an unlikely acreage goal; treatment of approximately 300 acres annually is a more realistic goal given current staffing and administrative challenges. This represents approximately 35 percent of the available restoration acreage identified - so-called amended acres. Assuming this level of management, approximately 4,100 acres or 15% of the Division's forests will be treated during the life of this plan. It should be noted that these estimates are all GIS-derived. It is likely that stands meeting our definition of merchantable will not be treated commercially in the next fifteen years - finer scale analysis and economic realities may remove them from consideration.

Table 5.3 Estimated Commercial Acres by Forest Type

Broad Forest Type	Natural Community Analog	Acres	Amended Acres (35%)	% of Division
Softwood	Lowland spruce-fir forest	3,087	1,080	4
Hardwood	Classic northern hardwood forest	4,352	1,523	5.6
Mixedwood	Red spruce-Hardwood forest	4,301	1,505	5.6
	Total	11,740	4,109	15.4

5.1.2.2. Non-commercial

Release cuttings of various kinds have long been known to help regulate species composition, improve stem quality and crown development, and increase survival, growth and yield in stands not past the sapling stage (Brissette, Frank Jr, Stone, & Skratt, 1999; Church, 1955; Godman & Marquis, 1969). Further, past research has shown that cleaning and early crop tree release will improve tree diameter growth – the more intense the release the greater the response (Heitzman & Nyland, 1991; Marquis, 1969; Weiskittel, Kenefic, Seymour, & Phillips, 2009) . Development of large trees is not merely of interest for aesthetic reasons. For example, larger birds and mammals often have minimum size requirements for cavity trees, snags, and fallen logs (Tubbs, DeGraaf, Yamasaki, & Healy, 1987). As noted in Table 5.4, the Division has an abundance of stands that would benefit from pre-commercial treatment. The stands identified met two criteria – overstory height is 0-30 feet and overstory density greater than 60%. Pre-commercial treatments require significant investments in labor, and will thus be subject to budget realities at the Division. The second column of Table 5.4 estimates current staffing and budgets will allow the

Refuge to treat a small portion of the available acreage.

Table 5.4 Estimated Non-commercial Acres by Forest Type

Broad Forest Type	Natural Community Analog	Acres	Amended Acres (5%)	% of Division
Softwood	Lowland spruce-fir forest	1,925	96	<1
Hardwood	Classic northern hardwood forest	498	25	<1
Mixedwood	Red spruce-Hardwood forest	619	31	<1
	Total	3,042	152	<1

5.1.3. Resources of concern

This chapter discusses management strategies to address the habitat management goals and objectives outlined in chapter 4. Management strategies identify the tools and techniques (e.g., mowing, timber harvesting, chemical application, etc.) used to achieve habitat objectives. A review of available literature supporting these potential strategies was incorporated during their development. Many environmental factors including wildlife populations, weather, seasonal variations, and habitat conditions affect the selected prescriptions and their ability to achieve objectives from year to year. As such, many of the details of prescriptions will be identified in the annual habitat management work plan. Prescriptions outlined herein are discussed on a conceptual level.

Work outlined in this habitat management plan is intended to be feasible given the available workload capacity of refuge staff, funding, and community support. The management prescriptions represent a comprehensive effort to guide management for the next 15 years. Given the inherent stochasticity of ecosystems it is unrealistic to predict the full suite of management strategies and prescriptions required over this period. Additional strategies may need to be added and others listed here may not be used.

5.1.4. Guiding documents

Forest management on the Refuge will generally follow the recommendations of the following publications:

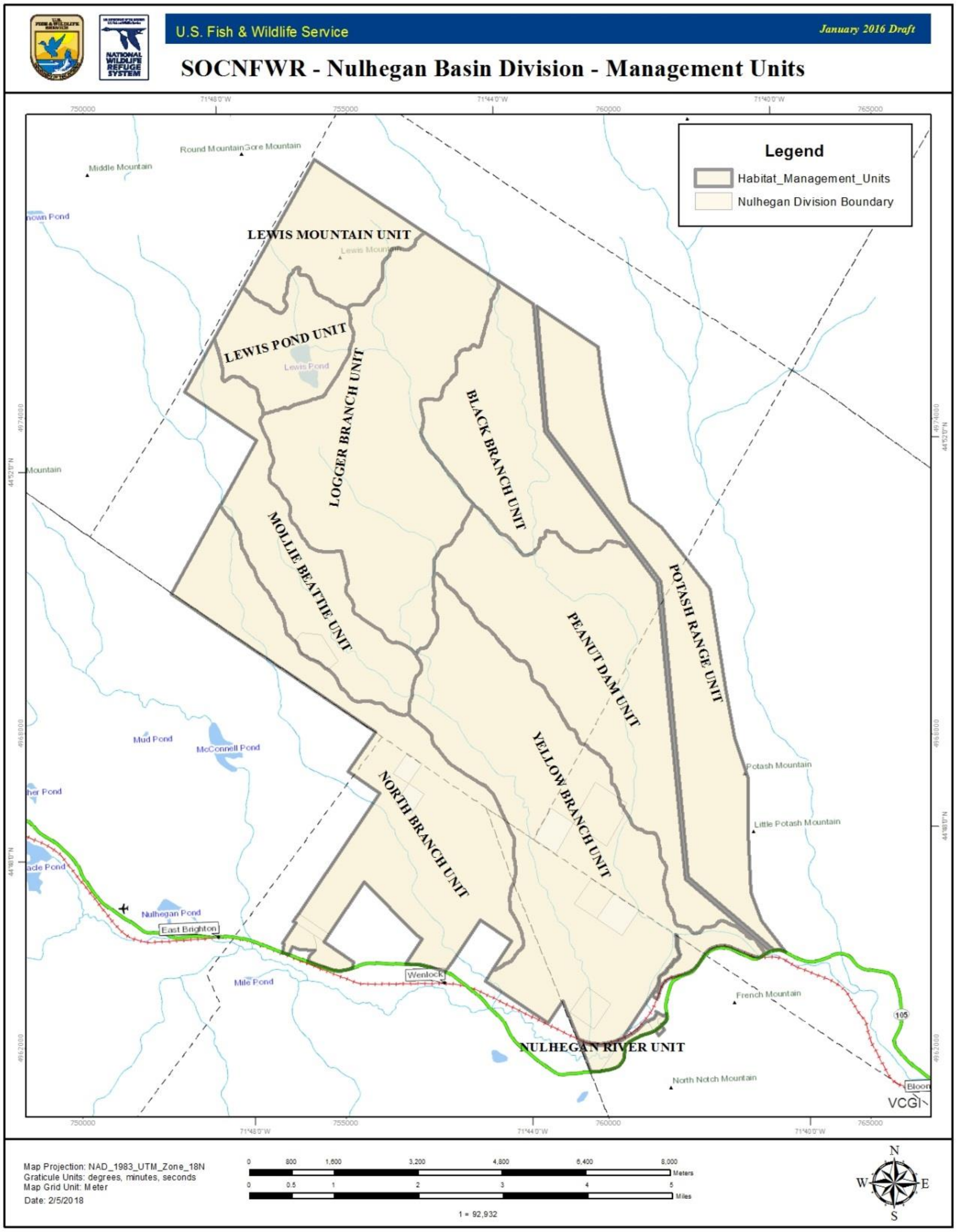
- Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire (Cullen, 2001)
- Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont (AMP's) (Vermont Department of Forests, Parks and Recreation, 1987)
- Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire (Bennett, 2010)
- Biodiversity in the Forests of Maine: Guidelines for Land Management (Flatebo et al., 1999)
- Forestry Habitat Management Guidelines for Vernal Pool Wildlife in Maine (Calhoun & Demaynadier, 2004)

5.2. Management Units

Management unit boundaries are identified as an administrative tool to aid managers in planning, record keeping, and logistics. Unit boundaries are based upon the Division gravel road network, creating units that can be managed ecologically, are recognizable to future Division staff, and are logistically intuitive. Map 5.1 shows delineated refuge management units. As new lands are acquired, existing management units will be expanded or new management units will be designated.

Within a unit, management actions will largely occur at the project scale - spraying a patch of invasive species, or harvesting or planting trees within a stand are examples. These projects will vary in spatial scale, but will have the common goal of restoring the unit's, and ultimately the Refuge's ecosystem integrity. Further discussion in the HMP outlines the expected management strategies to be employed in each unit.

Figure 5.2.1 Management Units on the Nulhegan Basin Division



5.3. Management Strategies and Prescriptions by Habitat Objective

5.3.1. Objective 1.1. Conifer Swamp/Spruce-fir forests

Improve the diversity of seral stages (where and when possible), restore historic composition and structure, and improve landscape connectivity of spruce-fir habitat to support species of conservation concern and aid in climate change adaptation. Management will provide breeding and foraging habitat for priority refuge resources of concern, including blackburnian warbler, rusty blackbird, and Canada warbler.

5.3.1.1. Sub-objective 1.1a Maintenance of landscape heterogeneity

Over the long-term (200-300 years), aim for a mosaic of spruce-fir stands of different age and structural classes at approximately the same seral distributions as occurred historically: ~15 percent early seral, ~35 percent mid seral and ~ 50 percent old single or old multilayer. Within 15 years, ensure approximately about 500 acres of spruce-fir natural community acres function as young, single-cohort stands to benefit rusty blackbird, and approximately 1,600 acres have been treated to establish a second age class.

The spruce-fir landscape will be managed to provide the following attributes:

- A mixture of successional stages
    - Ratio of single-cohort, even-aged stands to multi-cohort, uneven-aged stands will be decreased
- Native conifer tree species dominated by red spruce, with balsam fir, tamarack, and white spruce as associates.
- Where possible, retain hemlock and white pine in the landscape
- Patchy openings, including shrub swamps, peatlands, and windfall gaps.

<u>Management Strategies:</u>

- Identify existing single-cohort stands that may provide appropriate habitat conditions for single-cohort dependent focal species like rusty blackbird
- Where appropriate, create or maintain single-cohort stands using accepted silvicultural techniques to benefit focal species;
    - Site these single-cohort stands on landscape to create appropriate habitat for rusty blackbird (adjacent to wetlands and stream corridors)
- Begin conversion of spruce-fir stands in single-cohort condition to a more complex, multi-cohort condition through use of silvicultural analogs derived from natural disturbance regimes:
    - Regeneration is encouraged by creation of canopy gaps
    - Gap size will vary with soils, site conditions, tree species composition, and focal species habitat requirements
    - Retain biological legacies within gaps
- Identify no-management areas where forests are allowed to develop without intervention
    - In particular, attempt to locate and protect spruce-fir remnants identified by Lapin and Engstrom as being greater than 40 years old.
- Incorporate snags, den trees, coarse woody material , super canopy trees, and canopy gaps into management prescriptions
- Collaborate with Vermont Electric Cooperative to manage their utility corridor, where appropriate, to support landscape-level ecological goals including early successional dependent wildlife populations
- During management actions, establish special management buffers and restricted management buffers along streams, unique natural communities, vernal pools, seeps, and rare plant locations as outlined on enclosed maps
- Collaborate with adjacent landowners and partners to support landscape level ecological goals,

where appropriate.
    - Site single cohort stands on refuge lands so they are adjacent to single cohort stands on adjacent lands to expand acres of habitat available for early successional species.

Monitoring Elements
- Conduct a post-harvest assessment of treated stands
- Use historical forest inventory and post-harvest data to model future landscape size class distribution
- Monitor no-treatment stands
- Monitor single-cohort stands to document potential use by focal species

5.3.1.2. Sub-objective 1.1b Habitat patch size

Maintain a variety of stand sizes and shapes, and design forest landscapes that are capable of supporting viable populations of species whose life-history requirements include large areas of contiguous forest. Over the long-term reduce mean early successional patch size through gap creation using historic ecological analogs (.001 to 0.1 ha openings over 10% of canopy per decade).

Spruce-fir natural community habitat patches will be managed for the following attributes:
- Reduced size and extent of single-cohort spruce-fir stands resulting from previous clearcutting
- Native conifer tree species dominated by red spruce, with balsam fir, tamarack, and white spruce as associates.
- Where possible, retain hemlock and white pine in the landscape
- Vertically differentiated canopies and variable horizontal density that includes small canopy gaps

Management Strategies:
- Identify existing single-cohort stands that may provide appropriate habitat conditions for single-cohort dependent focal species like rusty blackbird
- Where appropriate, begin conversion of large, single-cohort stands not required for rusty blackbird, to a more complex, multi-cohort condition through use of silvicultural analogs derived from natural disturbance regimes:
    - Regeneration is encouraged by creation of small canopy gaps
    - Gap size will vary with soils, site conditions, tree species composition, and focal species habitat requirements
    - Retain biological legacies within gaps
- Incorporate snags, den trees, coarse woody material , super canopy trees, and canopy gaps into management prescriptions
- During management actions, establish special management buffers and restricted management buffers along streams, unique natural communities, vernal pools, seeps, and Rare, Threatened and Endangered (RTE) plant locations as outlined on enclosed maps

Monitoring Elements
- Conduct a post-harvest assessment of treated stands
- Use historical forest inventory and post-harvest data to model future landscape size class distribution
- Monitor no-treatment stands
- Monitor single-cohort stands to document potential use by focal species

5.3.1.3. Sub-objective 1.1c Diversity of vertical and horizontal structure

At stand level, within single-cohort stands, establish a successful new cohort of regeneration (defined as > 50 percent milacre plots stocked with spruce or fir on primary sites) under as intact an overstory as site conditions and stocking levels will allow to provide breeding and foraging habitat for blackburnian and Canada warblers, potential denning sites for Canada lynx, as well as habitat for uncommon resident boreal species, migrating landbirds and wintering deer.

Spruce-fir natural community types will be managed for the following attributes:

- Native conifer tree species dominated by red spruce, with balsam fir, tamarack, and white spruce as associates.
- Where possible, retain hemlock and white pine in the landscape
- Vertically differentiated canopies and variable horizontal density that includes small canopy gaps
- Where possible, canopy closure of matrix forests is >75 percent
- Patchy openings, including shrub swamps, peatlands, and windfall gaps.
- Openings with <30 percent canopy closure within and adjacent to riparian zones and northern swamps that provide a regeneration 7-20' in height
- Increased density of trees >16" dbh, large, live and dead snags, downed woody material
- Free of non-native invasive herbaceous and woody plant species, and minimal impact from non-native insects and disease

<u>Management Strategies:</u>

- Where appropriate, convert uniform stands to a more irregular, multi-age structure by regenerating a portion of the stand while keeping the canopy of the surrounding matrix relatively intact and thus, unregenerated.
  - Follow an area-based approach, rather than a tree size approach, in regenerating portions of a stand
  - Area to be regenerated should average approximately one percent per year to mimic natural disturbance rates
  - Multiply regeneration rate by a cutting cycle of approximately 20 years in spruce-fir; regenerate approximately 20 percent of a stand in gaps during each entry
    - These may vary with the proportion of spruce-fir
    - On sites with a greater proportion, or the ability to support red spruce, consider extending restoration period greater than 100 years
  - Where possible, gaps should remain small to follow bounds of natural disturbances - in spruce-fir gaps should remain ¼ acre or smaller
    - Consider altering gap size to insure creation of suitable habitat for focal species
  - Individual trees of long-lived species should be retained within some gaps to restore late successional characteristics
    - Retain these individuals permanently, allowing them to reach ecological maturity, die, and replenish the pool of large, woody material on the forest floor.
  - Where appropriate, consider enrichment planting within gaps to favor regeneration of red spruce
  - Where appropriate, consider early stand tending within gaps to accelerate succession
- Leave high exposed perches adjacent to, or within wetlands, even-aged cuts and small patch openings
- Utilize mechanical, chemical or biological control to manageinvasive species
- Where possible, re-allocate basal area to larger diameter classes
- Where possible, retain three cavity trees or snags per acre between 14 and 20 in. DBH and one tree greater than 24 in. DBH; or live trees in these diameters likely to lead to cavity formation.
  - Maintain a component of decadent hardwood species in spruce-fir stands due to their ability to grow to larger sizes and have more cavities than spruce-fir
- In critical deer wintering areas maintain updated maps of critical areas and manage these stands, to the extent compatible with management of Federal trust resources, to ensure long-term continuation of this habitat. The overall target would be to maintain a minimum of 50 percent of a

deer wintering area as quality shelter at any point in time. Quality shelter includes softwood cover over 35 feet tall and 70 percent or higher crown closure.
- In appropriate stands, consider precommercial thinnings to accelerate diameter increment in remaining stems.
- Protect vernal pools, headwater streams, seeps, and RTE plant locations with appropriate buffers and management
- Recognize conversions of even-aged, single-cohort stand structures to a more complex, multi-aged, multi-cohort structure is a long process, requiring regularly regenerating small portions of a stand frequently.

Monitoring Elements:
- Conduct forest breeding bird surveys according to regional Service protocols to establish a less biased baseline data (past surveys were conducted on roads), monitor habitat management and track breeding bird trends on the Division.
- Establish Monitoring Avian Productivity Survivability banding stations in habitats utilized by Canada warbler and blackburnian warbler to determine reproductive success of these species, as well as other conifer forest breeding birds. Determine the appropriate sampling distance and assess habitat conditions (i.e. canopy cover, tree species composition, etc.) at these banding sites.
- Evaluate and monitor regeneration of conifer species including potential impacts from deer, and moose browsing.
- Collaborate with VFWD to conduct ground surveys of deer wintering area to assess deer use and snow depths, also assess use of managed travel corridors, and make changes to management prescriptions, if needed.
- Continue to participate in research assessing potential impacts of climate change on carnivore occupancy and snowshoe hare demography along elevational and latitudinal gradients in New England.
- Continue to monitor for the presence of lynx and use of Division habitats.
- Collaborate with USFWS New England Field Office to ensure refuge habitat management is adaptive and appropriate for lynx conservation in northern Vermont.
- Conduct migratory bird surveys according to regional Service protocols, or other appropriate protocols, to determine migrant use of Division habitats
- Determine the forest management treatment(s) that provides habitat conditions required for successful reproduction by Canada warbler.
  - In particular, create gap openings of varying sizes from ¼ acre and larger to monitor use by Canada warbler
- Identify areas used by breeding Canada warblers (based on point count survey, habitat conditions, and observations), and assess habitat quality and habitat use by Canada warbler

5.3.1.4. Sub-objective 1.1d Native tree-species composition

Where possible, over the long-term (100-200 years) and dependent upon site and successional stage considerations, restore tree-species composition within spruce-fir stands to more closely match pre-settlement composition (improve abundance of spruce species. to approximately > 35 percent stocking by volume).

Spruce-fir natural community types will be managed for the following attributes:
- Increased proportions of longer-lived species: red spruce, eastern hemlock, eastern white pine
- Decreased proportions of pioneer hardwood species: grey birch, white birch, aspen spp., red maple

Management Strategies:
- Where appropriate, in more uniform stands that lack much species diversity, take advantage of

opportunities to conserve legacy trees and advanced regeneration of longer-lived species
- Where appropriate, use enrichment plantings of long-lived species following overstory treatments
    - Under plant within canopy gap openings
    - Plant root stock in aggregations rather than spaced uniformly
- Utilize mechanical, chemical or biological control to manage invasive species
- Where appropriate, apply herbicides to combat interfering species
    - Treat pioneer hardwood species to favor softwood species
- Recognize conversions of even-aged, single-cohort stand structures with limited species diversity to a more complex, multi-aged, multi-cohort structure is a long process, requiring regularly regenerating small portions of a stand frequently.

Monitoring Elements:
- Conduct a post-harvest assessment of treated stands
- Conduct a pre-harvest assessment of treated stands to evaluate success of treatments

5.3.1.5. Sub-objective 1.1e Down woody material, snags, and cavity trees

Over the long-term, maintain or restore a range of sizes and types of downed woody material, snags, and cavity trees and retain or provide downed woody material, snags, and cavity trees in sites where they are lacking. Within 15 years and where possible, forest management action should retain approximately three snags greater than 14” DBH and one greater than 24” DBH per acre

Spruce-fir natural community types will be managed for the following attributes:
- Old trees, especially inclusions of deciduous species (e.g. aspen, birch)
- Broken, leaning, damaged and cavity trees where appropriate
- Trees with abundant epiphytic lichen flora
- Various sizes of fallen dead wood, especially large logs
- Standing dead trees (snags)

Management Strategies:
- Wherever possible retain existing cavity trees and snags
- Where possible, prevent whole-tree harvesting
- Where possible, girdle, damage, or push over larger-diameter trees to create tip up mounds, downed wood, and broken trees
- Utilize winter harvesting whenever possible to avoid crushing of existing downed material

Monitoring Elements
- Conduct a post-harvest assessment of treated stands
- Conduct a pre-harvest assessment of treated stands to evaluate success of treatments

5.3.1.6. Sub-objective 1.1f Stand-level Early Successional

Over the next 15 years, manage approximately 500 acres of spruce-fir forests in early successional stands in patch sizes of varying shapes to provide breeding habitat for rusty blackbirds, Canada warbler, and foraging habitat for Canada lynx.

Spruce-fir natural community types will be managed for the following attributes:
- Dense native tree saplings between 1-20 years old dominate regeneration - red spruce, with balsam fir, tamarack, and white spruce as associates
- Shrub species may include speckled alder, blueberry and pin cherry
- Stands will be located within the vicinity of alder wetlands, forested wetlands or floodplains

Management Strategies

- Where appropriate, use even-aged silviculture to treat softwood dominant stands
  - Favor use of shelterwood variants to provide microclimate conditions more favorable to red spruce regeneration
  - Retain biological legacies within even-aged treatment areas, including snags, cavity trees, perch trees, etc.
  - Under even-aged management, retain patches or scattered trees from the original stand, including several >12 in. DBH, into the next rotation. Uncut patches should amount to at least five percent of the harvest area with one snag or den tree >18 in. DBH as the patch nucleus.
- Where possible, preferentially treat stands in close proximity to important hydrologic conditions (e.g. shrub swamps, floodplain, forested wetlands or seeps)
- Utilize mechanical, chemical or biological control to manage invasive species
- Maintain connectivity of early successional habitat, where feasible, to provide travel corridors for species such as snowshoe hare
- Protect vernal pools, headwater streams, seeps, and RTE plant locations with appropriate buffers and management

Monitoring Elements

- Determine the most effective forest management treatments that provide habitat conditions required for successful reproduction by rusty blackbird. Identify areas used by breeding rusty blackbirds (based on point count survey, habitat conditions, and observations), and assess habitat quality and habitat use by rusty blackbirds.
- Continue to collaborate with NH Audubon Society to evaluate rusty blackbird productivity and survivorship, and determine habitat conditions that influence successful reproduction.
- Determine the most effective forest management treatments (e.g. clear-cut, shelterwood, selection) that provide habitat conditions required for successful reproduction by Canada warbler. Identify areas used by breeding Canada warblers (based on point count survey, habitat conditions, and observations), and assess habitat quality and habitat use by Canada warbler
- Collaborate with VFWD to evaluate snowshoe hare populations in the State:
  - establish baseline data for hare densities in the state,
  - evaluate forest conditions in the State and impacts on hare densities,
  - determine percentage of hare harvested by hunters and impact on hare densities,
  - determine factors that affect hunter participation and preferences
- Determine if it is feasible to manage habitats concurrently for rusty blackbird, Canada warbler, and snowshoe hare (main prey for lynx and other carnivores) using data collected from research projects above.
- Conduct migratory and breeding bird surveys according to regional USFWS protocols, or other appropriate protocols, to determine other bird species use of this successional stage

5.3.2. Objective 2.1. Hardwood forests

Improve the diversity of seral stages and (where and when possible) restore historic composition and structure for the diversity of species present, including American woodcock, black-throated blue warbler, blackburnian warbler and, northern long-eared bat and tricolored bat.

5.3.2.1. Sub-objective 2.1a Landscape-level size distribution

Restore a range of successional stages within hardwood and mixedwood communities informed by the habitat needs of focal species, and whose proportions are more closely aligned with historical disturbance regimes. Within 15 years, increase ratio of multi-cohort stands to single-cohort stands by rehabilitating approximately 2,100 acres with silviculture treatments designed to move stands toward an all-aged condition.

Hardwood natural community types will be managed to provide the following attributes:

- A mixture of successional stages
- Native hardwood and conifer tree species dominated by sugar maple, yellow birch, American beech, Eastern hemlock, red spruce, with balsam fir, tamarack, and white ash as associates.
- Where possible, retain uncommon associates including: black cherry, beech without signs of beech bark disease, hemlock and white pine in the landscape
- Patchy openings, including shrub swamps and windfall gaps.
- Cover of non-native invasive herbaceous and woody plant species is at zero percent, and minimal impact from non-native insects and disease

<u>Management strategies:</u>

- Create or maintain single-cohort stands using accepted silvicultural techniques where appropriate to benefit focal species
- Reduce acreage of stands in single-cohort condition through use of silvicultural analogs derived from natural disturbance regimes to move single-cohort stands toward a two-aged, or multi-cohort structure
    - regeneration is encouraged by creation of canopy gaps
    - initial return intervals are 15-20 years
    - gap size will vary with site conditions and species composition
    - biological legacies may remain after gap creation
- Identify no-management areas where forests are allowed to develop without intervention
- Incorporate snags, den trees, coarse woody material , super canopy trees, and canopy gaps into management prescriptions
- Collaborate with Vermont Electric Cooperative to manage their utility corridor, where appropriate, to support landscape-level ecological goals including early successional dependent wildlife populations such as American woodcock
- Establish special management buffers and restricted management buffers along streams, unique natural communities, vernal pools, seeps, and RTE plant locations

<u>Monitoring Elements</u>

- Conduct a post-harvest assessment of treated stands
- Use historical forest inventory and post-harvest data to model future landscape size class distribution

5.3.2.2. Sub-objective 2.1b Rehabilitation of degraded stands

Restore full site occupancy on approximately 1,600 acres of hardwood and mixedwood stands through retention of the highest quality trees while securing regeneration beneath the retained overstory, creating understory conditions that benefit black-throated blue warbler, Canada warbler, and American woodcock.

<u>Management Strategies:</u>

- Establish special management buffers and restricted management buffers along streams, unique natural communities, vernal pools, seeps, and RTE plant locations
- Utilize mechanical, chemical or biological control to manage invasive and or exotic pests and plants
- Survey stands pretreatment to identify residuals and existing regeneration
    - Identify acceptable growing stock
        - At least a lower codominant stem or equivalent within a cohort
        - At least 20-25 percent of height in live branches
        - No fruiting bodies or holes on mainstem

        - Fewer than 25 percent of major branches dead or dying

Stands where stocking is too low to allow traditional uneven-aged management:

Option A - No quality residuals

- Consider treating with even-aged clearcut to release advanced regeneration if present
    - Risk of failure is high if no advance regeneration is present

Option B - Some good residuals

- Find trees of decent vigor and quality
- Consider applying irregular shelterwood variant
- Leave them at appropriate spacing dependent upon variant
- Release advanced regeneration or establish a new age class
- Where appropriate, consider enrichment planting within understory to favor regeneration of red spruce/white pine/others

Stands where stocking will allow application of uneven-aged techniques:

- Convert uniform stands to a more irregular, multi-age structure by regenerating a portion of the stand while keeping the canopy of the surrounding matrix relatively intact and thus, unregenerated.
    - Follow an area-based approach, rather than a tree size approach, in regenerating portions of a stand
    - Area to be regenerated should average approximately one percent per year to mimic natural disturbance rates (Seymour et al. 2002)
    - Multiply regeneration rate by site-appropriate cutting cycle (approximately 15-20 years in mixedwood); regenerate approximately 15-20 percent of a stand in gaps during each entry
        - These may vary with the proportion of softwood to hardwood
        - On sites with a greater proportion, or the ability to support red spruce, consider extending restoration period greater than 100 years
    - Where possible, gaps should remain small to follow bounds of natural disturbances - in mixedwood, gaps should remain ¼ acre or smaller
        - Consider altering gap size to insure creation of suitable habitat for focal species
        - Consider enlarging gap size on appropriate sites to regenerate intolerant species (e.g. yellow birch)
    - Individual trees of long-lived species should be retained within some gaps to restore late successional characteristics
        - Retain these individuals permanently, allowing them to reach ecological maturity, die, and replenish the pool of large, woody material on the forest floor.
    - Where appropriate, consider enrichment planting within gaps to favor regeneration of red spruce/white pine/others
    - Where appropriate, consider early stand tending within gaps to accelerate succession

- Leave high exposed perches adjacent to, or within wetlands, even-aged cuts and small patch openings
- Utilize mechanical, chemical or biological control to manage invasive species
- Where possible, re-allocate basal area to larger diameter classes
- Where possible, retain three cavity trees or snags per acre between 14 and 20 in. DBH and one tree greater than 24 in. DBH; or live trees in these diameters likely to lead to cavity formation.

- In appropriate stands in stem exclusion, consider pre-commercial thinning to accelerate diameter increment in remaining stems.
- Protect vernal pools, headwater streams, seeps, and RTE plant locations with appropriate buffers and management
- Recognize conversions of even-aged, single-cohort stand structures to a more complex, multi-aged, multi-cohort structure is a long process, requiring regularly regenerating small portions of a stand frequently.

Monitoring elements

- Conduct a post-harvest assessment of treated stands
- Conduct a pre-harvest assessment of treated stands to evaluate success of treatments

5.3.2.3. Sub-objective 2.1c Native tree species composition

Where possible, over the long-term (100-200 years) and dependent upon site and successional stage considerations, restore/maintain tree-species composition within hardwood and mixedwood stands to more closely match pre-settlement composition (increase percent basal area of long-lived species to include red spruce, white birch, white pine, and disease-free American beech).

Hardwood natural community types will be managed for the following attributes:

- Native hardwood and conifer tree species dominated by sugar maple, yellow birch, American beech, eastern hemlock, red spruce, with balsam fir, tamarack, and white ash as associates.
- Where possible, retain uncommon associates including: black cherry, beech without signs of beech bark disease, hemlock and white pine in the landscape
- Viable and abundant advanced regeneration of desirable species

Management Strategies:

- Use enrichment plantings in canopy openings where advanced regeneration has failed
  - Plant softwood species (red spruce, white spruce, white pine)
  - Plant individuals in clusters

- Apply herbicide to interfering understory vegetation where regeneration of desired tree species is a possibility
- Treat all occurrences of invasive species within a stand with herbicide, mechanical pulling, or other recommended mitigation strategy

Monitoring elements:

- Collaborate with state and federal partners to monitor for invasive insects.
- Continue to monitor for invasive plant species while conducting other field inventory work. Consider using the Regional Invasive Species Inventory Protocol to map invasive species throughout the Division every five years. Monitor active management areas post-harvest on an annual basis for at least three years.

5.3.2.4. Sub-objective 2.1d Diversity of vertical structure

Over 15 years across 2,100 acres, establish a successful new cohort of regeneration of shade-tolerant and mid-tolerant species (defined as >50% milacre plots stocked with at least one stem between 3 feet tall and 1.5 inches dbh) under as closed a canopy as site conditions and stocking will allow to provide breeding and foraging habitat for blackburnian, Canada, and black-throated blue warblers.

Hardwood natural community types will be managed for the following attributes:

- Native hardwood and conifer tree species dominated by sugar maple, yellow birch, American beech, eastern hemlock, red spruce, with balsam fir, tamarack, and white ash as associates.

- Where possible, retain uncommon associates including: black cherry, beech without signs of beech bark disease, hemlock and white pine in the landscape
- Patchy openings, including shrub swamps and windfall gaps.
- Vertically differentiated canopies, variable horizontal density that includes small canopy gaps
- Where possible overall canopy closure is >70 percent
- Increased density of trees >16" dbh, large, live and dead snags, downed woody material , and presence of late successional lichens and bryophytes.
- Cover of non-native invasive herbaceous and woody plant species at zero percent, and minimal impact from non-native insects and disease

Management Strategies:

- Establish special management buffers and restricted management buffers along streams, unique natural communities, vernal pools, seeps, and RTE plant locations
- Utilize mechanical, chemical or biological control to manage invasive and or exotic pests and plants

Monitoring elements:

- Collaborate with state and federal partners to monitor for invasive insects.
- Continue to monitor for invasive plant species while conducting other field inventory work. Consider using the Regional Invasive Species Inventory Protocol to map invasive species throughout the Division every five years. Monitor active management areas post-harvest on an annual basis for at least three years.

On conifer- dominated sites

- Where acceptable growing stock will allow, convert uniform stands to a more irregular, multi-age structure by regenerating a portion of the stand while keeping the canopy of the surrounding matrix intact.
    - Follow an area-based approach, rather than a tree size approach, in regenerating portions of a stand
    - Area to be regenerated should average approximately one percent per year to mimic natural disturbance rates
    - Multiply regeneration rate by site-appropriate cutting cycle (approximately 15-20 years in mixedwood); regenerate approximately 15-20 percent of a stand in gaps during each entry
        - These may vary with the proportion of softwood to hardwood
        - On sites with a greater proportion, or the ability to support red spruce, consider extending restoration period greater than 100 years
    - Where possible, gaps should remain small to follow bounds of natural disturbances - in mixedwood, gaps should remain ¼ acre or smaller
        - Consider altering gap size to insure creation of suitable habitat for focal species
        - Consider enlarging gap size on appropriate sites to regenerate intolerant species (e.g. yellow birch)
    - Individual trees of long-lived species should be retained within some gaps to restore late successional characteristics
        - Retain these individuals permanently, allowing them to reach ecological maturity, die, and replenish the pool of large, woody material on the forest floor.
    - Where appropriate, consider enrichment planting within gaps to favor regeneration of red spruce
    - Where appropriate, consider early stand tending within gaps to accelerate succession

- Leave high exposed perches adjacent to, or within wetlands, even-aged cuts and small patch openings
- Utilize mechanical, chemical or biological control to manage invasive species
- Where possible, re-allocate basal area to larger diameter classes
- Where possible, retain three cavity trees or snags per acre between 14 and 20 in. DBH and one tree greater than 24 in. DBH; or live trees in these diameters likely to lead to cavity formation.
- In appropriate stands in stem exclusion, consider precommercial thinnings to accelerate diameter increment in remaining stems.
- Protect vernal pools, headwater streams, seeps, and RTE plant locations with appropriate buffers and management
- Recognize conversions of even-aged, single-cohort stand structures to a more complex, multi-aged, multi-cohort structure is a long process, requiring regularly regenerating small portions of a stand frequently.

On hardwood- dominated sites

- Where acceptable growing stock will allow, convert uniform stands to a more irregular, multi-age structure by regenerating a portion of the stand while keeping the canopy of the surrounding matrix relatively intact and thus, unregenerated.
    - Follow an area-based approach, rather than a tree size approach, in regenerating portions of a stand
    - Area to be regenerated should average approximately one percent per year to mimic natural disturbance rates
    - Multiply regeneration rate by site-appropriate cutting cycle (approximately 15-20 years in mixedwood); regenerate approximately 15-20 percent of a stand in gaps during each entry
        - These may vary with the proportion of softwood to hardwood
        - On sites with a greater proportion, or the ability to support red spruce, consider extending restoration period greater than 100 years
    - Where possible, gaps should remain small to follow bounds of natural disturbances - in mixedwood, gaps should remain ¼ acre or smaller
        - Consider altering gap size to insure creation of suitable habitat for focal species
        - Consider enlarging gap size on appropriate sites to regenerate intolerant species (e.g. yellow birch)
    - Individual trees of long-lived species should be retained within some gaps to restore late successional characteristics
        - Retain these individuals permanently, allowing them to reach ecological maturity, die, and replenish the pool of large, woody material on the forest floor.
    - Where appropriate, consider enrichment planting within gaps to favor regeneration of red spruce
    - Where appropriate, consider early stand tending within gaps to accelerate succession
- Leave high exposed perches adjacent to, or within wetlands, even-aged cuts and small patch openings
- Utilize mechanical, chemical or biological control to manage invasive species
- Where possible, re-allocate basal area to larger diameter classes
- Where possible, retain three cavity trees or snags per acre between 14 and 20 in. DBH and one tree greater than 24 in. DBH; or live trees in these diameters likely to lead to cavity formation.
- In appropriate stands in stem exclusion, consider precommercial thinnings to accelerate diameter increment in remaining stems.
- Protect vernal pools, headwater streams, seeps, and RTE plant locations with appropriate buffers and management

- Recognize conversions of even-aged, single-cohort stand structures to a more complex, multi-aged, multi-cohort structure is a long process, requiring regularly regenerating small portions of a stand frequently.

Monitoring Elements:

- Conduct forest breeding bird surveys according to regional Service protocols to establish a less biased baseline dataset (past surveys were conducted on roads), monitor habitat management and track breeding bird trends on the Division.
- Establish Monitoring Avian Productivity Survivability banding stations in habitats utilized by black-throated blue and blackburnian warblers to determine reproductive success of these species, as well as other hardwood and mixedwood forest breeding birds. Determine the appropriate sampling distance and assess habitat conditions (i.e. canopy cover, tree species composition, etc.) at these banding sites.
- Evaluate and monitor regeneration of shrub species including potential impacts from deer and moose browsing.

5.3.2.5. Sub-objective 2.1e Downed woody material, snags, and cavity trees

Over the long-term, maintain or restore a range of sizes and types of downed woody material, snags, and cavity trees and retain or provide downed woody material, snags, and cavity trees in sites where they are lacking. Within 15 years and where possible, forest management action should retain approximately three snags greater than 14” DBH and one greater than 24” DBH per acre

Management Strategies

- Avoid damaging existing downed woody material during harvesting, especially large (16”+) hollow logs and stumps
- Leave downed woody material on site
- Leave several downed logs well distributed on site - pulpwood logs as long and large as is possible
    - Hollow butt log sections are good choices
- Retain 3-5 percent of stocking, where possible, to become cavity trees
- In stands managed using even-aged techniques - leave uncut patch approximately 0.25 acres for each ten acres harvested
- Maintain softwood inclusions in hardwood forests
- Retain live trees with cavities

5.3.2.6. Sub-objective 2.1f Maintenance of single-cohort stands (Early successional)

Over the next 15 years, manage approximately 287 acres of hardwood forest types in early successional stands in patch sizes of varying shapes, between 5 to 20 acres to provide breeding habitat for American woodcock.

Hardwood natural community types will be managed for the following attributes:

- Dense native tree saplings between 1-40 years old dominate regeneration - red maple, aspen, paper birch, yellow birch, and balsam fir
- Shrub species may include speckled alder and pin cherry
- Herbaceous cover may include raspberry, blackberry, goldenrod, ferns, and spirea
- Stands will be located within the vicinity of alder wetlands or floodplains

Management Strategies:

- Employ the even-age forest management clearcut method in varying sizes and shapes in a shifting mosaic that does not infringe on the integrity or longevity of late seral stage forests, and does not exceed 50 acres in size for a given area. Once four age classes are established following the WMDU Woodcock Management Plan, use a 40 year rotation age with four age class distributions (0-10 years, 10-20 years, 20-30 years, and 30-40 years)

- Use even-aged management on aspen stands adjacent to identified beaver meadows
- Retain snag aspen trees >10"dbh for yellow-bellied sapsucker not directly adjacent to beaver meadows.
- Where appropriate, apply shelterwood method to establish regeneration of desired tree species prior to treatments that provide an early successional forest stage of development
- Utilize retention trees, patches, and an irregular shelterwood system to the extent possible to emulate more large-scale natural disturbances
- Continue to manage the woodcock habitat demonstration areas according to the management plan
- Utilize mechanical, chemical or biological control to manage invasive species
- Work with Vermont Electric Company to manage power-line right of way to provide suitable early successional habitat
- Use accepted silvicultural practices in woodcock focus areas to create and sustain early successional habitat for American woodcock and Canada warbler.
    - Cutting cycles will be approximately 8-10 years on a 40 year rotation. Some 3-5 acre openings may be permanently maintained primarily by mowing and brush clearing using mechanized equipment.
    - Perpetuate aspen-birch communities where they exist, and strive to achieve an appropriate distribution of regenerating, young, mid and mature age classes

Monitoring Elements:

- Continue to monitor woodcock use of Woodcock Demonstration Management Units (WDMU) by conducting singing male surveys, roost surveys, and other monitoring efforts
- Monitor other breeding bird use of this seral stage, specifically targeting post-breeding birds
- Evaluate and monitor regeneration of shrub species including potential impacts from deer and moose browsing.
- Continue efforts to determine best mowing regime or other management techniques (ie burning) to maintain appropriate roosting habitat conditions.
- Monitor WDMU for breeding Canada warbler. Determine the most effective forest management treatments that provide habitat conditions required for successful reproduction of Canada warbler.
- Determine if it is feasible to manage habitats concurrently for Canada warbler, American woodcock and snowshoe hare (main prey for lynx and other carnivores) using data collected from research projects above.

5.3.3. **Objective 3.1** (Shrub Swamps and Floodplain Forest)

Manage shrub swamp and floodplain forest communities to support natural and rare ecological communities, and provide foraging habitat for priority refuge resources of concern including American woodcock and American black duck. Priority will be to maintain the alder-dominated shrub swamps within the Woodcock Management Units.

5.3.3.1. Sub-objective 3.1a Diverse Floodplain Communities

Perpetuate approximately 400 acres of floodplain natural communities to provide habitat for American woodcock, American black duck, cavity nesting waterfowl, and other species of conservation concern such as wood turtle.

Floodplain natural communities will be managed for the following attributes:

- Native tree species, including, where appropriate, black ash, white spruce, balsam fir, paper and yellow birches, and northern white cedar
- Native shrubs including, where appropriate, speckled alder, beaked hazel, mountain maple, black elderberry, highbush cranberry and red-osier dogwood
- Herbaceous species such as sedges and grasses, goldenrod, tall meadow-rue, sensitive fern, lady fern, mountain wood-sorrel, and virgin's-bower
- Moderate to closed canopy in forested communities
- Natural hydrologic function

Management Strategies

- Along first and second order streams, maintain a 50 ft no-management riparian buffer; along third, fourth, and fifth order streams maintain a 100 ft no-management riparian buffer
- Manage highly invasive non-native plant species (ie. buckthorn, phragmites, knotweed)
- Maintain natural hydrologic dynamics
- Retain cavity trees within a range of diameter classes on the edge of open water to provide roosting and nesting areas

Monitoring Elements

- Monitor on a biannual basis for the presence of non-native invasive species
- Conduct breeding bird surveys according to regional Service protocols to establish a less biased baseline dataset (past surveys were conducted on roads), monitor habitat management and track breeding bird trends on the Division
- Monitor bat populations, as needed, using acoustic surveys. Evaluate areas with a high density of feeding activity to determine if roosting habitat is being used in the vicinity, and in need of protection and management.
- In collaboration with the Wood Turtle Working Group and other partners, monitor wood turtle populations following USFWS protocol. Evaluate head start programs and other ways to enhance division population.

5.3.3.2. Sub-objective 3.1b Diverse Shrub Swamp Communities

Perpetuate approximately 290 acres of shrub- swamp natural communities as foraging habitat for American woodcock, rusty blackbird, and American black duck.

Shrub swamp natural communities will be managed for the following attributes:

- Native shrubs including speckled alder, wild raisin, *Spirea* and willow
- Native grasses, rushes and sedges
- Seasonal to permanent shallow water inundation
- Often adjacent to emergent marsh and sedge meadows

Management Strategies

- Allow natural patterns of vegetative and hydrologic change, including beaver dam cycle to occur
- In woodcock focus areas (see Appendix **Error! Reference source not found.** Map 2) manage shrub-swamps in proximity to upland nesting areas. Create and maintain alder in suitable age/size class to maintain quality foraging and brood areas. Alder would be maintained on approximately 20-year rotations.
- Retain cavity trees and snags that are located on the edge of flooded shrub swamp communities for cavity nesting waterfowl such as wood ducks.
- Manage highly invasive non-native plant species (ie. buckthorn, phragmites, knotweed)

Monitoring Elements

- Continue to monitor woodcock use of WDMU by conducting singing male surveys, roost surveys, and other monitoring efforts
- Continue to monitor for invasive plant species while conducting other field inventory work. Consider using the Regional Invasive Species Inventory Protocol to map invasive species throughout the Division every five years. Monitor active management areas post-management on an annual basis for at least three years.
- Monitor use of flooded wetlands by waterfowl to determine use of habitat and reproductive success
- Conduct breeding bird surveys according to regional Service protocols to establish a less biased baseline dataset (past surveys were conducted on roads), monitor habitat management and track breeding bird trends on the Division
- Monitor bat populations, as needed, using acoustic surveys. Evaluate areas with a high density of feeding activity to determine if roosting habitat is being used in the vicinity, and in need of protection and management.

5.3.4. **Objective 2.1 (Peatlands)**

Manage peatland communities to support natural and rare ecological communities, and provide breeding and foraging habitat for priority refuge resources of concern including American black duck.

5.3.4.1. Sub-objective 2.1a Maintain Peatland Community Diversity

Maintain the species composition, natural hydrologic and nutrient regimes, and the mosaic of vegetation structure within approximately 265 acres of peatland natural communities to provide habitat for a diversity of species including those that are rare or uncommon, regionally significant and species of conservation concern such as the American black duck.

Peatland natural communities will be managed for the following attributes:

- Stable water table at or near the soil surface.
- Sphagnum moss and liverworts are consistently abundant.
- Presence of low heath shrubs such as sheep and bog laurels, labrador tea, leatherleaf, *Rhodora*, bog rosemary, small cranberry and velvetleaf blueberry.
- Grasses and sedges include hare's tail cottongrass, three-seeded sedge, few-flowered sedge, and white beakrush.
- Presence of scattered to locally abundant stunted (<30 feet tall) black spruce and tamarack

Management Strategies:

- Use Best Management Practices regarding buffer zones, water quality, and other minimum impact practices when conducting active forest management in proximity to peatlands communities
- Restore the flow of water to a natural hydrologic regime in areas that are being impacted by unnatural drainage or impoundment
- Utilize passive management to allow natural processes to create, enhance, or maintain structural and biological diversity

Monitoring Elements

- Collaborate with Vermont Natural Heritage Program to identify and monitor rare species occurrences within peatland natural communities
- Conduct a hydro-geologic study of groundwater and nutrient flow that are maintaining refuge peatlands. Address issues or threats as necessary.
- Monitor use of peatland communities by waterfowl and rusty blackbird

- Conduct breeding bird surveys according to regional USFWS protocols to establish a less biased baseline dataset (past surveys were conducted on roads), monitor habitat management and track breeding bird trends on the Division

5.3.5. **<u>Objective 2.2</u> (Biological Integrity, Biological Diversity, and Environmental Health)**

Where and when appropriate, protect or restore habitats absent an identified species of conservation concern, recognizing the importance of all habitats in contributing to the biological integrity, diversity, and environmental health of refuge lands and the Watershed.

5.3.5.1. Sub-objective 2.2a. Diversity of Wetland Species

Protect water quality and natural hydrology, and maintain native species diversity within approximately 165 acres of refuge freshwater emergent marshes.

Freshwater emergent marsh natural communities will be managed for the following attributes:

- Mineral or shallow organic soils that are moist to saturated and inundated in the spring. Spring flooding with water depths around two feet. Summer water depths around two inches or exposed saturated soils.
- Grasses, sedges and herbs include bluejoint grass, rice cut-grass, bulrush, Joe-pye weed, white boneset, flat-topped aster, white turtlehead, sweet flag, narrow-leaf cattail and marsh fern.
- Less than 25 percent cover of scattered shrubs such as meadow-sweet, steeplebush, willows and speckled alder.

<u>Management Strategies:</u>

- Use Best Management Practices regarding buffer zones, water quality, and other minimum impact practices when conducting active forest management in proximity to emergent marsh communities
- Restore the flow of water to a natural hydrologic regime in areas that are being impacted by unnatural drainage or impoundment
- Utilize passive management to allow natural processes to create, enhance, or maintain structural and biological diversity
- Manage invasive plant species

Monitoring Elements

- Monitor use of emergent wetland communities by waterfowl
- Conduct breeding bird surveys according to regional Service protocols to establish a less biased baseline dataset (past surveys were conducted on roads), monitor habitat management and track breeding bird trends on the Division
- Monitor invasive plant management efforts

5.3.5.2. Sub-objective 2.2b. Diversity within Montane Communities

Maintain native species diversity of rocky outcrop and cliff and talus habitats within approximately 442 acres of refuge montane communities.

Rocky outcrop and cliff and talus habitats within montane natural communities will be managed for the following attributes:

- Areas with bare rock and sparse vegetation on shallow, dry soils
- Presence of scattered, low trees such as pin cherry, paper birch, heart-leaved paper birch, balsam fir and red spruce.
- Presence of scattered shrubs such as American mountain-ash and mountain maple.

Management Strategies:

- Utilize passive management to allow natural processes to create, enhance, or maintain structural and biological diversity

Monitoring Elements

- Continue to monitor for invasive plant species while conducting other field inventory work. Consider using the Regional Invasive Species Inventory Protocol to map invasive species throughout the Division every five years.
- Conduct breeding bird surveys according to regional USFWS protocols to establish a less biased baseline dataset (past surveys were conducted on roads), monitor habitat management and track breeding bird trends on the Division

5.3.6. **Objective 3.1** (Open Water Habitat)

In collaboration with the State and other partners, manage water resources and riparian areas to provide cold temperature regimes where appropriate, substrate diversity, and unimpeded fish passage that benefit priority refuge resources of concern including Eastern brook trout and Atlantic salmon. Also provide undisturbed breeding and foraging habitat for American black duck, and other waterfowl species.

5.3.6.1. Sub-objective 3.1a Improve Stream Function

In collaboration with the Vermont Agency of Natural Resources and Trout Unlimited increase brook trout populations by improving stream function through strategic wood additions within approximately 8 miles of stream habitat within the North Branch, Black Branch, Yellow Branch and Logger Branch of the Nulhegan River, as well as Tim Carroll Brook and Whisky Brook.

5.3.6.2. Sub-objective 3.1b Evaluate Additional Stream Restoration Sites

In collaboration with the Vermont Agency of Natural Resources and Trout Unlimited assess approximately 10 miles of stream within the North Branch and Black Branch of the Nulhegan River to evaluate the potential for additional brook trout habitat improvements using instream engineered structures.

5.3.6.3. Sub-objective 3.1c Restore Aquatic Organism Passage

In collaboration with the Vermont Agency of Natural Resources and Trout Unlimited restore aquatic organism access to over 17 miles of stream.

Stream habitats will be managed for the following attributes:

- Clear passage (i.e., lack of unnatural physical barriers) for aquatic organisms moving upstream or downstream in search of spawning habitat, cover, forage, or appropriate water temperatures.
- Stream corridors that meet State Aquatic Organism Passage standards and guidelines (i.e., culverts and bridges do not adversely affect the upstream passage of fish, mammals, amphibians, and reptiles).
- Establish and/or maintain equilibrium conditions and stable morphology in flowing waters.
- Presence of at least 150 pieces of at least 10 cm diameter woody material per hectare of stream to provide channel roughness and cover for fish.
- Vegetated stream bank and maximum canopy coverage.
- Native riparian trees along stream banks to provide shade and natural recruitment of wood and leaves that will ultimately feed aquatic invertebrates.

Management Strategies:

- Collaborate with VFWD and TU in stream restoration efforts, which may include:

    - Strategic Wood Additions: Use a chainsaw to strategically fell trees into the stream to create woody fish habitat structures.
    - Strategic Boulder Placement*:* Use grip-hoist methods to move in-stream boulders to create fish habitat structures and enhance point bars.
    - Static Whole Tree Additions: Whole trees with intact root wads that are still partially attached to the ground will be felled as a part of strategic wood addition structures. Single whole tree additions will also be used to modify flow and provide cover, in areas where the likelihood of movement is high for a sawn tree.
    - Mobile Whole Tree Additions: Use grip-hoist to remove whole trees, including the root ball, from the forest and strategically place them in the stream with the expectation that they will move downstream and secure themselves, then begin recruiting new wood and forming fish habitat.
- Continue to identify and replace culverts that are possible barriers to fish and other aquatic species passage
- Collaborate with VFWD and TU to continue to assess stream conditions and prioritize restoration efforts.
- Establish a 1,000' Special Management Zone forest buffer around rivers/streams (see Chapter 5.1.15.1.1 for details).

Monitoring Elements:
- Assist VFWD and TU in fish population sampling in rivers and streams
- Collaborate with VFWD and TU to monitor stream temperatures using temperature loggers
- Assist VFWD and TU to monitor stream restoration using a standardized protocol.

5.3.6.4. Sub-objective 3.1d Restore Lewis Pond Water Quality and Native Fisheries

In collaboration with the Vermont Agency of Natural Resources restore water quality and the native brook trout population in Lewis Pond within 15 years.

Lewis Pond aquatic communities will be managed for the following attributes:
- Self-sustaining native brook trout and other native aquatic species populations
- Native aquatic vegetation including water lilies
- Sandy/rocky bottom
- Intact natural communities within 1,000' buffer along the shoreline

Management Strategies:
- Collaborate with VFWD to evaluate best management options to restore native brook trout populations
- Maintain intact natural communities that surround the pond, and establish a 1000' no commercial forest management buffer around pond
- Collaborate with VDEC to determine best management options to restore water quality
- Retain cavity trees and snags located on the edge of the pond for cavity nesting waterfowl.
- Continue to work with volunteers to maintain the two wood duck boxes established on pond periphery.

Monitoring Elements:
- Continue to work with VFWD to monitor fish populations in Lewis Pond
- Continue to collaborate with Vermont Center for Ecostudies to monitor Common Loons
- In conjunction with the loon monitoring, also monitor other waterfowl species use of Lewis Pond and adjacent wetland habitats

6. Implementation

To facilitate implementation, the Management Units (MUs) and uplands considered for forest management were evaluated and prioritized using a combination of GIS data, and consultation with refuge staff and other experts. To stay within our goal of managing 4,500 forested acres during the life of this plan (Chapter 5.1.2), we prioritized the Management Units.

Table 6.1 shows the variables used to prioritize each Management Unit (MU). GIS analytical tools were used to develop these variables, and models were built to streamline the process. The variables include mean Euclidean distance of the unit to gravel roads and VT Route 105, the proportion of the unit with merchantable wood, the proportion of the unit with a moderate (HSI 3 or 0.34-0.47) Habitat Suitability Index for each of the four species, and the proportion of the unit that encompasses the deer wintering area. The following provides an explanation for the reasons behind the variable selection and ranking.

Variables: "Mean Euclidean Distance of the Unit to a Gravel Road" and "Mean Euclidean Distance of the Unit to VT Route 105"
Prioritization: The lower the mean distance equals a higher ranking.
Reason: The cost to the logger is lower (e.g. fuel and transportation costs) when access to well-maintained roads are a short distance from the harvest location.

Variable: "Proportion of the Unit with Merchantable Wood"
Prioritization: The higher the proportion of merchantable wood equals a higher ranking
Reason: A high proportion of merchantable wood provides more areas in the unit for commercial management. The cost to the logger is lower if harvest equipment is dedicated to one area.

Variable: "The Proportion of the Unit with a Moderate Habitat Suitability Index for Each of the four Species"
Prioritization: The higher the proportion of moderate HSI equals a higher ranking. Our ranking also captures the Units that provide benefits to multiple species.
Reason: We are assuming that a moderate HSI has few appropriate breeding habitat conditions, and management has the ability to improve these conditions. We are assuming that areas with a high HSI are currently providing the required breeding habitat conditions, and areas with low HSI are not suitable for the species or cannot be improved through active management.

Variable: "The Proportion of the Unit that Encompasses the Deer Wintering Area"
Prioritization: The higher the proportion equals a higher ranking
Reason: The deer wintering area was degraded in the 1980's, and current conditions are improving, but not ideal for wintering deer. Our management of this area will benefit wintering deer. Adding this variable into the Unit prioritization emphasizes the need to improve conditions.

Through this evaluation and prioritization process, each MU received a ranking between one and ten. The assumption is the MU with a ranking of one has higher value (based on the variable used) than a MU ranked at ten. Prioritizing habitat management within the higher ranked MUs will likely prove to be more economically feasible, and improve habitat conditions for multiple species at a larger scale. Our management approach, therefore, will be to manage and monitor forested habitats within the MUs in ranked order, beginning with the Peanut Dam Unit. It is important to note, that it is not practical to determine the number of MUs that will be managed over the next 15-years, as numerous factors will influence management of habitats such as weather, the economy of the lumber industry, and refuge staffing and funding. It is to be expected there will be some MUs where the forests will not be managed in the next 15-years, as well as stands within high management priority MUs that will not be treated. The following Management Unit profiles have been created to inform resource managers and assist with prioritization and preparation of forest management treatments in the next 15 years.

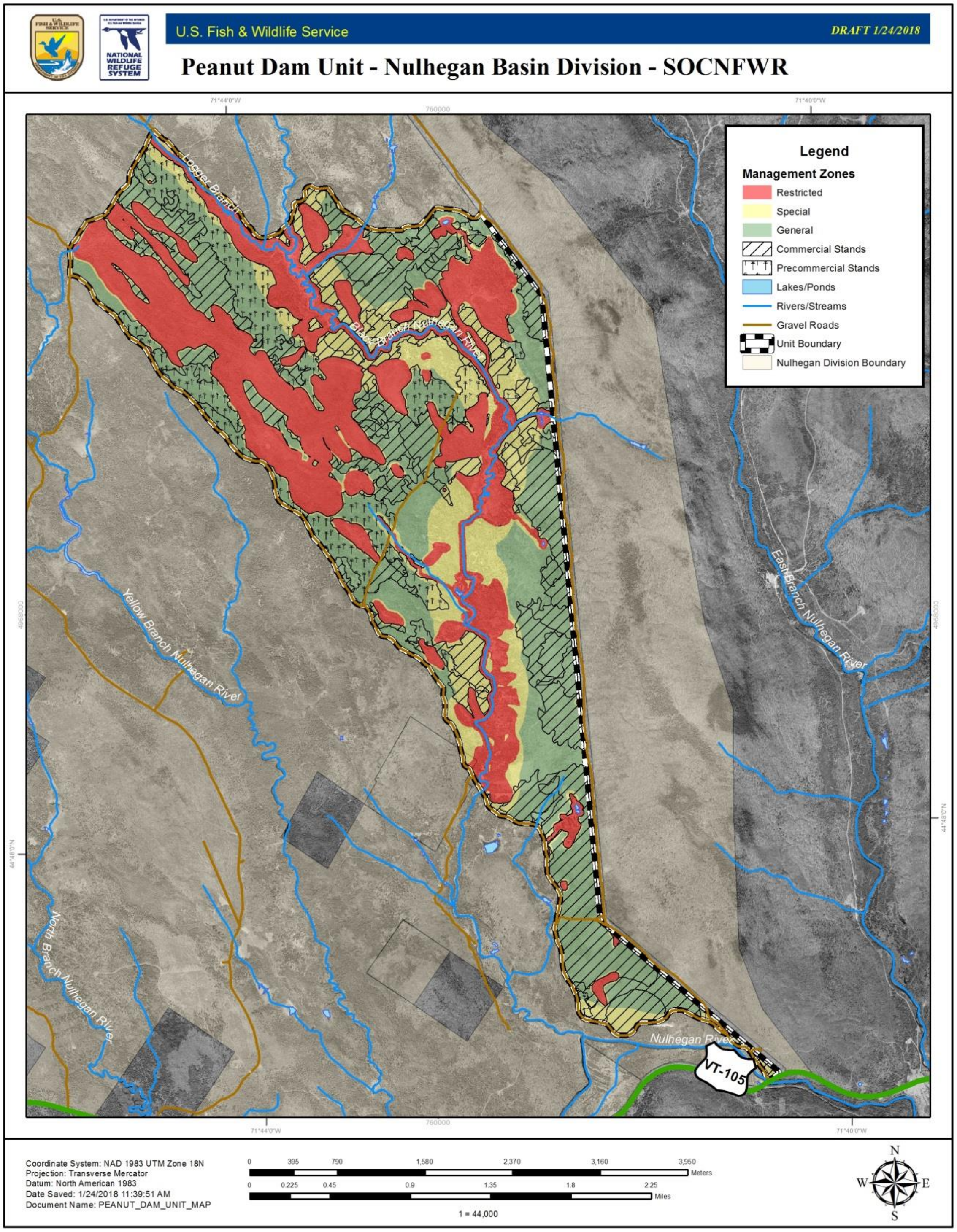
Table 6.1 Summary Variables Informing Management Unit Prioritization

Unit	Mean Euclidean Distance to Gravel Roads (meters)	1-10 Ranking	Mean Euclidean Distance to VT Route 105 (meters)	1-10 Ranking	(%) with Merchant able Wood	1-10 Ranking	(%) with a Moderate HSI for Blackburnian Warbler (HSI 3)	1-10 Ranking	(%) with a Moderate HSI for Black-throated Blue Warbler (HSI 3)	1-10 Ranking	(%) with a Moderate HSI for Canada Warbler (HSI 0.34-0.47)	1-10 Ranking	(%) with a Moderate HSI for Rusty Blackbird (HSI 0.34-0.47)	1-10 Ranking	(%) that Encompass the Deer Wintering Area	1-10 Ranking	Sum of Rankings (low number = high priority)
Peanut Dam	229.49	2	5739.43	4	35.28	6	35.76	6	46.18	7	27.04	7	32.75	1	64.82	2	**35**
Yellow Branch	353.97	7	3048.34	2	39.62	5	33.46	9	52.10	2	34.68	5	16.58	4	85.99	1	**35**
Mollie Beattie	258.74	4	7326.75	6	43.44	4	47.40	4	47.93	6	43.02	1	19.24	3	0.04	10	**38**
North Branch	301.87	6	3229.39	3	31.07	8	35.18	7	54.68	1	40.79	2	0.00	10	60.33	3	**40**
Logger Branch	256.19	3	9856.42	7	54.99	2	51.73	2	48.72	5	33.36	6	1.53	6	0.03	10	**41**
Black Branch	186.25	1	10138.87	8	48.60	3	49.96	3	40.31	8	37.46	4	5.96	5	0.01	10	**42**
Potash Range	482.31	9	6122.83	5	70.99	1	69.33	1	24.97	9	26.02	8	0.00	10	0.00	10	**53**
Lewis Pond	286.71	5	11341.83	9	31.72	7	34.79	8	51.86	3	38.57	3	0.00	10	0.00	10	**55**
Nulhegan River	1022.36	10	181.40	1	23.43	10	18.24	10	19.63	10	25.25	9	21.58	2	55.19	4	**56**
Lewis Mountain	361.03	8	13366.13	10	28.64	9	39.98	5	48.81	4	13.83	10	0.00	10	0.00	10	**66**

6.1. Peanut Dam Unit

The Peanut Dam Unit is approximately 3,704 acres. This area is also known as “Yellow Bogs,” a name often used by the local community to describe the topography and vegetative characteristics within the lower elevations of the eastern half of the Nulhegan Basin. This area of the basin contains large tracts of wet-mesic and well drained lowland spruce-fir forest including numerous swamps and bogs. This unit encompasses a large portion of the “Yellow Bogs,” containing some of the largest patches of wet-mesic lowland spruce-fir forest communities. The Black Branch of the Nulhegan River meanders slowly through this unit. This portion of the river comprises long stretches of the stream natural community types most characteristic of the basin bottom. Land in this MU is fee-owned land managed as Refuge. About 1,288 acres are within a restricted management zone, 801 acres are within a special management zone and 1,611 acres are within a general management zone (Figure 6.1.1 Peanut Dam Unit).

Figure 6.1.1 Peanut Dam Unit



Management Considerations: Unit Priority

Ranking: 1

Reasons for Ranking: See Table 6.1 Summary Variables Informing Management Unit Prioritization

Management Considerations: Focal Species

Based on current information, the focal species for this unit are Canada warbler, black-throated blue warbler, blackburnian warbler, rusty blackbird, and American woodcock. We will focus habitat management within stands that currently have a moderate species Habitat Suitability Index (HSI) (see Chapter 3.5.1 and summary text below). Stands will be evaluated in the field to determine the best management approach. If this unit is NOT managed within the next 15 years due to its low ranking or unforeseen circumstances, the HSIs will be re-evaluated using updated species information and/or refuge habitat data, if available. Provided below is an estimated area of the unit with moderate HSI for each species.

Canada warbler: The Canada warbler HSI map estimates that approximately 27 percent of this unit or 1,002 acres has moderate habitat suitability for this species.

Black-throated blue warbler: The black-throated blue warbler HSI map estimates that approximately 46 percent of this unit or 1,711 acres has moderate habitat suitability for this species.

Blackburnian warbler: The blackburnian warbler HSI map estimates that approximately 36 percent of this unit or 1,325 acres has moderate habitat suitability for this species.

Rusty blackbird: The rusty blackbird HSI map estimates that approximately 33 percent of this unit or 1,212 acres has moderate habitat suitability for this species.

American woodcock: A 134 acre Woodcock Habitat Management Demonstration Unit is located in this unit, and will continue to be managed to promote the habitat needs for breeding and migrating woodcock.

Management Considerations: Forest Characteristics

Site Capability: The Peanut Dam Unit is dominated by softwood natural communities. The mixedwood natural communities occur as a thin strip to the east as you move up in elevation. The primary softwood sites off of Peanut Dam Road may present an opportunity for rusty blackbird management.

Figure 6.1.2 Natural communities in Peanut Dam Unit

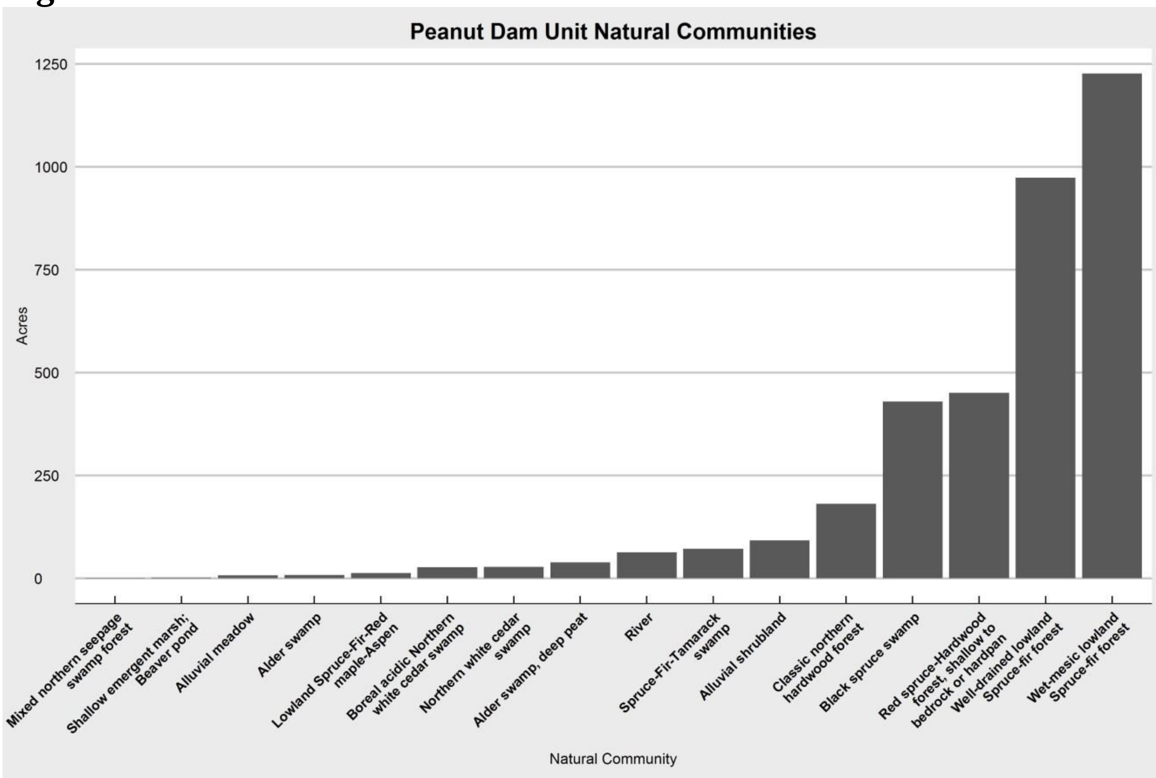


Figure 6.1.3 Complex forest structure within Peanut Dam Unit

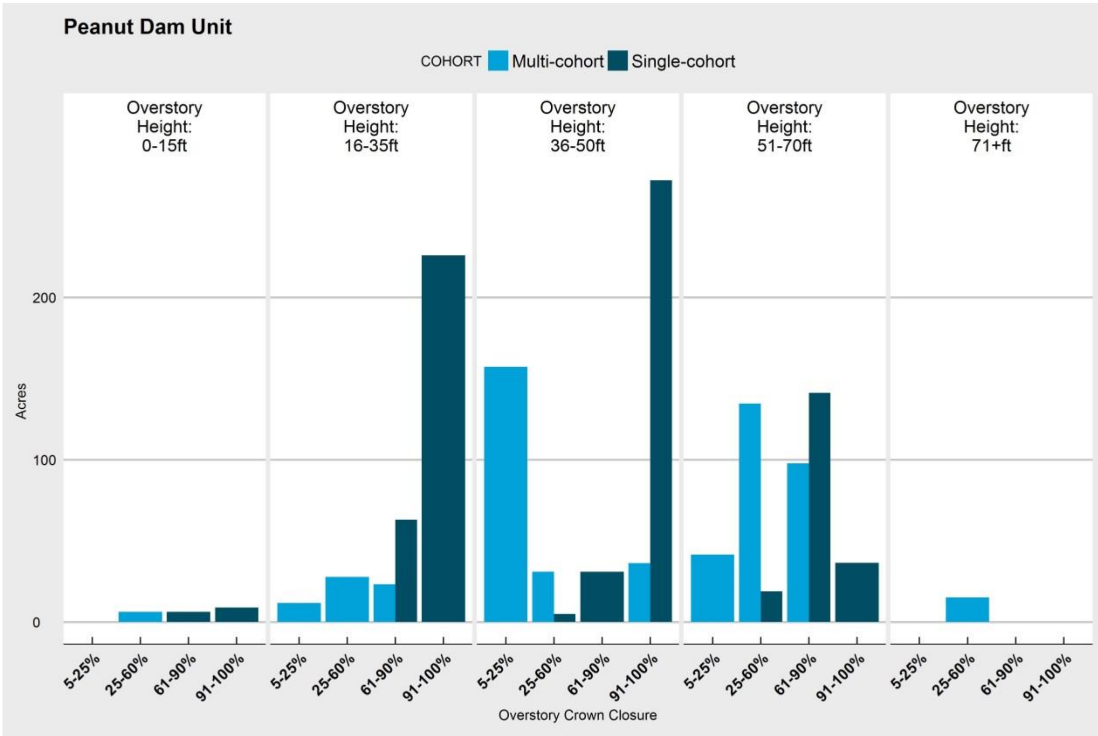
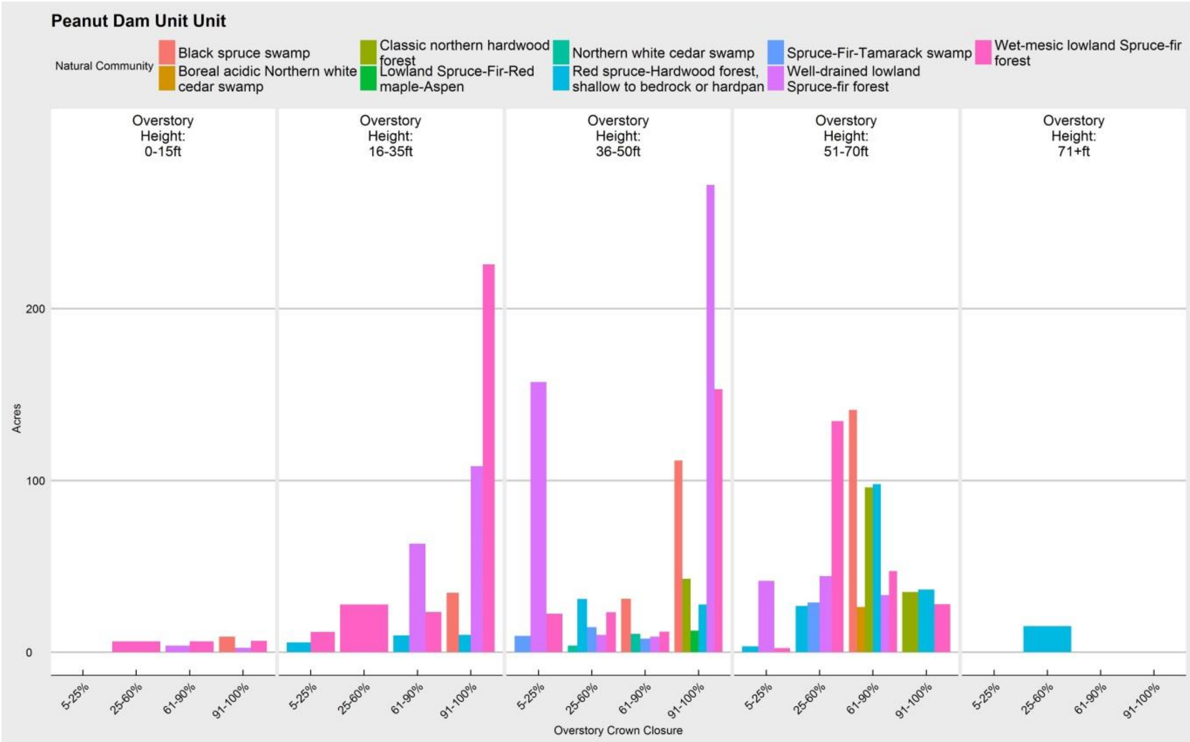


Figure 6.1.4 Canopy height and crown closure by natural community - Peanut Dam Unit



Rare, Exemplary, and Unique plants and communities: State uncommon and rare plant species that occur in this unit include drooping bluegrass, large leaved avens, auricled twayblade, mountain fly-honeysuckle, moose dung moss, lingonberry, swamp thistle, fall dropseed muhly, and pendulous bulrush. Spruce grouse a state endangered species also occupies habitats in this Unit. Black spruce swamp and black spruce woodland bog natural communities occur mostly in the northern portion of this unit. These natural communities are rare in the state, and the majority of them are in excellent condition.

Deer Wintering Area: A large portion of this unit is within the Nulhegan Basin deer wintering area. Our forest management will provide suitable shelter characteristics within the conifer-dominated forests, and woody browse.

Management Considerations: Other

- This unit consists of numerous forested and shrub wetlands, including the largest mixed northern seepage swamp on the Refuge, and one of the best examples of black spruce swamp in Vermont.
- Many of the forested wetlands have not been harvested, though there are a few exceptions.
- Historic dams located at the logger-black branch confluence and black branch impounded water to facilitate log drives. These dams are no longer present, and impacts to the natural communities in this area are unclear.
- Long stretches of the stream natural community types most characteristic of the basin bottom flow through this unit.
- This unit is one of two large contiguous acre blocks that is not fragmented by maintained gravel roads.
- This unit contains some of the largest patches and acreage of older forest.
- These lands are located in the town of Bloomfield and Lewis.

- The primary access would be on Canal and Stone Dam Roads. Furthest point from VT Route 105 is approximately 8 miles.

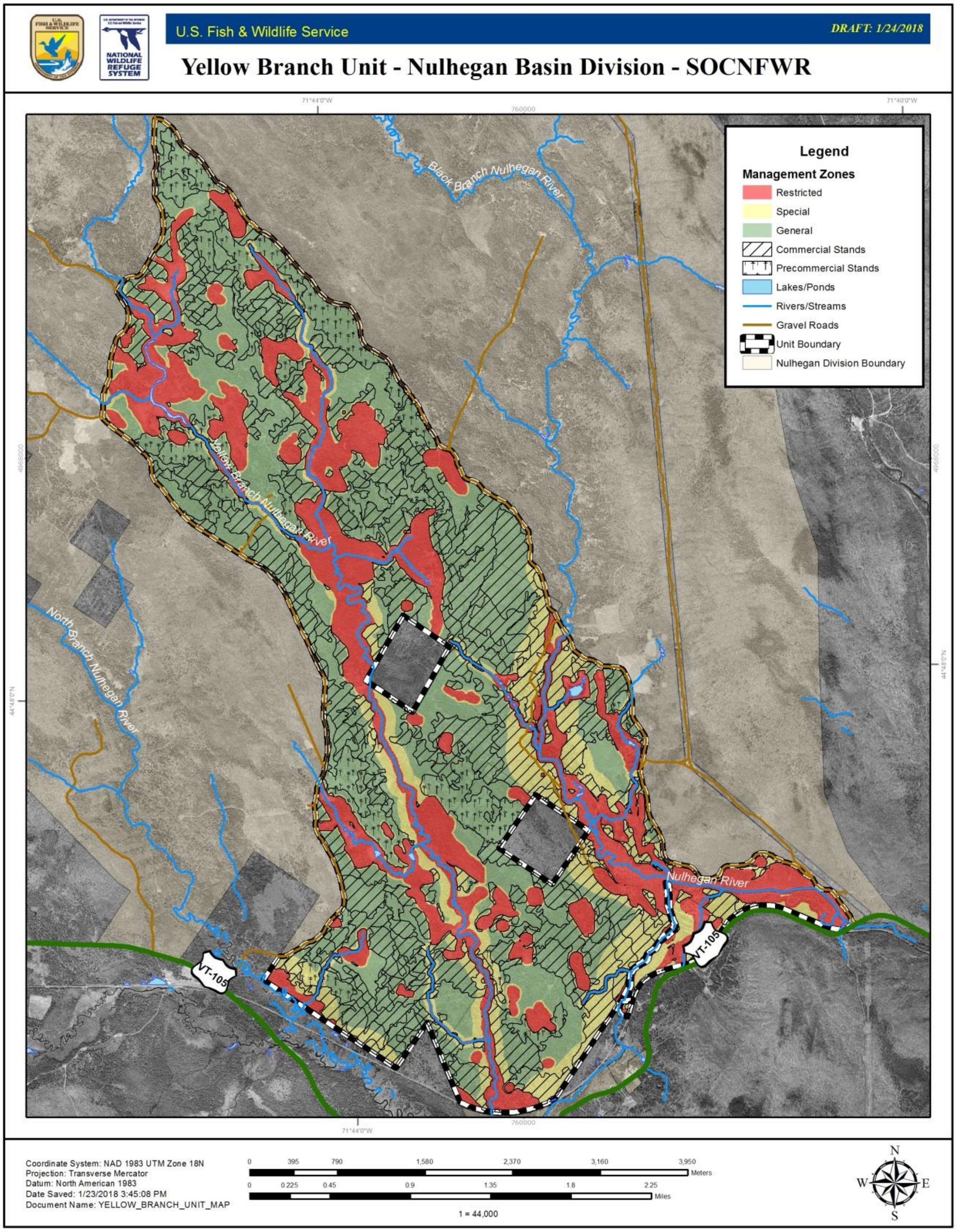
Forest Management

- Stands of softwood along the Peanut Dam road have a long history of precommercial thinning and are developing accordingly.
- Opportunities exist in the southern end of the unit to move even-aged pole and small sawtimber stands toward more diverse overstory structures.
- Precommercial thinning would accelerate growth and canopy development in the pole stands
- Unit 1 of the Woodcock Management Demonstration Area occurs within the unit.

6.2. Yellow Branch Unit

The Yellow Branch Unit is approximately 5,126 acres. Situated at the lower elevations of the Basin, this unit is also considered part of "Yellow Bogs." The slow moving Yellow Branch and the lower portion of the Black Branch of the Nulhegan River flow through this unit. This unit contains some of the best examples of intact and high integrity natural communities, as well as patches of mature forest. There are 5,122 acres in this MU that are fee owned lands managed as Refuge. About 1,474 acres are within a restricted management zone, 945 acres are within a special management zone and 2,703 acres are within a general management zone (Figure 6.2.1).

Figure 6.2.1 Yellow Branch Unit



Management Considerations: Unit Priority

Ranking: 2

Reasons for Ranking: See Table 6.1

Management Considerations: Focal Species

Based on current information, the focal species for this unit are Canada warbler, black-throated blue warbler, blackburnian warbler, rusty blackbird, and American woodcock. We will focus habitat management within stands that currently have a moderate species Habitat Suitability Index (HSI) (see Chapter 3.5.1., Table 6.1 and summary text below). Stands will be evaluated in the field to determine the best management approach. If this unit is NOT managed within the next 15 years due to its low ranking or unforeseen circumstances, the HSIs will be re-evaluated using updated species information and/or refuge habitat data, if available. Provided below is an estimated area of the unit with moderate HSI for each species.

Canada warbler: The Canada warbler HSI map shows that approximately 35 percent of this unit or 1,778 acres has moderate habitat suitability for this species.

Black-throated blue warbler: The black-throated blue warbler HSI map shows that approximately 52 percent of this unit or 2,671 acres has moderate habitat suitability for this species.

Blackburnian warbler: The blackburnian warbler HSI map shows that approximately 33 percent of this unit or 1,715 acres has moderate habitat suitability for this species.

Rusty blackbird: The rusty blackbird HSI map shows that approximately 16 percent of this unit or 849 acres has moderate habitat suitability for this species.

American woodcock: A 32 acre Woodcock Habitat Management Demonstration Unit is located in this unit, and will continue to be managed to promote the habitat needs for breeding and migrating woodcock.

Management Considerations: Forest Characteristics

Site Capability: This unit is dominated by softwood communities, particularly along the slow moving Yellow Branch to the west.

Figure 6.2.2 Natural communities in Yellow Branch Unit

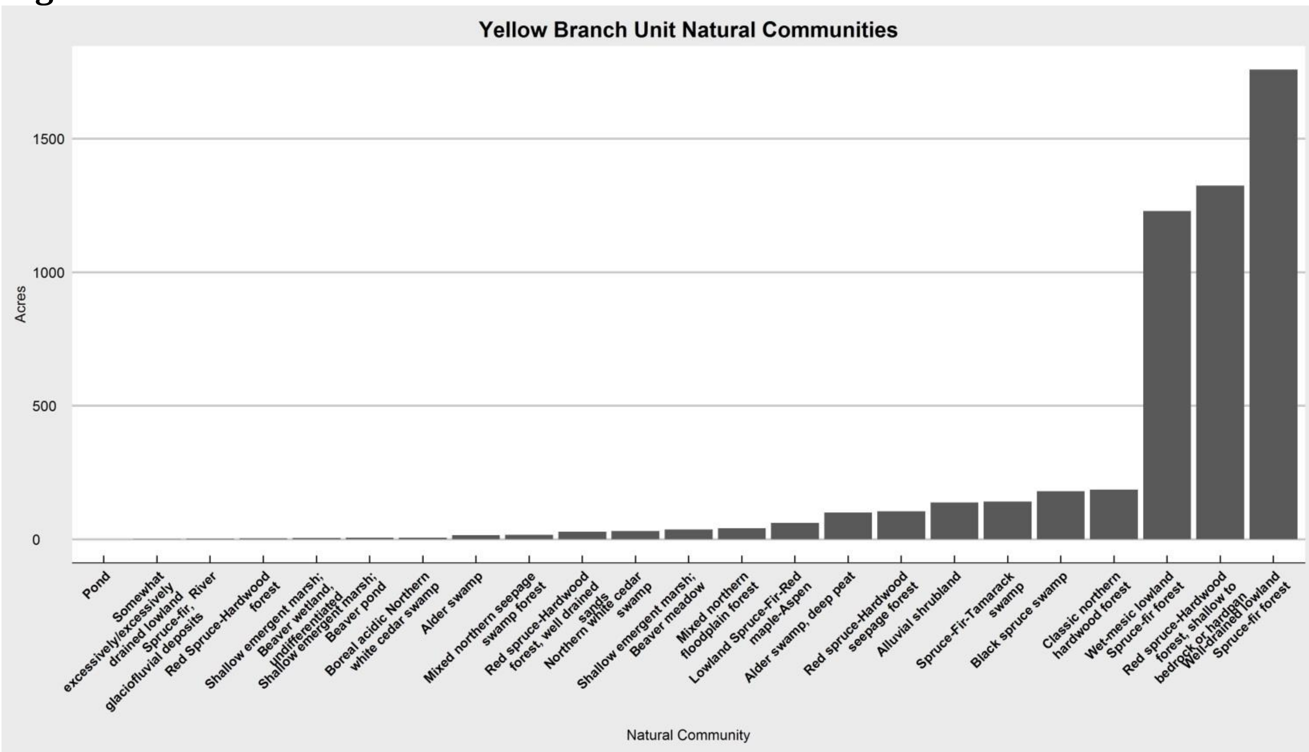


Figure 6.2.3 Complex forest structure within Yellow Branch Unit

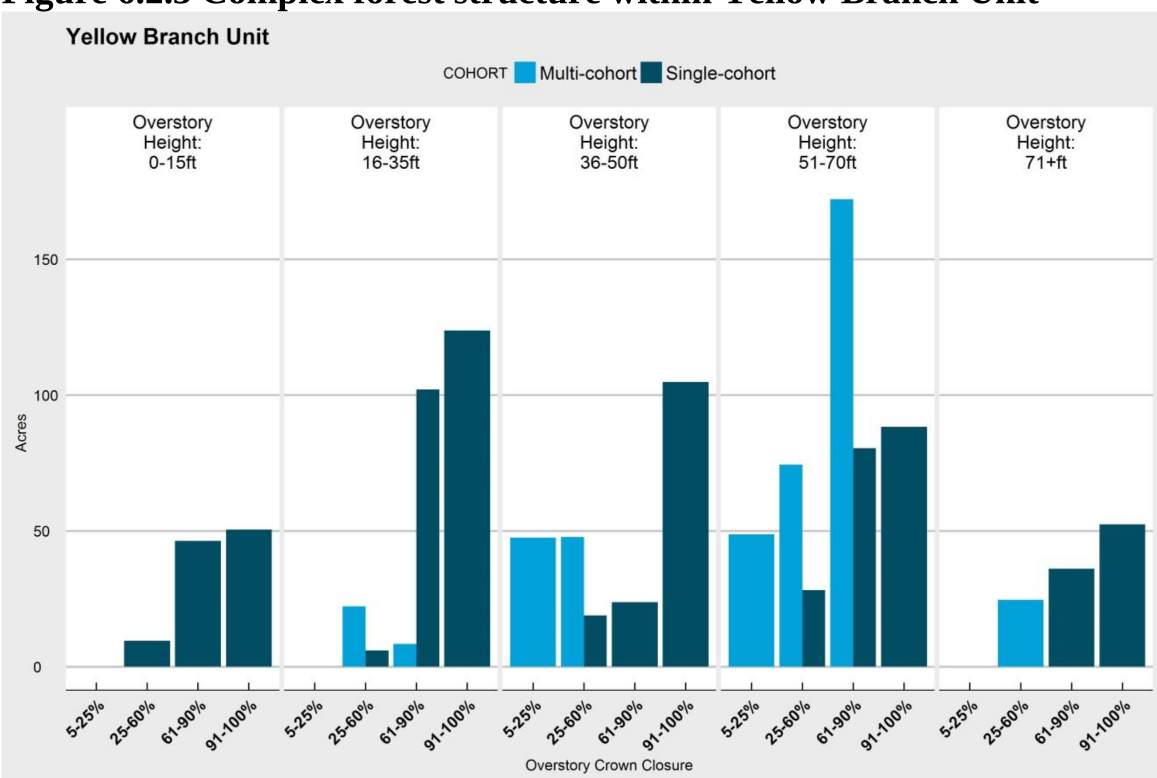
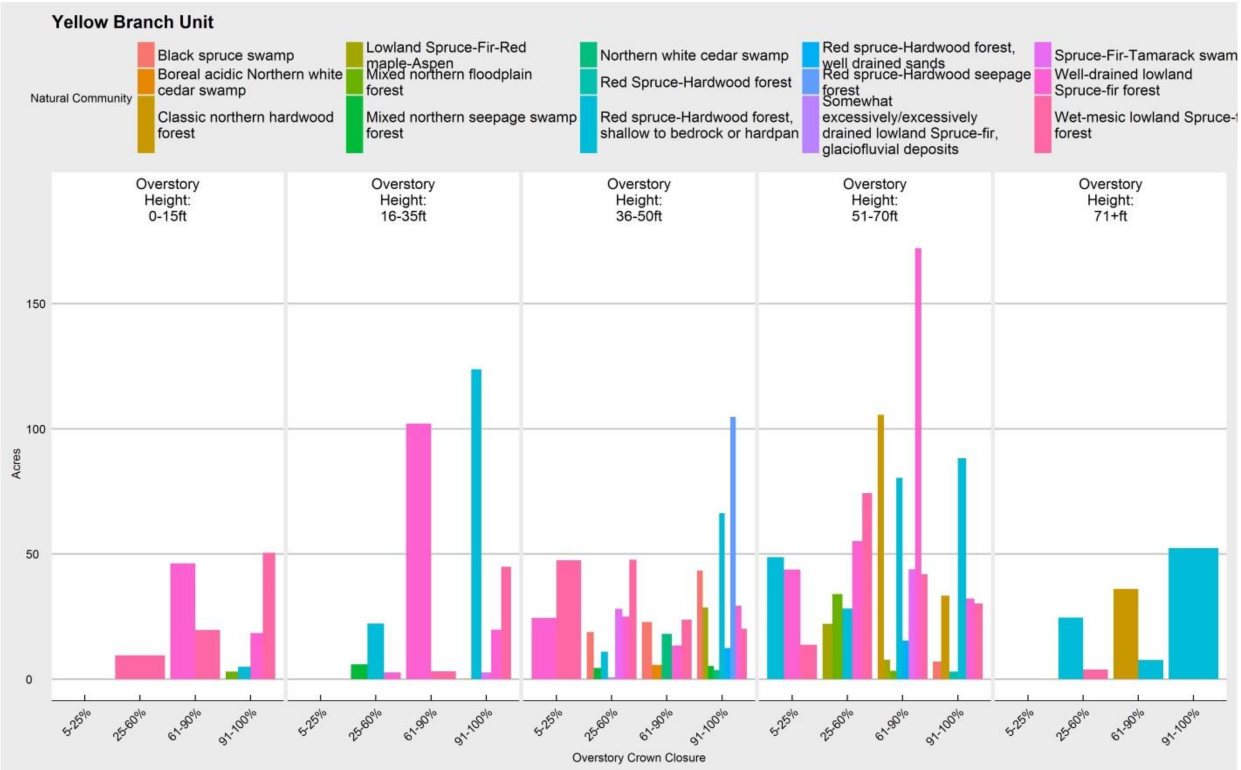


Figure 6.2.4 Canopy height and crown closure by natural community - Yellow Branch Unit



<u>Rare, Exemplary, and Unique plants and communities:</u> State rare and uncommon plants include mountain fly-honeysuckle, shore sedge, swamp thistle, woodland cudweed, water sedge, lingonberry, a moose dung moss, tall millet-grass, drooping bluegrass, Fernald alkali-grass, large leaved avens, and bog sedge. Black spruce swamp, a state rare natural community, occurs in various patches throughout the unit; many of which are in excellent condition. Other state rare natural communities that occur within this unit include poor fen and black spruce woodland bog communities; these communities are often adjacent or surrounded by black spruce swamp communities. River cobble shore and erosional river bluff, also state rare communities, occur along the banks of the Nulhegan River.

<u>Deer Wintering Area:</u> The majority of this unit is within the Nulhegan Basin deer wintering area as delineated by VTFWD. Our forest management will provide suitable shelter characteristics within the conifer-dominated forests, and woody browse.

<u>Management Considerations: Other</u>

- In the early 20th century, post-logging fires may have been more frequent and intense in the lower black branch and yellow branch area. Evidence of this fire history can be seen in the vegetation. There is an abundance of bracken fern, the occurrence of red maple-aspen lowland spruce-fir forest variant adjacent to the Nulhegan River system, and poor conifer regeneration in the lowland forest along the Black Branch-lower Stone Dam road area.

- Along the lower Yellow Branch is the most intact example of lowland spruce-fir forest in the Division. It is an even-aged 80 year old forest with trees ranging from 15 to 25 cm dbh. A private inholding in this same vicinity also features some of the most intact upland conifer forest north of the Nulhegan River.
- The upper yellow branch riparian complex appears to have the most natural community types of any of the open wetland systems associated with tributaries of the Nulhegan River. One of the rarest state listed plants, as well as other uncommon state listed species were found in this riparian complex.
- Long stretches of the stream natural community types most characteristic of the basin bottom flow through this unit.
- The lower reaches of the Black and Yellow branches and the mainstem of the Nulhegan River feature high-integrity riparian and floodplain systems—a part of the landscape that is generally under-represented in conservation reserves.
- Rusty blackbird was observed in this management unit.
- This unit is one of two large contiguous acre blocks that is not fragmented by gravel roads.
- This unit contains some of the largest patches and acreage of older forest.
- There are two in-holdings within this unit: one owned by the Town of Bloomfield, VT and the other by the Trustees of the Diocese of Vermont.
- Refuge lands are located in the town of Bloomfield, Brunswick, Ferdinand and Lewis.
- The primary access would be on the Lower Lewis Pond, Canal and Stone Dam Roads. Furthest point from VT Route 105 is approximately 7 miles.

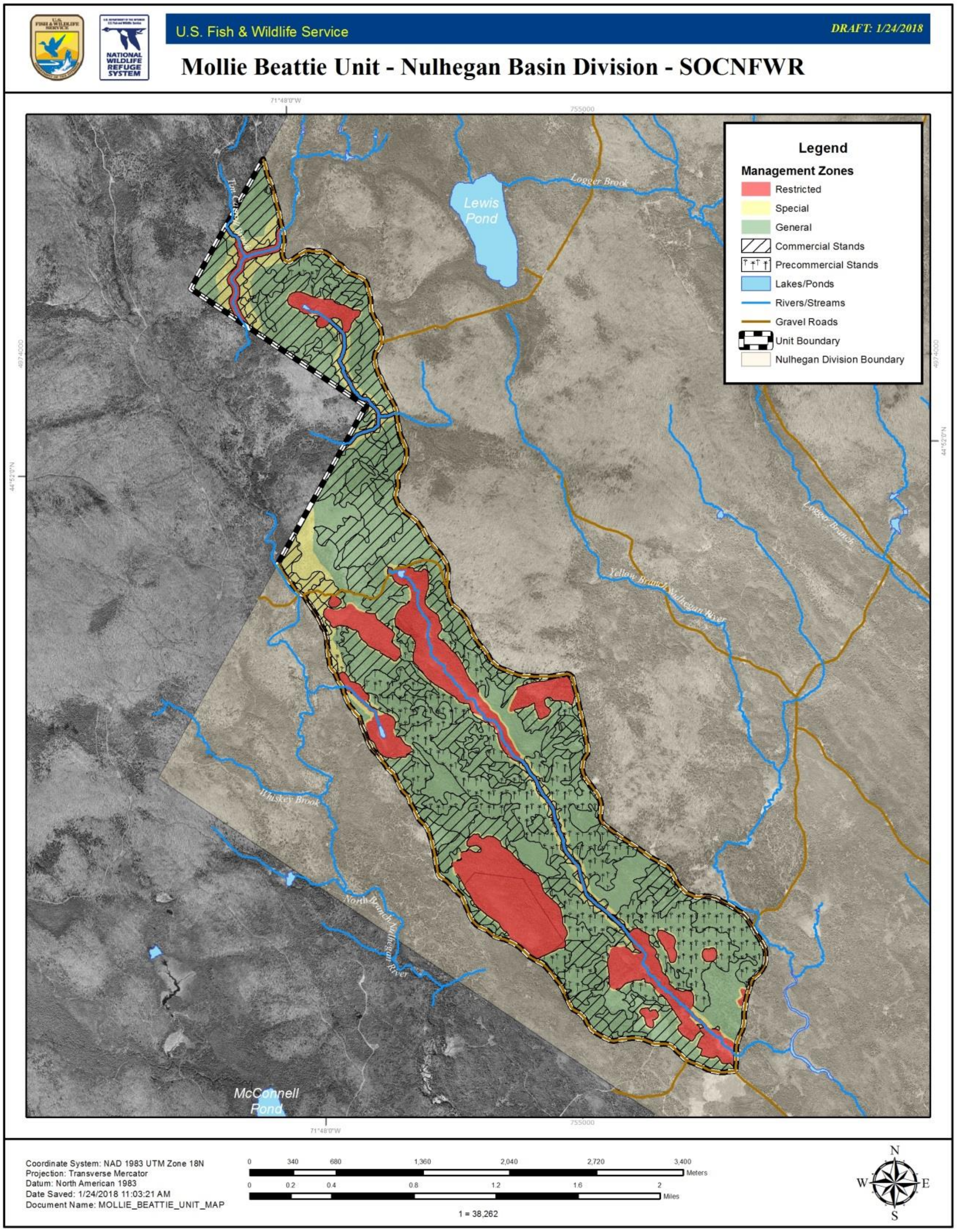
Forest Management

- There are large softwood clearcuts with single-cohort canopies - these areas should be treated to convert them toward a multi-cohort condition.
- Small patches of mature softwood in the very southern end of the unit should be expanded with appropriate silviculture.
- Precommercial thinning would accelerate growth and canopy development in the pole stands
- Unit 3 of the Woodcock Management Demonstration Area occurs within the unit.

6.3. Mollie Beattie Unit

The Mollie Beattie Unit is approximately 1,988 acres. This unit contains Mollie Beattie Bog, one of the most significant black spruce woodland bogs in Vermont. All of the land in this MU are fee owned lands managed as Refuge. About 414 acres are within a restricted management zone, 225 acres are within a special management zone and 1,348 acres are within a general management zone (Figure 6.3.1)Figure 6.3.1 Mollie Beattie Unit.

Figure 6.3.1 Mollie Beattie Unit



Management Considerations: Unit Priority

Ranking: 3

Reasons for Ranking: See Table 6.1 Summary Variables Informing Management Unit PrioritizationTable 6.1

Management Considerations: Focal Species

Based on current information, the focal species for this unit are Canada warbler, black-throated blue warbler, blackburnian warbler, rusty blackbird, and American woodcock. We will focus habitat management within stands that currently have a moderate species Habitat Suitability Index (HSI) (see Chapter 3.5.1., Table 6.1 and summary text below). Stands will be evaluated in the field to determine the best management approach. If this unit is NOT managed within the next 15 years due to its low ranking or unforeseen circumstances, the HSIs will be re-evaluated using updated species information and/or refuge habitat data, if available. Provided below is an estimated area of the unit with moderate HSI for each species.

Canada warbler: The Canada warbler HSI map shows that approximately 43 percent of this unit or 855 acres has moderate (4-6 HSI range) habitat suitability for this species.

Black-throated blue warbler: The black-throated blue warbler HSI map shows that approximately 48 percent of this unit or 953 acres has moderate habitat suitability for this species.

Blackburnian warbler: The blackburnian warbler HSI map shows that approximately 47 percent of this unit or 943 acres has moderate habitat suitability for this species.

Rusty blackbird: The rusty blackbird HSI map shows that approximately 19 percent of this unit or 382 acres has moderate habitat suitability for this species.

American woodcock: A 119 acre Woodcock Habitat Management Demonstration Unit is located in this unit, and will continue to be managed to promote the habitat needs for breeding and migrating woodcock.

Management Considerations: Forest Characteristics

Site Capability: This unit supports a large expanse of lowland spruce-fir. As you move north in the unit you gain elevation and transition from softwood to mixedwood to hardwood.

Figure 6.3.2 Natural communities within Mollie Beattie Unit

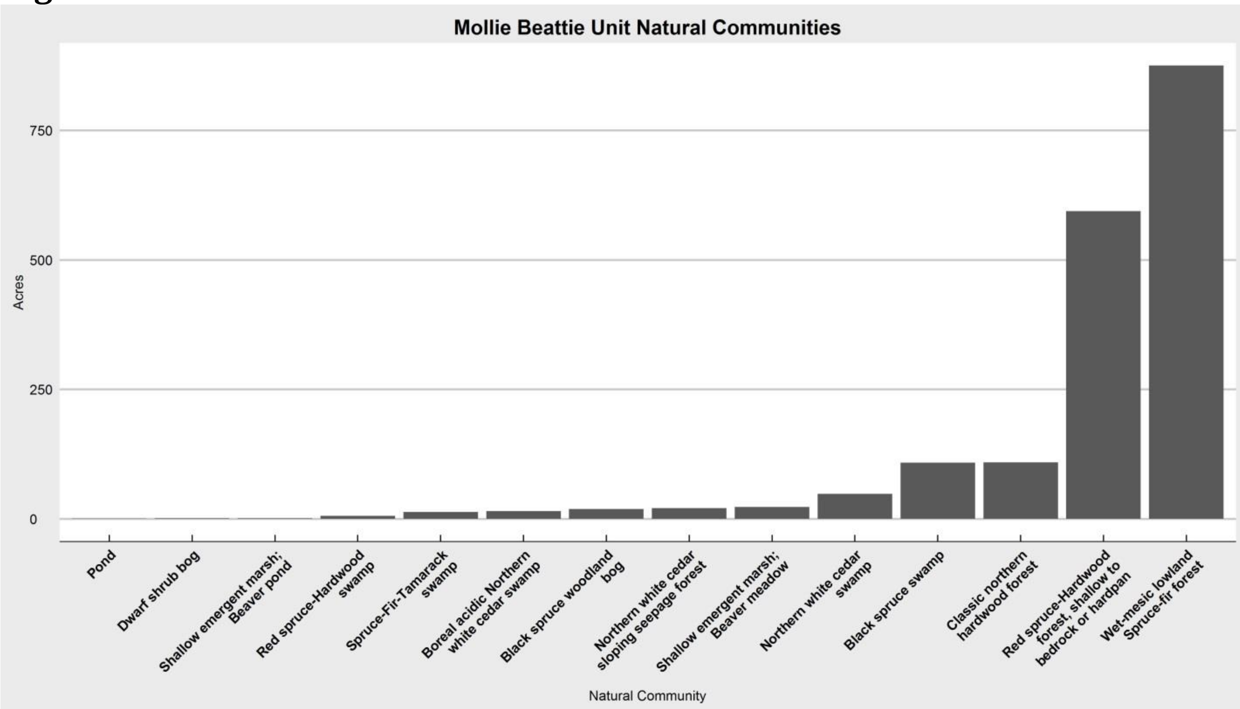


Figure 6.3.3 Complex forest structure within Mollie Beattie Unit

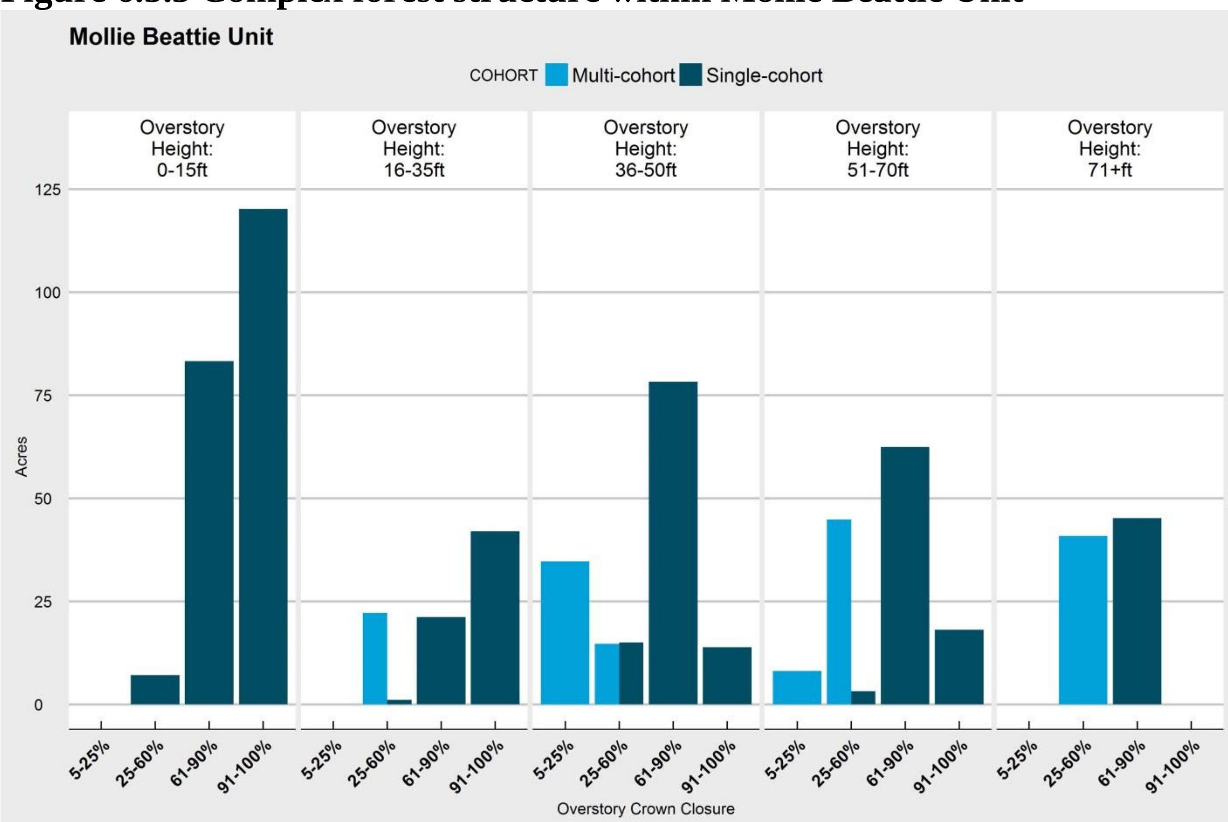
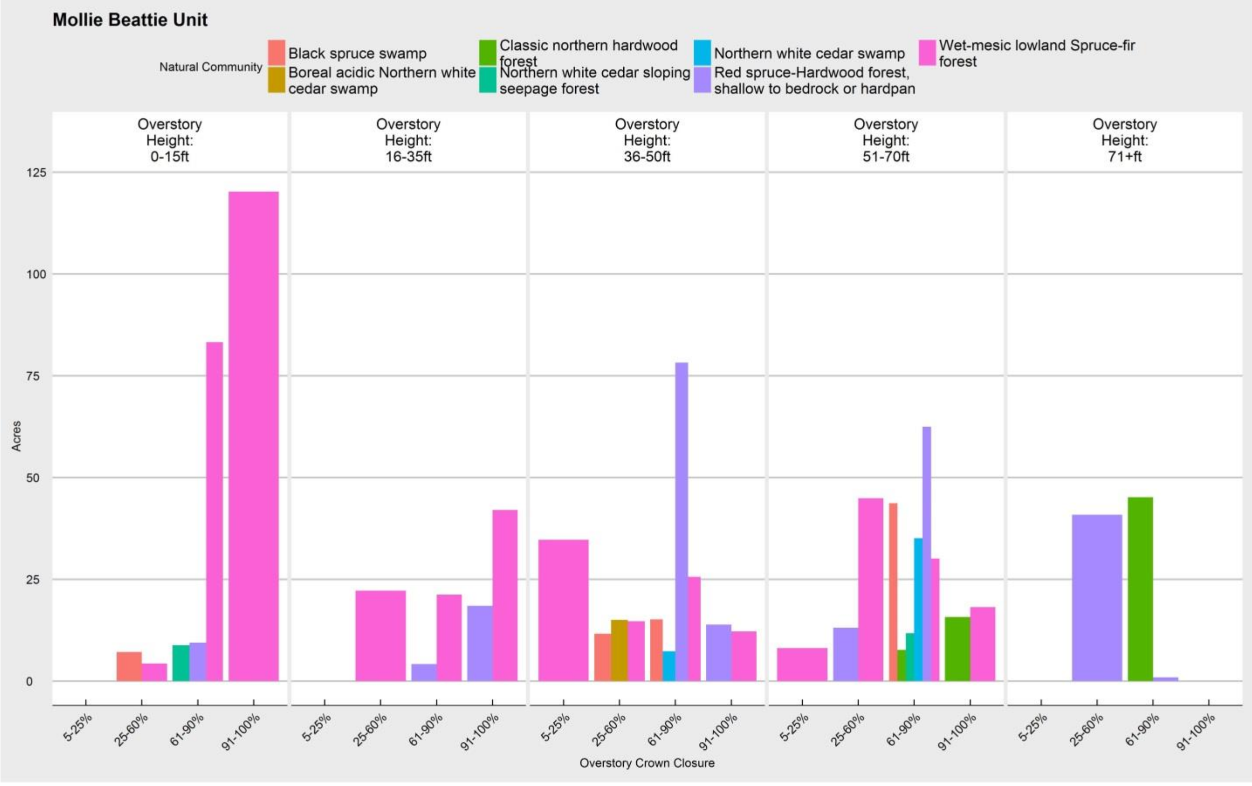


Figure 6.3.4 Canopy height and crown closure by natural community - Mollie Beattie Unit



Rare, Exemplary, and Unique plants and communities: Black spruce swamp, black spruce woodland bog, and dwarf shrub bog are state uncommon natural communities that occur throughout this unit. Many of these rare communities host a number of state rare and uncommon plant species including shining rose, mountain fly-honeysuckle, pod grass, water bur-reed, bog sedge, and Autumn willow. Spruce grouse a state endangered species also occupies habitats in this Unit.

Management Considerations: Other

- Mollie Beattie Bog occurs in this unit, and is one of the most significant black spruce woodland bogs in Vermont. Surrounding this bog are intact black spruce swamp and cedar swamp natural communities. The lowland spruce-fir and red spruce-hardwood forests have been clear-cut in the past. A diversity of rare plants occurs in the wetlands of this unit.

- A 4-vehicle parking area and 200 foot boardwalk provides public access to Mollie Beattie Bog.

- A right-of-way for forest management activities has been established on roads that pass through private lands on Lower Lewis Pond Road and Henshaw Road.
- These lands are located in the town of Lewis.
- The primary access would be on the Four Mile, Lower Lewis and Henshaw Roads. Furthest point from VT Route 105 is approximately 10 miles.

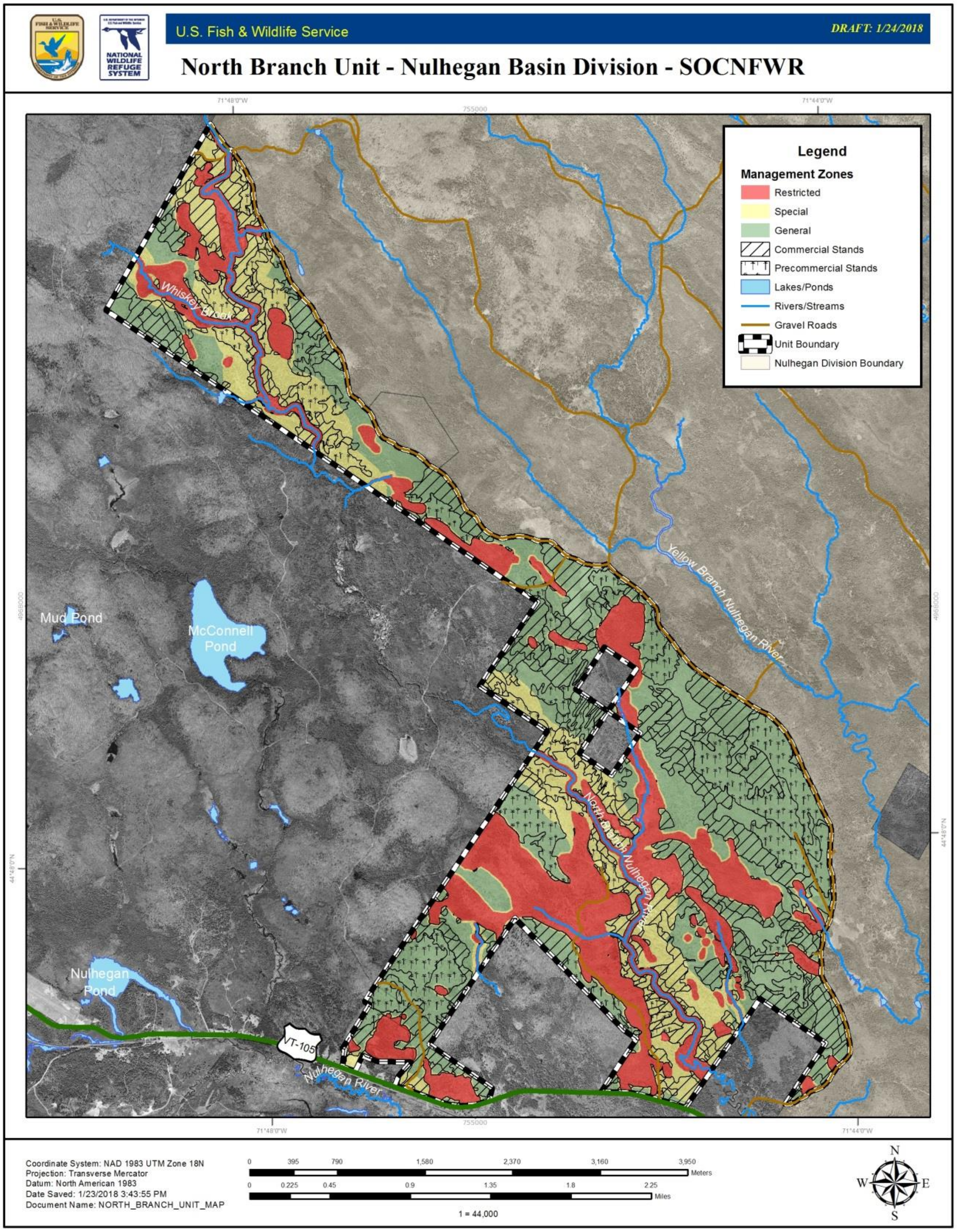
Forest Management

- This unit includes some of the largest clearcuts on the Refuge. Single-tree and group selection over time may help move these systems toward a more uneven-aged condition.

6.4. North Branch Unit

The North Branch Unit is approximately 3,816 acres. This Unit is situated on the southwest portion of the Division adjacent to conserved lands managed by the Conservation Fund. The North Branch of the Nulhegan River flows through the northern and southern portion of this unit. There are 3,812 acres in this MU that are fee owned lands managed as Refuge. About 1,062 acres are within a restricted management zone, 935 acres are within a special management zone and 1,815 acres are within a general management zone (Figure 6.4.1).

Figure 6.4.1 North Branch Unit



Management Considerations: Unit Priority

Ranking: 4
Reasons for Ranking: See Table 6.1

Management Considerations: Focal Species

Based on current information, the focal species for this unit are Canada warbler, black-throated blue warbler, blackburnian warbler and American woodcock. We will focus habitat management within stands that currently have a moderate species Habitat Suitability Index (HSI) (see Chapter 3.5.1., Table 6.1 and summary text below). Stands will be evaluated in the field to determine the best management approach. If this unit is NOT managed within the next 15 years due to its low ranking or unforeseen circumstances, the HSIs will be re-evaluated using updated species information and/or refuge habitat data, if available. Provided below is an estimated area of the unit with moderate HSI for each species.

Canada warbler: The Canada warbler HSI map shows that approximately 41 percent of this unit or 1,557 acres has moderate habitat suitability for this species.

Black-throated blue warbler: The black-throated blue warbler HSI map shows that approximately 55 percent of this unit or 2,087 acres has moderate habitat suitability for this species.

Blackburnian warbler: The blackburnian warbler HSI map shows that approximately 35 percent of this unit or 1,343 acres has moderate habitat suitability for this species.

American woodcock: A 119 acre Woodcock Habitat Management Demonstration Unit is located in this unit, and will continue to be managed to promote the habitat needs for breeding and migrating woodcock.

Management Considerations: Forest Characteristics

Site Capability: Low lying areas within this unit largely support spruce-fir natural communities. Small changes in topography and bedrock provide the soil conditions that support mixedwood natural communities.

Figure 6.4.2 Natural communities in North Branch Unit

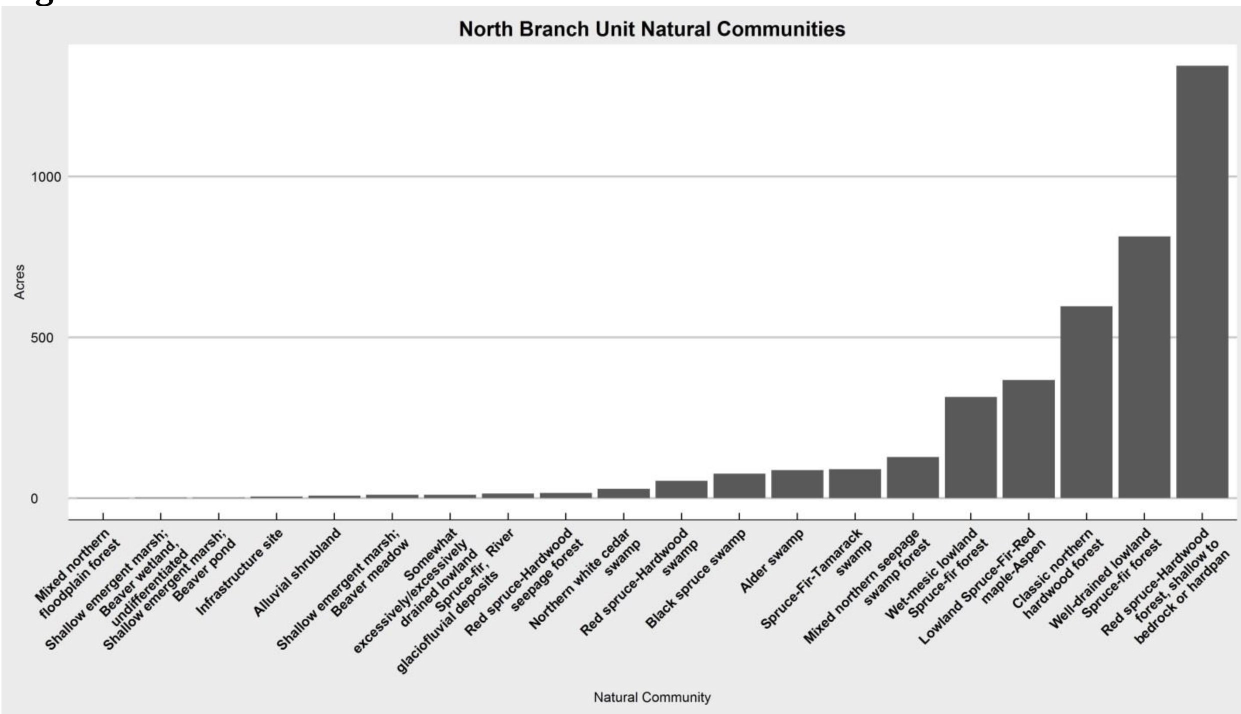


Figure 6.4.3 Complex forest structure within Peanut Dam Unit

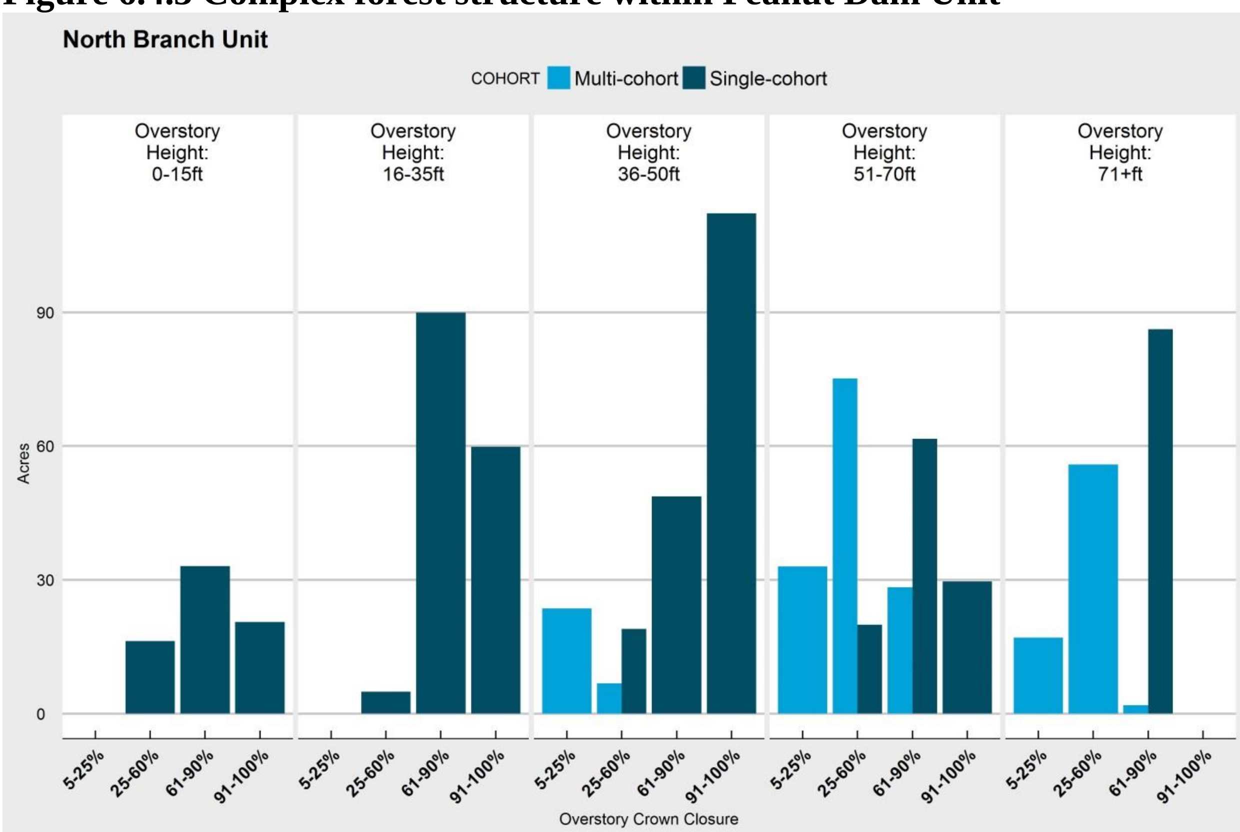
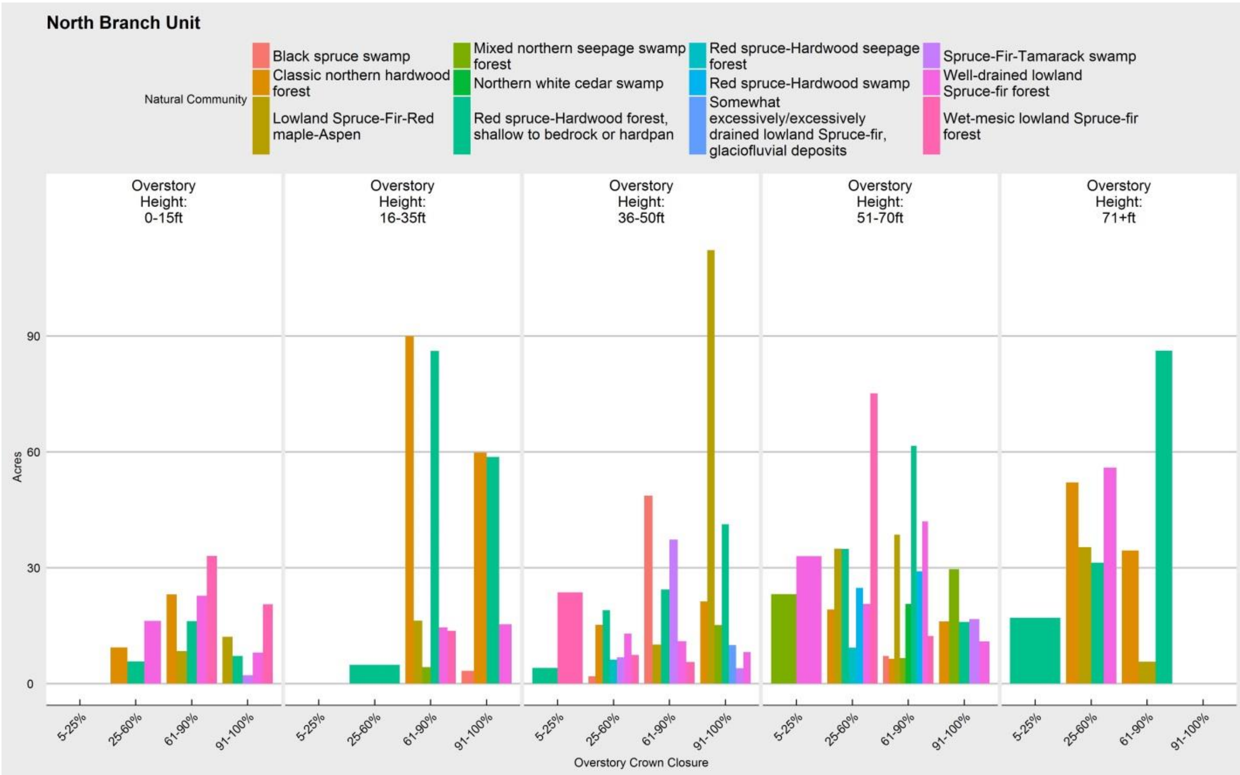


Figure 6.4.4 Canopy height and crown closure by natural community - North Branch Unit



Rare, Exemplary, and Unique plants and communities: Numerous state rare and uncommon plant species occur throughout this unit including small-flowered wood-rush, swamp thistle, a moose dung moss, Wiegand's sedge, mountain fly-honeysuckle, drooping bluegrass, northern bedstraw, and wild rye. Black spruce swamp natural community, a state rare community, occurs in various sized habitat patches throughout the unit, along with other state rare communities including poor fen, black spruce woodland bog, and dwarf shrub bog.

Deer Wintering Area: The majority of this unit is within the Nulhegan Basin deer wintering area as delineated by VTFWD. Our forest management will provide suitable shelter characteristics within the conifer-dominated forests, and woody browse.

Management Considerations: Other

- A 3-mile public hiking trail is located in the southern portion of this unit.
- A patch of knotweed is located in a past log yard in the southern portion of the unit. This patch of knotweed will need to be eradicated and monitored annually.
- Trout Unlimited and VTFWD are restoring stream habitat along the North Branch; dropping trees into the water to provide coarse woody material , to create deep pools, and shade for aquatic species, and to rehabilitate the stream channel.
- 4,790 acres of conserved lands managed by the Conservation Fund are situated along the southwest boundary of this Unit. The Conservation Fund and refuge staff often collaborate on

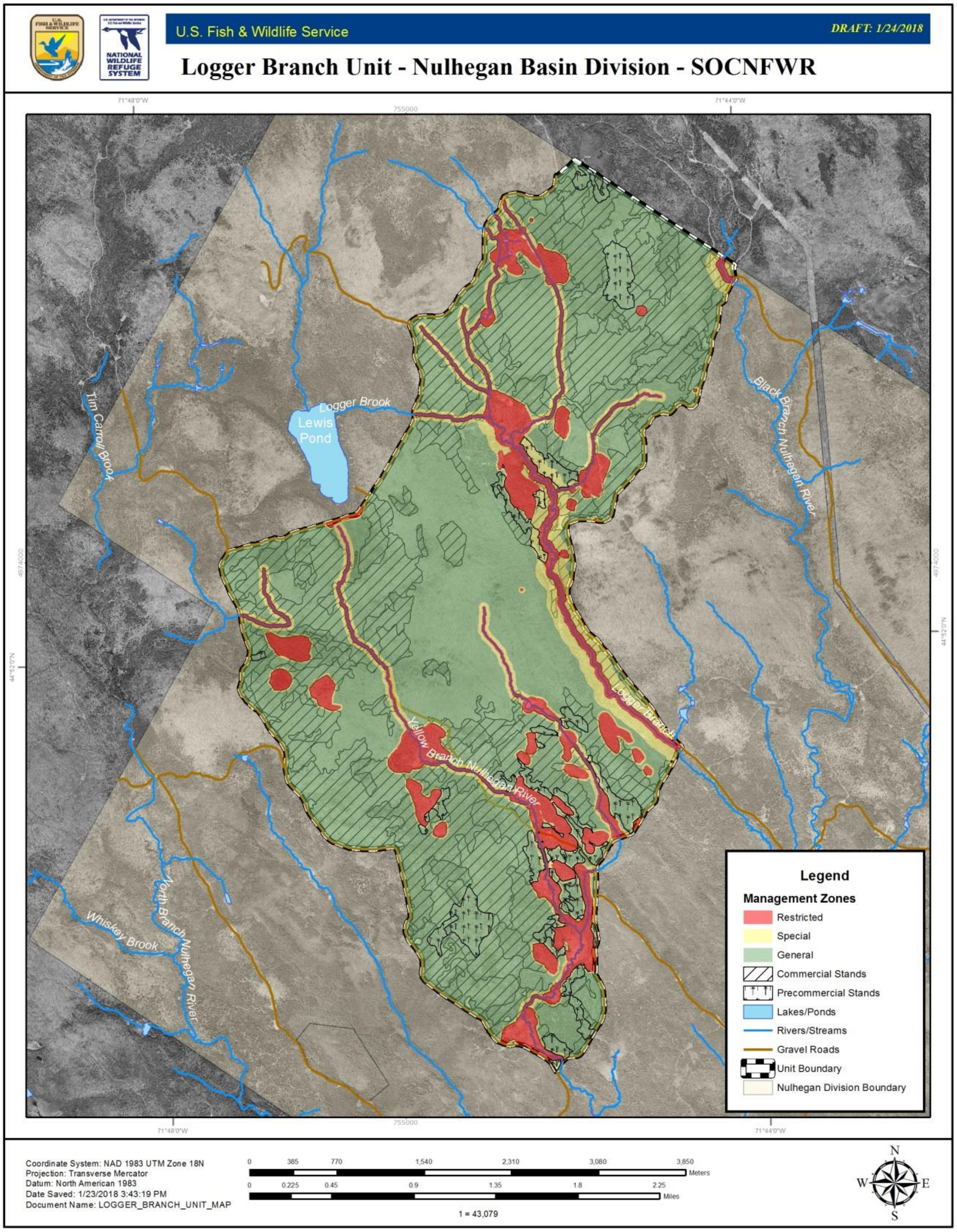
habitat management, inventory and monitoring projects that will benefit wildlife resources on refuge and Conservation Fund lands.
- A right-of-way for forest management activities has been established on roads that pass through private lands on Lower Lewis Pond Road and Henshaw Road.
- There are two in-holdings owned by Essex County, VT within this unit.
- The Dupont house, housing for employees and volunteers, and large truck garage occur in this unit. A snowmobile trail, located behind the house, provides refuge staff access to the VAST trail system.
- Refuge lands are located in the town of Ferdinand and Lewis.
- The primary access would be on the Four Mile, Henshaw and Lower Lewis Pond Roads. Furthest point from VT Route 105 is approximately 7 miles.

Forest Management
- Unit 2 of the Woodcock Management Demonstration Area occurs within the unit.
- Precommercial thinning would accelerate growth and canopy development in the large hardwood clearcuts on the south end of the Lewis Pond Road.
- Mixedwood stands would benefit from underplanting with red spruce.

6.5. Logger Branch Unit

The Logger Branch Unit is approximately 4,476 acres. The Logger and Upper Yellow Branches of the Nulhegan River flow through this Unit. The southern portion of this Unit quickly transitions from the dominant spruce forest types to the hardwood forests located along the rim of the Basin. All of the land in this MU are fee owned lands managed as Refuge. About 592 acres are within a restricted management zone, 453 acres are within a special management zone and 3,428 acres are within a general management zone (
Figure 6.5.1).

Figure 6.5.1 Logger Branch Unit



Management Considerations: Unit Priority

Ranking: 5

Reasons for Ranking: See Table 6.1

Management Considerations: Focal Species

Based on current information, the focal species for this unit are Canada warbler, black-throated blue warbler and blackburnian warbler. We will focus habitat management within stands that currently have a moderate species Habitat Suitability Index (HSI) (see Chapter 3.5.1., Table 6.1 and summary text below). Stands will be evaluated in the field to determine the best management approach. If this unit is NOT managed within the next 15 years due to its low ranking or unforeseen circumstances, the HSIs will be re-evaluated using updated species information and/or refuge habitat data, if available. Provided below is an estimated area of the unit with moderate HSI for each species.

Canada warbler: The Canada warbler HSI map shows that approximately 33 percent of this unit or 1,493 acres has moderate habitat suitability for this species.

Black-throated blue warbler: The black-throated blue warbler HSI map shows that approximately 49 percent of this unit or 2,181 acres has moderate habitat suitability for this species.

Blackburnian warbler: The blackburnian warbler HSI map shows that approximately 52 percent of this unit or 2,315 acres has moderate habitat suitability for this species.

Management Considerations: Forest Characteristics

Site Capability: This unit contains hardwood and mixedwood natural communities.

Figure 6.5.2 Natural communities in Logger Branch Unit

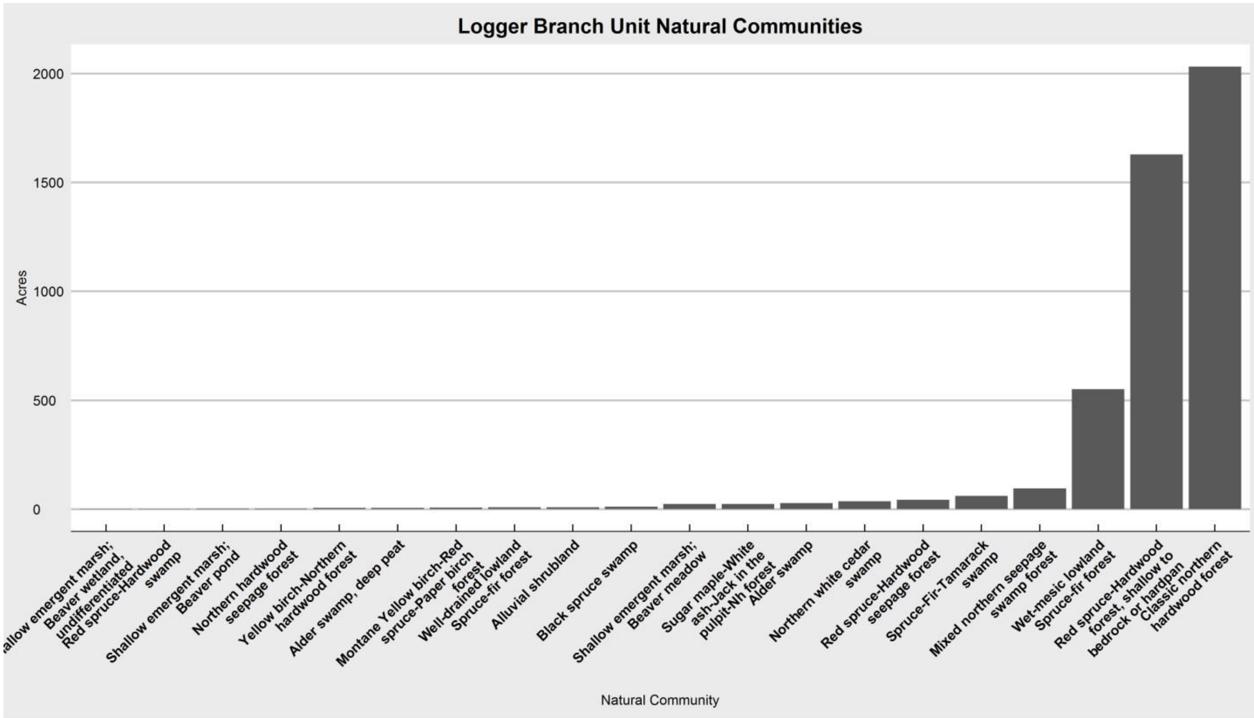


Figure 6.5.3 Complex forest structure within Logger Branch Unit

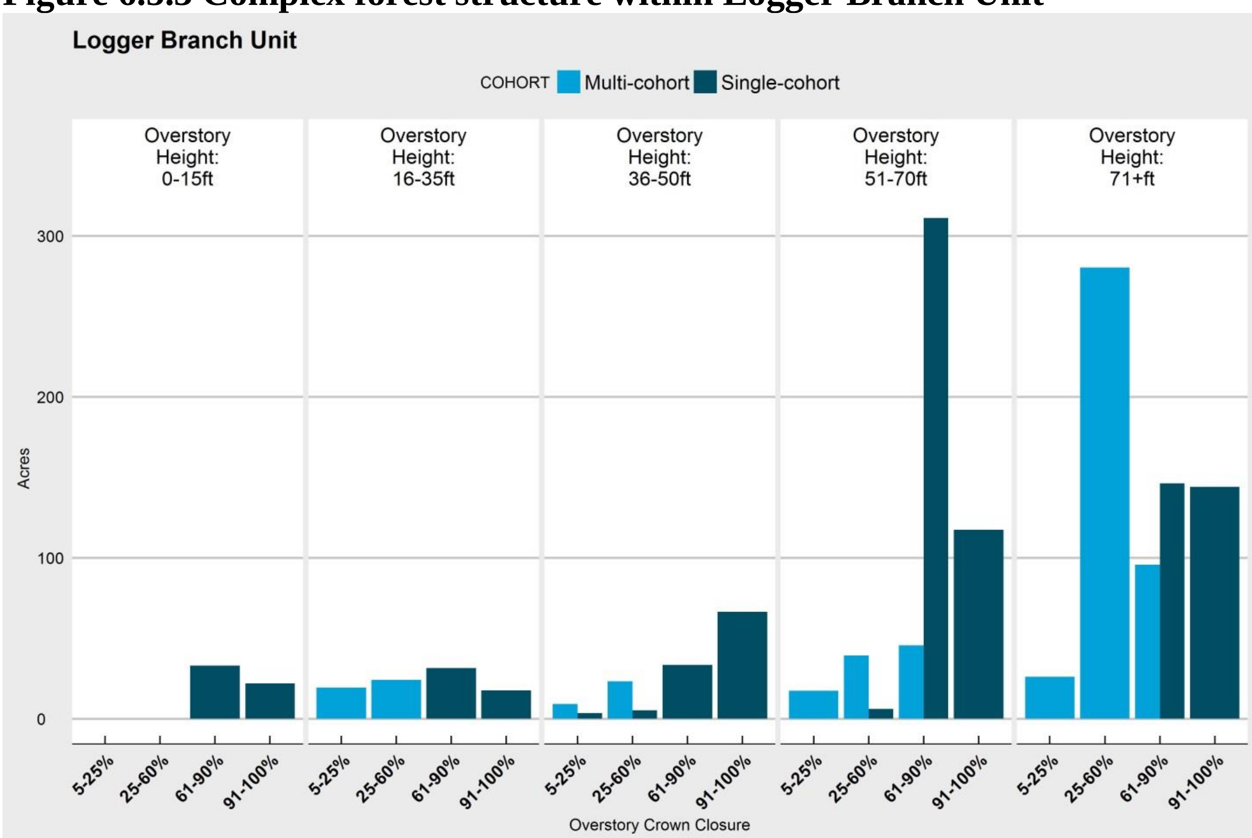
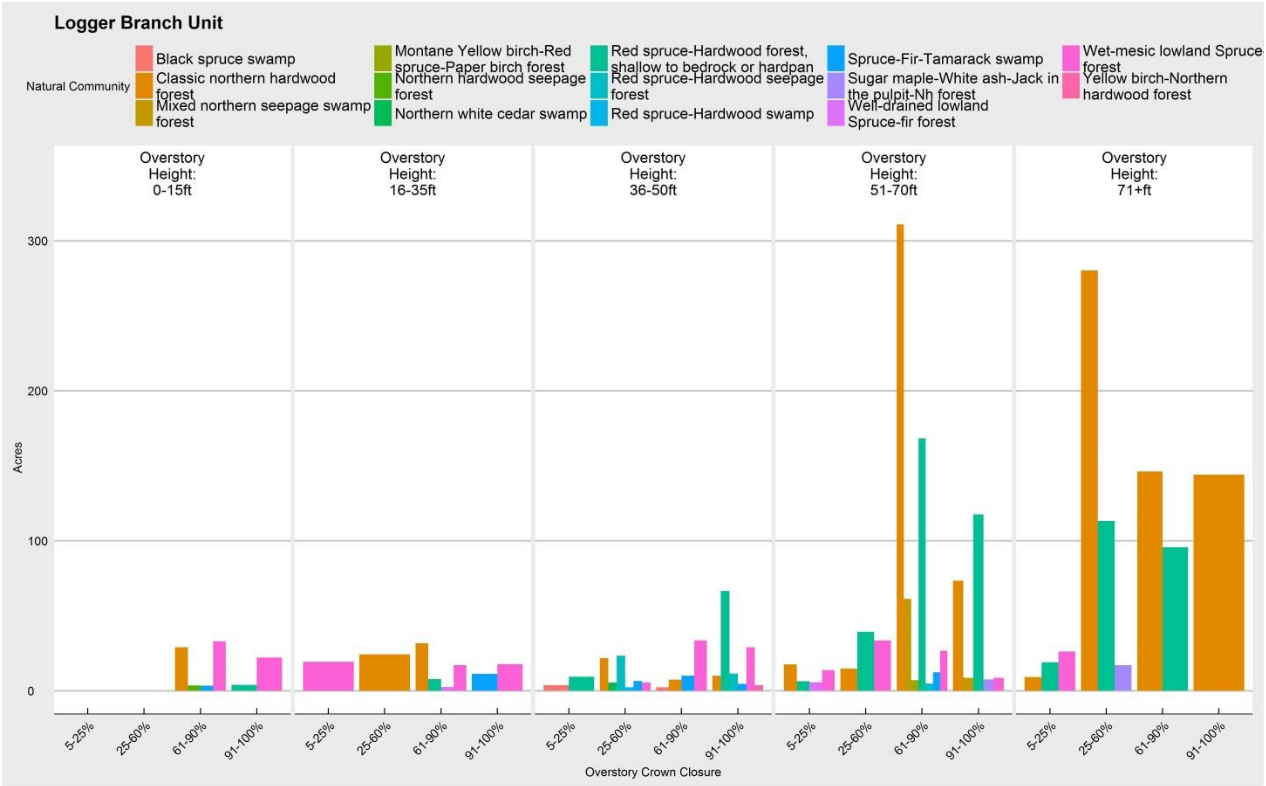


Figure 6.5.4 Canopy height and crown closure by natural community - Logger

Branch Unit



Rare, Exemplary, and Unique plants and communities: State rare and uncommon plant species that occur in the unit include Wiegand's sedge, mountain fly-honeysuckle, tall millet-grass, large leaved avens, Kamtschatkan Bedstraw, and drooping bluegrass. Three black spruce swamp patches, a state rare natural community, each under three acres occur in the southern portion of the unit.

Management Considerations: Other

- Mesic habitats occur mainly along the various streams flowing through this Unit, including the Logger and Upper Yellow Branches.
- These lands are located in the town of Lewis.
- The primary access would be on Lewis Pond, Upper Tin Shack, Eagles Nest, Canal and Stone Dam Roads. Furthest point from VT Route 105 is approximately 12 miles.

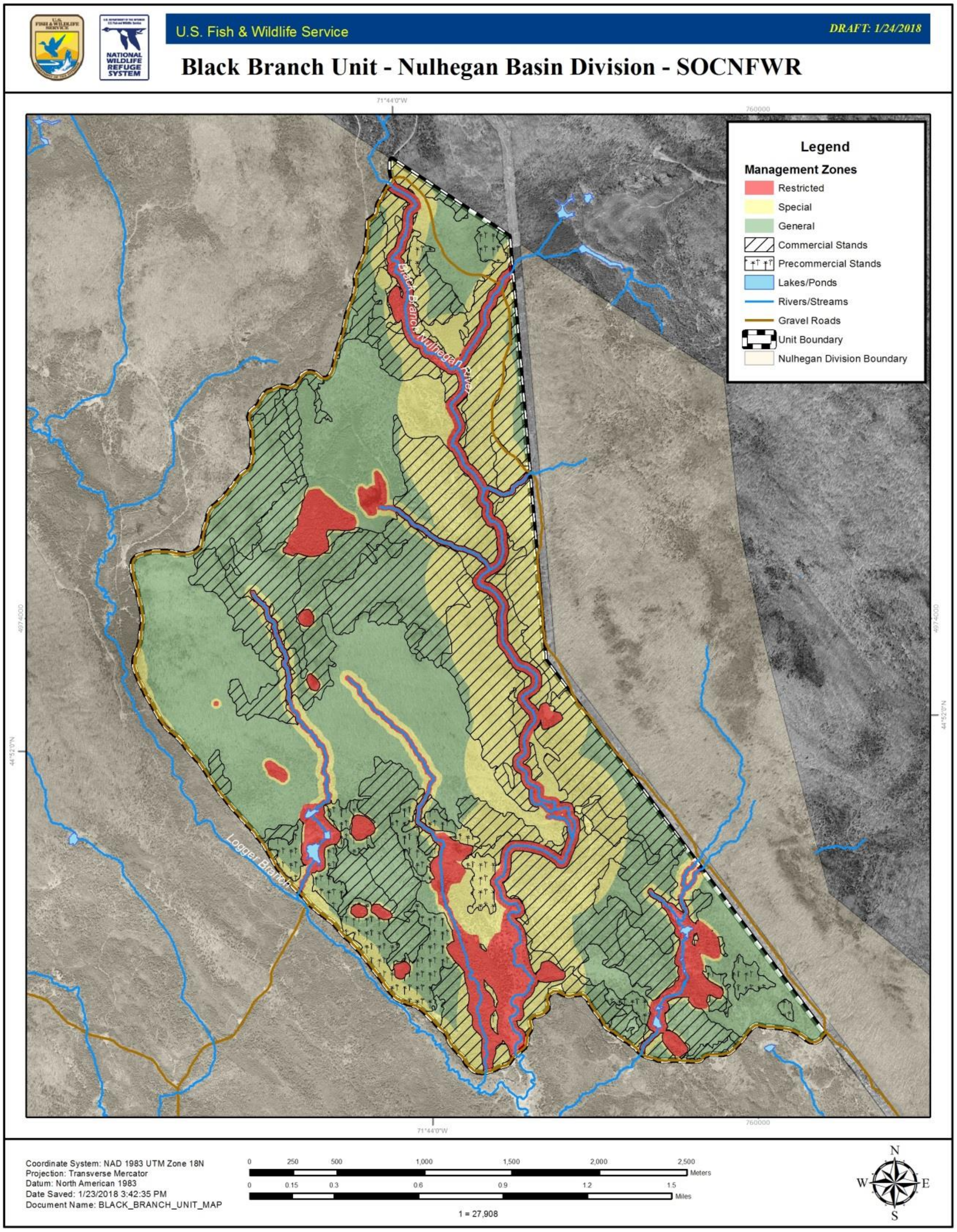
Forest Management

- Many of the mixedwood and hardwood stands within the unit have been high-graded and will present unique silvicultural challenges to restore
- Trucking access over the Logger Branch may be difficult.

6.6. Black Branch Unit

The Black Branch Unit is approximately 2,264 acres. The Black Branch of the Nulhegan River flows through this unit. The VELCO power-line is located along the eastern boundary of this Unit. All of the land in this MU are fee owned lands managed as Refuge. About 314 acres are within a restricted management zone, 7,126 acres are within a special management zone and 1,221 acres are within a general management zone (Figure 6.6.1).

Figure 6.6.1 Black Branch Unit



Management Considerations: Unit Priority
Ranking: 6
Reasons for Ranking: See Table 6.1 Summary Variables Informing Management Unit Prioritization

Management Considerations: Focal Species
Based on current information, the focal species for this unit are Canada warbler, black-throated blue warbler, blackburnian warbler and rusty blackbird. We will focus habitat management within stands that currently have a moderate species Habitat Suitability Index (HSI) (see Chapter 3.5.1., Table 6.1 and summary text below). Stands will be evaluated in the field to determine the best management approach. If this unit is NOT managed within the next 15 years due to its low ranking or unforeseen circumstances, the HSIs will be re-evaluated using updated species information and/or refuge habitat data, if available. Provided below is an estimated area of the unit with moderate HSI for each species.

Canada warbler: The Canada warbler HSI map shows that approximately 37 percent or 848 acres of this unit has moderate habitat suitability for this species.

Black-throated blue warbler: The black-throated blue warbler HSI map shows that approximately 40 percent of this unit or 913 acres has moderate habitat suitability for this species.

Blackburnian warbler: The blackburnian warbler HSI map shows that approximately 50 percent or 1,131 acres of this unit has moderate habitat suitability for this species.

Rusty blackbird: The rusty blackbird HSI map shows that approximately 5.9 percent or 135 acres of this unit has moderate habitat suitability for this species.

Management Considerations: Forest Characteristics
Site Capability: The acreage within this unit is divided evenly between hardwood, mixedwood, and softwood communities. Much of the softwood is young and occurs in even-aged stands.

Figure 6.6.2 Natural communities in Black Branch Unit

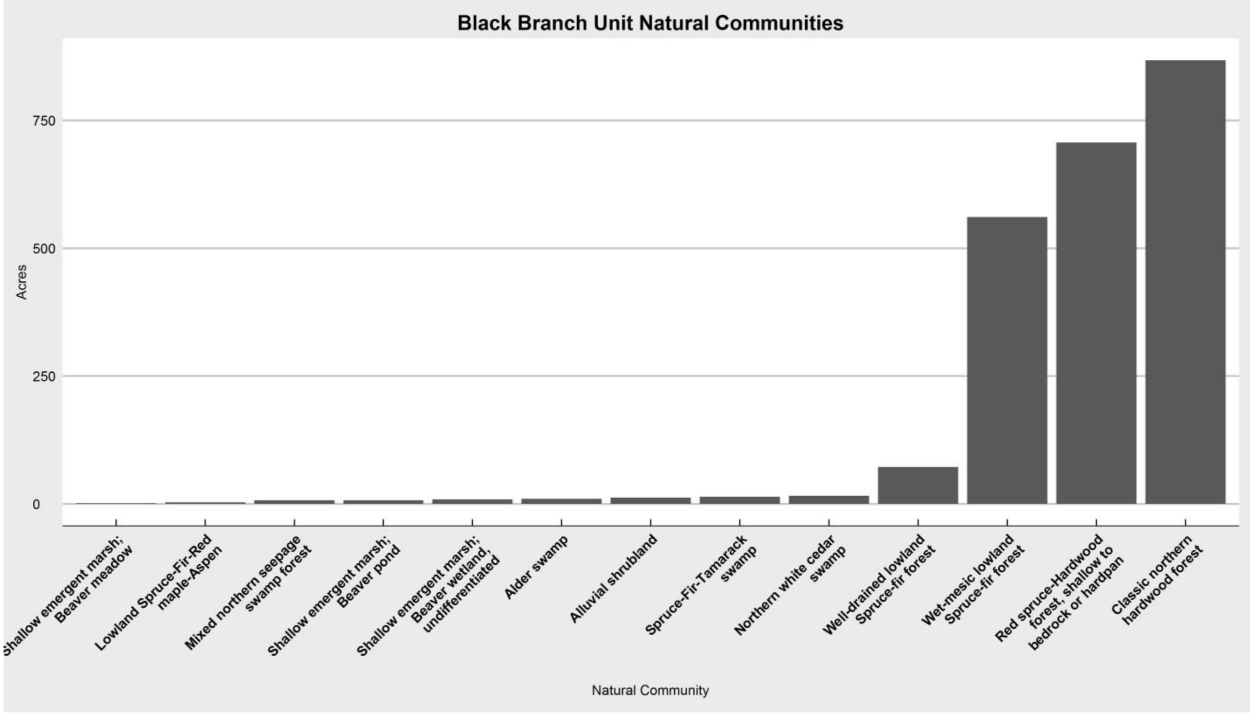


Figure 6.6.3 Complex forest structure within Black Branch Unit

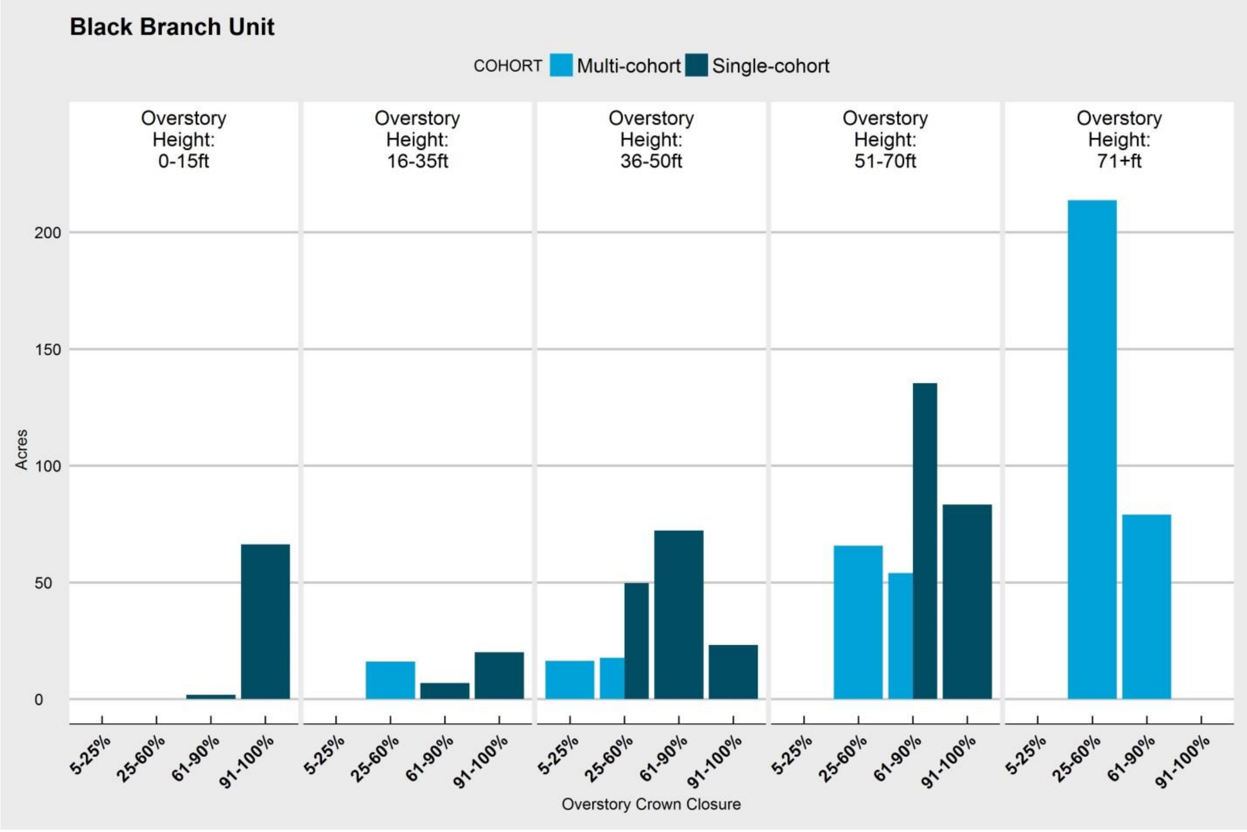
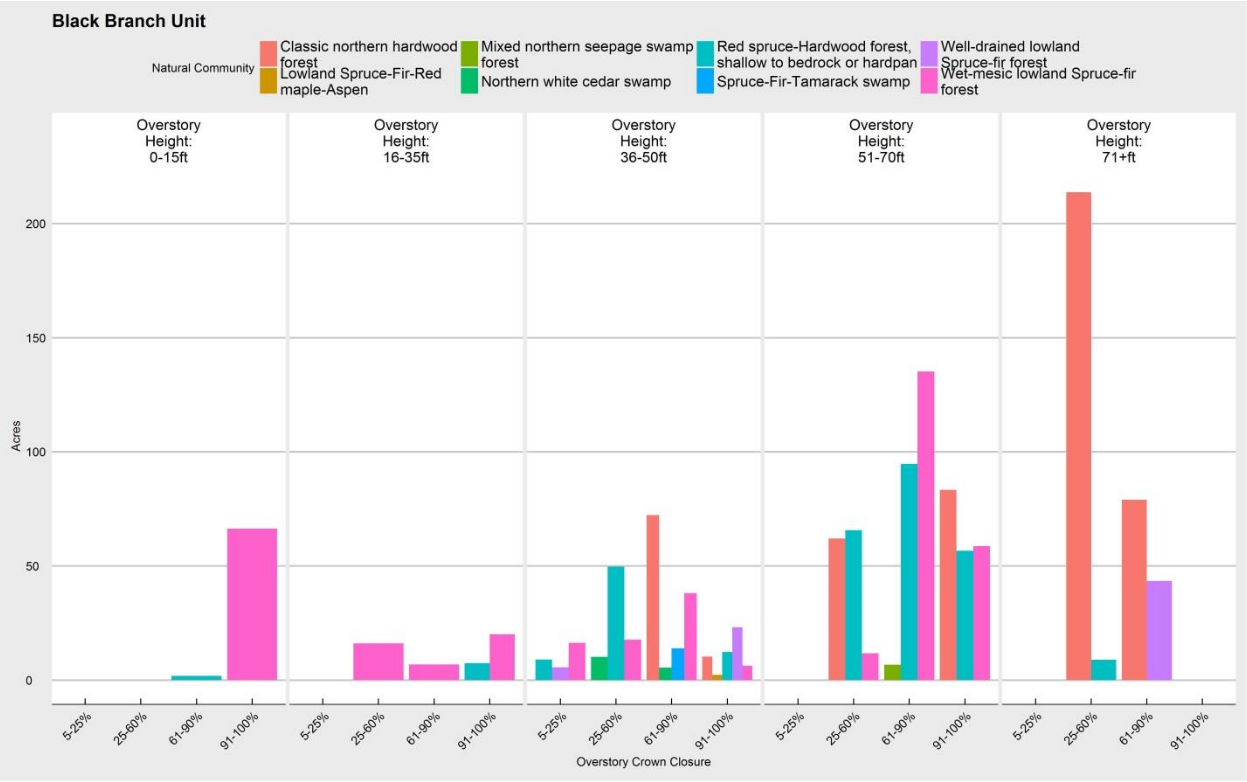


Figure 6.6.4 Canopy height and crown closure by natural community - Black Branch Unit



Rare, Exemplary, and Unique plants and communities: State rare and uncommon plant species that occur in this unit include large leaved avens, mountain fly-honeysuckle, goldie's fern, small-flowered wood-rush, and swamp thistle. There are no state rare or uncommon natural communities.

Management Considerations: Other

- The riparian forests in the upper black branch are more mature than average, and in places contain large trees. The forest is mapped as lowland spruce-fir forest, but in reality is more of a mosaic of spruce-fir and red spruce-northern hardwood forest. There are some undisturbed forests along the upper black branch, including a northern white cedar swamp with a few trees measuring 77 cm dbh.
- The VELCO powerline is maintained predominantly as shrubland and grassland habitats. Where feasible, trees are left along stream corridors to provide shade for aquatic resources. Maintaining connectivity to these corridors will be important to maintain their functionality.
- VELCO powerline maintains a gravel road that connects to refuge roads.
- These lands are located in the town of Lewis.
- The primary access would be on Tin Shack, Eagle's Nest, Canal and Stone Dam Roads. Furthest point from VT Route 105 is approximately 11 miles.

Forest Management

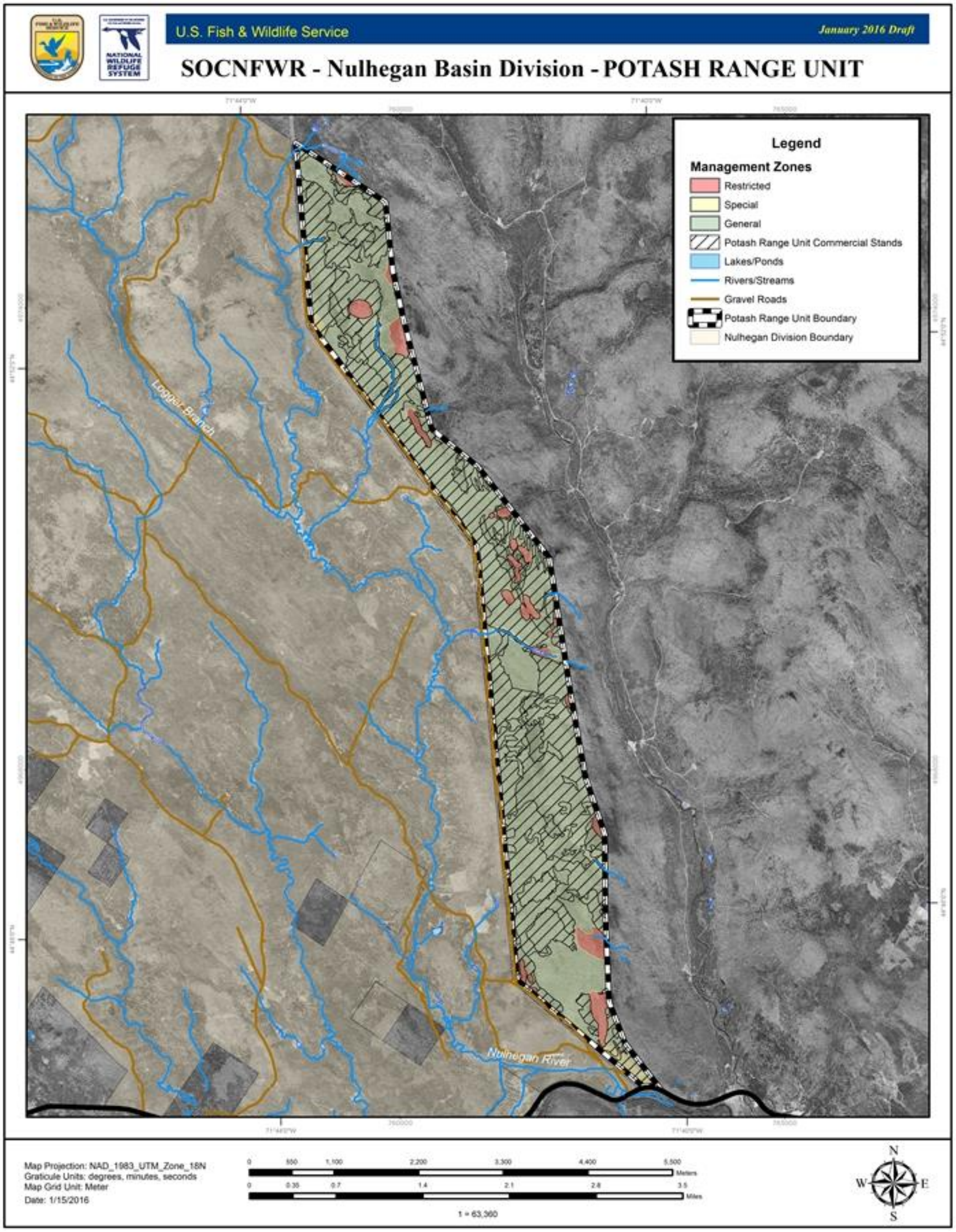
- Many of the hardwood and mixedwood stands have been high-graded and will need restorative silviculture to establish a new cohort

- Trucking access over the Black Branch will be difficult

6.7. Potash Range Unit

The Potash Range Unit is approximately 2,893 acres, and mostly contains northern hardwood forest natural community types. This MU is located along the eastern end of the Refuge boundary, and is adjacent to the Vermont Electric Company (VELCO) powerline property. All of the land in this MU are fee owned lands managed as Refuge. About 215 acres are within a restricted management zone, 164 acres are within a special management zone and 2,509 acres are within a general management zone (Figure 6.7.1).

Figure 6.7.1 Potash Range Unit



Management Considerations: Unit Priority
Ranking: 7
Reasons for Ranking: See Table 6.1

Management Considerations: Focal Species
Based on current information, the focal species for this unit are Canada warbler, black-throated blue warbler and blackburnian warbler. We will focus habitat management within stands that currently have a moderate species Habitat Suitability Index (HSI) (see Chapter 3.5.1., Table 6.1 and summary text below). Stands will be evaluated in the field to determine the best management approach. If this unit is NOT managed within the next 15 years due to its low ranking or unforeseen circumstances, the HSIs will be re-evaluated using updated species information and/or refuge habitat data, if available. Provided below is an estimated area of the unit with moderate HSI for each species.

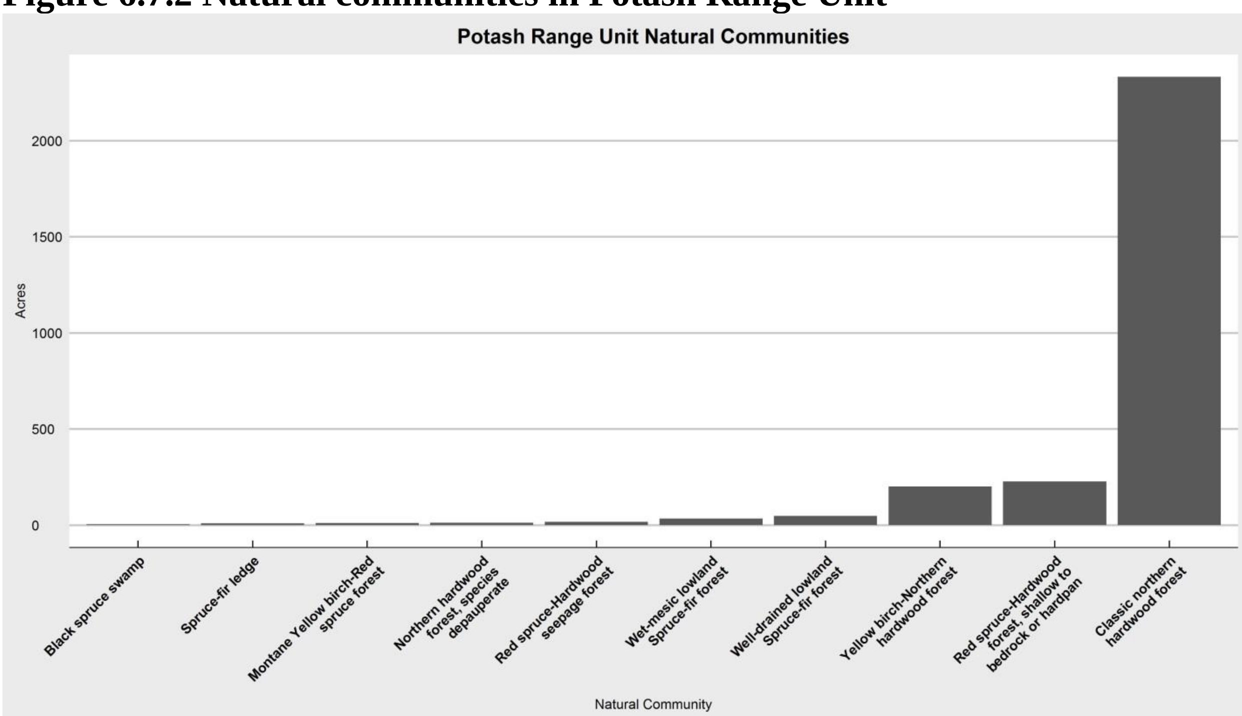
Canada warbler: The Canada warbler HSI map shows that approximately 26% of this unit or 753 acres has moderate habitat suitability for this species.

Black-throated blue warbler: The black-throated blue warbler HSI map shows that approximately 25% of this unit or 722 acres has moderate habitat suitability for this species.

Blackburnian warbler: The blackburnian warbler HSI map shows that approximately 69% of this unit or 2,006 acres has moderate habitat suitability for this species.

Management Considerations: Forest Characteristics
Site Capability: The unit is dominated by classic northern hardwood stands. Site indices are generally higher than other places on the Division.

Figure 6.7.2 Natural communities in Potash Range Unit



Complex Forest Structure: Unlike much of the Division, the Potash Unit has a greater proportion of multi-cohort stands than other units. The unit does have 566 acres of single-cohort classic northern hardwood forest and 70 acres of red-spruce-hardwood forest that is shallow to bedrock.

Figure 6.7.3 Complex forest structure within Potash Range Unit

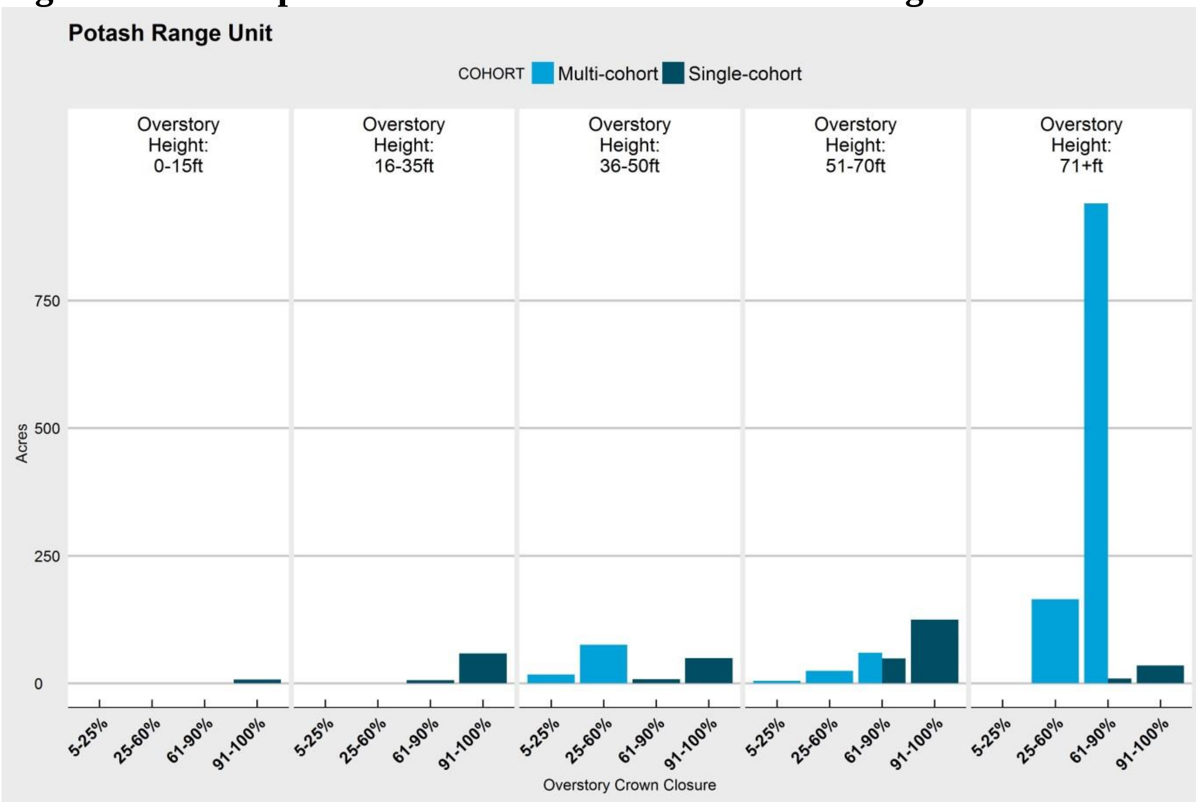
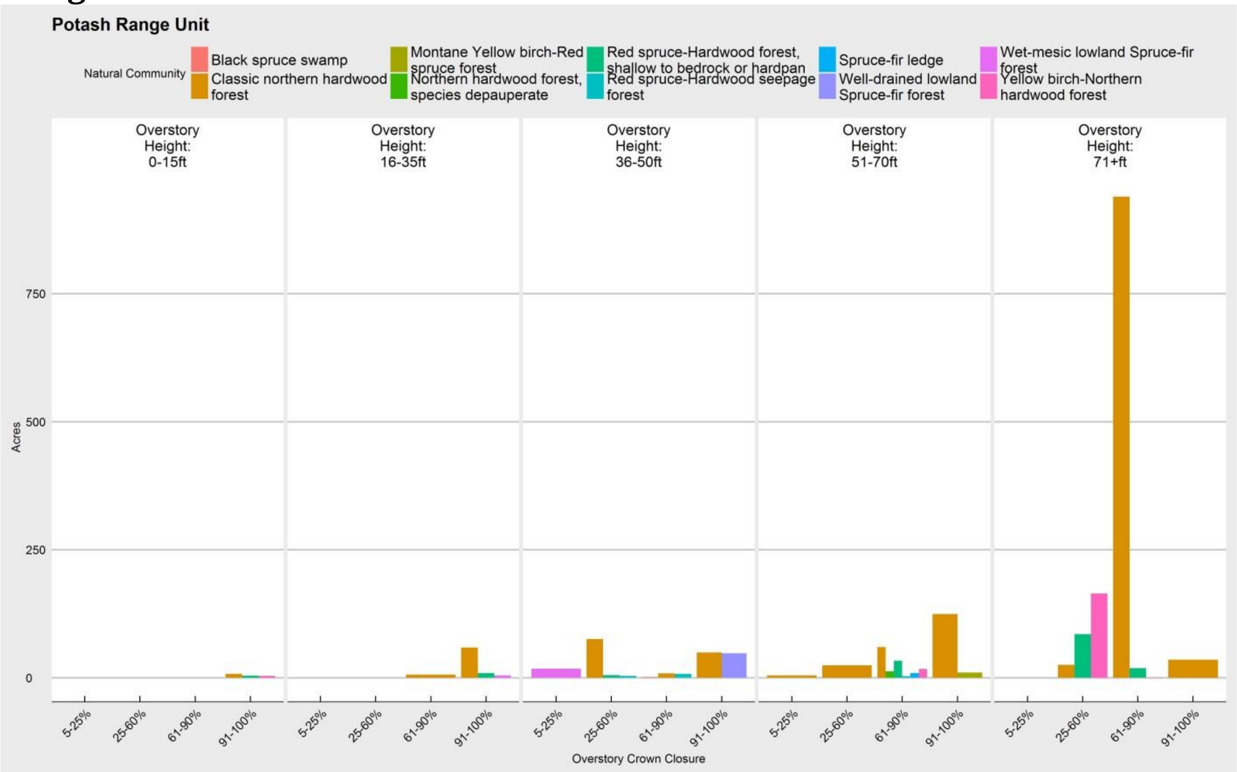


Figure 6.7.4 Canopy height and crown closure by natural community - Potash Range Unit



Rare, Exemplary, and Unique plants and communities: State uncommon plant species that occur in this unit are drooping bluegrass and goldie's fern. A five acre black spruce swamp, a state rare natural community, occurs at the northern portion of the unit.

Management Considerations: Other

- The VELCO powerline is maintained predominantly as shrubland and grassland habitats. Where feasible, trees are left along stream corridors to provide shade for aquatic resources. Maintaining connectivity to these corridors will be important to maintain their functionality.
- VELCO powerline maintains a gravel road that connects to refuge roads.
- The Potash Range is a mountain range that forms the eastern rim of the Nulhegan Basin.
- These lands are located in the town of Bloomfield and Lewis,
- The Refuge holds a forest management ROW over the VELCO road. Furthest point from VT Route 105 is approximately 9 miles.

Forest Management

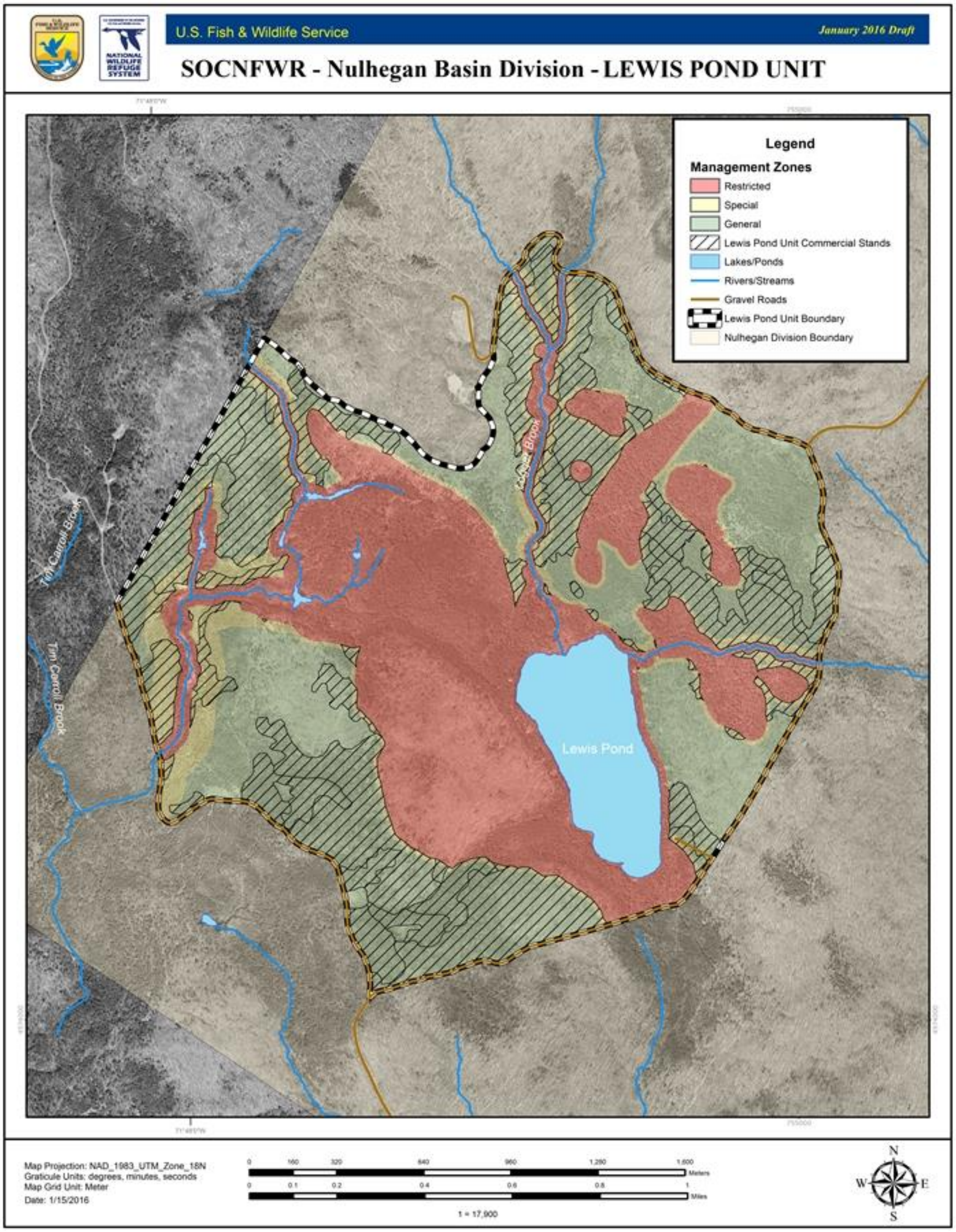
- Access to the unit is excellent
- Site indices along the Potash Range are generally higher than many parts of the refuge, offering the opportunity to grow taller trees and carry higher stocking.

6.8. Lewis Pond Unit

The Lewis Pond Unit is approximately 1,110 acres. It contains the 60 acre dystrophic Lewis Pond, and is part of the Lewis Pond basin, which is a small, very wet basin. The majority of the acreage within this unit are typed as forested wetland natural communities; many of which are intact and provide high-quality examples. All of the land in this management unit are fee owned lands managed as Refuge. About 494 acres are within a restricted management zone, 118 acres are within a special management zone and 497 acres are within a general management zone (

Figure 6.8.1 Lewis Pond Unit.

Figure 6.8.1 Lewis Pond Unit


U.S. Fish & Wildlife Service
January 2016 Draft
NATIONAL WILDLIFE REFUGE SYSTEM
SOCNFWR - Nulhegan Basin Division - LEWIS POND UNIT
Legend
Management Zones
Restricted
Special
General
Lewis Pond Unit Commercial Stands
Lakes/Ponds
Rivers/Streams
Gravel Roads
Lewis Pond Unit Boundary
Nulhegan Division Boundary
Tim Carroll Brook
Tim Carroll Brook
Lewis Pond
Map Projection: NAD_1983_UTM_Zone_18N
Graticule Units: degrees, minutes, seconds
Map Grid Unit: Meter
Date: 1/15/2016
0 160 320 640 960 1,280 1,600 Meters
0 0.1 0.2 0.4 0.6 0.8 1 Miles
1 = 17,900
N
W
E
S

Management Considerations: Unit Priority

Ranking: 8

Reasons for Ranking: See Table 6.1 Summary Variables Informing Management Unit Prioritization

Management Considerations: Focal Species

Based on current information, the focal species for this unit are Canada warbler, black-throated blue warbler and blackburnian warbler. We will focus habitat management within stands that currently have a moderate species Habitat Suitability Index (HSI) (see Chapter 3.5.1., Table 6.1 Summary Variables Informing Management Unit Prioritization and summary text below). Stands will be evaluated in the field to determine the best management approach. If this unit is not managed within the next 15 years due to its low ranking or unforeseen circumstances, the HSIs will be re-evaluated using updated species information and/or refuge habitat data, if available. Provided below is an estimated area of the unit with moderate HSI for each species.

Canada warbler: The Canada warbler HSI map shows that approximately 38 percent of this unit or 428 acres has moderate habitat suitability for this species.

Black-throated blue warbler: The black-throated blue warbler HSI map shows that approximately 52 percent of this unit or 576 acres has moderate habitat suitability for this species.

Blackburnian warbler: The blackburnian warbler HSI map shows that approximately 35 percent or 386 acres of this unit has moderate habitat suitability for this species.

Brook Trout: Brook trout are one of few species native to Lewis Pond, a 60 acre pond situated in the southeast corner of the Unit. Currently, the fish community has been altered with the introduction and establishment of fathead minnows and smallmouth bass. These non-native species may limit the natural reproduction of brook trout populations (J. Kratzer pers. comm. 2011). Removing these non-native fish is a priority to restore a healthy population of brook trout to this pond.

Management Considerations: Forest Characteristics

Complex Forest Structure: About 778 acres of unit occurs in single-cohort stands with the balance in a multi-cohort condition. Including 142 acres of single-cohort northern hardwood and 195 acres of red spruce-hardwood (mixedwood) stands in an even-aged or single-cohort condition.

Figure 6.8.2 Natural communities in Lewis Pond Unit

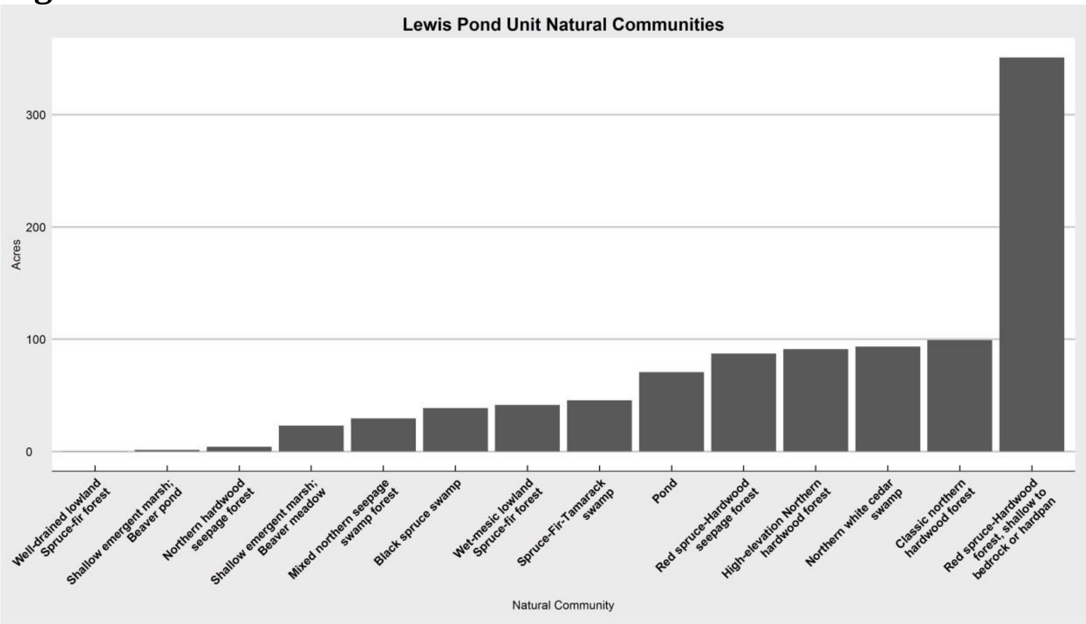


Figure 6.8.3 Complex forest structure within Lewis Pond Unit

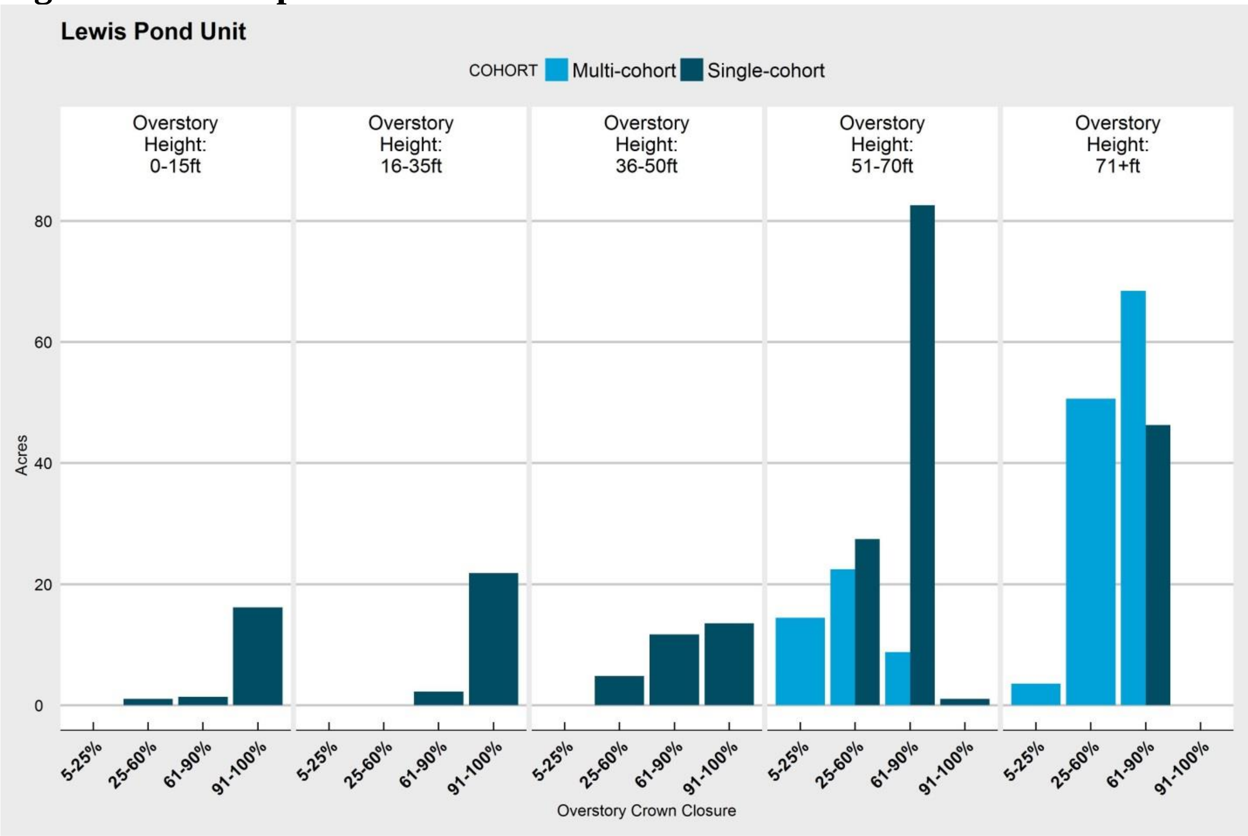
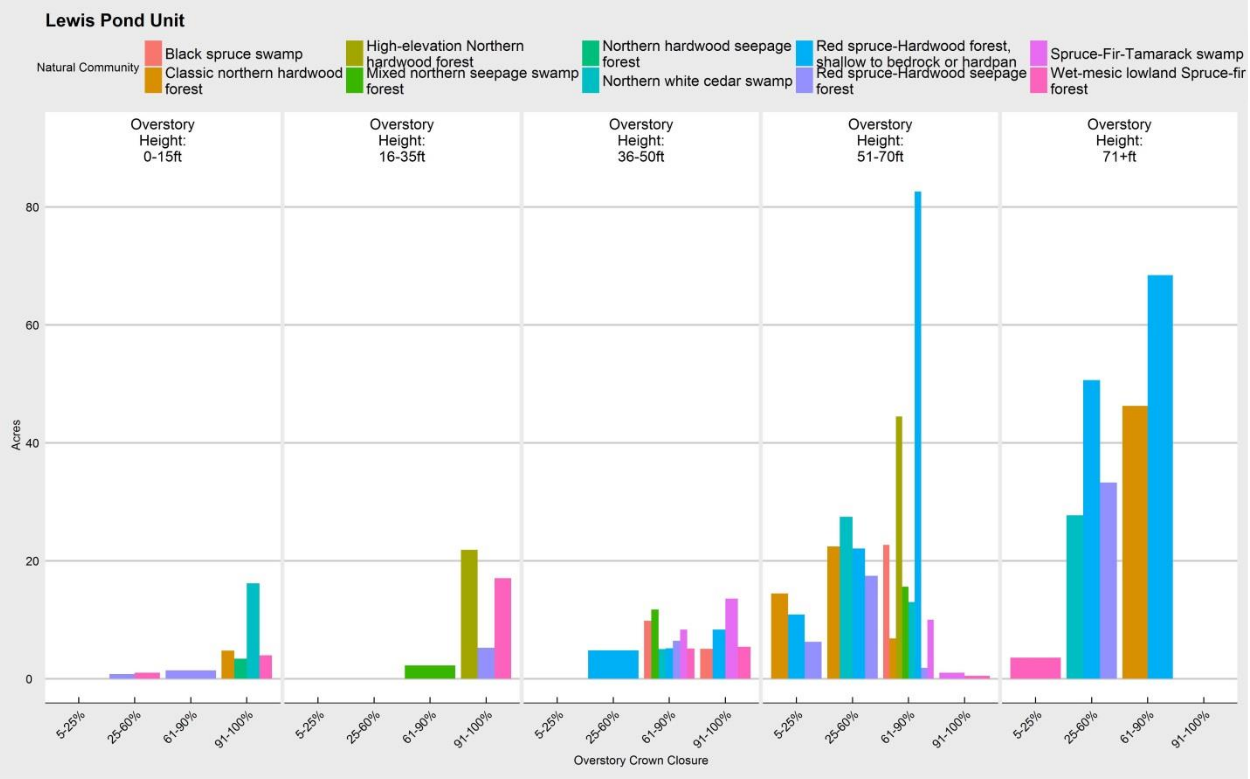


Figure 6.8.4 Canopy height and crown closure by natural community - Lewis Pond Unit



Rare, Exemplary, and Unique plants and communities: The high quality wetland natural communities and 60-acre dystrophic pond within the Lewis Pond Unit provide conditions for high species diversity including state threatened, rare and uncommon plant and insect species. These species include Northeastern bladderwort, purple bladderwort, Farwell's water-milfoil, swamp thistle, Kamtschatkan bedstraw, mountain fly-honeysuckle, Lake Emerald, and Ringed Emerald. A 37 acre black spruce swamp, a state rare natural community, occurs to the northwest of Lewis Pond.

Management Considerations: Other

- Lewis Pond is a 60 acre dystrophic pond and largest body of water in the Refuge. A forest buffer was left intact along Logger Brook by previous owners
- The Lewis Pond Unit contains one of the largest minerotrophic cedar swamps and perhaps the most species diverse natural community type in the Nulhegan Basin Division. Dominant cedars are greater than 50 cm dbh, and those that were aged were between 150 to 200 years old. Very few trees were harvested in the cedar swamp. Some spruce and fir were harvested along the edges of the swamp. State rare and uncommon species occur in this, and other wetlands in this unit.
- The elevation of this MU is approximately 1,800 feet
- Five hunting camps are located along the shore of Lewis Pond
- Lewis Pond is open to non-motorized boating and fishing
- These lands are located in the town of Lewis.

- Lewis Pond Road is the primary access. Furthest point from VT Route 105 is approximately 13 miles.

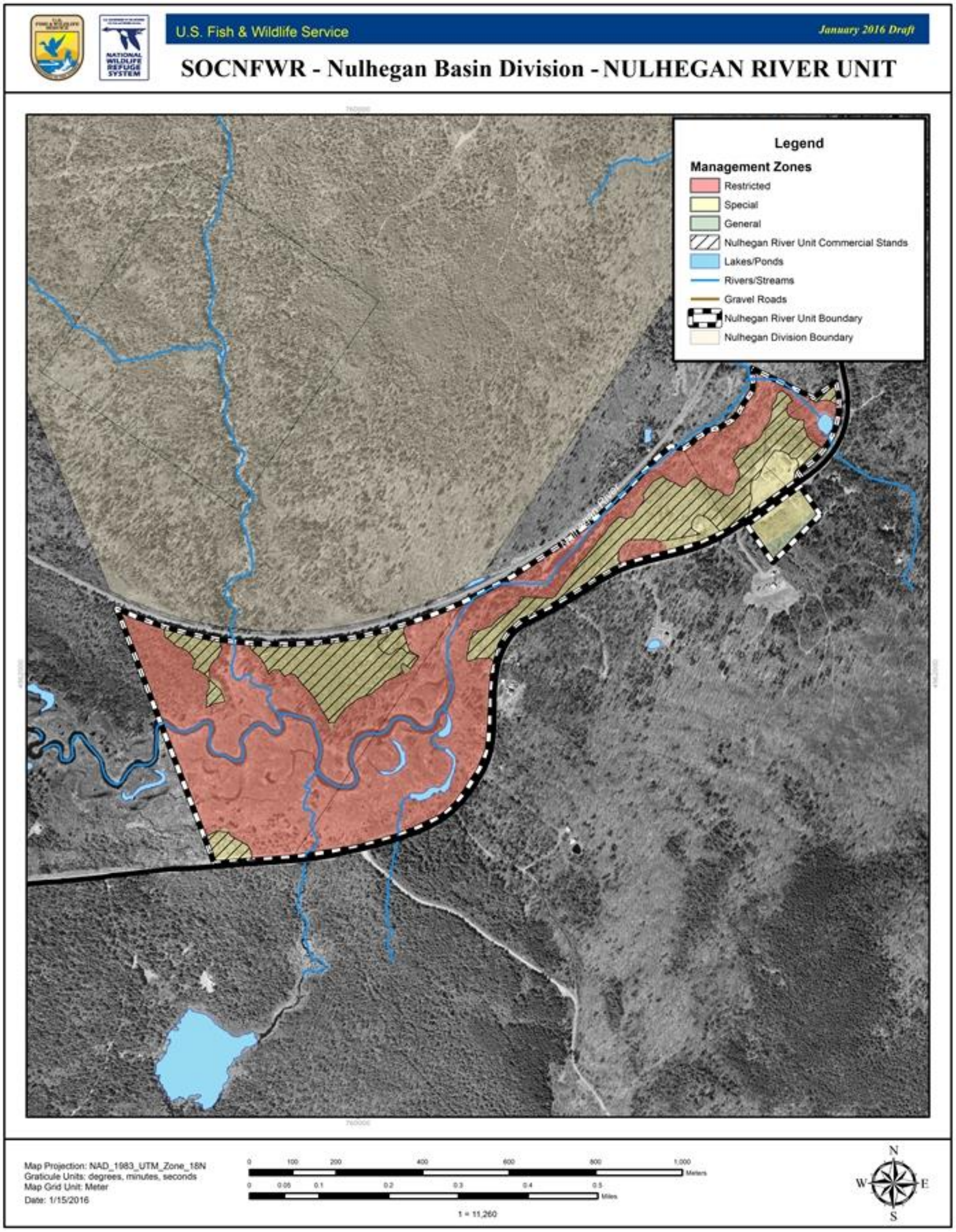
Forest Management

- This MU currently supports small areas of mature northern white cedar swamps and other softwood natural communities - these patches may serve as a core for surrounding treatments designed to accelerate succession to older conditions.

6.9. Nulhegan River Unit

The Nulhegan River Unit is approximately 131 acres. This unit includes the Division Visitor Contact Station buildings and parking area. The northern boundary is adjacent to an active railroad bed and the southern boundary is located along VT Route 105. A small portion of the Nulhegan River flows through this unit. All of the land in this MU are fee owned lands managed as Refuge. While the different zones are indicated on the map, there is no intention to use commercial forest management on this Unit. Ninety-three acres are within a restricted management zone, 36.8 acres are within a special management zone and 0.96 acres are within a general management zone. Enrichment planting of the understory with red spruce may improve its representation in the Red Spruce-Hardwood natural community downslope from the visitor center.

Figure 6.9.1 Nulhegan River Unit



<u>Management Considerations: Unit Priority</u>
<u>Ranking:</u> 9
<u>Reasons for Ranking:</u> See Table 6.1

<u>Management Considerations: Focal Species</u>
Based on current information, the focal species for this unit are Canada warbler, black-throated blue warbler, blackburnian warbler and rusty blackbird. We will focus habitat management within stands that currently have a moderate species Habitat Suitability Index (HSI) (see Chapter 3.5.1., Table 6.1 and summary text below). Stands will be evaluated in the field to determine the best management approach. If this unit is NOT managed within the next 15 years due to its low ranking or unforeseen circumstances, the HSIs will be re-evaluated using updated species information and/or refuge habitat data, if available. Provided below is an estimated area of the unit with moderate HSI for each species.

<u>Canada warbler</u>: The Canada warbler HSI map shows that approximately 25 percent of this unit or 25 acres has moderate habitat suitability for this species.

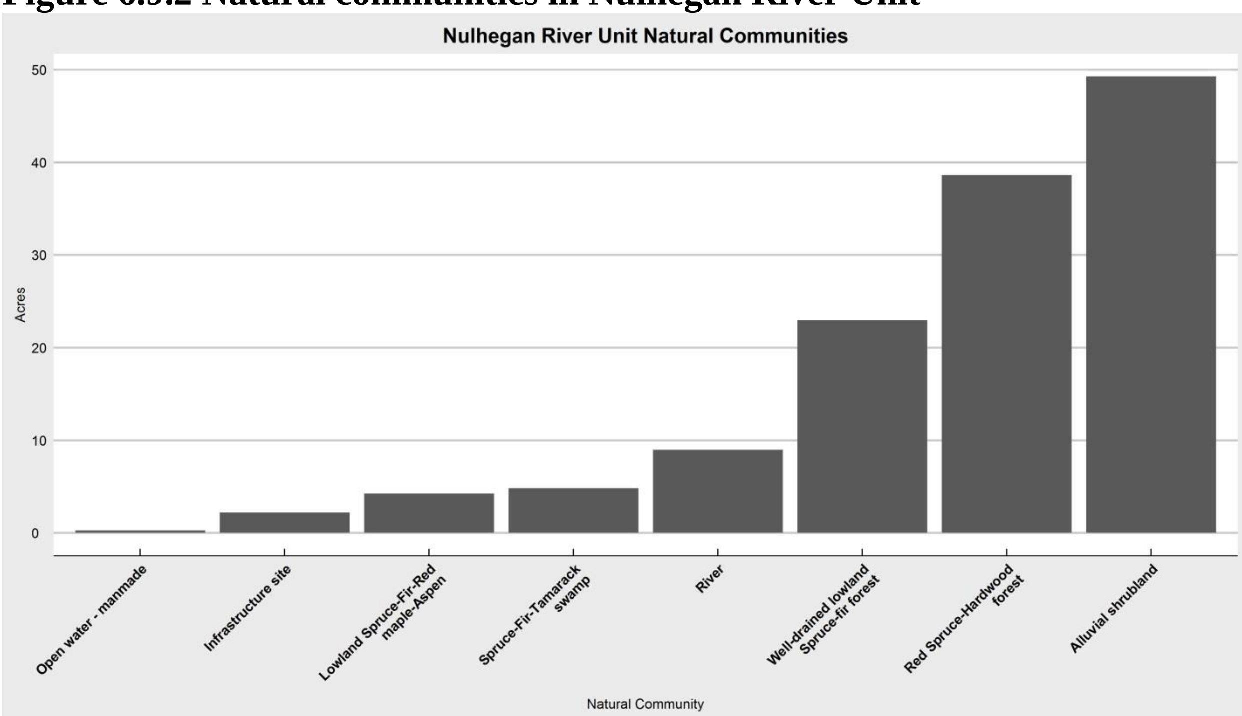
<u>Black-throated blue warbler:</u> The black-throated blue warbler HSI map shows that approximately 20 percent of this unit or 26 acres has moderate habitat suitability for this species.

<u>Blackburnian warbler:</u> The blackburnian warbler HSI map shows that approximately 18 percent of this unit or 24 acres has moderate habitat suitability for this species.

<u>Rusty blackbird:</u> The rusty blackbird HSI map shows that approximately 21 percent of this unit or 28 acres has moderate habitat suitability for this species.

<u>Management Considerations: Forest Characteristics</u>
<u>Site Capability:</u>

Figure 6.9.2 Natural communities in Nulhegan River Unit



Complex Forest Structure:

Figure 6.9.3 Complex forest structure within Nulhegan River Unit

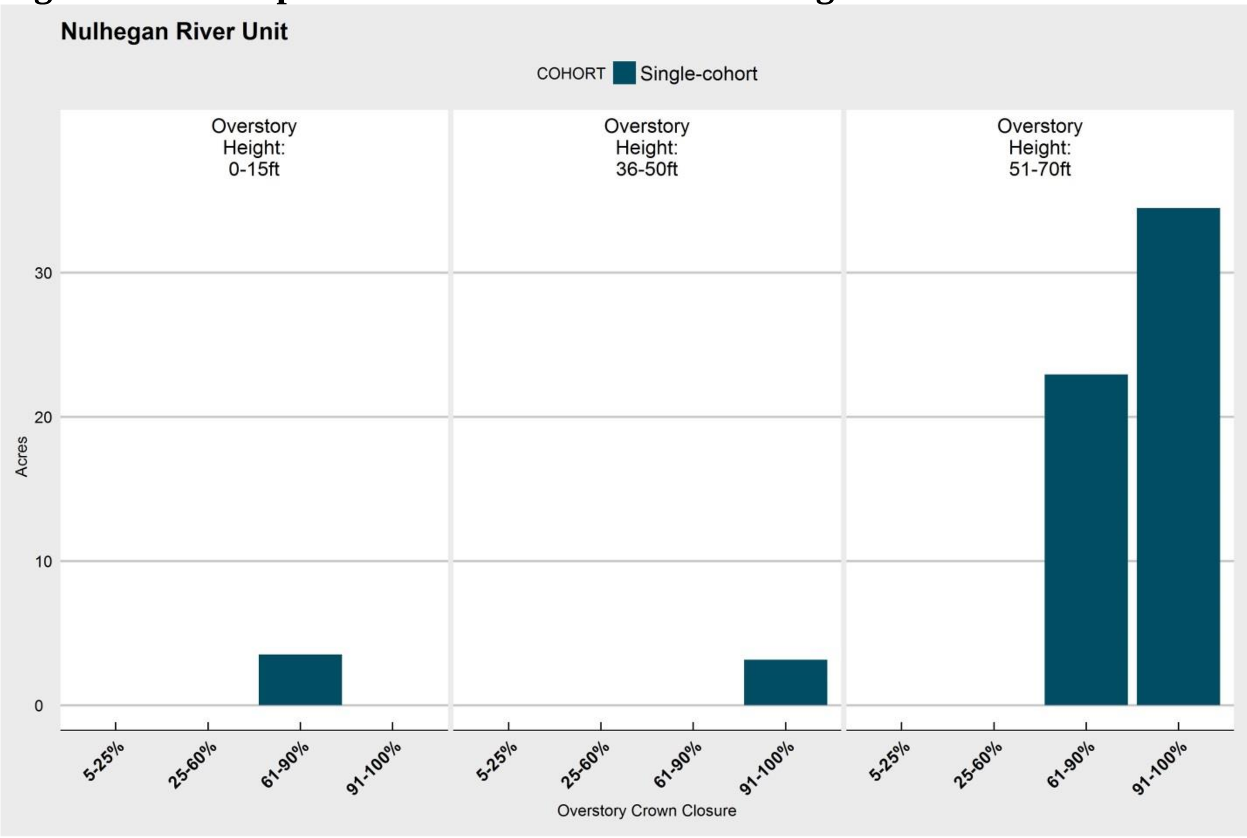
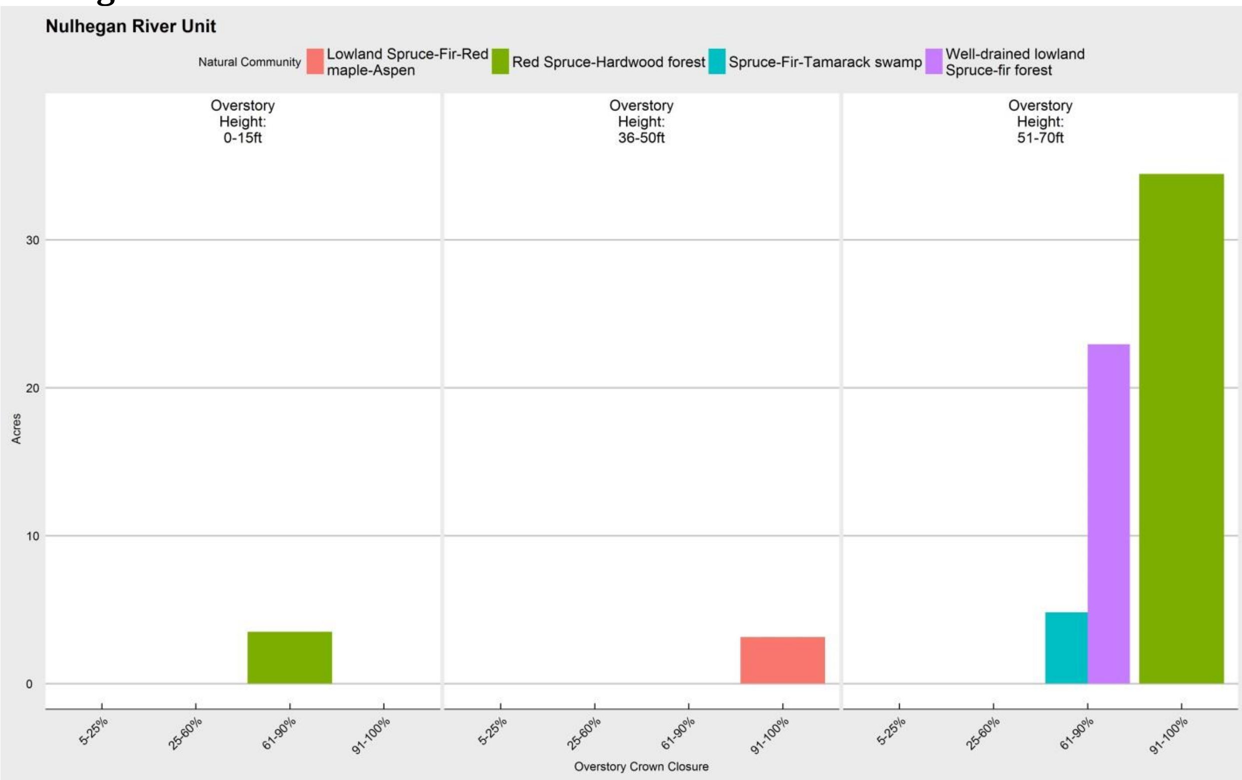


Figure 6.9.4 Canopy height and crown closure by natural community - Nulhegan River Unit



Rare, Exemplary, and Unique plants and communities: Swamp thistle, a state uncommon plant species, and drooping bluegrass, a state rare species, occur within the Nulhegan River floodplain. A five acre black spruce swamp, a state rare natural community, occurs in the northwest corner of the unit. This swamp is located between the Nulhegan River and active railroad tracks and is listed in fair condition.

Management Considerations: Other

- This unit includes a 28-acre alluvial shrubland, in excellent condition.
- The Division Visitor Contact Station, research quarters and out buildings are located in this unit.
- A maintained one mile loop trail provides visitors access to the Nulhegan River behind the Visitor Contact Station.
- A weather station is located across VT Route 105 from the Visitor Contact Station.
- These lands are located in the town of Brunswick.
- The primary access would be on VT Route 105. Furthest point from VT Route 105 is less than a mile.

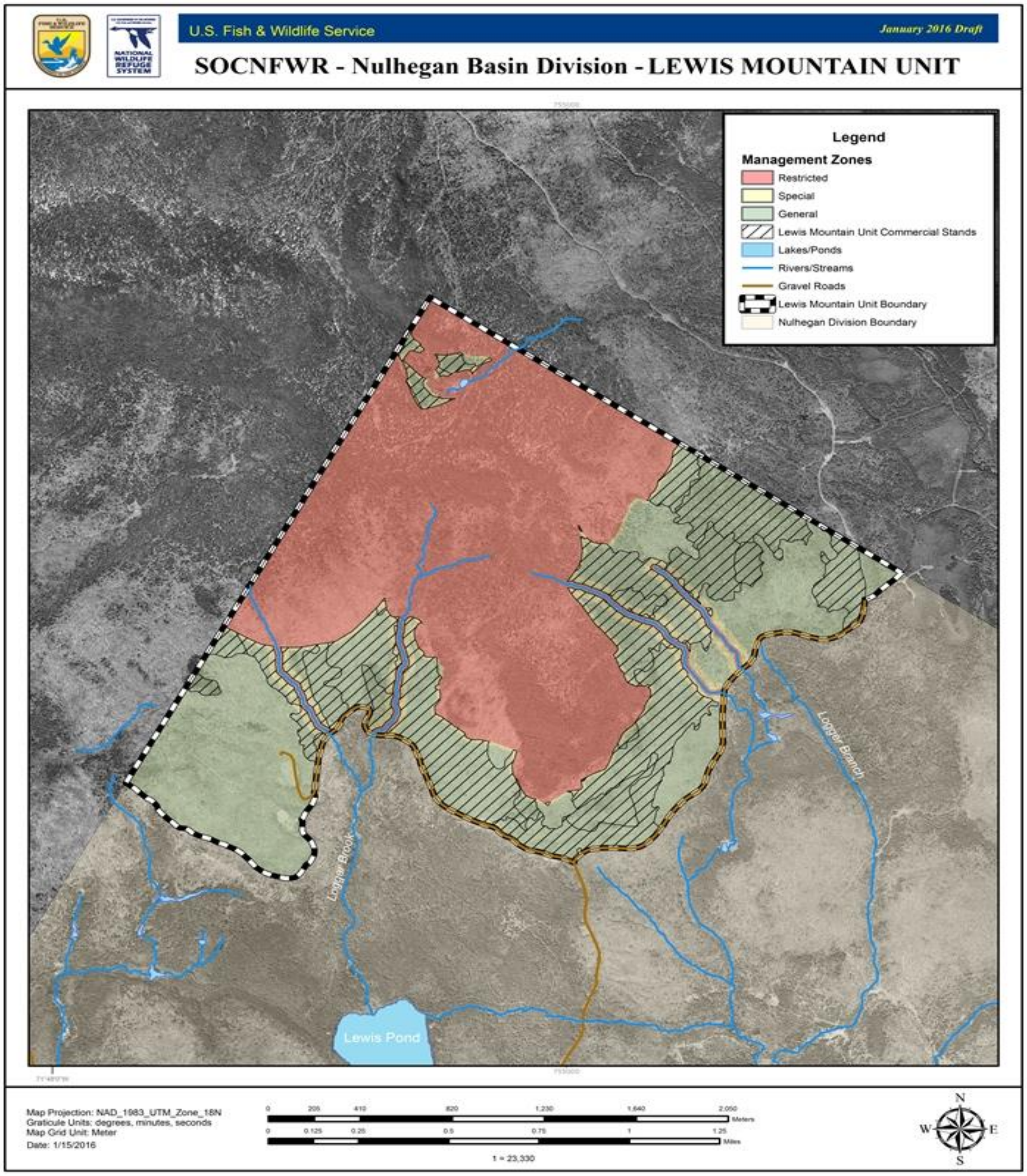
Forest Management

- Consider enrichment planting within the Red spruce-Hardwood natural community to the north of the visitor center.
- Work with private landowner to eradicate population of invasive phragmites along Route 105

6.10. Lewis Mountain Unit

Lewis Mountain Unit is 1,266 acres situated in the higher elevations of the Division. There are about 565 acres of montane natural communities where no or limited management will occur. The remaining acreage is mostly northern hardwood natural community types. All of the land in this MU are fee owned lands and managed as Refuge. About 637 acres are within a restricted management zone, 67 acres are within a special management zone and 561 acres are within a general management zone (Figure 6.10.1).

Figure 6.10.1 Lewis Mountain Unit



Management Considerations: Unit Priority

Ranking: 10

Reasons for Ranking: See Table 6.1

Management Considerations: Focal Species

Based on current information, the focal species for this unit are Canada warbler, black-throated blue warbler and blackburnian warbler. We will focus habitat management within stands that currently have a moderate species Habitat Suitability Index (HSI) (see Chapter 3.5.1., Table 6.1 and summary text below). Stands will be evaluated in the field to determine the best management approach. If this unit is NOT managed within the next 15 years due to its low ranking or unforeseen circumstances, the HSIs will be re-evaluated using updated species information and/or refuge habitat data, if available. Provided below is an estimated area of the unit with moderate HSI for each species.

Canada warbler: The Canada warbler HSI map shows that approximately 14 percent of this unit or 175 acres has moderate habitat suitability for this species.

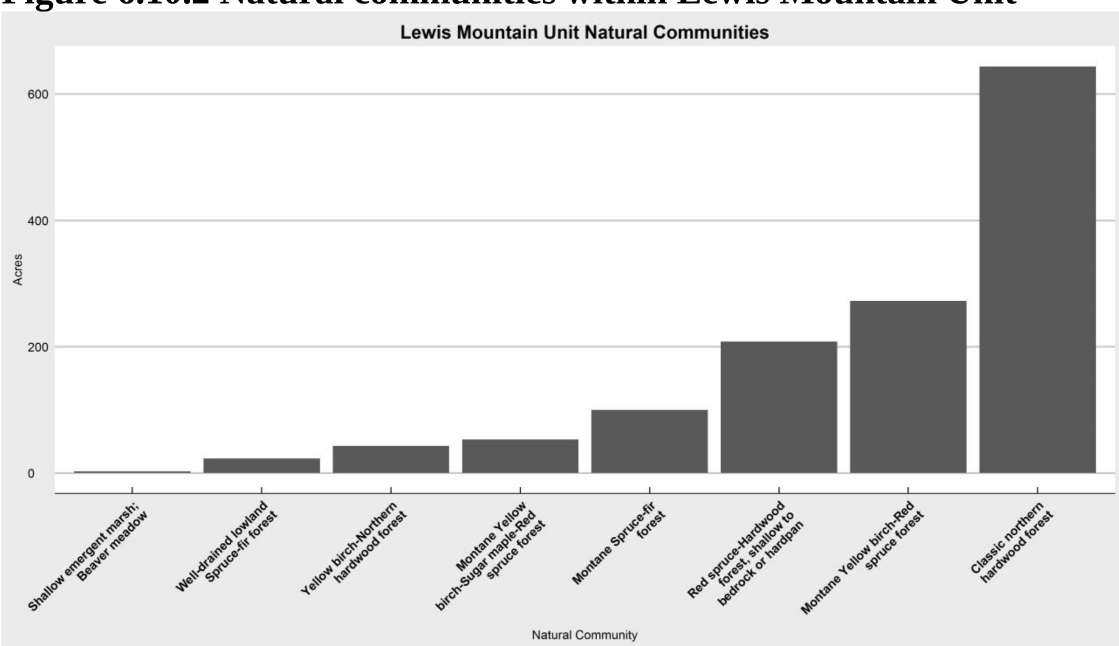
Black-throated blue warbler: The black-throated blue warbler HSI map shows that approximately 49 percent of this unit or about 618 acres has moderate habitat suitability for this species.

Blackburnian warbler: The blackburnian warbler HSI map shows that approximately 40 percent or 506 acres of this unit has moderate habitat suitability for this species.

Management Considerations: Forest Characteristics

Site capability: The majority of the forested uplands are suited for northern hardwood types; the highest elevations support softwood forest types. Site quality is generally poor and mature trees short.

Figure 6.10.2 Natural communities within Lewis Mountain Unit



Complex Forest Structure: About 860 acres of this MU occurs in single-cohort stands with the balance in a multi-cohort condition. This includes about 304 acres of classic northern hardwood forest and more than 225 acres of Montane Yellow birch-Red spruce forest natural community in a single-cohort condition.

Figure 6.10.3 Complex forest structure within Lewis Mountain Unit

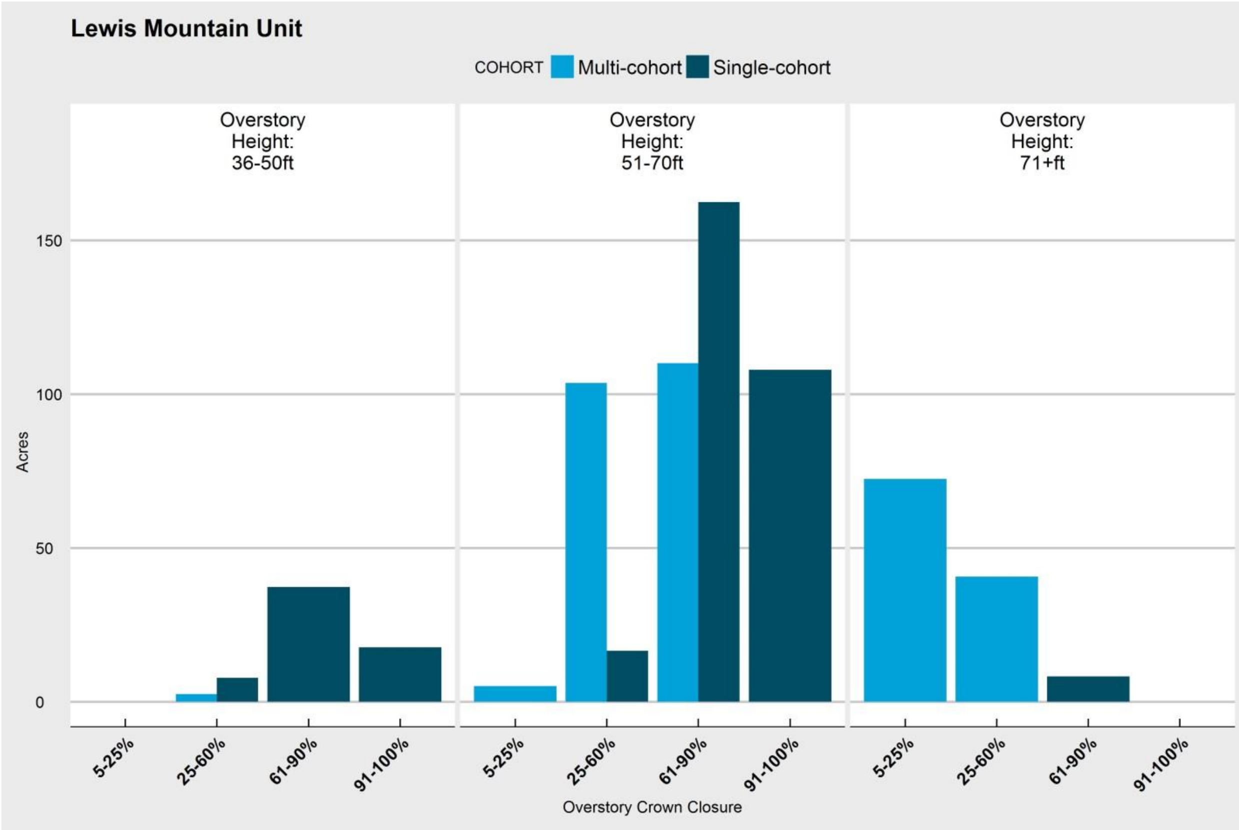
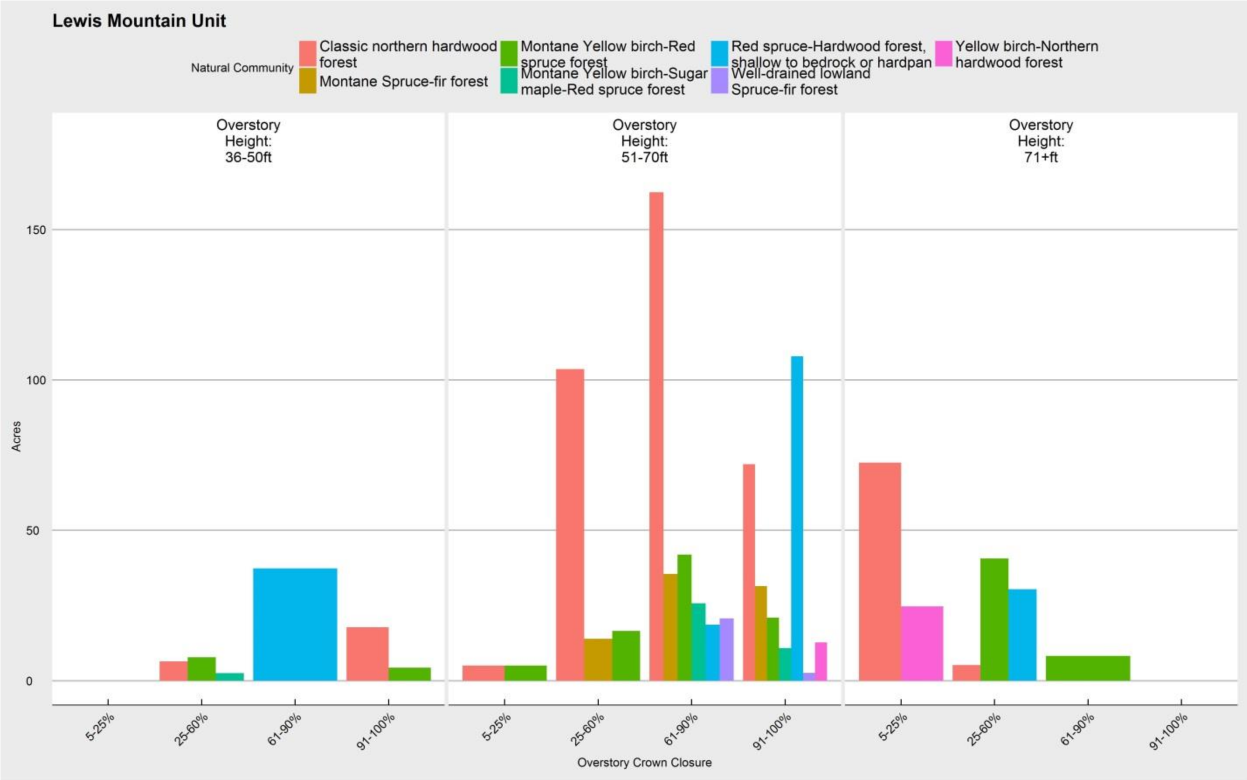


Figure 6.10.4 Canopy height and crown closure by natural community - Lewis Mountain Unit



Rare, Exemplary, and Unique plants and communities: Swamp thistle (*Cirsium pumilum)* a state uncommon species, occurs at the edge of a perched wetland, and Kamtschatkan bedstraw (*Galium kamtschaticum)*, another state uncommon plant occurs near the refuge boundary.

Management Considerations: Other

- Lewis Mountain has an elevation of 2,559 feet.
- Over 550 acres are typed as montane natural community types which are unique when compared to the rest of the community types present in the Division.
- A gravel pit is located on the southwest portion of the unit and will remain open for future road maintenance needs.
- A scenic overlook provides the public with panoramic views of the Nulhegan Basin, Lewis Pond and surrounding mountain ranges. A parking area for four vehicles and a maintained wheelchair accessible path provides access.
- A trail connector to Gore Mountain is proposed. Once established, the trailhead will be located near the Lewis Pond overlook.
- Lewis Pond Road is the primary access. Furthest point from VT Route 105 is approximately 16 miles.
- Lands are located in the town of Lewis.

Forest Management

- Soils are generally poorer quality and beech dominates much of the hardwood regeneration. Consider enlarging group openings to favor regeneration of mid-tolerants.

7. Prescription Guidelines

The following guidelines are provided for developing prescriptions for each management action.

7.1. Forest Management

Each forest type (stand) within a treatment area will have unique traits that will be evaluated at the time of implementation. Desired forest conditions and prescriptions will be developed for each stand after the evaluation is completed. The authors of this habitat management plan recognize forest ecosystems are complex and dynamic systems, and expected wildlife and plant responses to management actions can vary. The values presented here represent an effort to describe the desired wildlife habitat and stand characteristics – and to translate these characteristics into traditional silvicultural ideas.

7.1.1. Uneven-aged Management (Softwood Forest Types)

Silviculture: Utilize single tree and group selection harvesting to transition even-aged forests to multi-aged and multi-structure forests with a minimum of 3 age classes and a diameter distribution approaching a slope of q = 1.7, which has an approximate basal area distribution of 41ft²/acre in 6-10" diameters, 26 ft²/acre in 11-14" diameters, and 16 ft²/acre in 15"+ diameters. Use of the "q" is defined by (Leak, Solomon, & DeBald, 1986):

> *Diameter distributions are approximated by the reverse J-shaped curve, with a slope defined by "q" – the quotient between numbers of trees in successively smaller d.b.h. Classes*
> *Distribute 1/10 to 1/20 acre group cuts throughout the stand. Do not exceed 10-15% of the stand with group cut openings. Use single tree selection between groups when appropriate, but not consistently throughout the stand so that patches of uncut forest approximately 2-4 acres in size remain. Retain approximately 7 ft²/acre (approximately 6 trees/acre) as reserve trees to contribute to snag, cavity, and course woody material objectives. Reserve trees remain in the treatment area for the length of their natural lifecycle. Conduct harvests every 15 years with a residual basal area goal of approximately 100 ft²/acre.*

Preparation and layout: Promote the long term goal of a predominately closed canopy stand (>70% canopy closure) with a variety of age classes. Release advanced softwood regeneration using group cuts. Retain/promote mature trees and supercanopy trees, especially large pines and red spruce. Do not remove trees simply because they are damaged during the harvest operation. Only remove those needed to meet prescription objectives. Retain a higher proportion of red spruce than balsam fir. Retain and promote trees with large horizontal branches, if the species is desirable (e.g. red spruce) consider use as seed tree for an adjacent group selection. Retain any uncommon or rare species. Do not harvest any Northern White Cedar unless necessary for access to critical harvest areas.

7.1.2. Uneven-aged Management (Hardwood and Mixedwood Forest Types)

Silviculture: Utilize single tree and group selection harvesting to transition even-aged forests to multi-aged and multi-structure forests with a minimum of 3 age classes and a diameter distribution approaching the slope of q = 1.3, which has an approximate basal area distribution of 30 ft²/acre in 6-10" diameters, 28 ft²/acre in 12-14" diameters, and 42 ft²/acre in16"+ diameters. Use of the "q" is defined by (Leak et al., 1986):

> *Diameter distributions are approximated by the reverse J-shaped curve, with a slope defined by "q" – the quotient between numbers of trees in successively smaller d.b.h. classes*

Distribute 1/5 to 1/2 acre group cuts throughout the stand. When warranted, introduce patch clearcuts approximately 1-2 acres in size to meet habitat objectives. Space patch clearcuts widely apart (>1000 feet). Do not exceed 10-15% of the stand with group and patch openings. Use single tree selection between groups when appropriate. Retain approximately 7 ft²/acre (approximately 6 trees/acre) as reserve trees to contribute to snag, cavity, and course woody material objectives. Reserve trees remain in the treatment area for the length of their natural lifecycle. Conduct harvests every 15 years with a residual basal area goals of approximately 100 ft²/acre for Mixedwood forest types, and approximately 70 ft²/acre for Hardwood forest types.

Preparation and layout: Promote the long term goal of a predominately closed canopy stand (>70% canopy closure) with a variety of age classes. Do not harvest softwoods trees, unless necessary for access to adjacent harvest trees or placement of skid road. Promote regeneration of softwoods, especially red spruce. Retain beech trees especially those that exhibit potential resistance to beech bark disease. Release advanced softwood regeneration using group cuts. Retain/promote mature trees and supercanopy trees, especially large pines, hemlock, and red spruce. Do not remove trees simply because they are damaged during the harvest operation. Only remove those needed to meet prescription objectives. Retain and promote trees with large horizontal branches, if the species is desirable (e.g. red spruce) consider use as seed tree for an adjacent group selection. Retain any uncommon or rare species.

7.1.3. **Even-aged Management (Woodcock Focus Area)**

Silviculture: Where best suited for woodcock management within the Woodcock Focus Areas, include all height classes in area regulation and schedule 8-10 year harvest intervals to create and maintain 4 forest age classes with approximately 5 acre patch sizes and 40 year rotations. Where possible, focus initial harvests on areas with aspen that are mature and at risk of declining in population and/or vigor.

7.1.4. **Within Stand Features (All forest Types)**

Snag and cavity trees: Retain approximately 6 trees per acre for snag and cavity trees including trees that exhibit signs of developing into one or the other - 3 should have diameters in excess of 12 inches and 1 in excess of 18 inches. Good snag recruitment trees are those that exhibit crown dieback, excavation by woodpeckers or other wildlife, and trees with significantly damaged boles or broken tops or limbs. Good cavity recruitment trees are large long lived species such as red spruce, hemlock, yellow birch, or sugar maple, which may include those that were left as legacy trees during previous harvests. In addition, other good candidate trees are those that are obviously older than the average stand age and have diameters in excess of 20 inches as well as trees with large branches broken off at the main stem of the tree or other defects that appear to have the potential to develop into a cavity. Retain a group of shade trees adjacent to snag and cavity trees to maintain a shade & thermal regime. It is particularly important for shade trees to be left on the southern aspect of the focal snag or cavity tree.

Coarse Woody Material (CWM): Retain all CWM and root wads found resting on the forest floor. Leave topwood, branchwood, and other cull wood (especially hollow logs from harvested trees on the forest floor.

Vernal pools, seeps and streams: Create 100 foot no cut or limited cut buffers around vernal pools and seeps, and along 1st and 2nd order streams. Avoid adding woody material to streams and keep vernal pools and seeps free of logging debris/slash and sediment. Retain >70% canopy closure over vernal pools, seeps, and streams and >70% canopy closure within 300 ft. of vernal pools. Do not interrupt groundwater flow above or below seeps.

7.1.5. Roads and Landings (All forest types)

Haul Roads, skid roads, and landings: Where possible utilize existing haul roads, skid roads, and landings. If needed, place landings in strategic location that minimize the size and amount of alterations to the site. Do not place landings near 1st or 2nd order streams (should be at least 100 ft. distant). Keep skid road width to a minimum. Do not place skid roads/machinery in wet or dry vernal pool basins, headwater or other stream beds, intermittent stream beds or seeps. Keep skid roads at least 300 feet from vernal pools, if possible, and insure they don't alter water flow to or from vernal pools or create ruts near vernal pools. Avoid crossing streams if possible, and if stream crossings are necessary keep them to a minimum and use best management practices guidelines to ensure crossings have a minimal impact to stream beds and water quality. Establish skid roads that follow contours instead of straight uphill, where possible. Use waterbars, etc. to reduce erosion, place slash in skid trails.

7.2. Stream Restoration

Restoration of the Division's stream habitat will improve stream function and connectivity for aquatic species. Approximately, 25+ miles of stream habitat require restoration, and efforts are dependent on partnership involvement and funding availability.

Culvert replacement: Many of the culverts located along the Division's 40 miles of gravel roads require replacement to improve fish passage and connectivity to spawning habitat. Culverts have been prioritized based on a variety of parameters including number of stream miles restored, quality of stream habitat, number of fish species captured below the culvert, cost and public access. Heavy machinery will be used to remove existing barriers to aquatic organism passage and replace with appropriate crossings. When possible, culverts are replaced when water flow is low, and silt fence is used if siltation of the stream is a concern.

In-stream habitat restoration: Segments of stream habitat within the Division were straightened to provide easy passage for logs to the mills during the 1800s. Techniques used to improve stream function include:

- *Strategic Wood Additions:* Use a chainsaw to strategically fell trees into the stream to create woody fish habitat structures.
- *Strategic Boulder Placement:* Use grip-hoist methods to move in-stream boulders to create fish habitat structures and enhance point bars.
- *Static Whole Tree Additions:* Whole trees with intact root wads that are still partially attached to the ground will be felled as a part of strategic wood addition structures. Single whole tree additions will also be used to modify flow and provide cover, in areas where the likelihood of movement is high for a sawn tree.
- *Mobile Whole Tree Additions:* Use grip-hoist to remove whole trees, including the root ball, from the forest and strategically place them in the stream with the expectation that they will move downstream and secure themselves, then begin recruiting new wood and forming fish habitat.

7.3. Management of Roosting Areas within Woodcock Management Units

Woodcock require sparsely vegetated open areas at least 3 acres in size for roosting. To meet roosting needs, one roosting area was established in each Woodcock Management Unit. These areas can be maintained through a variety of strategies such as *mowing, prescribed burning, or disking* to ensure at least 30 – 40% of the area is free of dense herbaceous or woody vegetation.

Recommended method: Mow strips utilizing equipment such as tractor, ATV, or other vehicle able to negotiate off road use. Treatments may need to be applied annually or perhaps more often, depending on growth and density of herbaceous cover. Treatments will occur in late summer or early fall to avoid impacts to breeding birds.

7.4. Invasive Species Management

Management of invasive species is a long term commitment essential to maintaining the biological integrity and diversity of Division habitats. The USFWS emphasized the importance of this commitment in 2002, when a National Wildlife Refuge System strategy for management of invasive species was developed by a Fulfilling the Promise implementation team. This implementation team wrote a report, "The National Strategy for Management of Invasive Species," that recommends the following actions for invasive species management (U.S. Fish and Wildlife Service, 2003):

1. *Prevention and Education and Awareness*
2. *Early Detection/Rapid Response*
3. *Eradicate/control/contain*
5. *Monitor/Inventory*

7.4.1. Prevention and Education and Awareness

Preventing the introduction of new invasive species and the spread of current priority invasives provides an economic and ecological benefit to the Division. Implementation of this action in combination with education and awareness will be instrumental to counter the impacts of invasives species on Division habitats.

Invasive species can be introduced unintentionally through habitat manipulations or construction projects, from the public while engaged in recreational activities or spread to the Division from adjacent lands. The following prevention strategies will be incorporated into general refuge management procedures. These measures will also be incorporated into educational materials provided to partners, adjacent landowners and the general public.

<u>Prevention Strategies:</u>

Land Management

- Only use local contractors, if possible. Require all heavy equipment used for construction or habitat management projects be pressure washed before mobilization to a new site. Inspections should occur before and after use to ensure they are clear of mud, dirt, plants, and other debris that could hold seeds or rhizomes.
- Monitor disturbed or manipulated areas after management efforts for at least 5-years to detect invasive species occurrences early.
- Use certified weed seed free mulch, sand, gravel, dirt, and other construction materials.
- Do not stockpile weed-infested materials.

Recreational Users

- Maintain invasive species-free zones along trails, roads, parking lots and boat launches. Inspect these areas late spring and summer and control new infestations immediately.
- Provide educational material for recreational users about the importance of removing plant material, mud and soil from clothing, footwear, gear, and recreational vehicles such as bikes, ATVs, boats, etc. before moving to a new recreation area.

In addition to the above strategies, Division staff will engage landowners adjacent to the Division boundary in coordinated management efforts to prevent the spread of invasive species to Division lands. We will provide educational material, staff expertise and support in securing funding to manage invasive species on their property.

7.4.2. **Early Detection/Rapid Response**

Early detection/rapid response involves a targeted monitoring program for invasive species that do not occur on the Division, but are management priorities at the Regional or National Scale. And if these species are detected on Division lands, they become management priorities and all efforts are made to contain and eradicate the infestation. Early detection/rapid response procedures eradicate priority invasives while their populations are small, and before they impact habitats, making this a priority action for implementation.

Early Detection/Rapid Response Strategies:

- Establish a list of early detection species utilizing state and national websites.
- Conduct site assessments focusing on high public use areas and disturbed sites.
- If an early detection species is identified, contain the infestation (e.g. close off public access if it is on a foot trail) and eradicate using integrated pest management techniques described below.
- Monitor site on an annual basis and manage invasive if present. Monitor site until there is no return of the invasive for at least 3 consecutive years.
- Coordinate with partners and adjacent landowners, as needed, to manage and monitor site.
- Evaluate infestation to determine mode of transport and take steps to prevent another infestation.

7.4.3. **Eradicate/Control and Contain**

Management of invasive species can become overwhelming with the number of species and size of populations. Many stations lack the staff, time and funding to manage all infestations. It is important, therefore, to prioritize management of infestations to ensure a strategic approach that considers the biology of the pest, the impacted habitat, availability of trained staff and volunteers and available funds. There are various risk assessments used to prioritize invasive management. The USFWS national strategy recommends the following in priority order (USFWS 2003):

1. Smallest scale of infestation, including small satellite infestations
2. Poses greatest threat to land management objectives
3. Greatest ease of control

And an alternative priority order to use during limited resources:
1. Treat the smallest infestations (satellite populations).
2. Treat infestations on pathways of spread.
3. Treat the perimeter and advancing front of large infestations.

Very few invasive species populations occupy Division habitats, and the majority of these infestations are small in size. The following table provides the distribution and status of invasive species occurrence within the Division.

Invasive Species	**Distribution**	**Status**
Japanese knotweed	One location on Lower Lewis Pond Road within forest opening, patchy distribution	High priority and under management to eradicate.
common reed	Small patches along roadsides and forest openings	High priority and under management to eradicate.
American bittersweet	One plant at visitor contact station at the base of a landscaped fir tree	High priority and under management to eradicate.
coltsfoot	Established populations in gravel pits and along gravel roads	Low priority, considered naturalized. No management.
thistle species	Single plants scattered in low numbers along gravel roads	Medium priority, plants removed on an opportunistic basis. Contain.
crown vetch	One location at Stone dam road entrance at junction of route 105	Medium priority. No current management. Plan to eradicate.
reed canary grass	Large patches in wetlands	Undecided, it would take a lot of effort to manage this species. Needs to be evaluated further.
buckthorn species	Individual plants were detected within the Nulhegan floodplain	Individual plants were pulled in 2000. Area is monitored annually for presence.
largemouth bass	Species introduced to Lewis Pond	High priority. Working with VTFWD to eradicate

Management Strategies:

We will use an integrated pest management strategy approach that incorporates pest ecology, the size and distribution of the population and site-specific conditions. Best management practices will reduce potential effects to non-target species, sensitive habitats, soils and quality of surface and groundwater.

<u>Mechanical Methods</u> - These are non-chemical methods including removal by hand using a shovel, brute strength, snips or weed wrench; mowing with a brush hog or side-mounted mower; prescribed burning and using a tarp or plastic to cover infestation.

<u>Chemical Methods</u> - Chemical methods include all pesticides including herbicides, insecticides, fungicides, pesicides, etc. All chemicals will be applied using best management practices (Vermont Regulations for Control of Pesticides, 1991) such as:

- applied by a certified applicator;
- using targeted application methods, such as cut stem and drip, and stem injection treatments for plants to minimize injury to non-target species;

- during appropriate weather conditions;
- and within a timeframe that will have the most impact on the target species.
- Other management techniques include foliar herbicide treatment to treat areas where more targeted methods would not be effective.

Biological Control - Biological controls are intentional releases of living organisms such as diseases, insects, nematodes, etc. that are pests of the target species in its native habitat, and have been determined to selectively feed on the target species.

7.4.4. **Monitor/Inventory**

Monitoring involves measurements of management target over time to determine whether objectives for that target are being met. There are different levels of monitoring intensities: low, moderate and high (USFWS 2003).

Low Intensity - involves surveying the target species on an annual basis to evaluate the size and density of the infestation.

Moderate Intensity - involves surveying the target species on an annual basis as mentioned above, but adding photo points, transects or quadrats.

High Intensity - involves surveying the target species as mentioned above under moderate, but increasing the frequency to 2-4 times per year and conducting a statistical analysis.

The monitoring intensities used at the Division will depend on the biology of the invasive, size of the infestation, and resources available for the monitoring effort. The low intensity method will be used most often due to the low number of invasive species impacting habitats.

A strategic invasive species inventory of Division habitats will need to be conducted every five years to:

- map the location of new infestations.
- prioritize invasive species management objectives.
- evaluate prevention strategies.

An Invasive Species Inventory Protocol has been developed in Region 5. This protocol will be evaluated further to determine whether it is appropriate for use within the Division.

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APPENDIX A:
Nulhegan Basin Division Habitat Management Plan Environmental Assessment

Nulhegan Basin Division
Silvio O. Conte National Fish and Wildlife Refuge

Essex County, Vermont

August 2018

Prepared by:
U.S. Department of the Interior
Fish and Wildlife Service
Silvio O. Conte National Fish and Wildlife Refuge
Nulhegan Basin Division

Introduction

The Nulhegan Basin Division (division) is part of the Silvio O. Conte National Fish and Wildlife Refuge (Conte Refuge). The 26,605 acre division is located in Essex County, Vermont within the watersheds of the Nulhegan and Connecticut Rivers. It is part of the 132,000-acre parcel formerly owned by Champion International Company. The division was established on July 21, 1999, to provide long-term protection for important migratory bird habitat, habitat for rare species and plant communities, important fisheries habitat, and valuable wetlands.

This EA evaluates and compares the environmental impacts of two alternatives: (1) Current Management (No Action) - no additional habitat management efforts beyond management of existing early successional American woodcock areas and (2) Expanded Habitat Management - implementation of a habitat management program as described in the division's Habitat Management Plan (HMP; proposed action). This analysis will inform two decisions:

1. Determine whether the Service should implement an expanded habitat management plan for this division of Conte Refuge.
2. If yes, determine whether the selected alternative will have a significant impact on the quality of the human environment. This decision is required by the National Environmental Policy Act (NEPA) of 1969, as amended. If the quality of the human environment would not be affected, a "finding of no significant impact" will be signed and will be made available to the public. If the preferred alternative would have a significant impact, an environmental impact statement (EIS) will be prepared to further address those impacts.

Purpose and Need

The purpose of this EA is to develop an HMP that fulfills the management direction outlined for the Nulhegan Basin Division in the 2017 Conte Refuge Comprehensive Conservation Plan (CCP). HMPs are required by policy (U.S Fish and Wildlife Service, 2002) and provide the prescriptive and tactical direction required to achieve goals and objectives laid out in the CCP.

Description of Alternatives

This section presents and compares the two alternatives identified for this project. These alternatives were developed according to NEPA requirements. Some specific actions have been covered under previous NEPA documentation, but are still included herein to present proposed management direction in its entirety. For example, forest management to create three early successional management areas totaling 287 acres for American woodcock was evaluated in an earlier EA (U.S. Fish and Wildlife Service 2006). Other actions covered by existing NEPA include stream restoration efforts to improve aquatic connectivity and fish passage, and eradication of priority invasive plant species throughout division habitats. These management activities fall under a NEPA categorical exclusion (516 DM Chapter 8 *B(3)*)(U.S Fish and Wildlife Service, 2004b).

The alternatives evaluate the effects of planned habitat management activities within the division's boundary related to forest management, stream restoration, and non-native, invasive species management. They are described in more detail below.

Alternative 1: Current Management (No Action)

Under this alternative, the previously approved early successional woodcock habitat management demonstration areas would continue. No additional forest management would occur; hence the remainder of the division's forested acres would be managed under a "passive" management regime. Restoration efforts of the division's stream habitats would continue, as well as management of non-native invasive species. This alternative satisfies the NEPA requirement for a "no action" alternative, which we define as our current management.

Forest Management:

Three existing woodcock management demonstration units would continue to receive the prescribed management. This includes entries every 5 years across approximately 287 acres to establish 4 unique age classes in adjacency. Following this initial re-entry interval, treatments will occur approximately every 20 years to maintain a shifting mosaic of age classes across the 287 acres.

Typical commercial harvest techniques will be employed to remove vegetation that can be processed into a merchantable product. Operations will consist of harvesting trees, pulling the harvested trees to landing areas, processing the trees into logs or wood chips, and delivering the product to market. This method typically utilizes multiple types of machinery including a feller-buncher, skidder, loader, and a chipper. During this treatment, all woody stems 2-inch in diameter and larger will be removed, and a large proportion of the smaller diameter materials will be crushed as part of the harvest operation.
The use of a feller-buncher and skidder increases the potential for ground disturbance and will be mitigated by operating on frozen ground to ensure rutting is minimized. A Service employee will be responsible for monitoring temperature and ground condition to ensure site conditions are suitable for operations.

Stream Restoration:

The division's stream habitat would continue to be restored to improve stream function and connectivity for aquatic species. Restoration efforts are dependent on partnership involvement and funding availability. Approximately, 25+ miles of stream habitat are in need of restoration, and 2.3 stream miles have been restored since 2014.

Priority culverts will continue to be replaced on the division's 40 miles of gravel roads to improve fish passage and connectivity to spawning habitat. Heavy machinery will be used to remove existing non-functioning culverts and replace with appropriate crossings. When possible, culverts are replaced when water flow is low, and silt fence is used if siltation of the stream is a concern.

Restoration of in-stream habitat will also continue. Techniques used to improve stream function include the strategic addition of whole trees into streams using low impact methods such as felling trees with chainsaws and pulling trees over using a hand powered grip-hoist. These trees are strategically placed in streams to create woody fish habitat structures, to provide cover from predators, and modify water flow to create pools for additional cover and feeding opportunities for trout. According to research conducted by Kratzer and Warren (2013), the presence of at least 150 pieces of at least 10 cm diameter woody material per hectare of stream will provide channel roughness and cover required for fish.

Invasive Species Management:

Management of invasive plants, insects or diseases will continue to be based upon an integrated pest management strategy that incorporates pest ecology, the size and distribution of the population and site-specific conditions. Best management practices (BMPs) will reduce potential effects to non-target species, sensitive habitats, soils and quality of surface and groundwater.

There are few invasive species currently impacting division habitats. At this time, Japanese knotweed and common reed are management priorities at the division. Since these species occur in low numbers, the goal is to eradicate their occurrence in all habitats. These species are currently being managed using BMPs (State of Vermont, 1991) including the application of herbicides by a certified applicator; using targeted application methods, such as cut stem and drip, and stem injection treatments to minimize injury to non-target species; and timing applications during appropriate weather conditions and within a timeframe that will have the most impact on the target species. Other management techniques include foliar herbicide treatment using a backpack sprayer to treat areas where more targeted methods would not be effective.

Invasive species occur in low numbers within the division; therefore, monitoring sensitive habitats (e.g. wetlands) and high public use areas (e.g. hiking trails) for the arrival of new species is a priority. As we become aware of new species, we will continue to assess the level of management priority and best management techniques that should be applied.

Alternative 2: Expanded Habitat Management (Proposed Action)

Under this alternative, we would implement the proposed division's HMP, which is a step-down management plan from Conte Refuge's CCP (U.S. Fish and Wildlife Service, 2017). The HMP provides detailed management objectives, and specific management strategies and prescriptions, required to meet the goals and objectives set forth in the CCP. It is based on an evaluation of the suitability of division lands to support active management treatments and the desirability/opportunity to enhance/restore habitat for the refuge's priority refuge resources of concern (PRRC). The proposed action is to implement the goals, objectives and strategies included in the HMP over the next 15-years. Implementation of the HMP would include:

Forest Management:

Given the preponderance of forest cover at the division, the overwhelming majority of treatments will involve forest management as directed by silvicultural prescriptions designed to achieve the desired species composition, age class, and structural attributes necessary for refuge PRRC species' needs and to improve biological integrity, biological diversity, and environmental health (BIDEH) in the landscape as identified in the CCP and HMP.

Under this alternative, the woodcock demonstration areas would continue to be managed as described under Alternative 1. However, once four age classes have been fully established, we will employ a 40 year rotation age with 4 age class distributions (~0-10 years, ~10-20 years, ~20-30 years, and ~30-40 years) to maximize the early successional component and practical application of an even-age management silvicultural system.

Under this alternative, actively managed forested acres would increase from 287 acres to 4,500 acres over a 15 year period. Management will improve diversity of vertical structure, restore native tree species composition, rehabilitate degraded stands, and restore landscape successional stages. The habitat needs of refuge PRRC species will inform these efforts.

Vegetation manipulation would most often be performed by commercial loggers working under the direction of refuge staff. Active management techniques would include single tree and group selection harvesting, retention of snags and cavity trees, and patch cuts. Typical commercial harvest techniques will be employed to remove vegetation that can be processed into a merchantable product. Operations will consist of harvesting trees, pulling the harvested trees to landing areas, processing the trees into logs or wood chips, and delivering the product to market. This method typically utilizes multiple types of machinery such as a feller-buncher, skidder, loader, and a chipper. Operations will occur on frozen ground to ensure rutting is avoided or minimized. Additional, forest management activities would include hand girdling of trees, hand thinning to promote more desirable species, and planting/transplanting. A Service employee will be responsible for monitoring temperature and ground condition to ensure site conditions are suitable for operations.

Stream Restoration:
Stream restoration activities would be similar to alternative 1. See alternative 1 for details.

Invasive Species Management:
Invasive species management would be similar to alternative 1. See alternative 1 for details.

Alternatives Considered but Eliminated from Further Analysis
The Conte Refuge CCP went through extensive public and stakeholder involvement while preparing the accompanying Draft and Final EISs. Four alternatives were evaluated in those EISs. There were few comments associated with habitat management for this division, and none of those comments warrant an additional alternative for analysis. Appendix O in the final CCP/EIS provides a summary of public comments received and the Service's responses to them (*https://www.fws.gov/uploadedFiles/15w_Appendix_O_Response_to_Public_Comments(875KB)%20(1).pdf*).

Affected Environment
For discussion on refuge resources and affected environment, refer to the HMP (Chapter 2 - Background and Chapter 3 - Priority Resources of Concern), and the CCP (Chapter 3 - Affected Environment; (U.S. Fish and Wildlife Service, 2017)). To download a copy of the refuge CCP visit: *https://www.fws.gov/refuge/Silvio_O_Conte/what_we_do/finalccp.html*

Environmental Consequences
The following provides an analysis of beneficial and adverse environmental impacts over the short (< 15 years) and long term that are expected to occur from implementing both alternatives described above.

Alternative 1: Current Management (No Action)

Physical Resources

Soils
Habitat management measures under this alternative are generally expected to have negligible to minor adverse impacts to the soils of the division, principally over the long term.

Forest Management:
The active forest management actions proposed under this alternative are designed to improve habitat structure for woodcock and other early successional-dependent species. All active management would be performed by contractors under supervision of refuge staff.

Soil quality is central to sustainable forest management because it defines the current and future productivity of the land and promotes the health of its plant and animal communities (Doran, Coleman, Bezdicek, & Stewart, 1994). A significant concern in the maintenance of forest soil quality and functioning is assuring the replenishment of surface and soil organic matter and avoiding compaction of the soil (S.P. Gessel, D.S. Lacate, G.F. Weetman, & R.F. Powers, 1990). Forest harvest methods differ in their impact to soils. Martin (1988) noted that mechanized whole-tree harvesting causes a greater proportion of soil disturbance than other harvesting systems and will adversely affect advanced and subsequent regeneration to a greater degree. It is recommended to implement winter logging, use of tracked vehicles, placement of skid trails along land contours, and minimization of any practice that exposes infertile mineral soils. C. Wayne Martin et al. (1985) suggested that clear cutting of northern hardwood forests in New Hampshire accelerated the loss of nutrients when compared to reference forest stands. Brooks and Kyker-Snowman (2008), who note the importance of soil quality to forest amphibians, showed changes in forest floor temperature and soil moisture following timber harvest (compared to uncut forests) -- the impact varied with intensity of canopy openings and were short lived, concluding that harvesting has no lasting impact on forest floor temperature or soil moisture.

Forest management activities conducted by the refuge would follow ecological principles and Best Management Practices (BMPs) (Bennett, 2010; Calhoun & Demaynadier, 2004; Cullen, 2001; Flatebo et al., 1999; Vermont Department of Forests, Parks and Recreation, 1987) designed to minimize or eliminate adverse soil impacts, while developing forest structural conditions required by American woodcock and other early successional-dependent species. BMPs were used during the first and second harvest intervals of the division woodcock management units. Logging roads and harvest areas were strategically laid out to avoid wetlands, seeps and steep slopes to eliminate adverse impacts to these soils. Operations occurred on frozen ground using various types of machinery, including tracked vehicles, to minimize rutting. All woody stems 2-inch in diameter and larger were removed and hauled off the division to be processed into a merchantable product. These harvested areas are currently providing habitat conditions for early successional species, and there is very little to no evidence of soil erosion, compaction or rutting from these management activities.

Stream Restoration:

Stream restoration efforts will improve stream function and connectivity by replacing culverts that are barriers to fish passage and by improving in-stream habitat. These restoration efforts will adversely impact soils in the short term, and may require mitigation to prevent long term impacts. Improving the connectivity of a stream by replacing culverts will have the most impact on soils. Soils will be disturbed and compacted within a thirty foot area of the culvert while improving the crossing, and if not mitigated, can erode from the site after the culvert has been replaced. The design of the crossing is based on site specific assessment data collected and interpreted by professionals to ensure a suitable crossing is established for the site. Erosion prevention and soil stabilization in the form of headers and wing-walls is incorporated into the design of the project based on site characteristics such as channel characterization, hydrological dynamics, and physical environment.

Construction plans submitted for state regulatory approval often include a sediment and erosion plan. These plans may include using silt fence and sandbags to prevent stream sedimentation, and seeding and mulching exposed soil (Vermont Agency of Transportation 2017). These are put into place during restoration activities to minimize impacts.

Soils will be minimally disturbed during restoration of in-stream habitats. This involves placing whole trees with root wads still attached into the stream. During this effort, the topsoil is removed by hand below the tree root collar to expose the main root system. These roots are severed with an axe to make it easier to pull the tree over using a hand-powered grip hoist. The soil surrounding these roots and approximately one circular foot beyond the tree are disturbed as the tree is uprooted. This method is similar to a wind-throw, when a tree is blown over with root wad intact by a wind event. The soil disturbance with a wind-throw covers a much broader area than the area disturbed using this method. This technique is used in conjunction with other stream restoration methods and on an as needed basis as a considerable amount of time and effort is required for the application. The number of trees uprooted and placed in streams can range from zero to ten trees per mile on both sides of the bank. The short term and long term adverse impacts from this restoration technique is minimal based on the number of trees and the amount of soil that will be disturbed across short sections of miles of stream.

Invasive Species Management:

Management of invasive plants, insects or diseases will be based upon an integrated pest management strategy that incorporates pest ecology, the size and distribution of the population and site-specific conditions. Best management practices will reduce potential effects to non-target species, sensitive habitats, soils and quality of surface and groundwater.

There are few invasive species currently impacting division habitats. At this time, Japanese knotweed and common reed are management priorities at the division. These species are currently being managed using best management practices including the application of herbicides by a certified applicator; using targeted application methods, such as cut stem and drip, and stem injection treatments to minimize injury to non-target species; and timing applications during appropriate weather conditions and within a timeframe that will have the most impact on the target species. Herbicides used for treatments are the least toxic option available, and are approved by our Regional Contaminants Coordinator under a pesticide use proposal review process. This provides a healthy growing space for native plant species which quickly take over after non-native species are eliminated; their roots retaining the soil and minimizing erosion issues. Application of herbicides occurs during a time of year when the plant will absorb the maximum amount of active ingredient to limit soil contamination. Treatment also occurs when weather conditions are favorable to prevent drift or run-off from a rain event.

Invasive species impact the biological diversity of division habitats. Using an integrated pest management approach and applying on the ground best management practices will minimize short-term adverse impacts to soils, and eliminate the chance of having long-term impacts.

Wetlands and streams

Forest Management:

Continuation of the early successional habitat management demonstration project would have negligible impacts on local wetlands. We expect the underlying wetland functions would be retained, such as habitat for fish and aquatic wildlife, nutrient cycling, groundwater recharge, water filtration, reducing high-flow outwash into streams and tributaries, and mitigating impacts due to storm flooding (United States Environmental Protection Agency, 2017).

Following BMPs, harvest areas and logging roads would be strategically laid out to minimize or eliminate impacts to wetlands and streams. Forested buffers would be maintained along riparian areas and wetland habitats. Harvest operations would occur on frozen ground to minimize rutting and reduce sedimentation of wetland and stream habitats. A Service employee will be responsible for monitoring temperature and ground condition to ensure site conditions are suitable for operations.

Stream Restoration:

Stream restoration efforts will improve stream function and connectivity by replacing culverts that are barriers to fish passage and by improving in-stream habitat. These efforts will have short-term, minimal, adverse impacts to wetlands and streams, though positive impacts are expected over the long-term. Improving the connectivity of a stream by replacing culverts will have the most negative impact on a stream and adjacent wetlands due to sedimentation that may occur during restoration activities. See mitigation information under the soils section. There can be adverse impacts to streams and near-by wetlands if there is a need to pump water from a portion of the upstream-end to a section downstream to clear an area of water to efficiently replace a large culvert. To minimize impacts to aquatic life, a screen is used to ensure fish, mussels, etc. are safely removed and put back in the stream. This method is used for larger projects, and is a temporary impact that is conducted in a quick efficient manner (Melissa M. Reichert et al., 2009; Vermont Agency of Transportation, 2017).

Restoration of in-stream habitats include the strategic addition of whole trees into streams using low impact methods such as felling trees with chainsaws and pulling an entire tree over using a hand powered grip-hoist. These methods have been used successfully to improve stream function with no reported negative impacts on aquatic habitats.

Invasive Species Management:

Management of invasive plants, insects or diseases will be based upon an integrated pest management strategy that incorporates pest ecology, the size and distribution of the population and site-specific conditions. Best management practices will reduce potential effects to non-target species, sensitive habitats, soils and quality of surface and groundwater.

There are few invasive species currently impacting division habitats. Common reed is currently impacting wetland and riparian habitats. This species is being managed using BMPs including the application of herbicides by a certified applicator; using targeted application methods, such as cut stem and drip treatments to minimize injury to non-target species; and timing applications during appropriate weather conditions and within a timeframe that will have the most impact on the target species. Herbicides used for treatments are aquatic certified to minimize toxicity to ground and surface water.
Invasive species impact the biological diversity of division habitats. Using an integrated pest management approach and applying on the ground BMPs will minimize short-term adverse impacts to wetlands and streams, and eliminate the chance of having long-term impacts.

Refuge infrastructure

Forest Management:

Under this alternative, no changes to the existing infrastructure are anticipated; the current road network would suffice for the purpose of accessing and managing woodcock demonstration areas.

Stream Restoration:

Restoration of streams will involve the replacement of culverts along division gravel roads. This activity will improve road conditions, and will have no negative impacts.

Invasive Species Management:

Management of invasive plants, insects or diseases will be based upon an integrated pest management strategy that incorporates pest ecology, the size and distribution of the population and site-specific conditions. Best management practices will reduce potential effects to non-target species, sensitive habitats, soils and quality of surface and groundwater.

The invasive species that currently occupy division habitats are plant species that occur in small patches within forest openings or along division roads. These roads are monitored for invasive species on a regular basis since they receive high use by the public. Many invasive plants have been eliminated by pulling including purple loosestrife and spotted knapweed. Management of invasive plant species that occur along roadsides will include a combination of pulling, cutting and/or herbicide application. These methods will have no impact on this existing infrastructure.

Biological Resources

Vegetation

Forest Management:

Proposed management activities would neither have a major benefit or adverse impact on upland vegetation. Under this alternative, the only management-related vegetation impacts would occur on the 277 acres identified as part of the woodcock management demonstration project. Within the three treatment units, roughly 60 acres would be clear cut every five years until four distinct age classes are established. Afterwards, stands will be entered approximately every 20 years to maintain the forest structure critical to American woodcock.

Harvest operations will be performed by contractors under supervision of refuge staff and recognized BMPs will be employed throughout such operations to minimize short term adverse impacts to residual trees, soils, drainage patterns, streams, and isolated wetlands, as well as preventing and mitigating any fuel/oil spills.

No other active habitat management would occur; therefore the vast majority of the division's vegetation would mature over time, requiring a much longer timeframe to reach a later mature stage and several additional decades/regeneration cycles to develop the desired level of structural diversity and resilience important to those species dependent on later successional stages.

Rare plant species: No rare plants occur within the woodcock management demonstration units.

Stream Restoration:

Stream restoration efforts will improve stream function and connectivity by replacing culverts that are barriers to fish passage and by improving in-stream habitat. These efforts will have short-term negative impacts and long-term positive and negative impacts to vegetation. Herbaceous plants within project areas will be trampled by technicians or run over by heavy machinery while conducting restoration techniques. Impacts will be light to moderate, with the majority of the impact occurring during culvert replacements. Areas with exposed soils will be seeded and mulched, but the majority of the vegetation will retain their root system and recover by the next growing season. As mentioned above under alternative 1, trees will be cut and removed from targeted sections of the stream for strategic placement in streams. The removal of these trees may have a negative impacts on wildlife species utilizing them, but will have a positive impacts on other species by providing growing space for nearby trees and sunlight to nearby herbaceous vegetation.

Rare plant species: Any section of stream with known rare plant occurrences will be avoided.

Invasive Species Management:

Management of invasive plants, insects or diseases will be based upon an integrated pest management strategy that incorporates pest ecology, the size and distribution of the population and site-specific conditions. Best management practices will reduce potential effects to non-target species, sensitive habitats, soils and quality of surface and groundwater.

There are few invasive species currently impacting division habitats. At this time, Japanese knotweed and common reed are management priorities at the division. Management of these species will have negative short term impacts on native vegetation adjacent to the target species. Impacts may include trampling by applicator while managing target species and damage or die-off from inadvertent contact with herbicide. We will use best management practices including the following: the application of herbicides by a certified applicator; using targeted application methods, such as cut stem and drip, and stem injection treatments to minimize injury to non-target species; and timing applications during appropriate weather conditions and within a timeframe that will have the most impact on the target species.

Invasive species impact the biological diversity of division habitats. Using an integrated pest management approach and applying on the ground best management practices will minimize short-term adverse impacts to native vegetation, and eliminate the chance of having long-term impacts. Management of non-native species will have a positive impact over the long term by removing invasive species competition and maintaining native species diversity.

Rare plant species: The majority of rare plants that occur in the division occupy wetland and floodplain habitats. Competition from invasive plant species will adversely impact these rare plants. Management of these invasive species is a priority. Best management practices, as well as other precautionary measures will be necessary to minimize impacts on rare plant species. Additional measures may include: flagging rare plants to make them more visible to avoid trampling or inadvertent herbicide treatment; using absorbent material around invasive stems to prevent herbicide from entering soil or onto adjacent vegetation and temporarily covering rare plants with a light cloth to protect them from herbicide drift.

Wildlife

Forest Management:

Ground disturbing activities from harvest operations will not adversely impact migratory bird habitat; certainly habitat benefits are anticipated for American woodcock, as well as other early successional species including chestnut-sided warbler, mourning warbler, and common yellow-throat. The refuge recognizes that management designed to benefit particular species, such as these early-successional dependent birds, may represent a trade-off with habitat conditions for other species. These trade-offs are common to any ecosystem management regime, and the refuge considers their impacts to be negligible. This alternative is not expected to have an adverse effect on breeding bird populations, as active harvest operations would only occur in the winter months when migrant songbirds have left for their wintering grounds. Best Management Practices would also be used during harvest operations to avoid impacts to habitats used during the breeding season.

Early-successional forests and forest openings (created by roosting fields) will benefit many mammal species including snowshoe hare, moose, black bear, white-tailed deer, voles, shrews, red fox, and bats. Harvest operations may displace some mammals in the short term (due to human activity and equipment moving in and out), and long term if forest conditions are no longer appropriate habitat. This disturbance would be minimal, however, given the short length of time (less than a month) it will take to harvest the units and the small acreage of forest (approximately one percent) the division will maintain in an early-successional condition. Species will range to adjacent undisturbed forest habitats as needed. Continuation of the early successional management program is not expected to have any direct adverse effect to reptiles, amphibians, or fish due to the treatment occurring on frozen ground during the dormant season. Likewise, none of the treatment areas border fish-bearing streams. However, this alternative focuses solely on a narrow range of habitat treatment, thereby failing to accrue the much broader beneficial effects to all taxa anticipated with a habitat management program that strives for increased representation of natural communities, a diverse forest age class, and an overall more representative and resilient forest community.

Threatened and Endangered Species:

Federal listed and petitioned species include Canada lynx, a species listed as threatened under the Endangered Species Act (ESA), northern long-eared bat, a federal threatened species, and tricolored bat, a species petitioned for listing under the ESA.

The transitory Canada lynx population that has been detected intermittently since 2012 relies on the division spruce-fir forests which provide habitat for snowshoe hare, their main prey species. Snowshoe hare require young spruce-fir forests for cover and browse. The woodcock management units are dominated by hardwood species, and do not contain spruce-fir stands that would support snowshoe hare. Therefore, forest management under this alternative is not anticipated to adversely impact Canada lynx.

The division is within the range of the northern long-eared bat and tricolored bat. Bat acoustic surveys from 2012 - 2015 detected tricolored bats, and potential northern long-eared bats (calls were inconclusive). These bats forage on insects within wetlands and forested habitats, and roost in large diameter trees (Massachusetts Division of Fisheries and Wildlife, 2015; U.S. Fish and Wildlife Service, 2014). These roosting habitats also provide maternity sites where females will raise their young. The 287 acre woodcock units currently do not contain large diameter trees that could be used as roosting habitat. Potential roost trees will be provided elsewhere in the division. Management efforts under this alternative will not adversely impact these species, and may prove beneficial by providing forest openings for foraging.

State listed species include spruce grouse and American marten, which are listed as state endangered, and eastern pearlshell, a state threatened species.

A breeding spruce grouse population currently occupies the spruce-fir forests in the division. This species requires softwood habitat with complex vertical structure including a low to moderate shrub or regenerating softwood cover (Alexander & Parren, 2012). The woodcock management units do not contain the dense softwood typically occupied by spruce grouse, and therefore, forest management within these units would not adversely impact spruce grouse.

American marten uses a variety of forest types with a preference towards mature forests that contain abundance of snags, coarse woody debris, and within stand structural diversity (Lambert J.D. et al., 2017). This species was recently documented in the Nulhegan Basin Division, and is considered rare in the landscape. Marten tend to avoid large clear-cuts, and Lambert et al. recommend aggregating harvests to minimize habitat fragmentation. The 287 acres that will be managed under this alternative is dispersed across a wide area, and the total acres will not be harvested all at once but over the course of 20+ years. The number of acres harvested in any given year will not fragment the division forests and cause adverse impacts to marten populations.

The eastern pearlshell inhabits cold streams and rivers, and was documented and reported as rare in the Nulhegan River drainage (Christopher Fichtel & Douglas G. Smith, 1995; Rich Langdon & Steve Fiske, 2001). Forest management actions within the woodcock units would not impact stream habitats where this species was documented.

Stream Restoration:

Stream restoration efforts will improve stream function and connectivity by replacing culverts that are barriers to fish passage and by improving in-stream habitat. These efforts will have long-term positive impacts on aquatic species and possible short-term impacts on other species including migratory songbirds and a few small mammals. Many of the major streams that flow through the division have been impacted from past land uses. Streams were straightened to provide easier passage for logs during the log drives, and culverts used for stream crossings along miles of gravel roads impede fish passage. Stream restoration efforts will improve habitat quality for brook trout and other aquatic species over the long term of the project. Strategic wood additions, a management technique used to improve in-stream habitat, may have negative impacts to those species using the trees along the stream. These impacts will be minimized by cutting trees after the migratory songbird nesting season. The number of trees cut depends on the stream size and site tree characteristics. For example, on streams where trees are taller than 1.5 times the bankfull width, up to 300 trees per mile may be cut, but on large streams, between 100-150 trees may be cut per mile. The negative impacts to other species are minimal when compared to the amount of habitat that will be restored to benefit brook trout.

Threatened and Endangered Species:
Stream restoration efforts will have no adverse impacts to Canada lynx, marten, or spruce grouse. The number of trees that will be removed from the canopy is minimal, and will not fragment habitat that these species rely on.

Steps will be taken to reduce adverse impacts that may occur to northern long-eared and tri-colored bats. These species rely on large diameter trees for roosting and maternity sites. Large diameter trees are not required to restore stream habitats, and will not be cut if present in the restoration area. Restoration efforts will also occur after August 1st to minimize disturbance to potential maternity sites. Restoration of coldwater stream habitats will benefit Eastern pearlshell in the long term. Pearlshell rely on salmonids, such as brook trout, as host species for part of their lifecycle. These restoration efforts will increase brook trout populations by improving stream function and connectivity. Short-term adverse impacts to pearlshell is unlikely since it is considered to be a rare and scattered occurrence in the Nulhegan river drainage (Christopher Fichtel & Douglas G. Smith, 1995; Rich Langdon & Steve Fiske, 2001).

Invasive Species Management:

Management of invasive plants, insects or diseases will be based upon an integrated pest management strategy that incorporates pest ecology, the size and distribution of the population and site-specific conditions. Best management practices will reduce potential effects to non-target species, sensitive habitats, soils and quality of surface and groundwater.

There are few invasive species currently impacting division habitats. At this time, Japanese knotweed and common reed are management priorities at the division. Management of these species may have indirect short-term adverse impacts to wildlife. These include disturbance to wildlife species while conducting the management activity and temporary removal and trampling of vegetation that may alter use of habitat. Disturbance to wildlife species would occur during a short time-frame (e.g. one week) in late summer on days when weather conditions are appropriate to manage the target species. The amount of time to manage the species often takes less than an hour. The amount of disturbance is minimal and temporary, and we believe will have little adverse effect on species using the area. Best management practices will be used to minimize the toxicity risk to wildlife from herbicide application. The least toxic herbicides will be used for treatments, and when appropriate, will be aquatic certified to reduce risks to aquatic species. Targeted application methods will also be used to minimize contact that wildlife species may have with treatment area.

Invasive species impact the biological diversity of division habitats. Using an integrated pest management approach and applying on the ground best management practices will minimize short-term adverse impacts to wildlife, and eliminate the chance of having long-term impacts.

Threatened and Endangered Species: This management activity may have short-term adverse impacts on Canada lynx, marten, northern long-eared bat, tri-colored bat and spruce grouse due to the reasons listed above. Canada lynx are considered transient with only a few individuals occupying division habitats on occasion; American marten are rare and have been detected in very few locations, spruce grouse populations are small and occupy specific areas within the spruce-fir forests, and the number of large diameter trees that could be used as roost sites is small and scattered. Due to these species small populations and specific habitat requirements, it is highly unlikely that these species will be occupying the treatment area during management activities. However, the amount of disturbance to these species would be minimal and temporary due to the small amount of time required to manage these invasive species. We believe this will have little adverse impact on the mentioned threatened and endangered species. Eastern Pearlshell is also rare, and occupies coldwater stream habitats which do not require management for invasive species. Impacts from herbicides to all these species will be minimal due to the low toxicity level of selected herbicides, and the targeted application method used for treatments.

Socio-economic Resources

Economy

Forest Management:
This alternative is expected to have an immeasurable effect on the local economy. Given the mechanization of harvest operations and relatively small size of the treatment areas, it is estimated that fewer than five people would be engaged for a period lasting about 30 days. Likewise, the majority of the wood fiber extracted would be in the form of chips – among the lowest valued wood product. In addition, only those roads currently maintained for vehicle travel will be used to transport wood products, therefore, no additional local expenditures are expected for road reconstruction.

Stream Restoration:
Restoration of division streams is expected to have no impact on the local economy. Efforts will improve habitat for brook trout, a popular angler species, but the number of anglers is not expected to increase to a measurable difference.

Invasive Species Management:
Management of invasive species will have little to no impact on the local economy. At this time, a certified applicator on staff conducts management activities due to the low number of invasive species impacting refuge habitats. Larger infestations may require the help of a local contractor, though monitoring efforts should detect new species before they become too large. Access to treatment sites are from the current road system or by foot. No new infrastructure will need be built.

Recreational Use

Forest Management:
Recreational use of the division will be discontinued when necessary to protect public safety. This alternative is expected to have only minimal, insignificant impacts to recreational activities. During harvest operations, once every 5-7 years, snowmobilers will need to share trails with log trucks during the roughly 30-day hauling period. Such wintertime trail-sharing is an annual occurrence in this larger "working forest" landscape. Any negative impacts due to closures to snowshoe hare hunters, wildlife observers/photographers, or trappers due to wildlife disturbance around the demonstration units will be minor and short term in duration. As an indirect effect, the creation and maintenance of early successional habitat is likely to be viewed favorably by hunters seeking game.

Stream Restoration:
Restoration of division streams is expected to have an immeasurable impact on recreational use. Streams will not be closed to recreational fishing during restoration efforts. Brook trout are popular recreational fisheries, but the number of anglers is not expected to increase substantially.

Invasive Species Management:
Management of invasive species will have little to no impact on recreational activities. Best management practices will be used during application, and unless it is a requirement of the label, areas will not be closed during application. A sign will inform visitors that herbicides are being used so they can make an informed decision regarding recreational activities. Disturbance to recreationists will be minor and short-term in duration.

Archaeological Sites and Historic Structures

Forest Management:

Heavy machinery used to conduct forest management can adversely affect archaeological or cultural resources. Appropriate actions will be taken to protect known sites. A Service employee will oversee the project and monitor temperatures and ground conditions to ensure site conditions are suitable for operation. Using tracked harvesting equipment and operating grapple skidders on frozen ground is not expected to cause ground disturbance and will therefore not affect potential archaeological sites.

In the event that unrecorded archaeological or cultural resources are discovered while conducting forest management operations, the operation shall cease at that specific location and all reasonable efforts to avoid or minimize damage to the site shall be made. The USFWS Regional Historic Preservation Officer will be immediately notified and advised of the nature of the discovery.

Stream Restoration:

There will be no impact to archaeological sites or historic structures from stream restoration efforts. Ground disturbance will only occur on gravel roads during culvert replacement where impacts to archaeological sites and historic structures are not a concern.

Invasive Species Management:

Management of invasive species will not cause ground disturbance, and will therefore not impact potential archaeological sites.

Alternative 2: Expanded Habitat Management (Proposed Action and Preferred Alternative)

Environmental impacts that may occur from implementing stream restoration and non-native invasive species management are similar to those described under Alternative 1. Below describes potential impacts that may occur from an expanded forest management program.

Physical Resources

Soils

Proposed habitat management activities would neither significantly benefit nor adversely impact current local soil conditions. We expect soils to maintain their array of beneficial functions that include nutrient cycling through healthy soil mycorrhizal fungi and microbial populations, plant stability and support, filtering water runoff, reducing high water turbidity, reducing outwash into wetlands and streams, and preventing flooding (Susan Andrews & Michelle Wander, 2011).

Forest Management:

Forest management activities would be conducted using established best management practices to avoid soil compaction, soil displacement, rutting, erosion, and loss of soil productivity. We would monitor routine activities that have the potential to result in chemical contamination from leaks or spills.

In the long term, we expect the potential for an increase in the beneficial impact of forest harvesting because much of this management will occur on degraded forest habitats that are in need of ecologically based forest management intervention. Such management is expected to further enhance forest structure along with healthy soils, and is considered to be of minor beneficial impact in the short term and long term. The proposed forest management actions aim to improve the diversity of seral stages (where and when possible), restore historic composition and structure, and improve landscape connectivity of forested habitats. These forest management activities are believed to be of negligible adverse impact in the short term and ultimately will serve to the benefit of refuge forest health and function.

Wetlands and streams

Application of a broad-based habitat management program would neither significantly benefit nor significantly adversely impact local wetlands. We expect the underlying wetland functions will be retained, such as habitat for fish and aquatic wildlife, nutrient cycling, groundwater recharge, water filtration, and reducing high-flow outwash into streams and tributaries (United States Environmental Protection Agency, 2017).

Forest Management:

Habitat management within the division’s forested wetlands would typically involve efforts to restore the integrity, resilience, and structural diversity of degraded lowland spruce-fir forest. Habitat management in any forested wetland area would follow appropriate Best Management Practices (BMPs), which include techniques that help to protect wetlands and their ecological functions. Unique wetlands, such as seeps and vernal pools, would be protected from adverse disturbance.

Heavy equipment is the most effective and economical means to manage the division’s forested habitats, and as such, may cause some disturbance to wetlands (e.g., soil erosion and compaction of vegetation and soils). Therefore, we would limit such activities in wetlands or moist/soft ground to the time of year when the ground is frozen solid, as is typical of lowland logging activities in this region. Treatment efforts will make use of existing skid trails wherever possible. Any additional trail layout will use BMPs, which include provisions for wetland avoidance, acceptable trail grades, and stream buffers. In many cases our layouts will exceed BMPS, as is the case with our stream buffers (a minimum of 50 ft no harvest adjacent to 1st order streams).

Refuge infrastructure

Forest Management:

Under this alternative, only modest upgrades to the existing road infrastructure are anticipated. The major timber haul routes would incorporate roads that are part of the existing road network and are currently open for vehicular travel. Changes projected to the secondary haul roads, which are dead-end roads, often behind locked gates, will be upgraded by de-brushing, adding gravel, replacing culverts, and improving drainage. They will be used only for management purposes during the period of active harvest/log hauling and otherwise will be gated. Road infrastructure is expected to be improved under this alternative; no effects are anticipated to other forms of refuge infrastructure.

Biological Resources

Under this alternative, our long term goal is to improve habitat conditions for PRRC species, using a science-based program, treating on average, approximately 300 forested acres per year. Some negligible, adverse impacts of short duration are expected; however, we predict the long-term effects would be overwhelmingly positive.

Vegetation

Forest Management:

An altered and improved habitat structure will result from the application of targeted prescriptions in the management of forest vegetation on an average of 300 acres per year. We propose forest management for the purpose of improving forest structure and resilience, as well as, accelerating development of habitat structure suitable for PRRC species. We further expect habitat management to help maintain and promote natural beneficial upland functions and values that include nutrient cycling, groundwater recharge, filtering water, retarding down-stream turbidity, and diminishing adverse weather impacts (e.g., storm winds, heavy precipitation).

Forest management can improve and accelerate development of historic forest structure and species composition (Arseneault, Saunders, Seymour, & Wagner, 2011; Franklin et al., 2007; Keeton, 2006; North & Keeton, 2008; Raymond et al., 2009). In the absence of active management, the development of appropriate wildlife habitat may take longer or fail entirely, depending on site characteristics, prior management history, and natural disturbance frequency. An actively managed forest, where harvests act to mimic natural disturbances that create openings for new generations of trees while retaining some larger, older trees, will help maintain the appropriate forest structure and age or size classes important to focal species into the future, ensuring adequate habitat is available for the targeted PRRC species.

Harvest operations will be performed by contractors under supervision of the refuge staff, and recognized BMPs will be employed throughout such operations to minimize short term adverse impacts to residual trees, soils, drainage patterns, streams, and isolated wetlands. Natural debris from harvest operations will be left on site such as tree tops and brush piles These debris piles will a short term benefit on tree regeneration by retaining moisture, providing sites for seed germination, reducing impacts from deer and moose browse and serve as mini-greenhouses for growing seedlings. There are no plans for new road construction, rather existing roads will be de-brushed and proper drainage structures will be installed to allow for their use in accessing treatment areas.

Invasive species can be introduced or spread unintentionally from harvest equipment. This short-term or potentially long-term impact, if not recognized soon enough, can be prevented using prevention strategies such as use local contractors, require all heavy equipment used for habitat management projects be pressure washed before mobilization to a new site, inspect equipment before and after use to ensure they are clear of mud, dirt, plants, and other debris that could hold seeds or rhizomes, monitor disturbed or manipulated areas after management efforts for at least 5-years to detect invasive species occurrences early, and use certified weed seed free mulch, sand, gravel, dirt, and other construction materials.

Wildlife

Forest Management:

Ground disturbing activities that might adversely impact migratory bird habitat will occur, however such adverse effects would not be permanent; the application of the proposed HMP is intended to have substantial positive long term impacts to birds, particularly those species identified as PRRC. The refuge recognizes that management designed to benefit particular species may represent a trade-off with habitat conditions for other species. These trade-offs are common to any ecosystem management regime, and the refuge considers these impacts to be negligible. BMPs, some of which are outlined in "Silviculture with Birds in Mind: Options for Integrating Timber and Songbird Habitat Management in Northern Hardwood Stands in Vermont" (Hagenbuch, Manaras, Shallow, Sharpless, & Snyder, 2011), would be implemented in all forest management activities. This alternative is not expected to have an adverse effect on bird populations, with the exception of short-term displacement that may occur during active harvest operations. Such displacement would be mitigated by avoiding the peak songbird nesting season (May 15 – August 15) and scheduling most harvests for the winter months when migrant songbirds have left for their wintering grounds.

Our management actions would not contribute to the permanent impairment of habitat for mammals; we would continue to use recognized silvicultural BMP techniques designed to improve wildlife habitat, and recognize this benefits some species possibly at the expense of others. Little brown bat, northern long-eared bat, tri-colored bat, and eastern small-footed bat roost and raise young in cavities or loose bark of large trees or rocky outcrops within a forested landscape, often in the vicinity of hibernacula (caves used for hibernating in winter) (Daniel A.R. Taylor, 2006; R. M. DeGraaf & Yamasaki, 2001). The eastern red bat, a migratory species, uses tree foliage to roost and rear their young, and often feed around forest edges and clearings (Daniel A.R. Taylor, 2006). Our forest management will benefit these species over the long term as we improve age class diversity, and retain large mature trees, live cavity trees and snags. Known roosting trees will be protected, and the surrounding habitat managed to support bat populations. Larger terrestrial mammals use a mix of forest types and are highly mobile. They are expected to leave areas subject to active harvest and temporarily occupy nearby areas of suitable habitat. Over the long term, forest management efforts will provide a mosaic of habitat conditions that will benefit numerous species of mammal.

Forest management operations can adversely impact reptiles and amphibians (Andrew N. Ash, 1988; K. J. Martin & McComb, 2003) but may also create a beneficial diversity of habitat and species response (Craig Loehle et al., 2005). As noted previously, all forest silvicultural activities would follow established BMPs, including measures such as establishing stream and wetland buffers (see HMP 5.1.1 Management Zones Buffer table 5.2) or conducting operations over frozen ground in winter to minimize any adverse impacts.

It is recognized that roads may have an adverse effect on reptiles and amphibians (Jochimsen, Peterson, Andrews, & Whitfield Gibbons, 2013). Roads may be upgraded, re-opened, or maintained to improve access for the proposed habitat management actions. Any such activities will follow applicable BMPs to avoid wetlands, vernal pools, and sensitive habitat areas and to avoid creating reptile and amphibian migration barriers (although we recognize artificial depressions may seasonally function as vernal pools).

Forest management operations will also have short-term benefits for mammals by providing cover for rodents, fox, and snowshoe hare in the form of brush piles. These natural debris piles will also provide browse for deer and hare in the short-term. And potentially sites for salamanders, earthworms and other critters that benefit from moist conditions retained beneath these brush piles.

Threatened and Endangered Species

Forest management under this alternative will support development of a forested landscape that contains a mosaic of different age classes ranging from young to mature stands. Stand characteristics will include horizontal and vertical structural diversity with emphasis on providing coarse woody debris, large diameter trees and snags. Under this alternative, the division forests will benefit numerous species including Canada lynx, spruce grouse, American marten, northern long-eared bat and tricolored bat.

The eastern pearlshell will not be directly impacted from forest management under this alternative. Forested buffers will be left along cold water streams and rivers to minimize impacts to these habitats and associated aquatic species.

In summary, none of the habitat management activities are expected to have more than a negligible impact to wildlife taxa in the short-term and are designed to achieve multiple long-term benefits.

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APPENDIX B:
Response to Public Comments on the Nulhegan Basin Division Draft HMP/EA

Introduction
In February 2018,the Silvio O Conte Refuge released the draft Nulhegan Basin Habitat Management Plan and Environmental Assessment (draft HMP/EA) for public review. Alternative 2 is identified as the proposed action.

For sixty days between February 12th and April 12th, 2018, the draft HMP/EA was available for public review and comment. This appendix summarizes the comments received and provides a response.

Further evaluation and public comments on the draft HMP/EA, have led to minor modifications in Alternative 2, which remains the proposed action in the final HMP/EA. Modifications include additions, corrections and clarifications to the proposed action. These modifications are not significant enough to warrant publishing a revised or amended draft before publishing the final HMP/EA.

Summary of Comments Received
Six different commenters submitted letters. Comments came via email or documents sent through the US Postal Service. A list of commenters is below:

- Abenaki
- Cody Aylward
- Backcountry Hunters and Anglers
- The Nature Conservancy of Vermont
- Vermont Traditions Association
- Vermont Agency of Natural Resources

Response to Comments by Subject

<u>Planning Process</u>

Comment: A commenter asked if the HMP/EA had an effective lifetime.
Response: Per internal US Fish & Wildlife Service (USFWS) policy, the lifespan of the Habitat Management Plan is 15 years.

Comment: A commenter asked if there are additional step-down plans or notices that will inform the public when and why a specific management activity is being conducted.
Response: Specific management actions will be conducted based on staff and funding availability. Staff will adapt management as needed to successfully implement the goals and objectives outlined in the HMP. Additional step-down plans from the Conte Refuge's Comprehensive Conservation Plan include an Inventory and Monitoring Plan, Fire Management Plan, Public Use Plan, Fishing Access Plan, Hunt Plan and Furbearer Management Plan. Step-down plans will be developed based on Service policy. The development of the step-down plans will adhere to the National Environmental Policy Act and as such, will be made available for public comment as appropriate.

Integrated Pest and Invasive Plant Species Management

Comment: Commenters pointed out inconsistency in the plan on invasive species management efforts and requested clarification on management strategies for invasive plant species.

Response: Thank you for your comment. We have made changes to the text to create more consistency throughout the document.

Comment: Commenters suggested adding more information on our management response to forest pests and pathogens such as dutch elm disease, emerald ash borer and spruce budworm.

Response: Thank you for the comment. Please refer to Chapter 5 sub-objective 5.3.1.1. The commenter may also review other comment responses in this appendix to better understand any potential response to a forest pest outbreak.

Comment: A commenter reiterated the importance of taking precautions to avoid the introduction of invasive species as a byproduct from habitat management actions. They were pleased with the approach we are using to manage invasive species.

Response: Thank you for your comment. Management of invasive species and preventing their introduction into division habitats is a high priority.

Comment: A commenter questioned our goal of managing invasives plant cover to below 5 percent rather than to zero percent cover or eradication.

Response: Thank you for your comment. Management efforts will work to eradicate all invasives with the exception of those specific species mentioned in the table in Section 7.4. Where the language "less than 5% cover" occurs is inconsistent with Section 7.4. This strategy has been changed along with other inconsistencies as noted by the commenter.

Comment: A commenter suggested changing the language under the Nulhegan River Unit Forest Management strategies from " monitor *Phragmites* on route 105" to eradicate.

Response: Thank you for your comment. The text has been changed to read "work with private landowner to eradicate. . ."

Climate Change

Comment: A commenter thought that climate change should be addressed in more detail in the plan. They suggested that we add language early in the document that specifically addresses climate change and how it might influence the Nulhegan Basin. They also suggested that we add information on Division adaptation strategies and example management actions.

Response: Thank you for your comment. Calling explicit attention to the role planned management actions will improve Division natural communities adaptability to climate change is warranted. Please note a climate change section in Chapter 2 discusses climate change impacts and the plan's approach to assisting species adaptation.

Historical Context

Comment: A commenter thought the historical context about the Abenaki Nation Indians and their use of the Nulhegan Basin lands in Chapter 2 required additional information. The commenter provided suggested edits.

Response: Thank you for your comment. Information has been added to Chapter 2 of the HMP.

Roadless Areas

Comment: Some commenters advocated for minimizing habitat fragmentation and preserving the quality and character of large, remote areas with no new infrastructure.

Response: Thank you for your comment. In an effort to minimize habitat fragmentation and to protect the quality and character of the Division's roadless areas, no new permanent roads are being proposed on the Division (as identified in the EA).

Wildlife Species Management

Comment: A commenter expressed concern that proposed management would not provide habitat conditions for state listed species or species of concern including deer, marten and spruce grouse. This commenter suggested additional detail in the HMP that addresses how proposed management would benefit these state species of concern.

Response: Per USFWS policy, refuges are required to follow specific guidelines for choosing priority resources of concern. It is understood that spruce grouse, deer and American marten are a conservation concern for the State of Vermont. Management for these resources of concern are assumed to have benefits to a large suite of species. Where these benefits are thought to affect state species of concern language has been added to explicitly make this connection. As an example, the discussion of spruce-fir sub-objectives includes language directly discussing spruce grouse, white-tailed deer, and marten. Specifically, the discussion of sub-objective 4.2.1.2 outlines the importance of restoring large habitat patch sizes to benefit species like marten.

Additionally, a strategy has been added to 5.3.1.3 that states "collaborate with VFWD to assess spruce grouse and American marten populations."

Comment: Multiple commenters expressed appreciation for work being done on the Division to restore habitat for brook trout and American woodcock.

Response: Thank you for the comment.

Comment: A commenter appreciated the fact that white-tailed deer are mentioned in the plan and that management will enhance wintering habitat for these species.

Response: Thank you for the comment.

Comment: A commenter pointed out that wood turtle is under review for listing under the federal Endangered Species Act, and asked if it should be considered a refuge priority resource of concern.

Response: Wood turtle was petitioned while the draft HMP/EA was undergoing internal review. It has subsequently been added to the refuge resource of concern table. An additional strategy has been added under 5.3.3.1: "In collaboration with the Wood Turtle Working Group and other partners, monitor wood turtle populations following USFWS protocol. Evaluate head start programs and other ways to enhance division population."

Comment: A commenter thought it would helpful to reference habitat conservation guidelines for the federal listed bat species mentioned in the plan.

Response: Thank you for your comment. Management actions proposed in this HMP were evaluated through formal consultation with the USFWS Endangered Species Office. An intra-service Section 7 was submitted that evaluated potential impacts of proposed management on federally listed species. The Northern Long-eared Bat Interim Conference and Planning Guidance (USFWS 2014) is referenced in this document. Bat conservation guidelines will be used to minimize impacts from management activities. This Section 7 was approved in April 2018 and is an appendix of this HMP.

Comment: A commenter suggested adding information on snowshoe hare and their ecological role in the spruce-fir communities in the Division and surrounding landscape.

Response: Thank you for your comment. Information has been added in Chapter 2 on the importance of snowshoe hare as a keystone species in the region's spruce-fir forests.

Comment: A commenter was concerned with the lack of specific management strategies for functional deer winter shelter. They suggested adding a section outlining the attributes of and specific management strategies for functional deer winter habitat.

Response: Thank you for the comment. Chapter 5 outlines a number of specific management strategies that will improve spruce-fir habitats for wintering white-tailed deer, among other important species.

Comment: A commenter had questions about Table 5.1 Management Zone Descriptors.

Response: The Special Management table identifies specific habitat types and other features that may be impacted by active management activities. Within this zone active management may occur. Particular attention will be paid to specific habitat requirements of species of concern - percent canopy closure for whitetail deer for example.

Comment: A commenter questioned whether the "Deer Wintering Area" map represented the known current extent of deer winter habitat. They suggested providing a map depicting the historic context of the deer wintering area so the reader can compare the historic distribution with the present.

Response: The deer wintering area map provided in the HMP was developed by the Vermont Agency of Natural Resource as part of the publically available Natural Resources Atlas.

Comment: A commenter was confused over the use of the expressions "focal species," "species of concern," "responsibility species" and "priority species."

Response: Changes have been made to the text to provide more clarity.

<u>Adaptive Management</u>

Comment: A commenter discussed a number of hypothetical scenarios under the broad heading of adaptive management. These included, but were not limited to: damage from forest pests, impacts from climate change, appropriateness of salvage logging, and forest restoration broadly.

Response: Adaptive management as practiced within the DOI begins with problem assessment. Should any unforeseen or widespread ecological impact such as a forest pest outbreak occur, the first approach will be to assess those areas impacted. Forest conditions arising from a pest outbreak of unknown spatial and temporal intensity, for example, may not function as suitable early successional habitat for dependent species.

Invasive insect pests present a daunting and unique management challenge. As noted in previous comment responses, should an outbreak occur on the Division any response will follow USFWS adaptive management policy. This will involve assessment of the problem, design of an action, implementation, monitoring, and evaluation. In the case of large-scale invasive insect outbreaks, this will necessarily include consultation and coordination with a number of partners, including the Vermont Department of Fish and Wildlife.

Forest Management

Comment: A commenter feels that there is disconnect between Management Unit and stand level treatments. They felt that estimates of harvest acres or harvest configuration could be provided by extending the stepwise prioritization beyond the Management Unit level.

Response: Please review the individual unit maps which outline those stands currently thought to support a commercial forest management action. Those stands will be the priority. Stand-level prescriptions are beyond the scope of an HMP. The plan goes to great length in providing the reader with possible treatments given commonly occurring stand conditions across the Division. These conditions often occur at scales smaller than a stand; a single stand may include multiple treatments depending upon forest conditions.

Comment: A commenter was concerned with the lack of detail about harvest locations and treatment schedules. They would like to see more detailed forest management plans before harvests are implemented.

Response: All HMPs must be written per policy (USFWS Manual- Habitat Management Plans, Chapter 620 FW 1), as the standardized HMP design template is utilized for every National Wildlife Refuge across the country. Specific forest stand treatments have not been provided as there is considerable variation across forest stands throughout the refuge. Refuge staff will utilize the various treatments identified in the HMP on a stand by stand basis depending on species composition, stocking, canopy closure, forest conditions, access, market fluctuations and staff availability.

Comment: A commenter had concerns with staff relying too heavily on the Habitat Suitability Index (HSI) models for making management decisions.

Response: Thank you for the comment. The HSI models, along with other data sets, are an ongoing effort to inform prioritization of habitat management efforts. Model limitations are well understood. Field verification and on the ground knowledge will ultimately drive management decision making.

Comment: A commenter suggested adding specific target tree ages to forest objectives to ensure the development of old forest structure.

Response: The suggestion to include target tree ages is appreciated. The plan notes multiple different structural targets that will best identify stands that have developed ‘old forest structure.’ Focal species driven management prioritizes these attributes over the age of a given stand or tree.

Comment: A commenter suggests that we use active management to increase old forest structure throughout the Division.

Response: Thank you for the comment. The plan attempts to balance the needs of our identified focal species and the restoration of old forest structure. In most instances, active management will be used to accelerate the development of ecological characteristics indicative of older forests.

Comment: A commenter suggests that we describe the silvicultural practices that might be used for "ecological forestry." A concept that is used throughout the plan.

Response: We would point the reader to the extensive discussion of disturbance regimes characteristic of the forest communities under consideration, and specifically their silvicultural analogs (section 4.2.1 is likely informative here). Further, there is an extensive bibliography available to the reader to further explore ecological forestry concepts.

Comment: A commenter suggests adding more management strategies and prescription details in Chapter 5 on how and where desired forest conditions will be achieved.

Response: There is recognition the plan as written deviates substantially from a 'typical' forest management plan. It represents adherence to policy, plan templates, and a wildlife-driven forest management approach. Forest management will not target a specific basal area or mean stand diameter, but rather a habitat condition that the plan outlines in a number of sub-objectives.

Comment: A commenter suggests that we increase the stocking of white pine, hemlock and white cedar across the Division.

Response: Sub-objective 1.1d specifically addresses this concern. If the commenter will reference the management strategies portion of the document they'll note that softwood inclusion are targeted for retention when treating hardwood stands, underplanting guidelines emphasis the need for white pine, hemlock, and red spruce, and that white cedar stands are removed from any active management.

Comment: A commenter asked if whole tree harvesting would be allowed as part of forest management.

Response: The decision to whole-tree harvest will be treatment specific and will be informed by site, intended post-treatment condition, among other variables.

Comment: Commenter suggests that we use AMPs from the latest document version and reference the VT Voluntary harvesting guidelines.

Response: Thank you for the updated AMP guidelines. The document has been changed to reflect this comment.

Comment: Commenter asked whether the recent EAB discovery in VT would impact management on the Nulhegan.

Response: Invasive insect pests present a daunting and unique management challenge. As noted in previous comment responses, should an outbreak occur on the Division any response will follow USFWS adaptive management policy. This will involve assessment of the problem, design of an action, implementation, monitoring, and evaluation. In the case of large-scale invasive insect outbreaks, this will necessarily include consultation and coordination with a number of partners, including the Vermont Department of Fish and Wildlife.

Comment: Commenter suggests adding information on the benefits of summer vs. winter harvesting.

Response: The plan notes the importance of late summer/fall harvesting to expose mineral soil where regeneration depends upon such disturbance. Generally, all refuge forest management will occur during frozen ground conditions due to the preponderance of hydric soils, wildlife disturbance concerns, etc…

Comment: Commenter asked for more information on the unique silvicultural challenges associated with the mixedwood and hardwood stands

Response: As with most of the hardwood and mixedwood stands on the Division the Logger Branch stands have been high-graded during past management. The unique challenges noted in the plan include restoring these stands when standing volumes are low, of poor quality, and have poor logging chance.

Comment: Some commenters suggest increasing the number of acres being proposed for early successional management.

Response: Thank you for your comment. At the landscape scale, early successional habitat is being provided by adjacent landowners. The refuge is in a unique position to provide mature forest conditions which is lacking in the landscape. Further, many of the restoration efforts in highly-degraded stands may involve the creation of early successional acreage in the short-term.

Comment: A commenter suggests adding one or two additional age classes in Woodcock Management Units to make this management more economically viable, and more appealing to private landowners.

Response: The comment is appreciated. A different approach was applied to maximize the early successional component and practical application of an even-age management silvicultural system. Rather than adding additional age classes, rotation age was increased 40 years. Details can be found in Section 5.3.2.6

Comment: A commenter asked for clarification about using patches of mature northern white cedar swamps and other softwood natural communities as a core for surrounding treatments designed to accelerate succession to older conditions.

Response: An overarching goal on the Division is to increase the representation of large blocks of forest with ecological characteristics common to older forests. Identifying existing old forest characteristics on the landscape allows forest management designed to accelerate the development of these characteristics to be sited existing examples of older forest.

Comment: Commenter asked for clarification on the trucking challenges associated with the Black Branch Unit

Response: The dead-end roads on the Division, including the Black Branch Road, Peanut Dam Road, Lepine Camp Road, and Tim Carroll Road are in poor condition and will require significant investment to allow trucking.

Comment: Commenter asked if there is a better way to describe forest management rather than using q factor which is challenging to understand without a forestry background.

Response: The discussion of a q-factor is included because it follows other successful USFWS forest management plans in the region. The commenter is directed to more detailed discussions of stand-level silviculture where within-stand area regenerated rather than a q-factor will guide efforts to improve vertical and horizontal structure (see Chapter 5.3.1.3 specifically). Further, there is lengthy discussion throughout the document on the tenets of ecological forestry, where silviculture is designed to mimic natural disturbance regimes.

Comment: Commenter suggested replacing "woody debris" with "woody material," which denotes a more positive addition to dead wood to the forest floor for a range of benefits.

Response: Thank you for the comment. The change has been incorporated in the documented.

<u>Conflicting Management Priorities</u>

Comment: A commenter felt that additional clarity was needed to better explain how staff plan to address conflicting management priorities while implementing individual treatments. The commenter gave an example of managing riparian areas for brook trout, floodplain function and early successional habitat for rusty blackbird and woodcock.

Response: We appreciate the comment, but respectfully disagree. Management for American Woodcock is and will continue to be limited to those areas outlined in the Woodcock Management Plan. In implementing this management the restricted management zone buffers are followed.

There is not a conflict in providing habitat for rusty blackbird and maintaining forested floodplains for a number of reasons: 1) rusty blackbirds exclusively nest in young spruce-fir adjacent to open water wetlands, not streams; 2) stream floodplains dominated by spruce-fir often have more open canopies due to tree architecture; 3) rusty blackbird habitat must be sited within 500m of open water wetlands (Foss, unpublished), which will allow for buffering of any open water habitats during forest management.

Additional language has been added to the HMP to clarify that management for rusty blackbird and American woodcock will continue to honor the restricted management zone boundaries outlined in the HMP.

<u>Passive Management</u>

Comment: A commenter questioned whether commercial harvests are necessary for all stands across the division and over the long-term to maintain habitat heterogeneity. They suggest using passive management (no active management zones) on stands with the highest potential for self-recovery or as a long-term management option.

Response: Thank you for the comment. If the commenter reviews Chapter 5 and the management strategies outlined therein they should find specific strategies around identifying stands whose development will not be managed (see 5.3.1.1). As a reminder to the commenter, the document represents a 15 year plan for managing habitats on the Division. Current proposed management activities seek to strike a balance between forest restoration and the provision of the habitat needs of specific focal species known to be in peril. In the long-term it is impossible to know what species or trends will drive forest management.

Comment: Another commenter expressed their opposition to designating no management areas or ecological core areas, and felt it was short sighted to remove opportunities for treatments.

Response: In chapter 5.1 (Development of Management Strategies) the terms general management, special management and restricted management are used to identify where silvicultural treatments would be prescribed. Management zones are areas that govern the type of resource management that can be used. Management zones provide protection for a variety of forest and non-forest resources identified and discussed further in the Silvio O. Conte Refuge Comprehensive Conservation Plan (Jan 2016). Current proposed management activities seek to strike a balance between forest restoration and the provision of the habitat needs of specific focal species known to be in peril. In the long-term it is impossible to know what species or trends will drive forest management.

Miscellaneous

Comment: Commenters suggested adding an Executive Summary.

Response: Thank you for your comment. An Executive Summary will be added to the Final HMP/EA.

Comment: Commenter suggests adding more information on soils and the unique geology of the basin in relation to the surrounding landscape.

Response: Thank you for your comment. The commenter should review Chapter 2.5 Refuge Resources: Current Conditions. This chapter provides information on soils and geology, climate, habitat types, etc. that are specific to the Nulhegan Basin Division.

Comment: Commenter suggests adding working definition for mid- and late-seral habitats or provide guidance on how the two will be distinguished to provide a benchmark for evaluating success of management.

Response: We respectfully disagree with this assessment. There is no clearly defined definition of mid or late-successional in the literature. As such, we made efforts to clearly distinguish the habitat conditions common in older forests that are currently lacking in the Division's forests, and can be modified through forest management. These include, but are not limited to: multiple canopy layers, horizontal diversity, standing snags and cavity trees, dead and down material, large diameter trees, etc...

Riparian and Fisheries

Comment: A commenter suggested adding brook trout as a focal species for Lewis Pond Unit.

Response: Thank you for the comment. Brook trout has been added as a focal species to the Lewis Pond Unit.

Comment: Commenter suggested clarifying the stream restoration techniques (e.g. # of trees cut and uprooted per stream mile) in the EA.

Response: Thank you for the comment. The information has been changed.

Recreation

Comment: Commenter asked if ATVs are allowed on the Nulhegan Basin Division

Response: National Wildlife Refuge System policy prohibits the use of all terrain vehicles on National Wildlife Refuges.

Comment: Commenter suggests adding a reference to the Northern Forest Canoe Trail.
Response: Thank you for the comment. We have added the reference.

APPENDIX C: Woodcock Habitat Management Plan

for

Woodcock Habitat Management Demonstration

at the

Nulhegan Basin Division
Silvio O. Conte National Fish and Wildlife Refuge
Essex County, Vermont

March, 2009

Prepared by: Thomas LaPointe

U.S. Department of the Interior
Fish and Wildlife Service
Silvio O. Conte National Fish and Wildlife Refuge
Nulhegan Basin Division

Table of Contents

A. Introduction

In August, 2006, the staff at the Nulhegan Basin Division (Division) of the Silvio O. Conte National Fish and Wildlife Refuge (Conte Refuge) engaged in a process to determine whether contributions could be made to regional woodcock recovery efforts. Subsequently, three separate areas on the Division were selected to be managed for woodcock. This was intended to contribute to a variety of resource management goals within and outside of the USFWS, as well as, the goals of the Northern Forest Woodcock Initiative by providing public demonstration areas. These woodcock habitat management demonstration areas were selected because they provide the biophysical features conducive to managing habitat for woodcock, and are relatively easy to access to accommodate visitation.

These areas are being actively managed to ensure the habitat conditions woodcock require to complete their lifecycles are created and sustained, and thus provide examples of proper woodcock habitat management for demonstration and education. Initial implementation of habitat management occurred prior to developing this management plan but not without rationale, planning, and design. This Woodcock Habitat Management Plan was developed to provide:

- Background information that led to initial implementation
- Woodcock habitat management concepts and subsequent management designs
- Direction of future management applications
- An update regarding implementation of initial treatments

B. Scope and Rationale

The American woodcock (*Scolopax minor)* is a trust resource species of management concern in the Northeast Region of the Service. The American Woodcock is listed as a species of highest priority of concern in the U.S. Shorebird Conservation Plan (Brown 2001), The Partners In Flight (PIF) Bird Conservation Plan for Physiographic Region 28 (Rosenberg 2000), The American Woodcock Plan (U.S. Fish and Wildlife Service 1990), and the North American Bird Conservation Initiative (NABCI) Bird Conservation Region 14 (BCR 14). In Vermont, woodcock are listed as a species of medium concern according to the 2005 State Wildlife Action plan. The population has declined between 1968-2006 at an annual rate of 1.9% in the Eastern U.S. and 1.8% in the Central U.S. In Vermont, its population has declined at an annual rate of 1.1% between 1968 and 2004 (Vermont Department of Fish and Wildlife 2005). In 1996, the breeding population index was 1.58 singing males per route in the Eastern U.S., which was the lowest on record since the survey began. In 2006, the Eastern U.S. breeding population index was 1.69 singing males per route. This was lower than the predicted 1.73 (Kelley et al. 2006). The major causes of the decline are thought to be degradation and loss of suitable habitat on both breeding and wintering areas, caused by forest succession and changes in land use and various human uses (Dessecker and McAuley 2001). The goal of the Service's "American Woodcock Management Plan" is to stabilize the population declines and increase woodcock populations above current levels and to a level consistent with the demands of consumptive and non- consumptive users (U.S. Fish and Wildlife Service 1990).

Loss of early successional habitat has been identified as the primary cause for woodcock decline (Sepik et al. 1994). This vegetative stage of development also provides habitat for a variety of bird species such as the olive-sided flycatcher (*Contopus cooperi*), chestnut-sided warbler (*Dendroica pensylvanica*), and palm warbler (*Dendroica palmarum*), which Partners in Flight (PIF) has identified as being in need of population recovery. While preparing for development of a Habitat Management Plan (HMP) for the Division, a draft priority wildlife species list was developed. Species were identified using a regional approach to determine which refuges have the most opportunity to contribute to resources of regional concern, as well as to identify local resources of concern by integrating other planning efforts such as the Vermont State Wildlife Action Plan. Woodcock will likely be a priority species for future habitat management based on these planning efforts. Creating and sustaining early successional habitat, as well as other habitat components woodcock need for suitable habitat conditions (e.g., open areas for roosting), will contribute to the overall goal of providing natural diversity and biological integrity and will fulfill Refuge purposes #1 and #2.

A partnership has been initiated for the benefit of the American woodcock and other early successional migratory birds in New England and New York, and ultimately elsewhere in woodcock range in the U.S. Thirty-four cooperators have enlisted in this effort, which has been spearheaded by the Wildlife Management Institute (WMI). In 2003 an American Woodcock Initiative (AWI) was developed to address the rapid decline of the woodcock population with emphasis on the Atlantic Northern Forest and Southern New England Bird Conservation Regions. In 2007, the Woodcock Conservation Plan (WCP) was developed, which further address conservation efforts throughout the entire range of woodcock in the US. These plans are stratified into regional focus areas with the Northern Forest Woodcock Initiative (NFWI) focusing on BCR 14. The NFWI is a landscape level conservation effort that looks beyond the boundaries of landowners within BCR 14 and the Northern Appalachian Forest, and therefore is dependent on private and public involvement for it to be successful.

The Division was identified as one of the most suitable public land areas for woodcock management in BCR 14. This presents an opportunity for the Division to contribute to the recovery efforts of the NFWI and to the goals of those national plans indicating woodcock are a priority species of concern.

C. Environmental Assessment

An Environmental Assessment (EA) was prepared prior to implementation to discuss and evaluate the impacts of establishing Woodcock Management Demonstration Units (WMUs) on the Division. A press release announcing the intent of the Service to prepare a woodcock habitat management demonstration project and the call for agency and public input was delivered electronically to local media on September 25, 2006. In addition public notices were also placed in local media on September 21, 2006, and on September 25, 2006. The public input period ended October 9, 2006. Input also was requested from professional wildlife biologists that possessed pertinent knowledge and experience from various wildlife management agencies in the Northeast, and from representatives of the Refuge’s adjacent landowner agencies including the Vermont Fish and Wildlife Department, Essex Timber Company, The Conservation Fund, and Vermont Electric Company. Two public comments were received in favor of conducting woodcock management, and none were received in opposition.

The EA contained three alternatives that reflected various management scenarios based on: issues identified through internal and external scoping, existing State and Federal regulations, Service policies and guidance, the Conte Refuge’s purposes, existing wildlife populations and habitats, seasonal requirements, principles of wildlife ecology and management, and administrative, fiscal, and safety considerations. In the Service's opinion, the three alternatives represented a reasonable range as required by the National Environmental Policy Act of 1969, and impacts relating to the physical resource, biological resource, and socio-economic resource for each alternative were evaluated. The draft EA was made available for public review and comment. Digital versions and hard copies were sent to a number of interested parties. Two letters were received in support and none in opposition. This draft was finalized and signed in December of 2006, by the USFWS Region 5 Regional Director, thus allowing the Division to proceed with the preferred alternative as identified in the EA.

D. Compatibility Determination

A Compatibility Determination (CD) (Appendix II) was developed to ensure that this use of the refuge would not materially interfere with or detract from the purposes of the Refuge or the mission of the National Wildlife Refuge System (NWRS). Public notices and press releases were submitted inviting public review and comment of the draft Compatibility Determination in five newspapers with wide local distribution in northeastern Vermont and northern New Hampshire. The draft Compatibility Determination was also posted in the Refuge office in a conspicuous place at the visitor entrance for 30 calendar days (October 18– November 16, 2006) for public review and comment concurrently with the draft WMDA EA.

Public comment was also possible during two Comprehensive Conservation Planning meetings held in Island Pond, Vermont and Norwich, Vermont on November 8th and 9th, 2006. The public was given the opportunity to comment via traditional mail service, fax, or email, and oral and written comment could be delivered during normal business hours at the Headquarters/Visitor Contact Station or during the two public meetings. The period for comment exceeded the required 14-day minimum. The draft determination indicated the proposed use to be compatible.

No comments were received specific to the draft Compatibility Determination during either the input or comment period.

E. Link to other Plans

Although this effort contributes to goals and objectives of many governmental and non governmental conservation plans, the goals and objectives of this plan are specifically integrated into the Nulhegan Habitat Management Plan, and have been engineered to specifically contribute to the Northern Forest Woodcock Initiative.

The Nulhegan Basin Division Habitat Management Plan (HMP) is a step-down plan of the Conte Refuge Comprehensive Conservation Plan. Habitat goals and objectives developed in the HMP are guided by those in the CCP. The contents of this Woodcock Management Plan will be incorporated into the HMP and thus further contribute to the goals and objectives of the CCP

The American Woodcock Initiative is a regional conservation effort managed by the Wildlife Management Institute (WMI). In northern New England this plan is stepped down to provide local focus and guidance, and is referred to as the Northern Forest Woodcock Initiative (NFWI). Success of this initiative is dependent on working cooperatively through partnerships and utilizing such strategies as establishing woodcock management areas for the purpose of demonstration and education.

F. Woodcock Habitat

Woodcock migrating to their summer breeding grounds require suitable habitat conditions to complete their lifecycle. The somewhat subtle but important variability in habitat conditions provides the environment for courtship, nesting and breeding, feeding, and night time roosting to occur. These habitats are better utilized when juxtaposed directly adjacent, or within reasonable proximity to each other. For courtship, woodcock typically use small open areas, resulting from recent field abandonment or timber harvesting that are in or adjacent to suitable nesting and breeding habitat. Nesting and breeding habitats are dense, shrubby, early successional forests where shade intolerant tree species such as poplars (*Populus spp*.) and birches (*Betula spp*.) are present in their seedling and saplings stages of development. For feeding, woodcock seek areas dominated by alder, on moist fertile ground capable of sustaining earthworms and larval stages of insects in the soils where they probe for food. At night, they seek open areas where herbaceous cover does not dominate, yet sparse shrubs and regeneration are present.

G. Management Units

Using recent habitat inventory data, a habitat analysis was performed and areas that could be readily managed for woodcock were identified. Variables used to identify areas on the Division (Map 1) well suited for managing for woodcock were presence and abundance of poplar and alder (*Alnus spp*.), topography, proximity to roads, woodcock survey findings, and conflicts with other resources of concern. Three separate areas totaling 287.8 acres were selected because they were best suited for management and demonstration purposes (Map 2). Each Woodcock Habitat Management Demonstration Unit (WMU) is stratified into treatment areas, which are treated based on an approximate schedule that anticipates vegetative responses to prior and adjacent treatments (Maps 3, 4, 5). The series of treatments creates and sustains 4 types of habitat conditions. Acreages for each habitat condition were calculated and are summarized in Table 1. Treatment zones were primarily stratified based on desired size and arrangement and variables that affect habitat conditions such as topography and species present.

H. WMU Locations

The WMUs are located on the Division, in Essex County, Vermont (Map 2). WMU 1 is located in Bloomfield, VT adjacent to Stone Dam Road approximately 2.3 miles from the Stone Dam Road entrance. WMU 2 is located in Lewis, VT, adjacent to Four Mile Road, near the intersection with Lewis Pond Road. Unit 2 is approximately 4 miles from the Henshaw Road entrance. WMU 3 is located in Brunswick, VT adjacent to lower Lewis Pond Road. WMU 3 is approximately 1.5 miles from Vermont Route 105, but public access from this entry point is prohibited by a gate on privately owned land that lies between Route 105 and the Division. WMU 3 can be accessed by the public from one of the other Division entrances and is approximately 2.5 miles from the intersection of Four Mile Road and Lewis Pond Road.

I. Historical Setting

The Division and subsequently all three WMUs are on land that has been in industrial ownership for centuries, and were subject to intensive timber harvesting within the last 30 years.

Unit 1 manipulation occurred sometime in the early 1970's. The area appears (1962 aerial photos) to have been a mature mixedwood forest prior to harvesting. Reports from local contractors and others indicate a wind event in the early 1970's blew down a significant amount of the forest in this area. Salvage harvesting and total removal of remaining trees followed the event. White spruce seedlings were planted in the cut areas. Use of herbicide to combat hardwood regeneration from out-competing the white spruce was restricted by state regulation. Natural regeneration of early successional, shade-intolerant, hardwood species occurred and eventually became the dominant vegetation.

Unit 2 manipulation occurred on most of the unit sometime in the early 1970's but at varying levels of intensity from total removal in some areas to partial harvests in other areas. Most of the area appears (1962 aerial photos) to have been a mature mixedwood forest prior to harvesting, although a portion of Unit 2 was a decadent balsam fir dominated forest until the early 1990's. At that time, Champion International worked with representatives from the state of Vermont in an effort to harvest the balsam fir because "the stand was falling apart", yet preserve the potential for the area to once again offer the composition and structure that would benefit wintering deer. All of the standing timber was removed and an unknown quantity of red spruce seedlings were planted in what is now the "Roosting Area."

Unit 3 manipulation occurred sometime in the early 1990's. The area appears to have been a mature mixedwood forest prior to harvesting. Near total removal of mature vegetation occurred at that time. Most of the trees left standing at the time of harvesting have succumbed to windthrow since, some of which are still evident.

J. Current Conditions

In all three WMUs, tree composition outside of the recently treated areas is predominately mixed intolerant hardwood species including poplar, red maple (*Acrer rubrum),* white birch (*Betula papyrifera*), and choke cherry (*Prunus virginiana*) ranging from saplings to pole size stems (1-9" stem diameter). Alder is sparsely scattered in the understory throughout most of the areas with denser concentrations on gently sloping or level ground with poor drainage. The presence of alder is a good indication that soil properties are moist and fertile, which is favorable for woodcock foraging and reproduction. However, structural variability is lacking, namely in young early successional stages of development, which discourages woodcock utilization. More specifically, the age class in WMU 1 and WMU 2 is around 25-35 years, and they both contain a higher density of pole sized vegetation, and greater component of poplar. The age class of the vegetation in WMU 3 is slightly younger (approximately 15-20 yrs) and there is less of a component of poplar and higher sapling densities of white and gray birch, red maple, and choke cherry.

The current stage of development, outside of the 2007 treatments areas, is nearing the end of suitable conditions for nesting/breeding and feeding cover and will soon grow into a condition that does not provide any of the habitat components a woodcock requires to complete its lifecycle. Recently treated areas, discussed in greater detail later in this document, provide habitat that was not available prior to implementation. More explicit information pertaining to the composition and vegetative response to the 2008 treatment areas can be found in the 2008 Woodcock Vegetation Monitoring Results document.

K. Guidance on Habitat Management

To adhere to woodcock management guidelines and recommended practices, a variety of early successional stages, as well as sparsely vegetated openings, need to be created and sustained. Four similar, yet characteristically different early successional stages provide the necessary components of suitable woodcock habitat, namely nesting and breeding, feeding, roosting, and courtship. To provide the full suite of habitat components, apply a series of commercial and/or non-commercial treatments that shift throughout the nesting and breeding as well as the feeding treatment areas, within each WMU, over the course of approximately 20 years. Under this paradigm, individual treatment locations are on 20 year even-aged rotations, resulting in a distribution of 4 age classes (0-5 yrs, 5-10 yrs, 10-15 yrs, 15-20 yrs). In addition, maintain roosting and courtship areas with sparse vegetation through annual treatments. Combining these treatments and habitat components within close proximity of each other enhances the quality and therefore overall success of woodcock use. Woodcock travel a few miles to reach suitable habitat, but it is recommended this array of habitat components occurs within approximately 0.5 mile.

Use the treatment schedules and WMU treatment maps (Appendix Map 3, 4, 5) to guide applications of the treatments. Please note that an increase or decrease in the timing of treatments may be needed to reach habitat goals and should be primarily determined by adjacent treatment results and habitat suitability. For example, after a treatment in nesting and breeding areas, forest succession (secondary succession) typically results in the vegetative responses and densities desired to initiate subsequent treatments; but other factors such as merchantability, weather, site conditions, impacts to vegetation (browse), and operator availability may impact the occurrence and/or necessity of subsequent treatments, thus delaying or increasing the time between them. For instance, a more aggressive approach with a shorter amount of time between treatments could be implemented if the current habitat conditions are unsuited (e.g. mature forest) for woodcock use. In contrast, unsuccessful results of vegetative response to prior treatments of adjacent areas could perhaps delay the timing of a treatment.

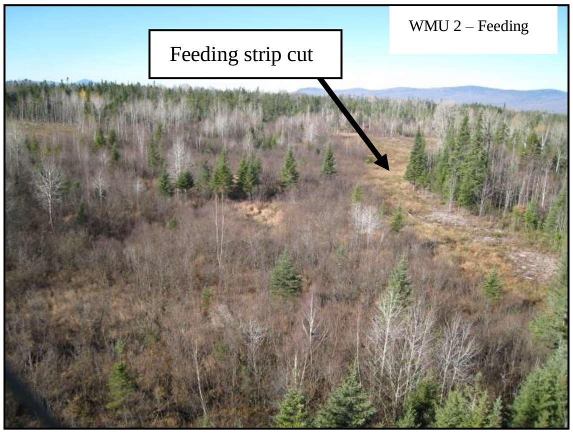
Slight variations of site characteristics contribute to the suitability and use by woodcock. For that reason each habitat component is further described to ensure the conditions needed to meet habitat goals and objectives are met.

Nesting and Breeding

To meet nesting and breeding needs, establish treatment areas on ground with upland characteristics and provide a sustainable diversity and distribution of early successional conditions. Apply treatments in a patchwork layout within the treatment areas, each patch not less than 1 acre in size (Example 1). Remove or reduce all woody stems greater than 1 inch in diameter for each treatment. To enhance the suitability of this habitat component, target areas with fairly level or gently sloping topography with the presence of poplar. Apply treatments to approximately ¼ of the treatment area approximately every 5 years.

<u>Example 1:</u> Suggested cutting cycle sequence for nesting and breeding habitat.

1	3	4	2
4	2	1	3

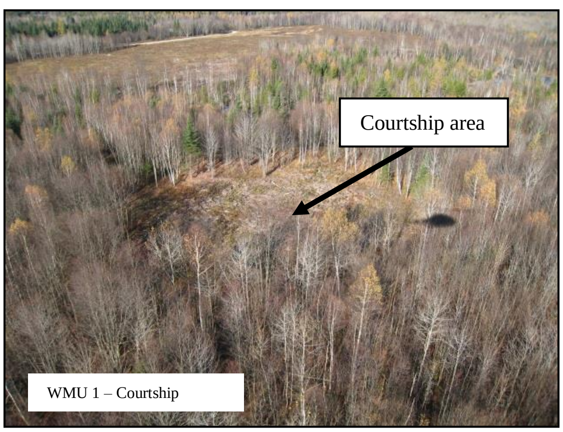


Feeding

To meet feeding needs, establish treatment areas on ground with lowland characteristics and provide a sustainable diversity and distribution of early successional conditions. Apply treatments in a strip or a patch cut layout within the treatment areas. Remove or reduce all woody stems greater than 1 inch in diameter for each treatment. Apply treatments to approximately ¼ of the treatment area approximately every 5 years. To enhance the suitability of this habitat component, target treatment areas on alder or poplar dominant low lying ground with nearly level topography.

Roosting

To meet roosting needs, establish and maintain sparsely vegetated open areas at least 3 acres in size at each WMU. Maintain the areas through a variety of strategies such as mowing, prescribed burning, or disking to ensure at least 30 – 40% of the area free of dense herbaceous or woody vegetation. Treatments may need to be applied annually or perhaps more often, depending on growth and density of herbaceous cover. Dense herbaceous vegetation such as grasses and ferns will discourage woodcock use.



Courtship

To meet courtship needs, establish and maintain sparsely vegetated open areas approximately 0.5 acres in size and distribute the courtship areas throughout the WMUs. Point of contact of the four age classes in the nesting and breeding treatment areas are good locations for courtship clearings, particularly if blocks are ± 5 acres in size. Maintain the areas through a variety of strategies such as mowing (mechanical or by hand), prescribed burning, or disking to ensure the majority of the treatment locations are free of dense herbaceous or woody vegetation. Consider implications of accessibility for treatments during summer months because it is likely access will be limited to some areas due to topography and other natural barriers and therefore will need to be maintained by other methods such as hand crews. Also, variability in vegetation growth and development, whether through soil limitations or browsing or other factors, will likely create some natural variability that may result in conditions woodcock seek for courtship; but it is not recommended that courtship areas be solely dependent on natural variability, for it is unlikely these conditions will persist or be large enough to attract and serve a wide population of woodcock.

L. Archaeological Sites and Historic Structures

In 1999, the Archaeology Research Center at the University of Maine, Farmington completed a Phase Ia background study of the former Champion lands, including the Nulhegan Basin Division – "People Land and History: The Cultural Landscape of the Nulhegan District." The study shows known historic archaeological sites on a map, none of which are located in the proposed management demonstration units. The Nulhegan River is considered likely to have as yet undiscovered historic sites, and according to the study the north end of the Refuge might have historic sites on that River's upper reaches. There are no historic structures in the proposed management demonstration units. There are no known prehistoric sites on the Refuge. The study provides maps of potential Native American site sensitivity, and much of the land in the three proposed management demonstration units is characterized as potentially highly sensitive (e.g., likely to contain Native American archaeological sites). Some of the criteria for determining site sensitivity are:

- Proximity to wetlands or surface water
- Proximity to stream confluences, waterfalls and rapids
- Proximity to heads of draws, passes, drainage divides, and lithic outcrops
- Location on kames, alluvial terraces, flood plains

Proposed management demonstration units for the project contain combinations of these and other criteria, and contain potentially low, moderate, and highly sensitive land. To avoid possible disturbances of unknown archeological and historic sites, operate on frozen or dry ground with proper equipment to ensure disturbance to the ground is minimal or at best avoided completely.

M. Vermont Electric Power Company (VELCO)

A powerline corridor managed by Vermont Electric Power Company (VELCO) is adjacent to WMU 1. VELCO has agreed to be a partner in the NFWI, and they graciously donated the use of 2 brontosaurus machines, which were used to help implement treatments at WMU 1. They have also agreed to manage approximately 14.5 acres of powerline ROW adjacent to WMU 1 (map 3) to contribute to the goals of this effort and thusly the NFWI.

Of the 14.5 acres, approximately 4 acres were treated in summer of 2008 utilizing an excavator and bucket with thumb attachment to remove loose debris such as rocks and stumps, and reduce dips and hummocks. This was performed to facilitate mowing operations, which were intended to maintain roosting habitat conditions. The remaining acreage was determined to possess saturated soils and fairly level topography, which are more suited to feeding habitat needs, and therefore are intended to be maintained as such.

N. Data

Geographic Information System (GIS) data layers were created to map and catalogue treatment areas. This data, coupled with a handheld Global Positioning System (GPS) computer, will provide field personnel with on the ground locations of treatment areas. This data is provided in a compact disc that accompanies this report but is only current up to the date of this report. These files will be stored and kept current at the Nulhegan Basin Division's data warehouse.

O. Habitat Goals, Objectives, and Strategies

Goal: ***Create and sustain the diversity of habitat conditions woodcock require to complete their summer breeding ground lifecycles in areas that provide access for the purpose of education and demonstration, and thus contribute to the Northern Forest Woodcock Initiative***

Objective: Woodcock Habitat Management
Manage WMU 1, 2, and 3 totaling 287.8 acres on the Division to create and sustain ideal woodcock nesting and breeding, feeding, roosting, and courtship habitat during the summer breeding ground season of May – September

Strategies
- Utilize even-age silvicultural techniques, namely clear-cutting, to create and sustain 4 similar yet characteristically different early successional conditions at each WMU
- Establish and maintain areas in an open condition with sparse vegetation

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Objective: Demonstration and Education
Provide information and education to increase awareness about the need for woodcock population recovery, management strategies that can be used, and the Northern Forest Woodcock Initiative

Strategies
- Create and install interpretive panels at each demonstration location
- Create and make available brochures and or other literature to inform the public about the demonstration areas
- Invite students and other interested parties to the refuge to visit the demonstration areas
- Utilize local media to increase public awareness of the demonstration areas

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P. Habitat Management Strategies and Prescriptions

Strategy: Utilize even-age silvicultural techniques, namely clear-cutting, to create and sustain 4 similar yet characteristically different early successional conditions at each WMU

Management Prescriptions:
1) Apply treatments according to the treatment location and schedules for each WMU (Appendix; Table 2, Maps 3, 4, 5). Under this regime, natural regeneration of desirable species is expected. Conduct treatments during late fall and early winter when the ground is either dry or frozen and the vegetation is dormant. Treatments during this time will result in more aggressive sprouting and accelerated growth of the regeneration during the spring and summer growing season, thus accelerating desired habitat conditions. Mid or late winter treatments typically result in a similar vegetative response, but deep snow may limit the accessibility of the treatment areas and perhaps limit the ability to successfully apply the treatments. In addition, conduct the treatments during periods of frozen or perhaps dry soil conditions to ensure the ground is not disturbed thus preserving any unknown archaeological sites or artifacts that may exist. Utilize equipment with devices such as tracks, or high flotation wheels to further minimize the potential for ground disturbance. To abide by standards addressed in the EA, significant ground disturbance must not occur. Utilize commercial and non-commercial methods to achieve the following:

- **Nesting and Breeding (NB) -** Regenerate predominately shade-intolerant hardwood species with poplar dominance and allow these areas to develop into a young forest.
    - *Note:* Poplar responds best through asexual regeneration of the root system, also known as root-suckering. Poplar can be difficult to regenerate in areas where it does not currently exist. These areas were selected in part because of the presence of poplar; therefore it is critical that the species is reestablished within these areas.

- **Feeding (F) –** Regenerate alder and allow it to develop into a young alder shrub dominated thicket.
    - *Note:* Speckled alder typically regenerates in areas with a high water table and moist soils. These areas were selected in part because of the presence of alder and the probability that alder will dominate these areas again

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Strategy: Establish and maintain areas in an open condition with sparse vegetation

Management Prescriptions:

1) Apply annual treatments according to the treatment location and schedules for each WMU (Appendix; Table 2, Maps 3, 4, 5). The recommended method is to mow these areas utilizing such equipment as tractor, ATV, or other vehicle able to negotiate off road use to achieve the following:

- **Roosting (R) and Courtship (C) -** Maintain with at least 30-40 % open ground space and the remaining 60-70% with sparse shrub and regeneration cover
    - *Note:* The use of prescribed fire has been considered as a tool to maintain these conditions. It was concluded that habitat objectives could not likely be attained by using this tool. Topography, climate, soil properties, and availability of certified personnel were all identified as being limiting factors.

2) Expand the existing log landings at WMU 1 and WMU 3 by spreading the existing gravel deposits and berms. Pile loose debris such as rocks and remnant woody debris from the initial treatment, and any other hazards that would limit the ability to mow the area.
3) Remove the existing vegetation in the roosting area at WMU 2. Pile loose debris such as rocks and remnant woody debris from the initial treatment, and any other hazards that would limit the ability to mow the area.

Q. Recent Treatments

In developing an EA and CD, plans were created to administer a series of treatments over a 20 year period (Table 2) to meet the goals and objective as stated in this management plan. Initial treatments were implemented during January through April of 2007. A total of 88.7 acres were treated using either commercial or non-commercial methods (Table 3) to reduce or remove the vegetation. All of the nesting breeding, feeding, and roosting areas identified for treatment in 2007 were treated, in all of the WMUs. In addition, all of the courtship areas were treated, with the exception of one in the north east quadrant of WMU 2.

In WMU 1 approximately 24.9 acres were treated with solely non-commercial methods (Map 6) using 2 different types of "brontosaurus" shredder. Both of the excavators that had the brontosaurus shredding implements attached utilized auxiliary motors to power the shredding heads. One of these utilized a shredding head with fixed teeth, while the other utilized a head with reciprocating teeth. Both proved to be capable of conducting the treatment. The remaining 14.6 acres were treated using commercial removal of merchantable products, which constituted approximately 99% removal of the vegetation within this area (Map 6). A feller buncher, grapple skidder, and loader/slasher were used to conduct whole tree removal. A non-commercial application utilizing a brontosaurus was then implemented to reduce any remaining vegetation that was not removed by the feller buncher. Approximate volumes removed were:

Pulp

Poplar Roundwood	28.06 cords
Hardwood Pulp	63.86 cords
Softwood Pulp	14.27 cords
Chipwood	488.57 tons

Sawlogs

Softwood logs	11,550 BF
Hardwood logs	4,220 BF

In WMU 2 approximately 27.5 acres were treated with solely non-commercial methods (Map7) using one type of brontosaurus shredder. This excavator did not have an auxiliary motor to run the brontosaurus, but the head was somewhat different than the ones used in WMU 1. The head appeared to be less industrial in its design meaning it was smaller and lighter in appearance. This head had fixed teeth, and also proved to be capable of conducting the treatment. The remaining 8.7 acres were subject to a commercial removal of merchantable products which constituted approximately 99% removal of the vegetation within this area (Map 7). A feller buncher, grapple skidder, and loader/slasher were used to conduct whole tree removal. A non-commercial application utilizing a brontosaurus was then implemented to reduce any remaining vegetation that was not removed by the feller buncher. Approximate volumes removed were:

Pulp

Poplar Roundwood	12.67 cords
Chipwood	429.38 tons

In WMU 3 approximately 11.7 acres were treated with solely a non-commercial method (Map 8). The type of brontosaurus used is the same as in WMU2. This acreage accounts for all of the treatments completed in this WMU.

In addition, during September of 2008, treatments occurred on WMU 1 and WMU 3 (totalling 7.9 acres) to help facilitate mowing of the roosting fields. These treatments consisted of utilizing an excavator with a bucket and thumb attachment to comb through the dense grass and shrub vegetation to flatten high spots as well as gather and pile rocks and other loose debris. This treatment was also conducted on 3.9 acres of the powerline corridor in partnership with VELCO (Map 3). This same treatment is scheduled to occur on approximately 9 acres in WMU 3, during the summer of 2009.

R. Monitoring

Assessing and monitoring vegetation and woodcock response to treatments over time is critical for evaluating habitat use and conditions and determining if treatment objectives, and thusly, habitat goals and objectives are being achieved. Two monitoring protocols have been developed to measure 1) the vegetative response and 2) the response by woodcock to the treatments.

The Woodcock Vegetation Monitoring Survey Protocol utilizes population sampling methods collected biennially on treated areas at each WMU (Map 9,10,11). The objective of each survey is to develop a statistically reliant representation of the condition and vegetative composition that results from the applied management treatments. Conducting biennial surveys will track changes that occur over time and will be used to measure success, identify potential threats, and guide the timing and methods used for future treatments.

- In **NB** treatment areas, the survey focuses on determining the species and stocking of regeneration that will likely dominate and continue to mature.
- In **F** treatment areas, the survey focuses on determining the dominant species composition and % coverage of woody and herbaceous vegetation
- In **R** treatment areas, the survey focuses on determining % coverage of woody and herbaceous vegetation
- In **C** treatment areas, the survey focuses on determining % coverage of woody and herbaceous vegetation

A woodcock survey protocol has been implemented on the Division since the spring of 2000. This survey accounts for presence or absence of woodcock by recording “peenting” sounds often made by the male woodcock during their evening courting ritual in the spring. Transects incorporate portions of the gravel road network that exists on the Division. A modified woodcock singing ground survey has been developed for the WMUs that uses the methodology of the Division survey, but specifically targets each woodcock demonstration unit (Map 12,13,14). Survey points were added within each WMU to monitor presence or absence of woodcock using these sites. Surveys will be conducted in combination with the Division-wide survey.

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Table 1: WMU Habitat Type Acreages

WMU 1	Acreage
Nesting/Breeding	117.1
Roosting	4.9
Feeding	9.5
Courtship	2.4
Total	133.9

WMU 2	Acreage
Nesting/Breeding	95.4
Roosting	9.8
Feeding	13.8
Courtship	3.0
Total	122.0

WMU 3	Acreage
Nesting/Breeding	24.1
Roosting	3.9
Feeding	3.0
Courtship	1.2
Total	32.2

Table 2: Treatment Schedules

WMU 1
Treatment Schedule:

2007:		
	Nesting/Breeding:	30.2 ac
	Roosting:	4.9 ac
	Courtship:	2.4 ac
	Feeding:	2.4 ac
	Total:	39.9 ac
2012:		
	Nesting/Breeding:	27.8 ac
	Feeding:	2.5 ac
	Total:	30.3 ac
2017:		
	Nesting/Breeding:	30.5 ac
	Feeding:	2.4 ac
	Total:	32.9 ac
2022:		
	Nesting/Breeding:	30.1 ac
	Feeding:	2.2 ac
	Total:	32.3 ac
Annual Mowing:		
Courtship Areas:		2.4 ac
Roosting Field:		4.9 ac
Total:		7.3 ac

WMU 2
Treatment Schedule:

2007:		
	Nesting/Breeding:	22.7 ac
	Roosting:	9.8 ac
	Courtship:	3.0 ac
	Feeding:	3.7 ac
	Total:	39.2 ac
2012:		
	Nesting/Breeding:	23.4 ac
	Feeding:	2.9 ac
	Total:	26.3 ac
2017:		
	Nesting/Breeding:	22.8 ac
	Feeding:	3.1 ac
	Total:	25.9 ac
2022:		
	Nesting/Breeding:	24.6 ac
	Feeding:	4.1 ac
	Total:	28.7 ac
Annual Mowing:		
Courtship Areas:		3.0 ac
Roosting Field:		12.5 ac
Total:		15.5 ac

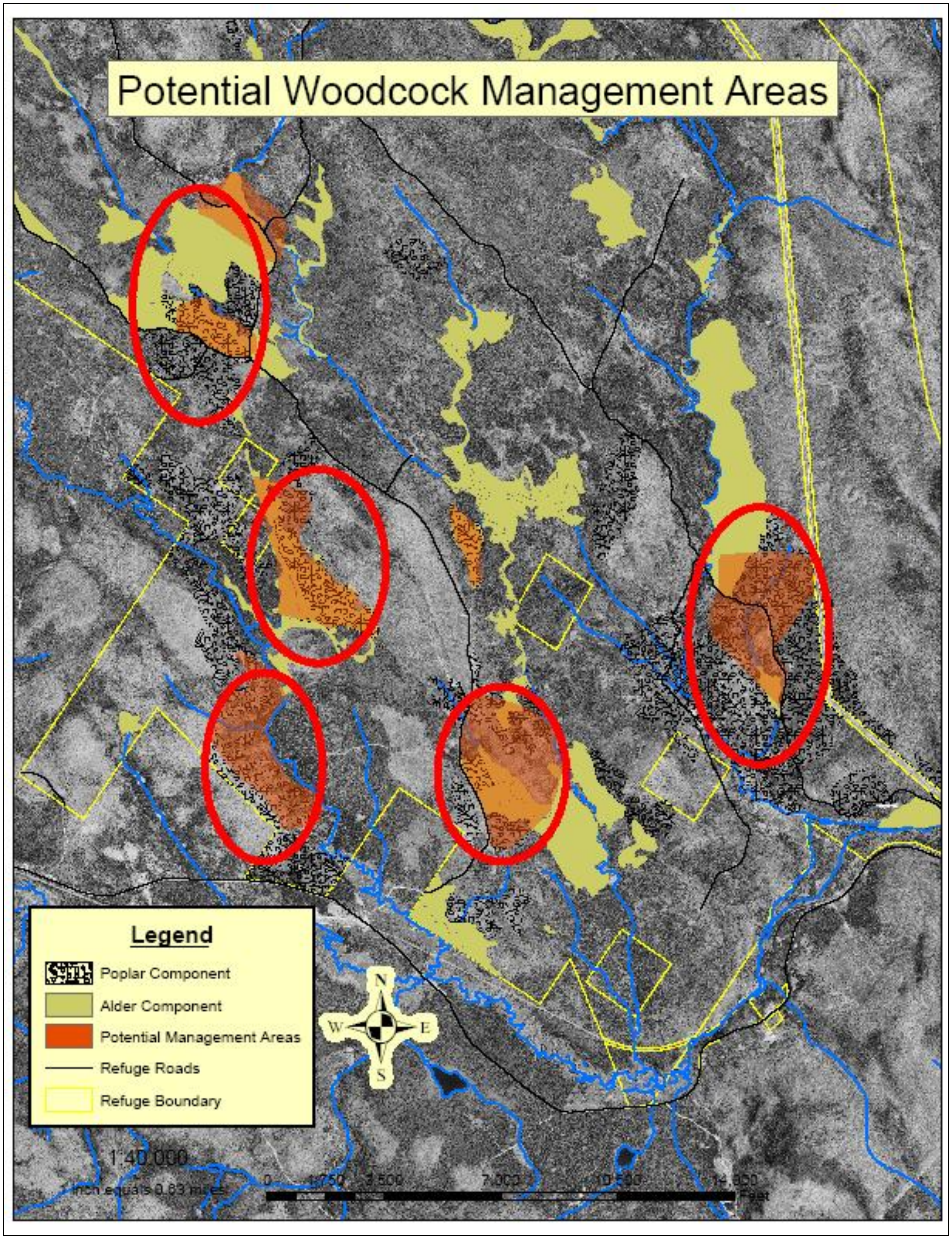
WMU 3
Treatment Schedule:

2007:		
	Nesting/Breeding:	5.7 ac
	Roosting:	3.9 ac
	Courtship:	1.2 ac
	Feeding:	0.9 ac
	Total:	11.7 ac
2012:		
	Nesting/Breeding:	5.7 ac
	Feeding:	0.7 ac
	Total:	6.4 ac
2017:		
	Nesting/Breeding:	5.3 ac
	Feeding:	0.6 ac
	Total:	5.9 ac
2022:		
	Nesting/Breeding:	7.6 ac
	Feeding:	0.8 ac
	Total:	8.4 ac
Annual Mowing:		
Courtship Areas:		1.2 ac
Roosting Field:		3.9 ac
Total:		5.1 ac

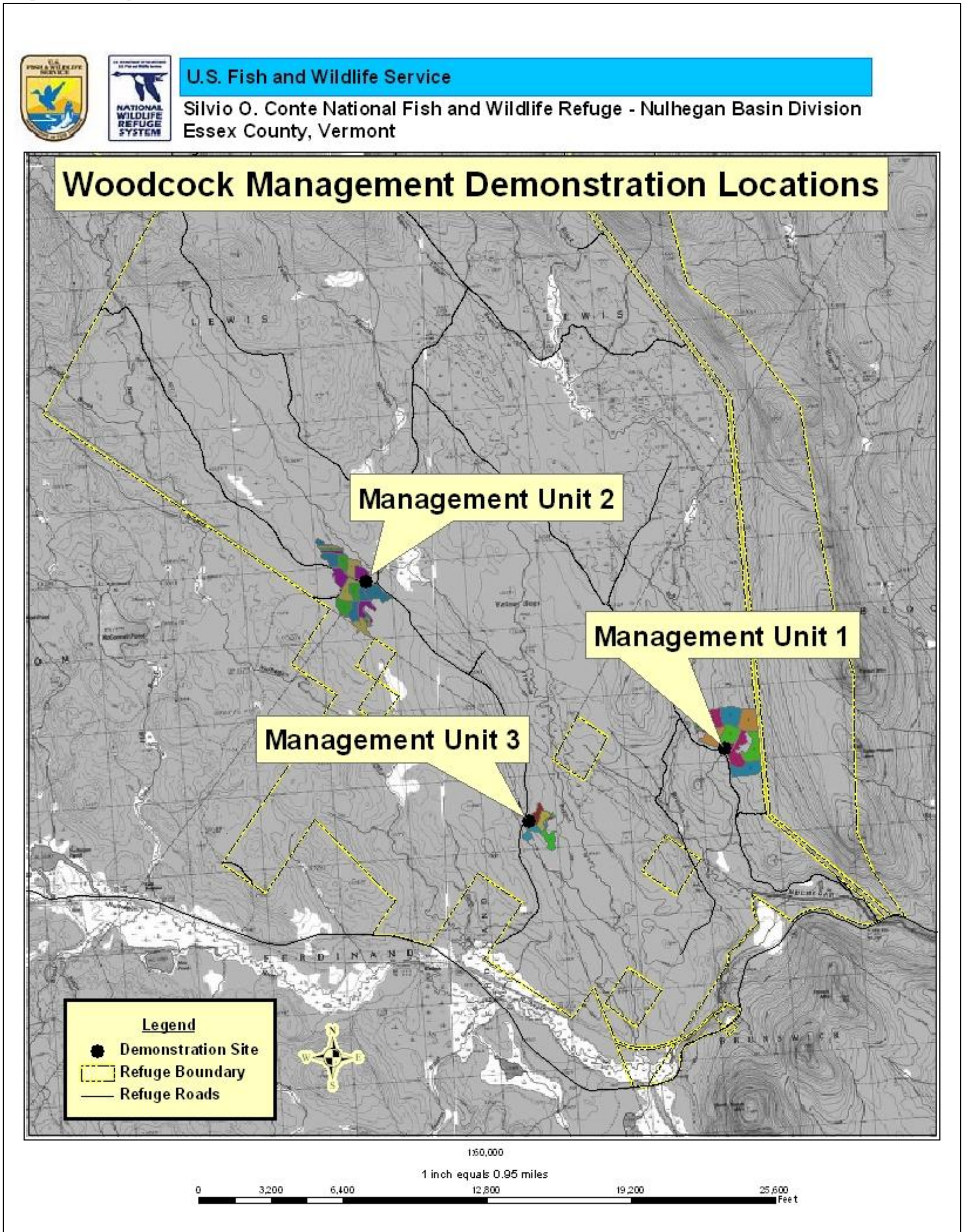
Table 3: Commercial and Non-Commercial Treatments

WMU	Commercial (Acres)	Non-Commercial (Acres)	Total (Acres)
1	14.6	25.1	39.7
2	8.2	29.2	37.4
3	0	11.7	11.7

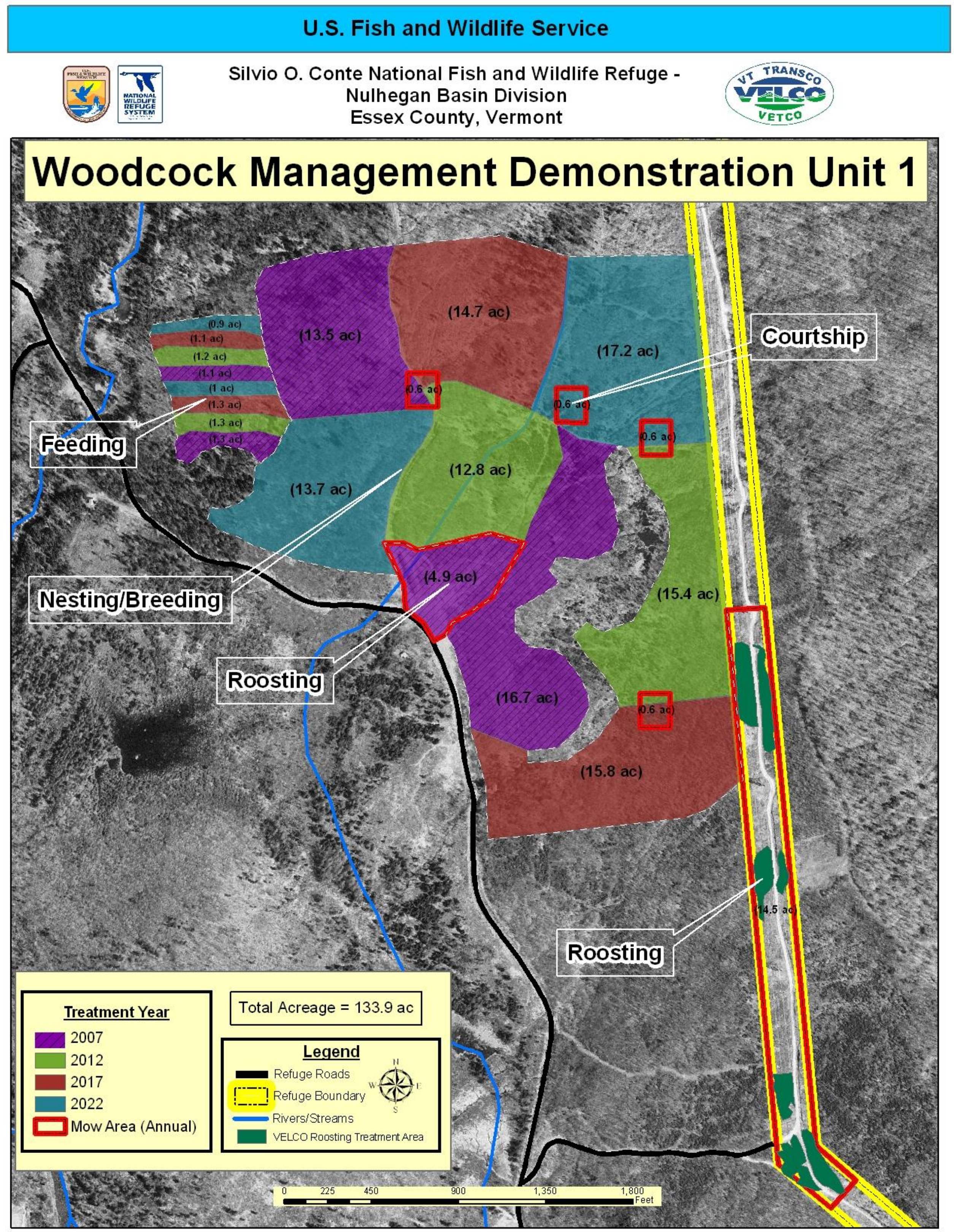
Map 1: Potential Woodcock Management Areas



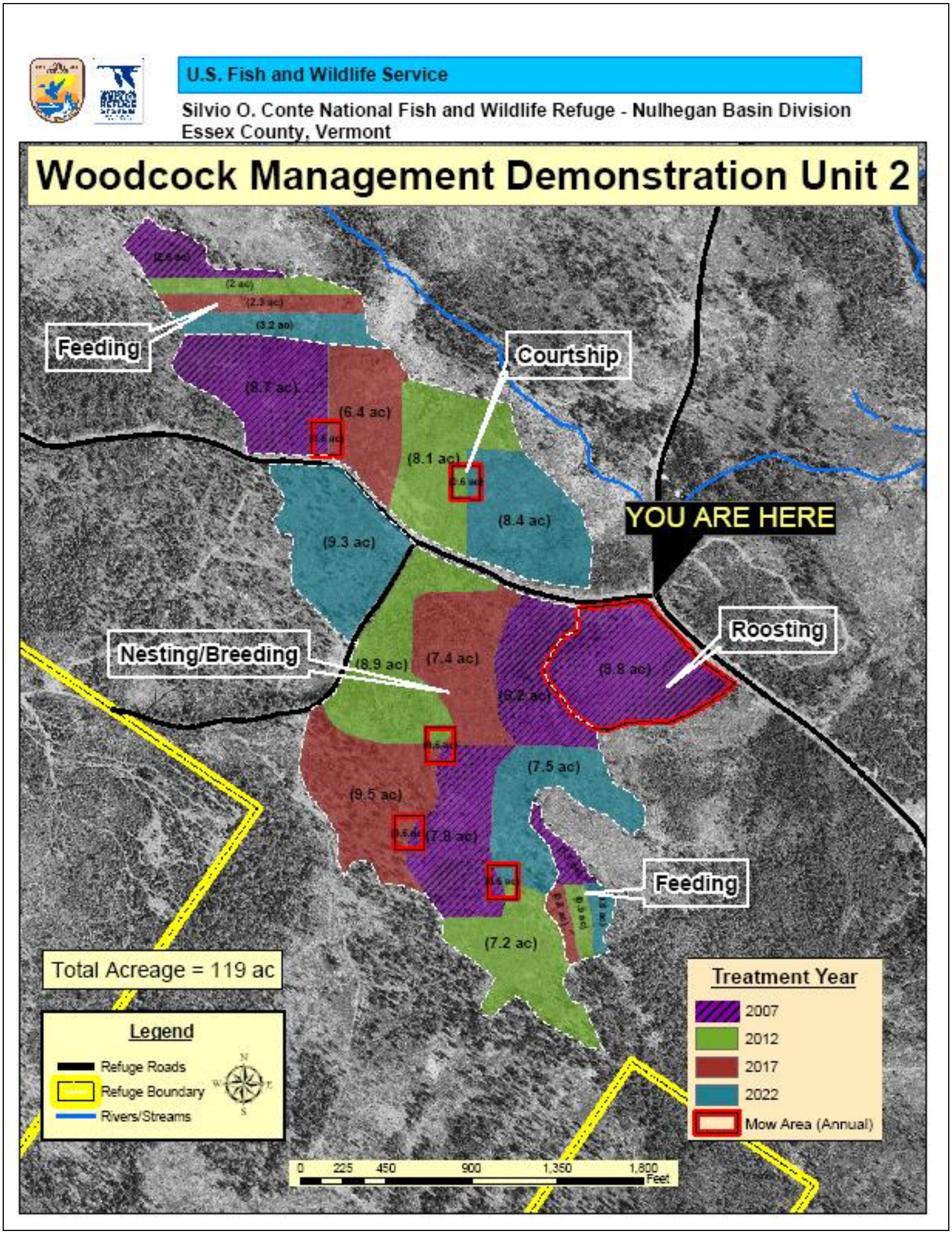
Map 2: Management Demonstration Unit Locations



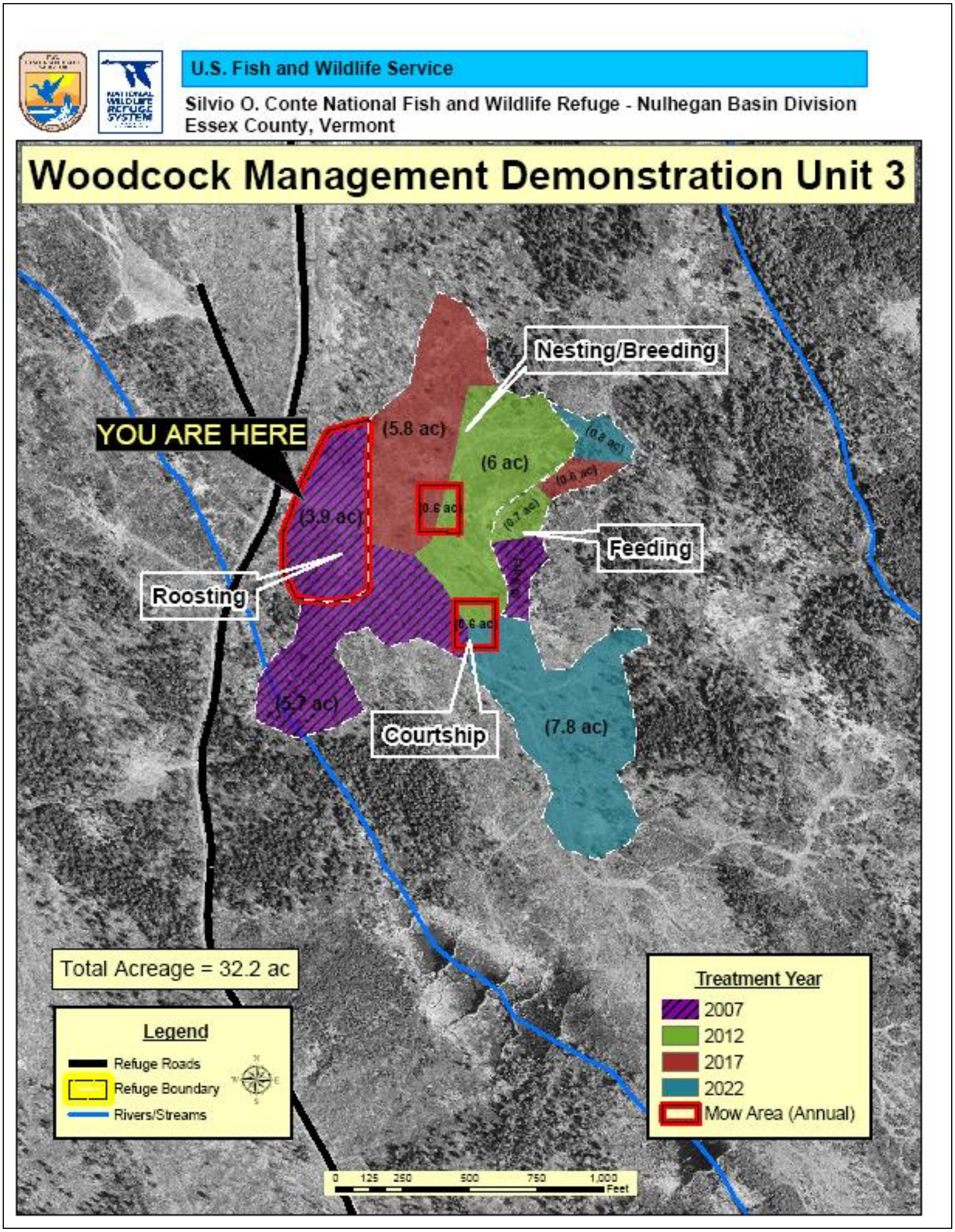
Map 3: Unit 1 Treatment



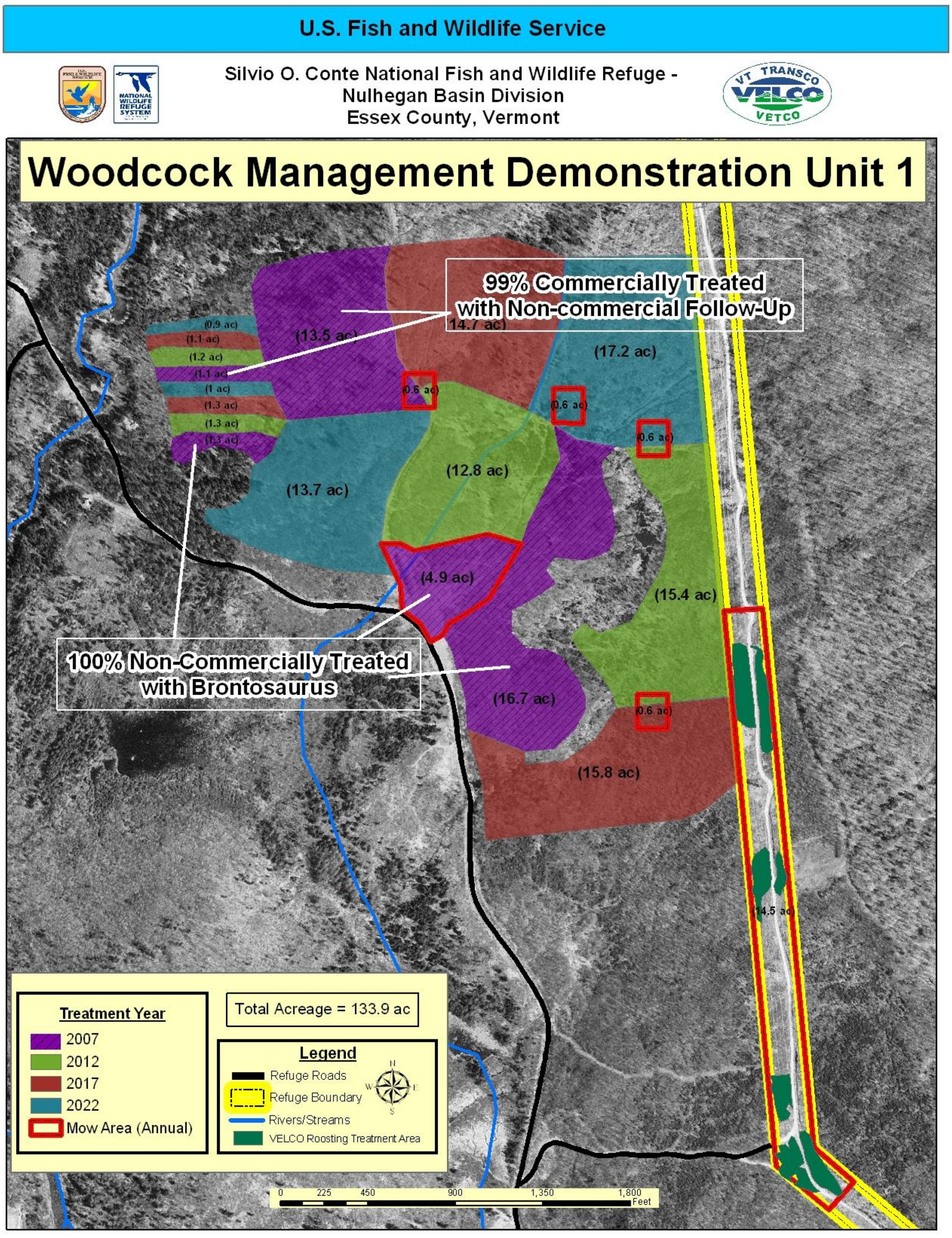
Map 4: Unit 2 Treatment



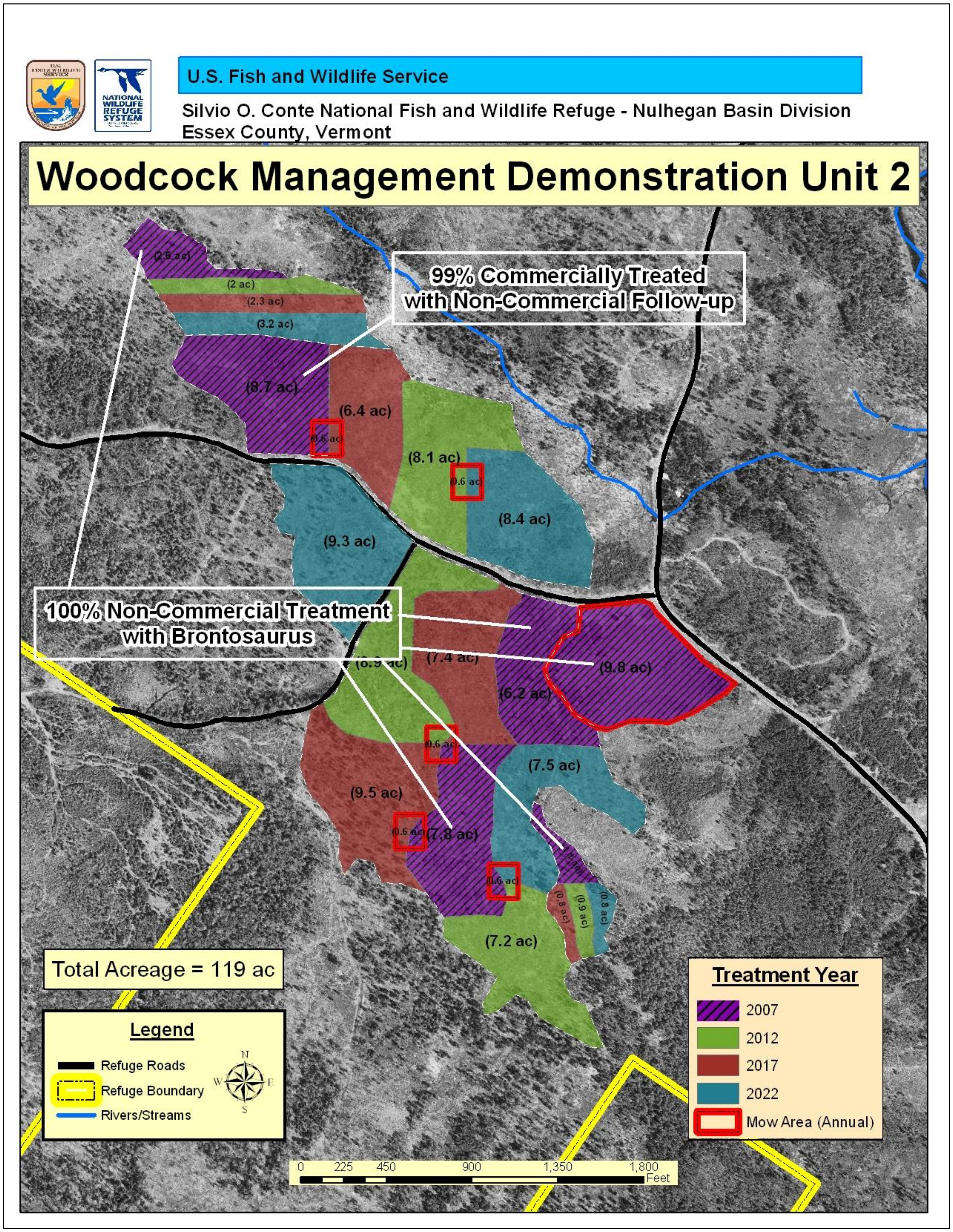
Map 5: Unit 3 Treatment



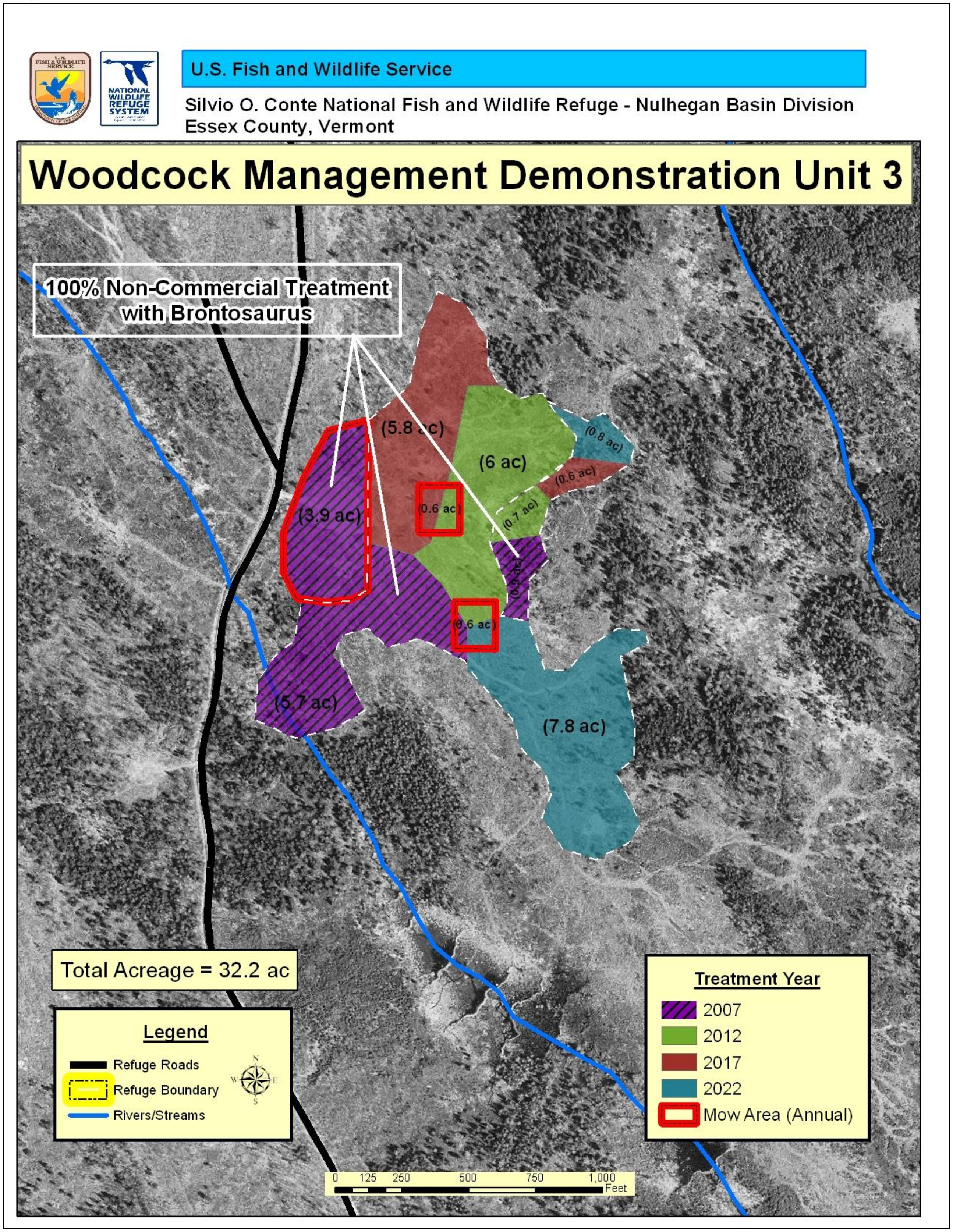
Map 6: WMU 1 Treatment Method



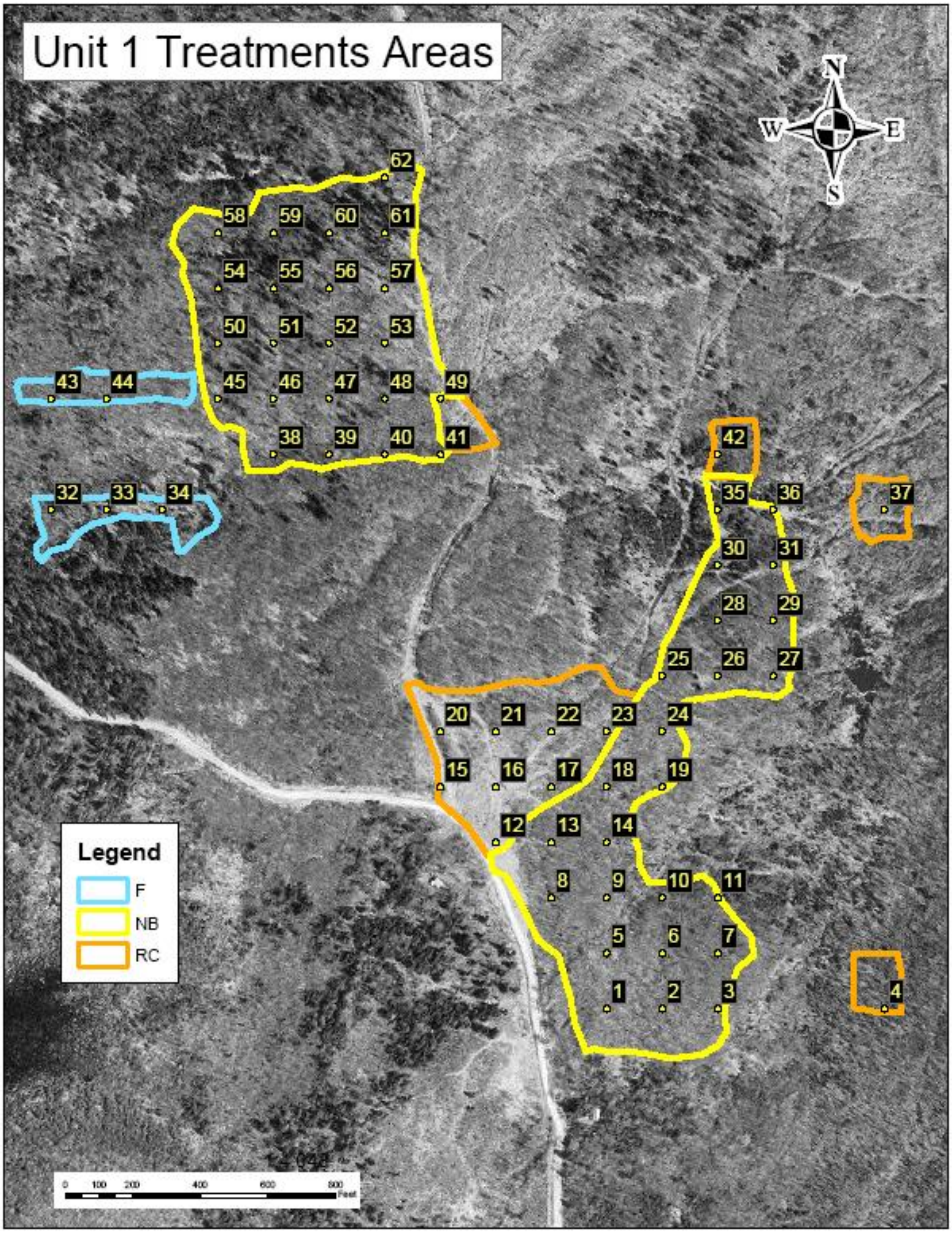
Map 7: WMU 2 Treatment Method



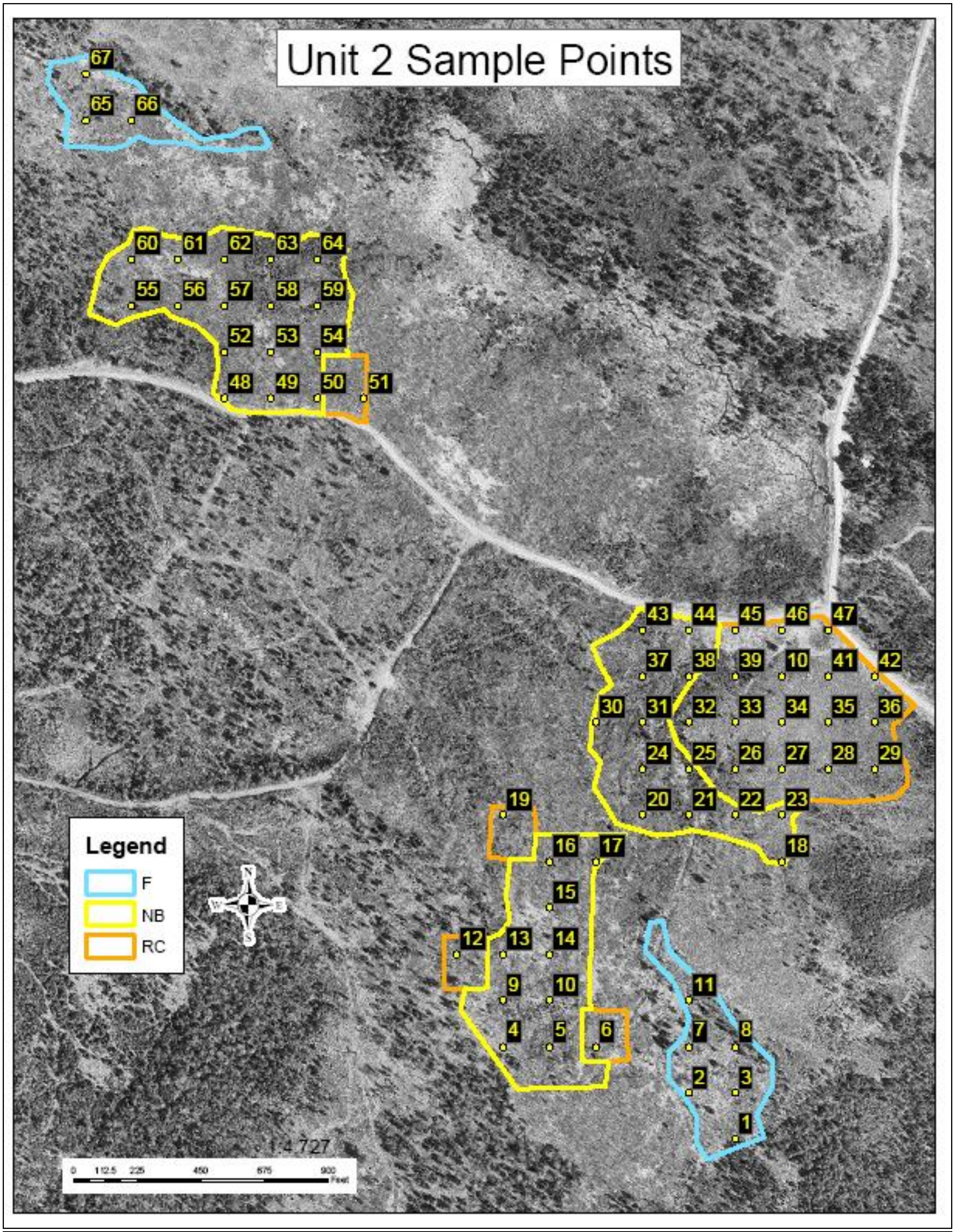
Map 8: WMU 2 Treatment Method



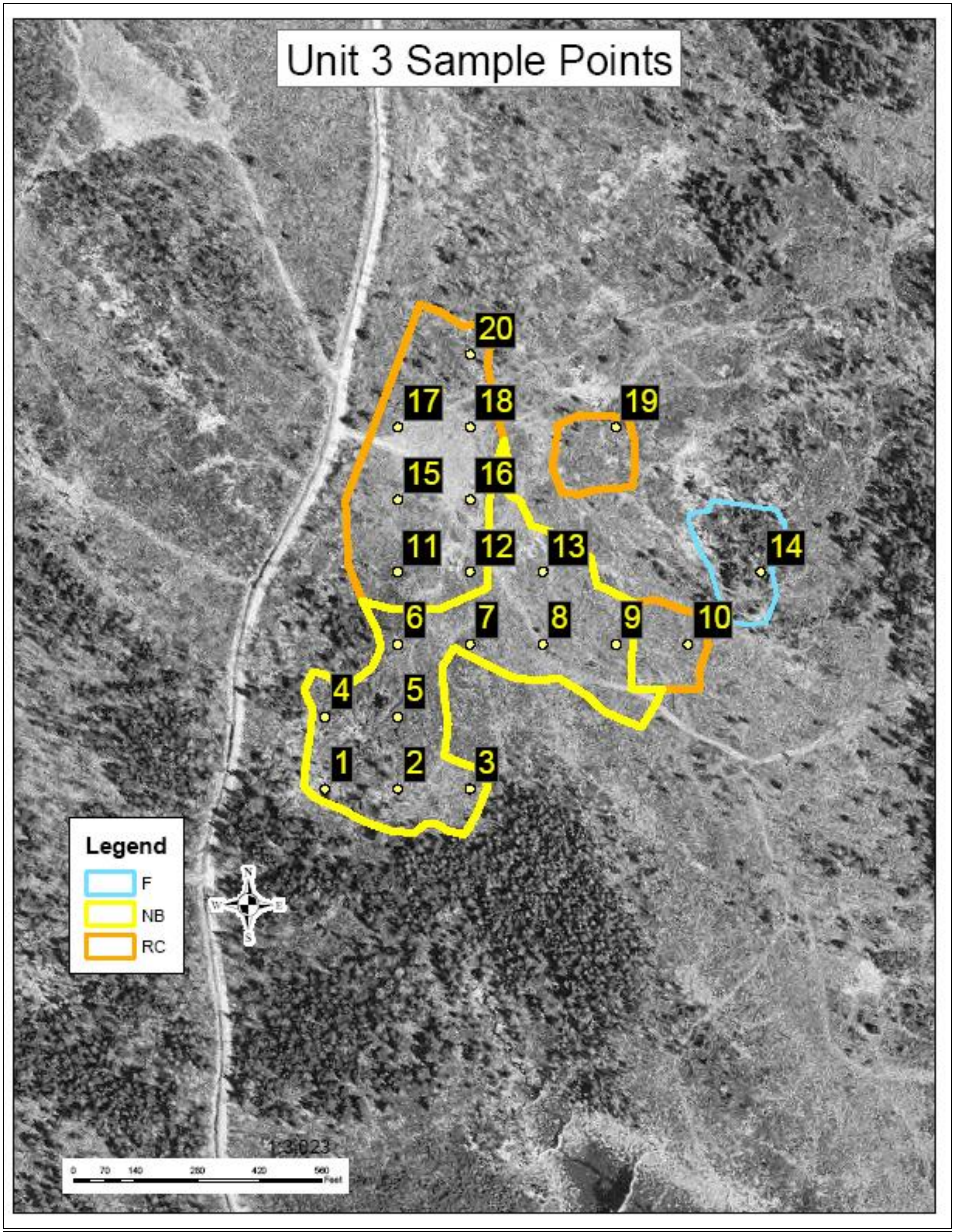
Map 9: WMU 1 Vegetation Survey



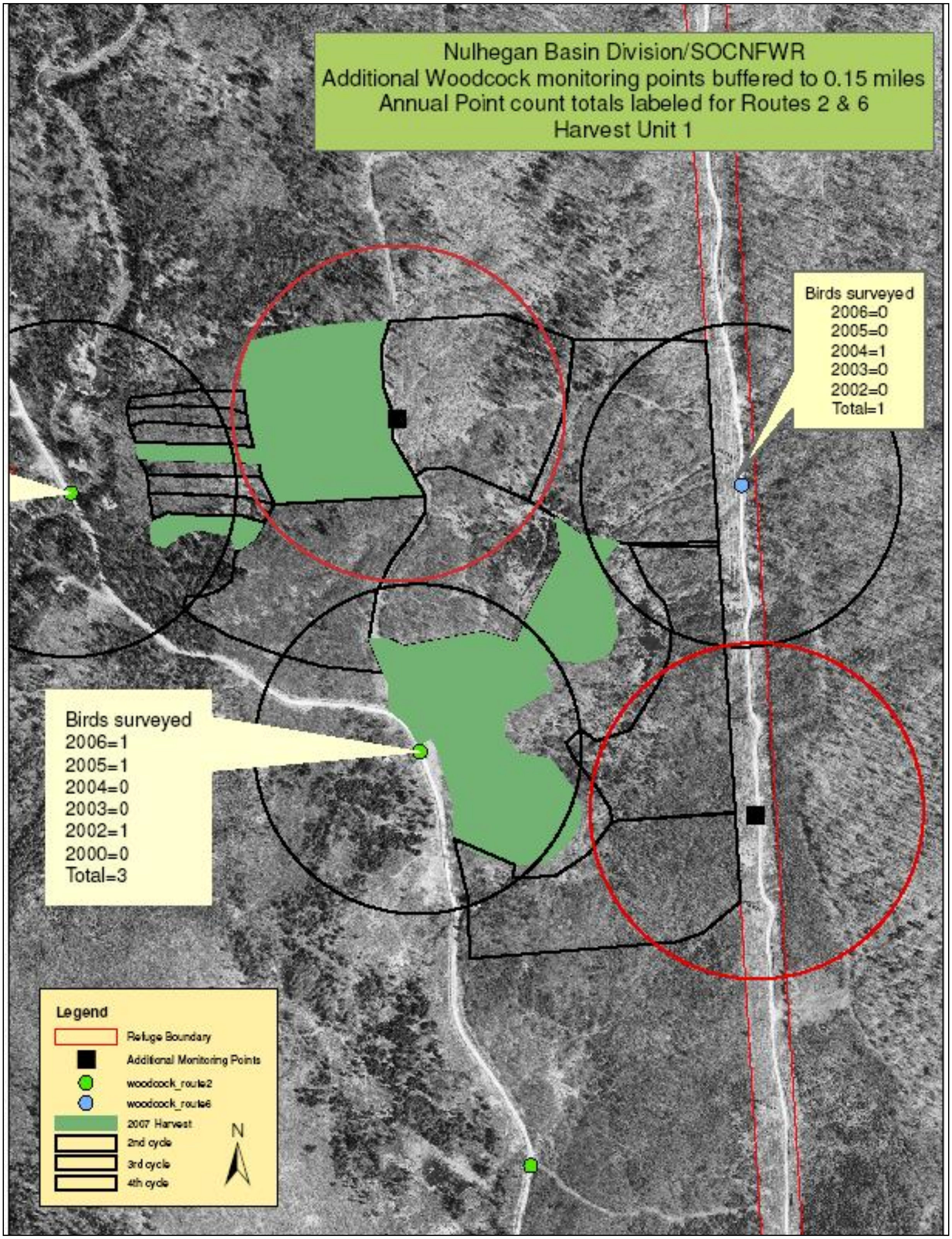
Map 10: WMU 1 Vegetation Survey



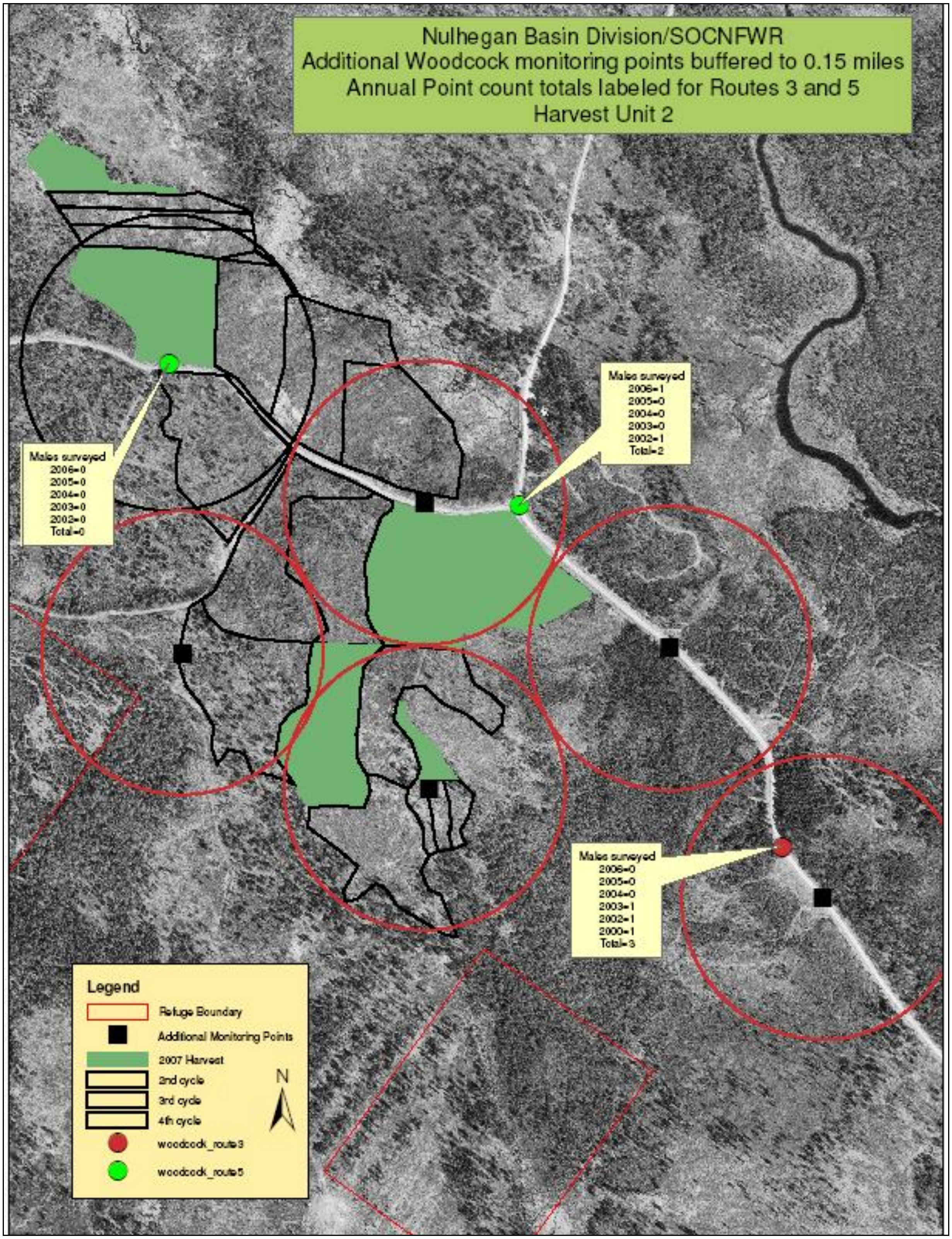
Map 11: WMU 1 Vegetation Survey



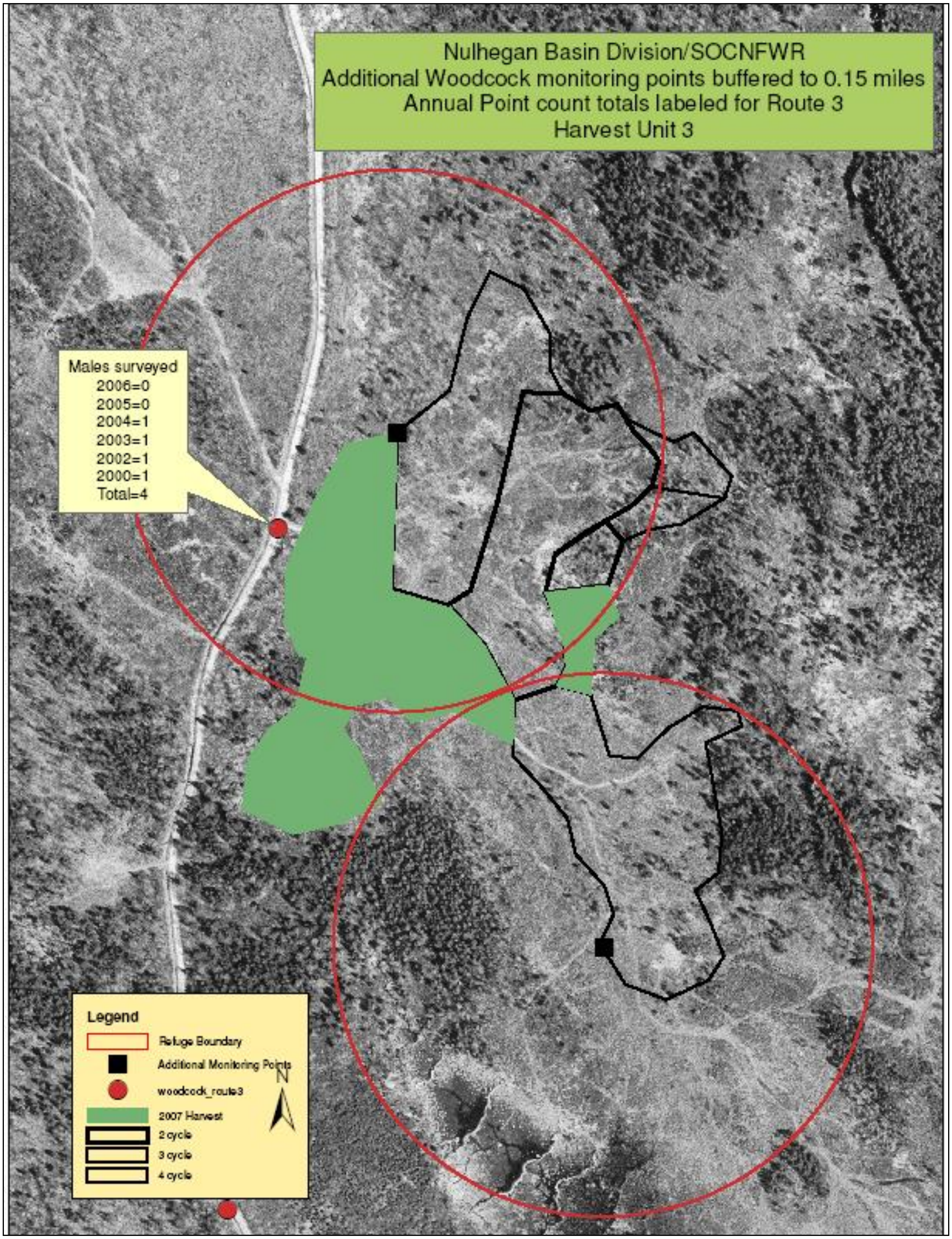
Map 12: WMU 1 Woodcock Survey



Map 13: WMU 2 Woodcock Survey


Nulhegan Basin Division/SOCNFWR
Additional Woodcock monitoring points buffered to 0.15 miles
Annual Point count totals labeled for Routes 3 and 5
Harvest Unit 2
Males surveyed
2006=1
2005=0
2004=0
2003=0
2002=1
Total=2
Males surveyed
2006=0
2005=0
2004=0
2003=0
2002=0
Total=0
Males surveyed
2006=0
2005=0
2004=0
2003=1
2002=1
2000=1
Total=3
Legend
Refuge Boundary
Additional Monitoring Points
2007 Harvest
2nd cycle
3rd cycle
4th cycle
woodcock_route3
woodcock_route5
N

Map 14: WMU 3 Woodcock Survey



APPENDIX D:
Environmental Assessment for Woodcock Habitat Management

at the

Nulhegan Basin Division
Silvio O. Conte National Fish and Wildlife Refuge
Essex County, Vermont

December 15, 2006

Prepared by:

U.S. Department of the Interior
Fish and Wildlife Service
Silvio O. Conte National Fish and Wildlife Refuge
Nulhegan Basin Division

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I. **Purpose**

The purpose of this environmental assessment (EA) is to discuss and evaluate the environmental impacts of establishing a woodcock habitat management demonstration project at the Nulhegan Basin Division (Refuge) (Figure 1) of the Silvio O. Conte National Fish and Wildlife Refuge (Conte Refuge), Essex County, Vermont.

II. **Proposal**

The U.S. Fish and Wildlife Service (Service) proposes to contribute to the objectives of the Northern Forest Woodcock Initiative by establishing woodcock management demonstration units to provide examples of proper woodcock management and provide research and monitoring efforts on the Refuge. These demonstration units will also create the opportunity for education and interpretation at the Refuge, and will thus contribute to the goals of the Service and the Conte Refuge. Over the next 20 years, a total of about 287 acres will be mechanically treated on the Refuge to provide suitable woodcock habitat on three demonstration units (Figure 2) according to the preferred alternative and in accordance with the treatment schedule (Table 1) and treatment locations outlined on each management demonstration unit divisional map (Figure 3, Figure 4, and Figure 5). This program will apply only to lands owned in fee by the Service in Vermont's Nulhegan Basin.

III. **Need for Action**

The American woodcock (*Scolopax minor*) is a trust resource species of management concern in the Northeast Region of the Service. It is listed as a species of highest priority of concern in the U.S. Shorebird Conservation Plan (Brown 2001), The Partners In Flight (PIF) Bird Conservation Plan for Physiographic Region 28 (Rosenberg 2000), The American Woodcock Plan (U.S. Fish and Wildlife Service 1990), and the North American Bird Conservation Initiative (NABCI) Bird Conservation Region 14 (BCR 14). In Vermont, the woodcock is listed as a species of medium concern according to the 2005 State Wildlife Action plan. The population has declined between 1968-2006 at an annual rate of 1.9% in the Eastern U.S. and 1.8% in the Central U.S. In Vermont, its population has declined at an annual rate of 1.1% between 1968 and 2004 (Vermont Department of Fish and Wildlife 2005). In 1996, the breeding population index was 1.58 singing males per route in the Eastern U.S., which was the lowest on record since the survey began. In 2006, the Eastern U.S. breeding population index was 1.69 singing males per route (Appendix I). This was lower than the predicted 1.73 (Kelley et al. 2006). The major causes of the decline are thought to be degradation and loss of suitable habitat on both breeding and wintering areas, caused by forest succession and changes in land use and various human uses (Dessecker and McAuley 2001). The goal of the Service's "American Woodcock Management Plan" is to stabilize the population declines and increase woodcock populations above current levels and to a level consistent with the demands of consumptive and non- consumptive users (U.S. Fish and Wildlife Service 1990).

Loss of early successional habitat has been identified as the primary cause for woodcock decline (Sepik et al. 1994). This vegetative stage of development also provides habitat for a variety of bird species such as the olive-sided flycatcher (*Contopus cooperi*), chestnut-sided warbler (*Dendroica pensylvanica*), and palm warbler (*Dendroica palmarum*), which Partners in Flight (PIF) has identified as being in need of population recovery. While preparing for development of a Refuge Habitat Management Plan (HMP), a draft priority wildlife species list was developed. Species were identified using a regional approach to determine which refuges have the most opportunity to contribute to resources of regional concern, as well as to identify local resources of concern by integrating other planning efforts such as the Vermont State Wildlife Action Plan. Woodcock will likely be a priority species for future Refuge habitat management based on these planning efforts. Creating and maintaining early successional habitat, as well as other habitat components woodcock need for suitable habitat conditions (e.g., open areas for roosting), will contribute to the overall goal of providing natural diversity and biological integrity on the Refuge, and will fulfill Conte Refuge purposes #1 and #2.

A partnership has been initiated for the benefit of the American woodcock and other early successional migratory birds in Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, and ultimately elsewhere in woodcock range in the U.S. Twenty-four cooperators have enlisted in this effort, which has been spearheaded by the Wildlife Management Institute (Appendix II). This Northern Forest Woodcock Initiative (NFWI) is a landscape level conservation approach that is dependent on private and public involvement. NFWI has been developed to address the rapid decline of woodcock population levels. The Refuge was identified as one of the most suitable public land areas for woodcock management in Bird Conservation Region 14 (BCR 14). This presents opportunity for the Refuge to contribute to the recovery efforts of the NFWI and to the goals of national plans indicating that woodcock is a priority species of concern. One of the goals of the NFWI is to establish woodcock demonstration areas to provide examples of proper woodcock management and provide research and monitoring efforts. Creating such demonstration areas on the Refuge will also provide the opportunity for education and interpretation at the Refuge, and thus will further contribute to the goals of the Service and Conte Refuge purpose #6.

IV. Background

National Wildlife Refuge System

The Conte Refuge is part of the National Wildlife Refuge System (System), the world's largest and most diverse collection of lands set aside specifically for wildlife. The System includes 546 refuges and encompasses more than 97 million acres of fish and wildlife habitat. The System is administered by the Service, an agency within the Department of the Interior. The Service's primary responsibilities are for migratory birds, endangered species, freshwater and anadromous fish, and certain marine mammals.

The National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57) established wildlife conservation as the fundamental mission of the System. The Refuge Improvement Act specifically states: the mission of the National Wildlife Refuge System is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans." The Refuge Improvement Act requires maintenance of the Refuge System's biological integrity, diversity, and environmental health; and monitoring of the status and trends of refuge fish, wildlife, and plants. All uses of a national wildlife refuge are subjected to a determination of compatibility. A compatible use is one which, in the sound professional judgment of the Refuge Manager, will not materially interfere with or detract from fulfillment of the Refuge System mission, or the purposes for which the refuge was established. Furthermore, when making refuge management decisions, the Refuge Improvement Act requires effective coordination with other Federal agencies, state fish and wildlife or conservation agencies, and refuge neighbors.

Location of the Nulhegan Basin Division

The Refuge is located in Essex County in the Northeast Kingdom area of Vermont. The Refuge is part of the 132,000-acre parcel formerly owned by Champion International Company and known as the Champion Lands. That parcel now consists of the Refuge (26,300 acres north of Vermont Route 105), the 22,000-acre West Mountain Wildlife Management Area (WMA) owned by the Vermont Agency of Natural Resources, and the 84,000 acres of Essex Timber Company lands. The Refuge lies in the crater-like Nulhegan Basin within the watersheds of the Nulhegan and Connecticut Rivers. It is located approximately 7 miles east of Island Pond and 4 miles west of the village of Bloomfield, Vermont (and the Connecticut River) (Figure 1). The 2,000-acre Wenlock WMA and the West Mountain WMA adjoin the Refuge on its south boundary; the 4,800 McConnell Pond tract of The Conservation Fund borders the

Refuge to the southwest. The remainder of the Refuge is surrounded by Essex Timber Company lands. The Refuge lies within the Wildlife Management Unit E and Watershed Management Unit 16 as designated by the Vermont Fish and Wildlife Department.

History and Purpose of the Refuge

The Conte Refuge was authorized by the Silvio O. Conte National Fish and Wildlife Refuge Act (Public Law 102-212) in 1991. To date the Conte Refuge has operated as set forth in the Selected Alternative (Alternative D) of the Final Environmental Impact Statement (U.S. Fish and Wildlife Service 1995). The purposes for the Conte Refuge, as stated in the Act are:

(1) to conserve, protect and enhance the Connecticut River populations of Atlantic salmon, American shad, river herring, shortnose sturgeon, bald eagles, peregrine falcons, osprey, black ducks, and other native species of plants, fish, and wildlife;

(2) to conserve, protect and enhance the natural diversity and abundance of plant, fish and wildlife species and the ecosystem upon which these species depend within the Refuge;

(3) to protect species listed as endangered or threatened, or identified as candidates for listing, pursuant to the Endangered Species Act of 1973 as amended (16 U.S. 1531 et seq.);

(4) to restore and maintain the chemical, physical and biological integrity of wetland and other waters within the Refuge;

(5) to fulfill the international treaty obligations of the United States relating to fish and wildlife and wetlands; and

(6) to provide opportunities for scientific research, environmental education, and fish and wildlife oriented recreation and access to the extent compatible with the other purposes stated in this section.

An EA was prepared to discuss and analyze the impacts of fee-simple acquisition of 26,000 acres in the Nulhegan Basin of Essex County, Vermont (U. S. Fish and Wildlife Service 1999). The Refuge was established on July 21, 1999 to provide long-term protection for important migratory bird habitat, habitat for rare species and plant communities, important fisheries habitat, and valuable wetlands. The partnership to protect 132,000 acres of the Champion Lands included the Vermont Agency of Natural Resources, The Conservation Fund, Vermont Land Trust, the Vermont Housing and Conservation Board, The Nature Conservancy, Essex Timber Company, the Freeman Foundation, and the Richard King Mellon Foundation. Additionally, support was gained from local governments, numerous conservation and sportsmen's organizations, local landowners, and citizens. Approximately 16,000 acres of the Refuge was purchased through the Migratory Bird Conservation Act of 1929 and the remaining lands (approximately 10,000 acres) were purchased through authority of the Land and Water Conservation Fund Act of 1965. The Refuge has been operating as set forth by Alternative 2 (Preferred Alternative) of the Final EA (U. S. Fish and Wildlife Service 1999).

V. Scoping

A press release announcing the intent of the Service to prepare a woodcock habitat management demonstration project and the call for agency and public input was delivered electronically to *The New Hampshire News and Sentinel*, *The Coos County Democrat*, *The Caledonian Record*, *The Barton Chronicle*, and *The Newport Daily Express* on September 25, 2006. The release was re-sent to the *Newport Daily Express* on September 26, 2006 via fax due to an email error. In addition a public notice was placed in *The Caledonian Record* on September 21, 2006 and the *New Hampshire News and Sentinel* and *The Barton Chronicle* on September 25, 2006. The public input period ended October 9, 2006. Input also was requested from professional wildlife biologists that possessed pertinent knowledge and experience from various wildlife management agencies in the Northeast, and from representatives of the Refuge's adjacent landowner agencies including the Vermont Fish and Wildlife Department, Essex Timber Company, The Conservation Fund, and Vermont Electric Company. Two comments were received in favor of conducting woodcock management on the Refuge during the initial input period.

VI. Alternatives

These alternatives reflect various management scenarios that were developed based on: issues identified through internal and external scoping, existing State and Federal regulations, Service policies and guidance, purposes established for the Conte Refuge, existing wildlife populations and habitats, seasonal requirements, principles of wildlife ecology and management, and administrative, fiscal, and safety considerations. In the Service's opinion, these three alternatives represent a reasonable range as required by the National Environmental Policy Act of 1969.

Three alternatives were identified during the planning process:

A. Alternative 1: No habitat manipulation (No Action/Status Quo)
Under this alternative, a woodcock habitat management demonstration project would not be pursued, no habitat manipulation will occur, and the habitats in the subject area will be left to mature.

B. Alternative 2: Non-commercial treatment
Under this alternative, a non-commercial treatment will be performed in accordance with the treatment schedule (Table 1) and treatment locations outlined on each management demonstration unit divisional map (Figure 3, Figure 4, and Figure 5). This method utilizes machinery to shred the vegetation as it stands reducing the treatment area to an open condition completely void of woody vegetation or slash buildup. The Brontosaurus chipper and Hydro-Ax are two examples of machinery often used to perform vegetation shredding operations. This method is considered non-commercial because forest products will not be recovered from the treatments and sold on the open market.

Under this alternative, the contractor(s) will be responsible for:

- Shredding all vegetation within each treatment area in accordance with the treatment schedule and treatment locations outlined on each management demonstration unit divisional map (Figure 3, Figure 4, and Figure 5)
- Maintenance of all equipment to ensure hazardous waste, such as oil and hydraulic fluid, does not come in contact with the ground, and if it does, clean-up will commence immediately and be in accordance with federal hazardous waste procedures.
- Removing any and all debris from equipment by means of a pressure washer, or similar equipment, prior to transport on to the Refuge to prevent introduction of invasive species.
- Road maintenance, such as snow plowing or general repair that is needed to facilitate harvesting equipment ingress and egress.

C. Alternative 3: (Preferred Alternative) – Commercial harvest combined with Non-commercial treatment

Under this alternative, a commercial harvest will be conducted to remove vegetation that can be processed into a merchantable product. This will be followed by non-commercial treatment of the remaining vegetation. Both treatments will be performed in accordance with the treatment schedule and treatment locations outlined on each management demonstration unit divisional map (Figure 3, Figure 4, and Figure 5). A combination of the two methods is preferred but unfavorable circumstances beyond our control such as merchantability, timing, weather, site conditions, and operator availability can hinder joint utilization of both methods.

The commercial harvest will consist of harvesting trees, pulling the harvested trees to landing areas, processing the trees into wood chips, and delivering the wood chips to markets. This method is considered a commercial operation because merchantable forest products will be produced from the vegetation that is removed during the treatment. This method typically utilizes multiple types of machinery such as a feller buncher, skidder, loader, and a chipper. During this treatment, all woody stems 2-inch in diameter and larger will be removed.

Following the commercial harvest, the non-commercial treatment will be used to remove remaining vegetation that can not be harvested commercially, such as in the woodcock feeding areas where the dominant vegetation is speckled alder (*Alnus rugosa*). Speckled alder is considered non-merchantable because it is a woody shrub that does not typically exceed 2-inches in diameter and often binds harvesting and chipping equipment due to its tangled growth characteristics. This method utilizes machinery to shred the vegetation as it stands reducing the treatment area to an open condition completely void of woody vegetation or slash buildup. The Brontosaurus chipper and Hydro-Ax are two examples of machinery often used to perform vegetation shredding operations. This method is considered non-commercial because forest products will not be recovered from the treatments and sold on the open market.

The use of a feller buncher and skidder increases the potential for ground disturbance and will be mitigated by operating on frozen ground to ensure rutting is avoided or minimized. A U. S. Fish and Wildlife Service sale administrator will be responsible for monitoring temperature and ground condition at least every other day while the sale is active to ensure ground (site) conditions are suitable for operations.

Under this alternative, the contractor(s) will be responsible for:

- Removing and or shredding all vegetation within each treatment area in accordance with the treatment schedule and treatment locations outlined on each management demonstration unit divisional map (Figure 3, Figure 4, and Figure 5)
- Maintenance of all equipment to ensure hazardous waste, such as oil and hydraulic fluid, does not come in contact with the ground, and if it does, clean-up will commence immediately and be in accordance with federal hazardous waste procedures.
- Removing any and all debris from equipment by means of a pressure washer, or similar equipment, prior to transport on to the Refuge to prevent introduction of invasive species.
- Road maintenance, such as snow plowing or general repair that is needed to facilitate harvesting equipment and trucking ingress and egress.
- Returning roads used to access management demonstration units to a condition that is considered as good as or better than they were prior to operational use.
- Employing Best Management Practices at all times to avoid, minimize or reduce impacts to the soil, streams, or residual vegetation.

- Removing all slash and logging debris from log landings, and leaving log landings in an acceptable condition at the completion of the contract
- Creating water control features such as water bars or run off ditching, where warranted, on all skid trails used during treatment operations.
- Submitting all volume reports at the completion of the contract.

VII. Affected Environment

The affected environment of northeastern Vermont, with specific reference to the Nulhegan Basin (Basin), is discussed in detail in Chapter 3 of the Refuge EA (U.S. Fish and Wildlife Service 1999).

1. Physical Resources

Climate
The average temperature of the area is approximately 42 degrees Fahrenheit, with high temperatures in the 90 degree range and low temperatures around 30 degrees below zero. The average frost free period is 100 days. Annual snowfall measures between 80 and 100 inches. Snow depths average 25 inches and duration of continuous snow cover averages more than 100 days (Alexander and Horton 1986).

Geology
The Basin was formed when a pool of magma formed within existing metamorphic rock. The magma cooled into a relatively soft granitic rock called quartz monzonite. Once erosion wore away the cap of metamorphic rock, the softer monzonite eroded more rapidly than the surrounding metamorphic rock. This resulted in a relatively flat circular interior area, roughly 10 miles in diameter, surrounded by hills. Sand and gravel were later deposited in the bottom of the Basin by melting glaciers (Thompson 1989). Elevations on the Refuge range from approximately 1,000 feet to 2,800 feet above sea level.

Soils
No detailed soil survey has been performed for this area. However, soils on upland sites are generally sandy loam spodosols, with a thick organic soil horizon of low pH. Some kame and outwash deposits exist that are very sandy/gravely. Wetland sites have peaty soils (Loso et al. 1996).

Soils within the management demonstration units are generally moist resulting from poor to moderate drainage conditions. Topography is predominately flat but some gentle sloping does occur through slight dips and rises in the landscape. Areas that support alder are generally wetter than areas supporting woody vegetation, meaning areas within the demonstration units categorized as “Feeding” will be saturated for extended periods of time.

Lakes and streams
Three of the four major tributaries of the Nulhegan River -- the North, Yellow, and Black Branches -- run south through the Refuge. A network of smaller streams feed these branches. The main course of the Nulhegan River runs adjacent to the south boundary of the Refuge. The 68-acre Lewis Pond is located in the northwest portion of the Refuge.

Refuge infrastructure
The land that now comprises the Refuge has been in private ownership as commercially-managed forest for over a century. Approximately 40 miles of gravel roads and 17 miles of woods roads occur on the Refuge. The majority of the gravel roads become snowmobile trails as part of the Vermont Association of Snow Travelers (VAST) statewide trail network the third week of December each year. The VAST trails on the Refuge are maintained by the Brighton Snowmobile Club and the Canaan Border Riders. Five wooden bridges traverse Refuge streams. A 450kV high voltage direct current transmission line,

constructed in 1986 on a 200-foot wide corridor owned by Vermont Electric Transmission Company, Inc., runs north-south through the entire length of the Refuge on the east side. The St. Lawrence and Atlantic Railroad runs through or adjacent to the southeastern boundary of the Refuge. Fifty-six privately-owned cabins originally existed on Refuge land on lots leased from the Service when the Refuge was established. Since 1999, the Service has purchased 21 cabins, removed four cabins, and 35 remain in private ownership. Five inholdings totaling approximately 327 acres exist within the Refuge boundary. They are held by The Nature Conservancy (79 acres), the town of Bloomfield (84 acres), the Trustees of the Diocese of Vermont (84 acres), and two are Essex County Lease Lots (approximately 40 acres each). The Refuge headquarters and visitor contact station is located in Brunswick, Vermont (approximately 10 miles east of Island Pond). A five bedroom quarters building and storage barn are located directly adjacent to the headquarters building. A 200-foot interpretive boardwalk is located on Four Mile Road of the Refuge in the area known as Mollie Beattie Bog. Three interpretive kiosks are located at the main entrances of the Refuge and an overlook is located at the headquarters site and at the end of Lewis Pond Overlook road. About 15 year-round residences and numerous seasonal cabins are located within one mile of the Refuge boundary, primarily along Vermont Route 105.

2. Biological Resources

Vegetation

Located just a few miles south of the Canadian border, the Basin's vegetation most closely resembles that of the northern Appalachian Mountains, interspersed with elements of the boreal forest to the north. The Refuge is predominantly forested with natural openings small and most frequently associated with wetlands (e.g., bogs and beaver flowages), although windthrow events have temporarily created larger openings. The most conspicuous openings in the landscape are a result of clearcuts ranging in approximate size from 10 to more than 100 acres. Shrublands, primarily dominated by speckled alder, are restricted to poor drained areas, small seepage zones, and wide alluvial stretches of the Nulhegan River and its principal tributaries.

Northern hardwood forest, dominated by sugar and red maple (*Acer saccharum, A. rubrum*), american beech (*Fagus grandifolia*), and yellow and paper birch (*Betula alleghaniensis, B. papyrifera*), cloak the mountains of the Basin rim and the larger hills of the Basin interior. Notably absent in the Basin, are any oaks another indicator of the more northern character of the forest. Spruce-fir forest covers large areas of the Basin bottom. Red and black spruce (*Picea rubens, P. marianna*) and balsam fir (*Abies balsamea*) are the principal trees in these forests, which cover both wetlands on shallow to deep peat soil deposits, and adjacent kame and till soils of the shallow valleys, flats, and low hills. Another northern forest conifer, white spruce (*P. glauca*), occurs sparingly in flood plains and certain swamps. In upland situations, successional stages of these spruce-fir forests can be dominated by quaking and bigtooth aspen (*Populus tremuloides, P. grandidentata*), red maple and paper birch. Tamarack (*Larix decidua*), Northern white cedar (*Thuja occidentalis*) and black ash (*Fraxinus nigra*) occur commonly in the Basin, although restricted to wetlands more heavily influenced by groundwater.

Within the proposed management demonstration units the vegetation is 25-35 years of age and is a result of clearcut harvesting that occurred during the late 1970's and early 1980's, while under previous ownership. This style of even-aged management has resulted in predominately mixed intolerant hardwood species (e.g., aspen (*Populus spp.*), paper and gray birch (*Betula populifolia*), choke cherry (*Prunus virginiana*) ranging from saplings to pole size stems (1-9" stem diameter). Speckled alder is sparsely scattered in the understory with denser concentrations directly adjacent to wooded areas where soils are more saturated.

Rare plants of Vermont found in the Refuge include white-fringed orchid (*Habenaria blephariglottis*), bog sedge (*Carex exilis*), shining rose (*Rosa nitida*), drooping bluegrass (*Poa saltuensis*), ligonberry

(*Vaccinium vitis-idaea*), and the State-endangered auricled twayblade (*Listera auriculata*). Most of these plants are associated with bogs and other peatlands common in the Refuge, and are more common to the north of the Basin. Peat mosses of the genus *Sphagnum* are a predominant groundcover in the numerous swamps and bogs of the Refuge. No plant species are currently known to occur on the Refuge that are federally-listed as endangered or threatened, or are proposed for federal listing. The state-endangered auricled twayblade (*Listera auriculata*) exists on the Refuge but is not found in any of the proposed demonstration units.

Wildlife

The Refuge provides habitat for a wide diversity of vertebrate and invertebrate fauna. The primary species that inhabit the Refuge are white-tailed deer (*Odocoileus virginianus*), black bear (*Ursus americanus*), moose (*Alces alces*), snowshoe hare (*Lepus americanus*), turkey (*Meleagris gallopavo*), ruffed grouse (*Bonasa umbellus*), spruce grouse (*Dendragapus canadensis*), coyote (*Canis latrans*), red squirrel (*Tamiasciurus hudsonicus*), fisher (*Martes pennanti*), bobcat (*Lynx rufus*), porcupine (*Erethizon dorsatum*), raptors, amphibians and reptiles, and many migratory and resident song birds. A partial list of vertebrate species, by common and scientific names, that occur on the Refuge or in the immediate vicinity is presented in Appendix III. The Refuge provides nesting and migratory habitat for numerous migratory bird species including woodcock, waterfowl, marsh and wading birds, shorebirds, raptors, and neotropical migrants. The Basin contains the largest deer wintering area in the state, about 15,000 acres, the majority of which is located on the Refuge. Some of the best habitats for moose and bear in Vermont exist in Essex County, including Refuge lands. The Refuge was designated part of the State's largest Important Bird Area by the Vermont chapter of The Audubon Society in 2001.

Threatened and Endangered Species:

No federally-listed or proposed wildlife species currently are known to occur on the Refuge; therefore, this alternative would not affect any listed species. Although the Canada lynx (*Lynx Canadensis*) was classified as a State-Endangered species in Vermont in 1987, and federally-listed as Threatened in 2000, it is the opinion of the Service and Vermont Fish and Wildlife Department that lynx do not currently inhabit Vermont, nor the southern Quebec Province in the vicinity of the international border about 6.5 miles to the north of the Refuge lands (M. Amaral, USFWS, Senior Endangered Species Specialist, and K. Royar, VFWD Furbearer Team Leader, personal communication). Only four verifiable records of lynx occurrence in Vermont are available, the most recent of which occurred in 1965; none were from the Northeast Kingdom area (Ruggiero et al. 2000). The most recent and closest documented occurrence of lynx in the area was in the vicinity of Jefferson, NH in 2005, approximately 30 miles straight line distance from the Refuge. If lynx are discovered on the Refuge, the compatibility of woodcock management demonstration units as conducted under the preferred alternative will need to be reevaluated to determine if any negative impacts exist.

Woodcock:

The Refuge is considered one of the most suitable public land areas for woodcock management in BCR 14. Woodcock migrating to their summer breeding grounds require suitable habitat conditions for courtship, nesting and breeding cover, roosting fields, and feeding areas. These habitats should be directly adjacent, or within reasonable proximity to each other. Woodcock typically use open areas, resulting from recent field abandonment or timber harvesting, for courtship and roosting. Areas in an early successional stage where sparse shrubs and regeneration are present, and herbaceous cover does not dominate, are often used for roosting. Regeneration and sapling stages of successional development are typically used for nesting, brood rearing, and feeding. Areas dominated by alder, on moist fertile ground capable of sustaining earthworms, are excellent feeding cover.

Spruce Grouse:

The only State-listed endangered wildlife species found on the Refuge is spruce grouse. In fact, Vermont's only viable breeding population of spruce grouse is mainly located on the Refuge. In this region, their preferred habitat is multi-structured lowland areas that have a dominance of spruce, balsam fir, and tamarack. Their diet is dependent on the availability of needles from these preferred tree species; especially in the fall and winter when other food sources such as blueberries (*Vaccinium spp.*) and insects are not available (Alexander et al 1993). None of the proposed demonstration units contains typical spruce grouse habitat.

Deer Wintering Areas:
All three management demonstration units are either directly adjacent or within the historical "Nulhegan Deer Winter Area" (NDWA) boundary, as defined by the State of Vermont, but the areas that will be treated are not within current functional shelter, where the deer will most likely be located. The NDWA is the largest in the State of Vermont and is recovering from forest harvesting that severely reduced the functionality of the NDWA, conducted under the previous ownership. One of the most critical components of the NDWA is functional shelter. Functional shelter as defined by the state of Vermont is "softwood cover at least 35 feet tall, with at least 70% crown closure" (Reay et al.1990).

3. Socio-economic Resources

Population
Vermont is the most rural state in the nation according to the 1990 Census (Glass et al. 1995). Vermont's Essex County had an estimated 6,602 residents in 2005 according to U.S. Census Bureau data. This represents 1.1% of Vermont's population occupying 7% of the state's land area (Vermont Department of Employment and Training 1998). The Connecticut River watershed portion of Essex County, in which the Refuge is located, had the second lowest population density of all the counties in the entire watershed (U.S. Fish and Wildlife Service 1995). The Connecticut River watershed of Vermont and New Hampshire has experienced low population growth compared to the remainder of those states, probably related to lack of job opportunities (Adams 1995).

Communities
In Essex County, Vermont, four towns contain Refuge lands. These towns are Bloomfield, Brunswick, Ferdinand, and Lewis. Based on 2000 U.S. Census Bureau data, the total population of the towns that contain Refuge lands in Essex County is 391 residents (261 in Bloomfield, 107 in Brunswick, 23 in Ferdinand, and 0 in Lewis). The acreage of the towns that contain Refuge lands are 101,233 acres (25,740 total acres in Bloomfield, 16,110 in Brunswick, 33,989 in Ferdinand, and 25,394 in Lewis). Lewis and Ferdinand are unincorporated towns; a Board of Governors acts as the government for these towns. Bloomfield and Brunswick have Boards of Selectmen that serve as the governing bodies.

Economy
For Essex County alone, employment is reported as follows: Manufacturing 29.8% (882 jobs), Trade 12% (355 jobs), Services 5%, Contract Construction 5.4% (160 jobs) Transportation and Utilities 4.8% (142 jobs) Agriculture, Forestry and Fishing 6.2% (185 jobs), Finance, Insurance and Real Estate 1.8% (53 jobs), Education, health, social services 19.3% (571 jobs), Professional, scientific, management, administrative, waste management 3.3% (98 jobs), and Information 0.8% (23 jobs) (U.S. Census Bureau 2000). A total of 63.2% of the counties population (16 years and over) are employed. The median household income for Essex County according to 2003 U.S. Census estimates is between $29,295 and $33,214. Essex County has the lowest per capita personal income of the Connecticut River watershed counties (U.S. Fish and Wildlife Service 1995) and in the state (Vermont Department of Employment and Training 1998), a result of the low number of wage-earners relative to the total county population. The unemployment rate in Essex County in 2000 was 27% (U.S. Census Bureau 2000).

Recreational Use/Natural Resource Utilization

The Refuge is a popular area for hunting, fishing, wildlife observation, and wildlife photography. Under the previous ownership, no limits were placed on the number of recreationists that used these lands; however, visitation counts were not performed. Much of the recreational use of the Refuge, particularly hunting, is based out of leased cabins, but day use is frequent on a year-round basis, particularly for hunting and fishing. Major wildlife species of interest to the public for observation or harvest on the Refuge include deer, bear, moose, snowshoe hare, ruffed grouse, neotropical songbirds, furbearers, and brook trout. Snowmobiling on designated trails is currently allowed on the Refuge to facilitate winter access in support of priority public use activities, and to conduct management programs such as wildlife and habitat inventory work and law enforcement. Snowmobiling is confined to designated VAST trails, which are generally open the third week of December to about mid-March to mid-April every year. To prevent excessive damage to Refuge roads, public travel by motor vehicle is prohibited during the spring mud season. During this period, which generally is from snow breakup to late May, roads on the Refuge, West Mountain WMA, and Essex Timber are closed to vehicular access.

Archaeological Sites and Historic Structures

In 1999, the Archaeology Research Center at the University of Maine, Farmington completed a Phase Ia background study of the former Champion lands, including the Nulhegan Basin Division – "People Land and History: The Cultural Landscape of the Nulhegan District." The study shows known historic archaeological sites on a map, none of which are located in the proposed management demonstration units. The Nulhegan River is considered likely to have as yet undiscovered historic sites, and the north end of the Refuge might have historic sites on that River's upper reaches, according to the study. There is no specific information about the Refuge area contained within the proposed management demonstration units, however, that makes them more likely to contain historic archaeological sites. There are no historic structures in the proposed management demonstration units. There are no known prehistoric sites on the Refuge. The study provides maps of potential Native American site sensitivity, and much of land in the three proposed management demonstration units is potentially high sensitive, likely to contain Native American archaeological sites. Some of the criteria for determining site sensitivity are:

- Proximity to wetlands or surface water
- Proximity to stream confluences, waterfalls and rapids
- Proximity to heads of draws, passes, drainage divides, and lithic outcrops
- Location on kames, alluvial terraces, flood plains

Proposed management demonstration units for the project contain combinations of these and other criteria, and contain potentially low, moderate, and highly sensitive land.

VIII. Environmental Consequences

A. Alternative 1: No manipulation (No action)

1. Physical Resources

Soils:
Under this alternative, soils will not be displaced or altered.

Lakes and streams
Under this alternative, streams and waterways will not be displaced or altered.

Refuge infrastructure
Under this alternative, Refuge roads will not be impacted from ingress and egress of equipment used to conduct treatment, or from increased vehicular traffic in route to visit the demonstration units.

2. Biological Resources

Vegetation
If early successional habitat is not created within the demonstration units, through human-caused activities or natural means, vegetation will continue to develop into a mature forested state. Forest succession is the natural progression of forest vegetation and structure as it develops over time. No vegetation manipulation would result in the continuation of forest succession. The current vegetative composition is predominantly comprised of shade intolerant species (e.g., aspen, paper and gray birch, choke cherry) which have relatively short life spans. As individual stems expire, moderately shade tolerant species (e.g., yellow birch, balsam fir, red maple) will eventually dominate the composition. This process will continue until a late successional stage of development has been reached, which consists of predominately shade tolerant species (e.g., sugar maple, american beech, red spruce) commonly referred to as climax species (DeGraaf et al 2005). If no significant disturbance disrupts this progression a multi-aged, multi-structured forest will likely prevail in a few hundred years.

As the forest progresses through succession, shade intolerant species will be reduced, and likely, removed from the vegetative composition. It can be difficult to establish regeneration of some early successional species, such as poplar, once that species has been removed through natural development, thus limiting the ability to manipulate habitat to achieve specific habitat conditions in the future, such as managing for woodcock or ruffed grouse.

Very little early successional habitat exists on the Refuge, the landscape, or within the region. Soft mast such as choke cherry, wild strawberry (*Fragaria virginiana*), blueberry, and raspberry (*Rubus spp.*) that are very common components of early succession are less available as a wildlife food source as a forest matures.

Wildlife
Under this alternative, the forest habitat would mature and species associated with early successional habitat such as woodcock, snowshoe hare, ruffed grouse, and a variety of migratory songbirds would not benefit. The proposed demonstration units are of such a small acreage in comparison to the entire Refuge and similar habitat types in and around the Refuge, that any positive effect would be negligible for wildlife that utilize the more mature forest habitat conditions that would result under this alternative.

Threatened and Endangered Species:
No federally-listed or proposed plant or wildlife species currently are known to occur on the Refuge

therefore, implementation of this alternative would not affect any listed species.

Woodcock:
Under this alternative habitat conditions that woodcock require will not be created. The forest will continue to mature, which will further discourage woodcock use of the proposed demonstration units.

Spruce Grouse:
The proposed woodcock management demonstration units are predominately hardwood, which is not a preferred habitat component of the spruce grouse. It is possible that natural development of the units could eventually convert the hardwood composition to softwood dominance but due to the relatively young age of the current vegetation and lengthy process of successional development, the demonstration units would not likely develop into habitat preferred by spruce grouse until far into the future (e.g., over 200 years), if at all.

Deer Wintering Areas:
The proposed woodcock management demonstration units are predominately hardwood which is not used by wintering deer for shelter, and is too advanced to be considered available browse. It is possible that natural development of the units could eventually convert the hardwood composition to softwood dominance, but due to the relatively young age of the current vegetation and lengthy process of successional development, the demonstration units will not likely develop into habitat preferred by wintering deer until far into the future, if at all.

Monitoring
Under this alternative, woodcock singing ground surveys will not be altered from the current protocol (Figure 6). The current protocol accounts for presence or absence of woodcock by recording "peenting" sounds often made by the male woodcock during their evening courting ritual in the spring. There are six survey transects strategically placed along roads within the Refuge. Some of these transects are directly adjacent to the management demonstration units.

A habitat monitoring protocol does not currently exist for the Refuge and under this alternative, no new habitat monitoring survey will be developed that specifically targets each woodcock management demonstration unit.

3. Socio-economic Resources

Economy
Under this alternative, revenues associated with operations will not be introduced to the local economy. Commercial and non-commercial treatments used to accomplish management goals and objectives create opportunity for local contractors to generate income. Under this alternative, additional income for local contractors will not be possible and the trickling down of revenues through direct and indirect expenditures will not occur.

Recreational Use/Natural Resource Utilization
Under this alternative, the habitat and management conditions needed to provide demonstration of proper woodcock habitat management, and create opportunity for many facets of education and interpretation related to wildlife management, will not be accomplished. As the forest continues to mature, hunting, photography, and observation of migratory and resident wildlife associated with target conditions will decrease. Due to much greater abundance of similar mature habitat available elsewhere on the Refuge, numbers of wildlife attracted to the more mature habitat resultant in these areas is not expected to provide greatly increased benefit for recreationists.

Use of the infrastructure will not be limited through temporary road or trail closures, thus negating any inconvenience or confusion by visitors accessing the Refuge via snowmobile, or other vehicle to specific destinations or adjacent lands.

Archaeological Sites and Historic Structures
Under this alternative, no ground disturbance will occur, nor will the threat of ground disturbance occur due to the absence of equipment that would only be used for active manipulation, therefore this "No Action" alternative will not affect archaeological sites or historic structures.

B. Alternative 2: Non-commercial treatment

1. Physical Resources

Soils
Dry or frozen conditions need to exist or occur to ensure ground disturbance is avoided or kept at a minimum. The equipment used to perform the treatments will be required to have sufficient track or tire surface area to ensure machinery weight is distributed evenly, and ground disturbance is avoided or kept at a minimum. This will allow treatment operations to be conducted during dry or frozen conditions with minimal impact to the forest floor throughout the management demonstration units.

By shredding the vegetation as it stands, discarded tree fragments are scattered among the landscape. This often provides the soil with greater resilience to rutting from machinery. Tracked machinery such as an excavator is often the machinery used with the brontosaurus chipping head. The combination of tracked machinery and tree mulch creates the least amount of risk of excessive soil disturbance over a greater variability in soil conditions. This provides greater flexibility during the operational window of December through January because dry conditions are as favorable as frozen conditions with very little disturbance risk.

Vegetative composition and health indicate the soils have an adequate amount of nutrients for woody stem development, so post manipulation seed germination and tree development is not expected to be hindered from a lack of soil nutrients, and decomposition of debris from the treatment will contribute to nutrient cycling. Research does indicate that an increase in soil leaching of trace metals may occur immediately after an area is devoid of vegetation, but quick reestablishment of vegetation will help mitigate impacts that may result from this activity.

Lakes and streams
None of the rivers and streams that are adjacent to the management demonstration units flow into any lakes or ponds, and none of the units abut or are adjacent to any lakes or ponds, therefore no direct or indirect impacts will be incurred on any lakes or ponds. However, some effects may be incurred by the rivers and streams that are adjacent to the management demonstration units. Research indicates that after clearcutting has occurred an increase in trace metals can occur in stream water from leaching of soils. Due to the size of the treatment areas in relation to the area of the watershed, the impact is negligible and will not alter aquatic ecosystems.

In locations where the treatments approach stream banks, protective buffer strips will be left in accordance with the Vermont "Acceptable Management Practices for Maintaining Water Quality" (Appendix IV). Light or no harvesting within the protective strips will result in continuous vegetative cover which will maintain streambank stability, maintain shade, maintain connectivity of riparian corridors, and prevent stream sedimentation from surface run-off (Department of Forests, Parks and Recreation, 1987). No increase in temperature of stream water is expected to result from the treatments.

Refuge infrastructure
Under this alternative, Refuge infrastructure will be used for ingress and egress of equipment, and an increase in vehicular traffic in route to visit the demonstration units is expected. The roads have been built to a standard that can support such use, and any damage that results from equipment ingress and egress will be repaired by the contractor.

2. Biological Resources

Under this alternative, there is potential for some disturbance or impacts to biological resources, but the small number of acres being treated during any one year, and total operations over the 20-year project, is negligible in relation to the 26,300 acres of Refuge land and the amount of similar habitat that occurs on and adjacent to the Refuge.

Vegetation
Under this alternative, four stages of vegetative development will be created and maintained. In addition, some areas have been designated to be maintained in an open, partially shrubby condition. A patch work design of clearcut harvests on 5-year cycles will result in an open-initiation stage, a young-shrubby-regenerating stage, a seedling-sapling stage, and a sapling-pole stage. The use of mowing to maintain roosting and courtship areas will maintain designated areas in an open-partially shrubby stage.

The current vegetation is predominately mixed shade-intolerant hardwood species and the resultant condition following the treatment will be similar to the silvicultural technique of clearcutting, and would be expected to promote continued hardwood regeneration. Typically after a treatment, in which an open-light condition is created, herbaceous vegetation such as spirea (*Spiraea spp.*), goldenrod (*Solidago spp*.), and mixed grasses will quickly re-establish the exposed forest floor. Within one to two growing seasons, this open-initiation stage condition will develop into a young-shrubby-regenerating stage dominated by shrubbery such as raspberry, hazelnut (*Corylus spp.*), and blueberry and woody stems will start to develop but in relatively low densities. Woody stems that typically regenerate in an open-light condition are shade-intolerant species such as poplar, cherry (*Prunus spp.*), and paper and gray birches, however in this Northern Appalachian region balsam fir may also be in the compositional mix. As time persists, the young-shrubby-regenerating stage will evolve into a seedling-sapling stage and eventually a sapling-pole stage, where woody stems are the dominant vegetation. Seedling-sapling and sapling-pole stages of development are typically characterized by a high number of woody stems per acre.

Wildlife
The primary species that inhabit the Refuge are white-tailed deer, black bear, moose, snowshoe hare, turkey, ruffed grouse, spruce grouse, coyote, red squirrel, fisher, bobcat, porcupine, raptors, amphibians and reptiles, and many migratory and resident song birds. There is some potential for a slight increase in vehicle collisions with wildlife due to increased traffic. However, due to the time of year, the layout/location of the units, and the short duration of the operation, little effect on resident wildlife in terms of direct and indirect mortality or undue disturbance or displacement is expected during the treatment operation. There is potential that black bear could be occupying a ground nest or excavation in a stump or root-wad, and could be displaced by these operations, but it is not likely because the current conditions within the management demonstration units are not prime den habitat. It is possible some reptile, amphibian, or invertebrate mortality may occur during treatment operations but due to the small scale of the project impacts to the population would be minor. Other species such as moose, snowshoe hare, ruffed grouse, and migratory song birds will be mutual benefactors from the habitat that is created through this project. Neo-tropical migrants will not be occupying these areas at the time of treatment.

Threatened and Endangered Species:
No federally-listed or proposed plant or wildlife species currently are known to occur on the Refuge;

therefore, implementation of this alternative would not affect any listed species. However, if any listed species should be discovered on the Refuge, further implementation of the woodcock management demonstration units would be reevaluated in terms of positive or negative impacts to such species and their habitats, and a Section 7 consultation would be performed.

Woodcock:
Woodcock are the primary benefactors of this project. Under this alternative the four critical habitat components that are required by woodcock will be created. Successful results from the treatments will likely lead to increased use of the management demonstration units by woodcock. The total acreage designated for this project will not have a measurable impact on national or regional populations, but proper woodcock management demonstration and implementation of these practices elsewhere will contribute to attaining the goals and objectives of the USFWS and the Northern Forest Woodcock Initiative (Appendix II).

Spruce Grouse:
The woodcock management demonstration units are predominately hardwood. Management of this habitat is intended to continually proliferate the presence of hardwood, which is not a preferred habitat component of the spruce grouse. Due to the relatively small scale of the demonstration units in comparison to other areas on the Refuge that are more suited for spruce grouse habitat, managing for woodcock objectives under this alternative during fall or winter, will not have a direct impact on spruce grouse.

Deer Wintering Areas:
The woodcock management demonstration units are predominately hardwood and therefore vegetative manipulation therein will not reduce the quantity or quality of the available functional softwood shelter, nor will it limit connectivity or potential future "deer yard" management. The woodcock management demonstration units are too far from current functional softwood shelter for the woody browse that develops from this project to be considered usable by wintering deer. Even though this is a 20-year project, the intent is to perpetually sustain the early successional conditions created during the 20-year term into the future, and because these units are within or directly adjacent to the NDWA, woody browse will be made available to wintering deer as functional softwood shelter develops within closer proximity, thus enhancing the potential browse availability for future wintering area habitat.

It is important to conduct operations during late fall and/or early winter to ensure the desired frozen ground, leaf-off conditions for woodcock habitat manipulation. During this time, abundance of deer utilizing the wintering area will vary depending on location and distribution of functional shelter and the severity of winter conditions. If an operation is conducted while deer are in the wintering area, any potential impacts on them will be minor due to the small scale and short duration of the operation, and distance from functional softwood shelter where wintering deer may congregate.

Monitoring
Under this alternative, a new woodcock singing ground survey will be initiated that specifically targets each woodcock demonstration unit. The current protocol accounts for presence or absence of woodcock by recording "peenting" sounds often made by the male woodcock during their evening courting ritual in the spring. Instead of conducting these surveys only along the current fixed roadside transects, survey points will be added within each woodcock demonstration unit to monitor future presence or absence of woodcock using these sites.

Under this alternative, a new habitat monitoring survey will be developed that specifically targets each woodcock demonstration unit. This protocol will be designed to target habitat variables specific to woodcock habitat suitability, such as woody stem and shrub composition and density, to determine if desired conditions are being achieved and ultimately if habitat objectives are being met.

3. Socio-economic Resources

Economy

To meet management demonstration unit objectives treatment will need to occur on 5-year cycles. Annual mowing of roosting and courtship areas will also need to occur. Based on current and expected future staffing, budget projections, and regional availability of machinery it is predicted most operations conducted on the Refuge will be through contractual agreements. A competitive bidding process will be used prior to awarding a contract. Essex County, Vermont has the lowest per capita family income of any county in the state. Revenues and direct and indirect expenditures resulting from contractual operations will contribute to the local economy of this area.

Recreational Use/Natural Resource Utilization

Under this alternative, operations will be performed during late fall and or early winter. Visitor use of the Refuge typically peaks during the fall hunting seasons that occur from October through November, and during snowmobile season. The VAST snowmobile trails open the 3rd Monday in December but use of the trail system is dependent on snow conditions. Use of the snowmobile trail system typically peaks in February, which is beyond the expected treatment application timeframe. The window that is targeted to conduct operations is December through January. This window provides a timeframe in which necessary operating conditions (frozen ground) are likely to occur and coincidentally minimizes impacts on other uses of the Refuge by occurring at the end of the deer and grouse hunting seasons, and at the beginning of the snowmobile season.

If conditions require work to be completed during snowmobile season, temporary trail closures will likely occur while equipment is being transported to and from each management demonstration unit. Transport is not expected to last more than a few hours at the beginning and end of each management demonstration unit treatment. Snowmobile trail closure will only be during transport of equipment to and from each management demonstration unit. Operations will not take place in the snowmobile trail, which will allow the trail to be opened once the transport of the equipment is complete. No use of the Refuge will be discontinued while operations are being conducted. Negative visitor impacts from inconvenience or confusion are expected to be minimal and temporary trail closures will ensure visitor safety during transport of equipment. Directional information will be provided to the public through various means such as press releases, signage, and verbal information. Any negative impacts to snowshoe hare hunters, wildlife observers/photographers, or trappers due to wildlife disturbance around the demonstration units will be minor and short term in duration.

Archaeological Sites and Historic Structures

Using the brontosaurus or hydro-ax is not expected to cause ground disturbance because of frozen or dry ground conditions, and will not affect potential archaeological sites.

C. Alternative 3: (Preferred Alternative) – Commercial harvest combined with Non-commercial treatment

1. Physical Resources

Soils

The use of a feller buncher and skidders increases the potential for ground disturbance and necessitates operating on frozen ground to ensure rutting is avoided or minimized. The equipment used to perform the treatments will be required to have sufficient track or tire surface area to ensure machinery weight is distributed evenly, and ground disturbance is avoided or kept at a minimum.

Vegetative composition and health indicate the soils have an adequate amount of nutrients for woody stem development, so post manipulation seed germination and tree development is not expected to be hindered from a lack of soil nutrients. However, the cumulative effects on nutrient cycling from operations utilizing whole tree removal is a concern of resource professionals, especially when vegetative rotation lengths are less than 40-years. The relatively modern ability to utilize tree fiber in its entirety has not allowed substantive studies to be conducted, and therefore information that provides explicit short term and long-term impacts, or methods to mitigate any impacts, is not yet available. Research indicates an increase in soil leaching of nutrients and trace metals can occur immediately after a clearcut, and it is likely that repeated whole tree removal could result in nutrient depletion over time, but quick reestablishment of vegetation combined with utilizing both treatment techniques (commercial and non-commercial) will help mitigate impacts that may result from this activity.

Lakes and streams

None of the rivers and streams that are adjacent to the management demonstration units flow into any lakes or ponds, and none of the units abut or are adjacent to any lakes or ponds, therefore no direct or indirect impacts will be incurred on any lakes or ponds. However, some effects may be incurred by the rivers and streams that are adjacent to the management demonstration units. Research indicates after clearcutting has occurred an increase in trace metals can occur in stream water from leaching of soils. Due to the size of the treatment areas in relation to the area of the watershed, the impact is negligible and will not alter aquatic ecosystems.

In locations where the treatments approach stream banks, protective buffer strips will be left in accordance with the Vermont "Acceptable Management Practices for Maintaining Water Quality" (Appendix IV). Light or no harvesting within the protective strips will result in continuous vegetative cover which will maintain streambank stability, maintain shade, maintain connectivity of riparian corridors, and prevent stream sedimentation from surface run-off (Department of Forests, Parks and Recreation, 1987). No increase in temperature of stream water is expected to result from the treatments.

Refuge infrastructure

Under this alternative, Refuge infrastructure will be used for ingress and egress of equipment, and an increase in vehicular traffic in route to visit the demonstration units is expected. Greater volume of equipment traffic will be experienced with this alternative compared to Alternative 2, but the roads have been built to a standard that can support such use, and any damage that results from equipment ingress and egress will be repaired by the contractor.

2. Biological Resources

Under this alternative, there is potential for some disturbance or impacts to biological resources, but the small number of acres being treated during any one year, and total operations over the 20-year project, is negligible in relation to the 26,300 acres of Refuge land and the amount of similar habitat that occurs on and off the Refuge.

Vegetation
Under this alternative, four stages of vegetative development will be created and maintained. In addition, some areas have been designated to be maintained in an open, partially shrubby condition. A patch work design of clearcut harvests on 5-year cycles will result in an open-initiation stage, a young-shrubby-regenerating stage, a seedling-sapling stage, and a sapling-pole stage. The use of mowing to maintain roosting and courtship areas will maintain designated areas in an open-partially shrubby stage.

The current vegetation is predominately mixed shade-intolerant hardwood species and implementation of this alternative is expected to produce vegetative results similar to those of the silvicultural technique of clearcutting, which would be expected to promote continued hardwood regeneration. Typically after a treatment, in which an open-light condition is created, herbaceous vegetation such as spirea, goldenrod, and mixed grasses will quickly re-establish the exposed forest floor. Within one to two growing seasons, this open-initiation stage condition will develop into a young-shrubby-regenerating stage dominated by shrubbery such as raspberry, hazelnut, and blueberry and woody stems will start to develop but in relatively low densities. Woody stems that typically regenerate in an open-light condition are shade-intolerant species such as poplar, cherry, and paper and gray birches, however in this Northern Appalachian region balsam fir may also be in the compositional mix. As time persists, the young-shrubby-regenerating stage will evolve into a seedling-sapling stage and eventually a sapling-pole stage, where woody stems are the dominant vegetation. Seedling-sapling and sapling-pole stages of development are typically characterized by a high number of woody stems per acre.

Wildlife
The primary species that inhabit the Refuge are white-tailed deer, black bear, moose, snowshoe hare, turkey, ruffed grouse, spruce grouse, coyote, red squirrel, fisher, bobcat, porcupine, raptors, amphibians and reptiles, and many migratory and resident song birds. There is some potential for a slight increase in vehicle collisions with wildlife due to increased traffic. However, due to the time of year, the layout/location of the units, and the short duration of the operation, little effect on resident wildlife in terms of direct and indirect mortality or undue disturbance or displacement is expected during the treatment operation. There is potential that black bear could be occupying a ground nest or excavation in a stump or root-wad, and could be displaced by these operations, but it is not likely because the current conditions within the management demonstration units are not prime den habitat. It is possible some reptile, amphibian, or invertebrate mortality may occur during treatment operations but due to the small scale of the project impacts to the population would be minor. Other species such as moose, snowshoe hare, ruffed grouse, and migratory song birds will be mutual benefactors from the habitat that is created through this project. Neo-tropical migrants will not be occupying these areas at the time of treatment.

Threatened and Endangered Species:
No federally-listed or proposed plant or wildlife species currently are known to occur on the Refuge; therefore, implementation of this alternative would not affect any listed species. However, if any listed species should be discovered on the Refuge, the compatibility of woodcock demonstration units would need to be reevaluated in terms of positive or negative impacts to such species and their habitats, and a Section 7 consultation would be performed.

Woodcock:
Woodcock are the primary benefactors of this project. Under this alternative the four critical habitat components that are required by woodcock will be created. Successful results from the treatments will likely lead to increased use of the management demonstration units by woodcock. The total acreage designated for this project will not have a significant impact on national or regional, populations, but proper woodcock management demonstration and implementation of the practices elsewhere will contribute to attaining the goals and objectives of the USFWS and the Northern Forest Woodcock

Initiative (Appendix 2).

Spruce Grouse:
The woodcock management demonstration units are predominately hardwood. Management of this habitat is intended to perpetuate the presence of hardwood, which is not a preferred habitat component of the spruce grouse. Due to the relatively small scale of the demonstration units in comparison to other areas on the Refuge that are more suited for spruce grouse habitat, managing for woodcock objectives under this alternative during fall or winter, will not have a direct impact on spruce grouse.

Deer Wintering Areas:
The woodcock management demonstration units are predominately hardwood and therefore vegetative manipulation therein will not reduce the quantity or quality of the available functional softwood shelter, nor will it limit connectivity or potential future "deer yard" management. The woodcock management demonstration units are too far from current functional softwood shelter for the woody browse that develops from this project to be considered usable by wintering deer. Even though this is a 20-year project, the intent is to perpetually sustain the early successional conditions created during the 20-year term into the future, and because these units are within or directly adjacent to the NDWA, woody browse will be made available to wintering deer as functional softwood shelter develops within closer proximity, thus enhancing the potential for future wintering area habitat.

It is important to conduct operations during late fall and/or early winter to ensure the desired frozen ground, leaf-off, conditions for woodcock habitat manipulation. During this time, abundance of deer utilizing the wintering area will vary depending on location and distribution of functional shelter and the severity of winter conditions. If an operation is conducted while deer are in the wintering area, any potential impacts on them will be minor due to the small scale and short duration of the operation, and distance from functional softwood shelter where wintering deer may congregate.

Monitoring
Under this alternative, a new woodcock singing ground survey will be initiated that specifically targets each woodcock demonstration unit. The current protocol accounts for presence or absence of woodcock by recording "peenting" sounds often made by the male woodcock during their evening courting ritual in the spring. Instead of conducting these surveys only along the current fixed roadside transects, survey points will be added within each woodcock demonstration unit to monitor future presence or absence of woodcock using these sites.

Under this alternative, a new habitat monitoring survey will be developed that specifically targets each woodcock demonstration unit. This protocol will be designed to target habitat variables specific to woodcock habitat suitability, such as woody stem and shrub composition and density, to determine if desired conditions are being achieved and ultimately if habitat objectives are being met.

3. Socio-economic Resources

Economy
To meet management demonstration unit objectives treatment will need to occur on 5-year cycles. Annual mowing of roosting and courtship areas will also need to occur. Based on current and expected future staffing, budget projections, and regional availability of machinery it is predicted most operations conducted on the Refuge will be through contractual agreements. A competitive bidding process will be used prior to awarding a contract. Essex County, Vermont has the lowest per capita family income of any county in the state. Revenues and direct and indirect expenditures resulting from contractual operations will contribute to the local economy of this area.

Recreational Use/Natural Resource Utilization

Under this alternative, operations will be performed between late fall and winter. Visitor use of the Refuge typically peaks during the fall hunting seasons that occur from October through November, and during snowmobile season. The VAST snowmobile trails open the 3rd Monday in December but use of the trail system is dependent on snow conditions. Use of the snowmobile trail system typically peaks in February.

If conditions require work to be completed during snowmobile season, temporary trail closures will likely occur during transport of equipment and forest products to and from each management demonstration unit. Transport of equipment is not expected to last more than a few hours at the beginning and end of each management demonstration unit treatment. The transport of forest products will likely result in day-time trail closures. Negative visitor impacts from inconvenience or confusion are expected to be minimal and temporary trail closures will ensure visitor safety during transport of equipment and forest products. Any negative impacts to snowshoe hare hunters, wildlife observers/photographers, or trappers due to wildlife disturbance around the demonstration units will be minor and short term in duration.

Archaeological Sites and Historic Structures

Using the brontosaurus or hydro-ax and operating grapple skidders on frozen ground is not expected to cause ground disturbance and will not affect potential archaeological sites. A U.S. Fish and Wildlife Service forester will be responsible for monitoring temperature and ground condition at least every other day while the sale is active to ensure ground (site) conditions are suitable for operation.

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X. Consultation and Coordination with Others

In addition to input provided by the public that was analyzed to identify issues and develop management alternatives, the following natural resource professionals were consulted with and contributed information used in the development of this draft EA.

Dan McCauley, U.S. Geological Survey, Patuxent Wildlife Research Laboratory

Majorie Snyder, U.S. Fish and Wildlife Service, Regional NEPA coordinator

Shelly Hight, U.S. Fish and Wildlife Service, Cultural Resources

Scot Williamson, Wildlife Management Institute, Northeast Representative

Cedric Alexander, Vermont Fish and Wildlife Department, Wildlife Biologist

Gary Donovan, International Paper Company, Forester

Dave Small, Vermont Electric Company, Habitat specialist

Dave Willard, Vermont Forest and Parks Department, Forester

Thomas Decker, Vermont Fish and Wildlife Department, Chief of Operations

Len Gerardi, Vermont Fish and Wildlife Department, Fisheries Biologist

Will Staats, New Hampshire Fish and Game Department, Regional Wildlife Biologist

Jim Wood, Essex Timber Company, Forestland Manager

Nancy Bell, The Conservation Fund

Paul Hamelin, Vermont Fish and Wildlife Department, Wildlife Biologist

Paul Karczmarczyk, Ruffed Grouse Society, Wildlife Biologist

Jonathan Wood, Vermont Forest and Parks Department, Commissioner

Wayne Laroche, Vermont Fish and Wildlife Department, Commissioner

Jan Taylor, U.S. Fish and Wildlife Biologist, Northeast Regional Biologist

Steve Hill, U.S. Fish and Wildlife Biologist

William Kolodnicki, U.S. Fish and Wildlife Biologist, Refuge Manager

Paul Casey, U.S. Fish and Wildlife Biologist, Refuge Manager

Janet Kennedy, U.S. Fish and Wildlife Service, Northeast Region Supervisor

Susi VonOettingen, U.S. Fish and Wildlife Service, Endangered Species Biologist

Judith Ehrlich, Vermont Division for Historic Preservation

Lamar Gore, U.S. Fish and Wildlife Service**,** Assistant Supervisor-Refuges North

Barry Parrish, U.S. Fish and Wildlife Service, Refuge Manager

XI. Public Review and Comment on Draft EA

A public notice announcing the 30-day public comment period (October 18th – November 16th, 2006) for the draft EA was placed in *The New Hampshire News and Sentinel*, *The Caledonian Record*, and *The Barton Chronicle* on October 18, 2006. In addition, press releases were sent to these newspapers and to *Newport Daily Express* and *Coos County Democrat*. The announcement that a draft EA was available for comment was also posted in the Brighton Town Hall, the Island Pond Public Library, and the Island Pond Post Office. Copies of the draft EA were sent to professional wildlife biologists that possessed pertinent knowledge and experience from various wildlife management agencies in the Northeast, and from representatives of the Refuge's adjacent landowner agencies including the Vermont Fish and Wildlife Department, Essex Timber Company, The Conservation Fund, The Nature Conservancy, and Vermont Electric Company. Some other recipients were representatives from VT Department of Forests Parks and Recreation, VT Department of Historic Preservation, and NH Fish and Game Department. The draft Compatibility Determination and EA were both posted in the Refuge office in a conspicuous place at the visitor entrance for 30 calendar days (October 18– November 16, 2006) for public review and comment for woodcock management on these demonstration units. The comment period included two moose hunting seasons when the facility at which the draft documents were posted was the site of a state moose check station. The opportunity for public comment was announced at two public Comprehensive Conservation Planning meetings in the towns of Island Pond and Norwich, Vermont, on November 8th and 9th respectively. Copies of the draft EA and Compatibility Determination also were available at these meetings.

- Three comments were received in favor of creating woodcock management demonstration units on the Refuge
- One comment was received expressing concern about a possible conflict that may develop during Habitat Management Planning between potential reserve areas and juxtaposition of the woodcock management demonstration units, particularly Unit 3 off the lower Lewis Pond Rd.

Response:
At this point in the planning process for the Nulhegan Basin Division Habitat Management Plan, no habitat management strategies have been developed or analyzed. Even so, there is potential that within the range of future strategies designed to achieve what are yet to be determined habitat/wildlife goals, "reserve" area(s) could be implemented (in which no habitat manipulation would be prescribed) in order to achieve the ideal mosaic of forest communities. The area east of Woodcock Management Demonstration Unit 3 offers an opportunity to provide for an example of exemplary lowland spruce-fir natural community through some type of "reserve" area. However, given the small size of MDU 3 (32 acres), its location on the fringe of lowland spruce-fir forest, and its location on Lewis Pond Road, we would expect that any negative ramifications of implementing this MDU within or adjacent to a speculative reserve area would be minor, particularly when compared to the expected benefits of contributing to the goals of the NFWI and promoting best management practices for a federal trust species that is of high management priority.

Figure 1. Nulhegan Basin Division of the Silvio O. Conte NFWR

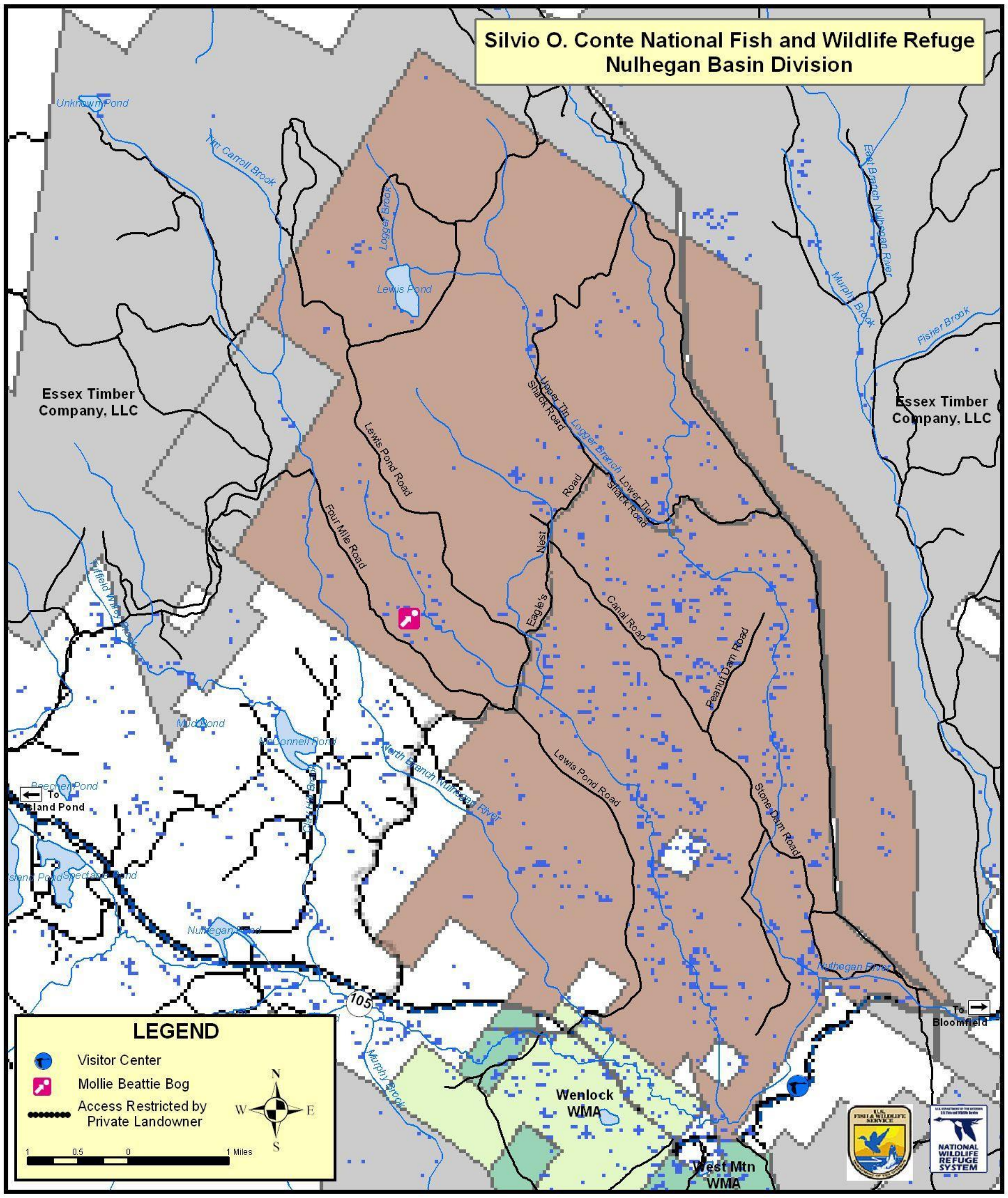


Figure 2. Location Map of the Management Demonstration Units

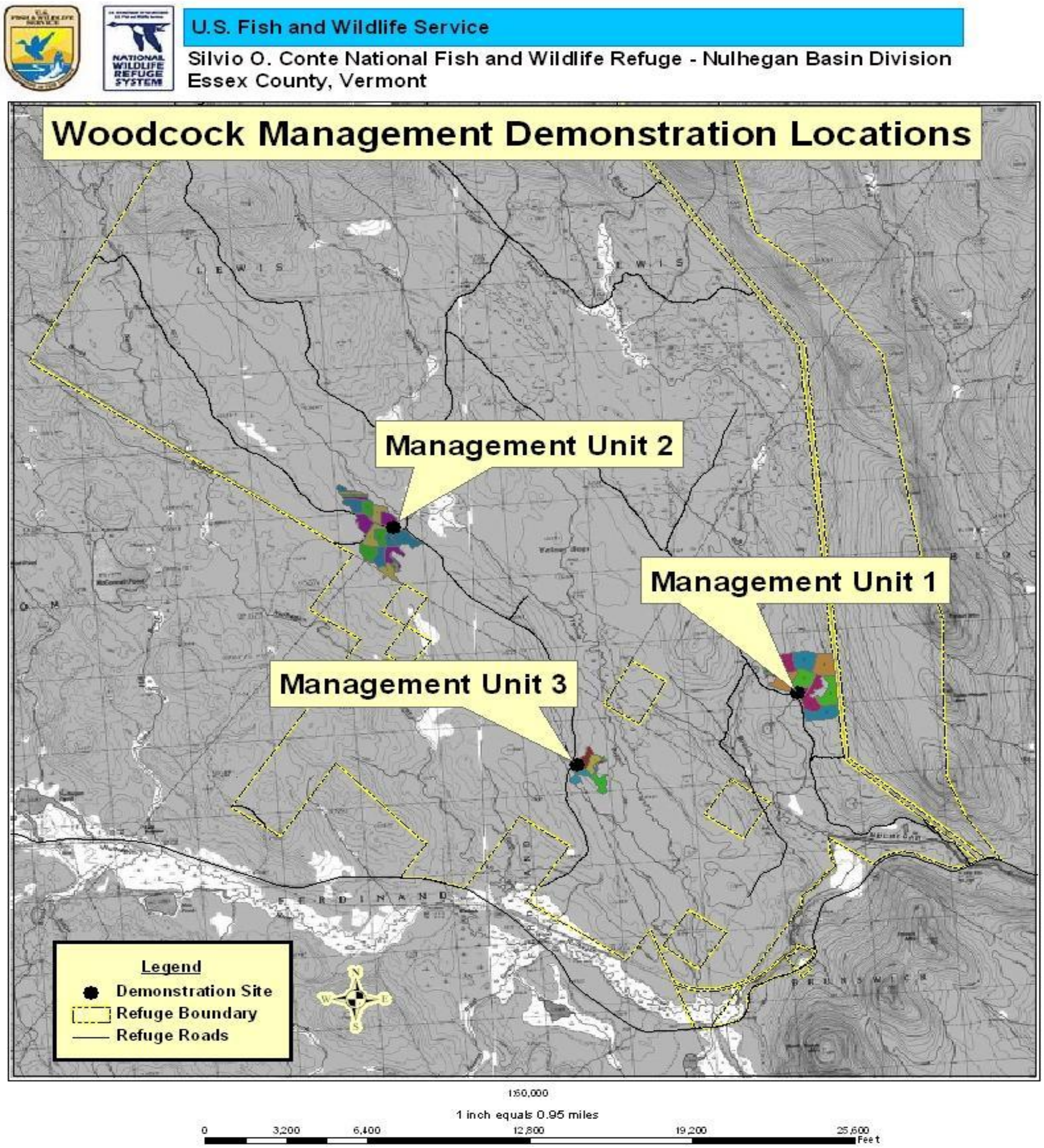


Figure 3: Management Demonstration Unit 1

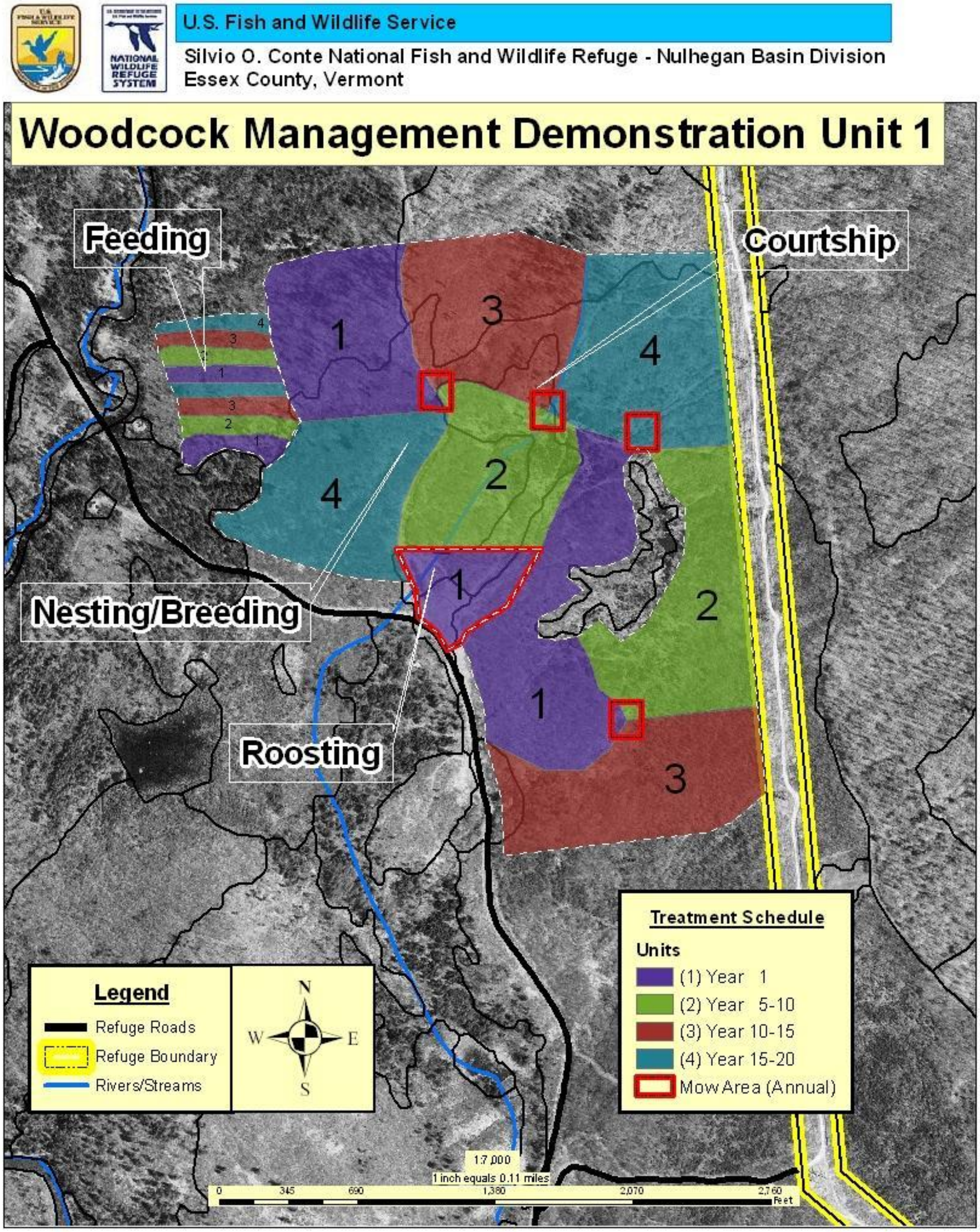


Figure 4: Management Demonstration Unit 2

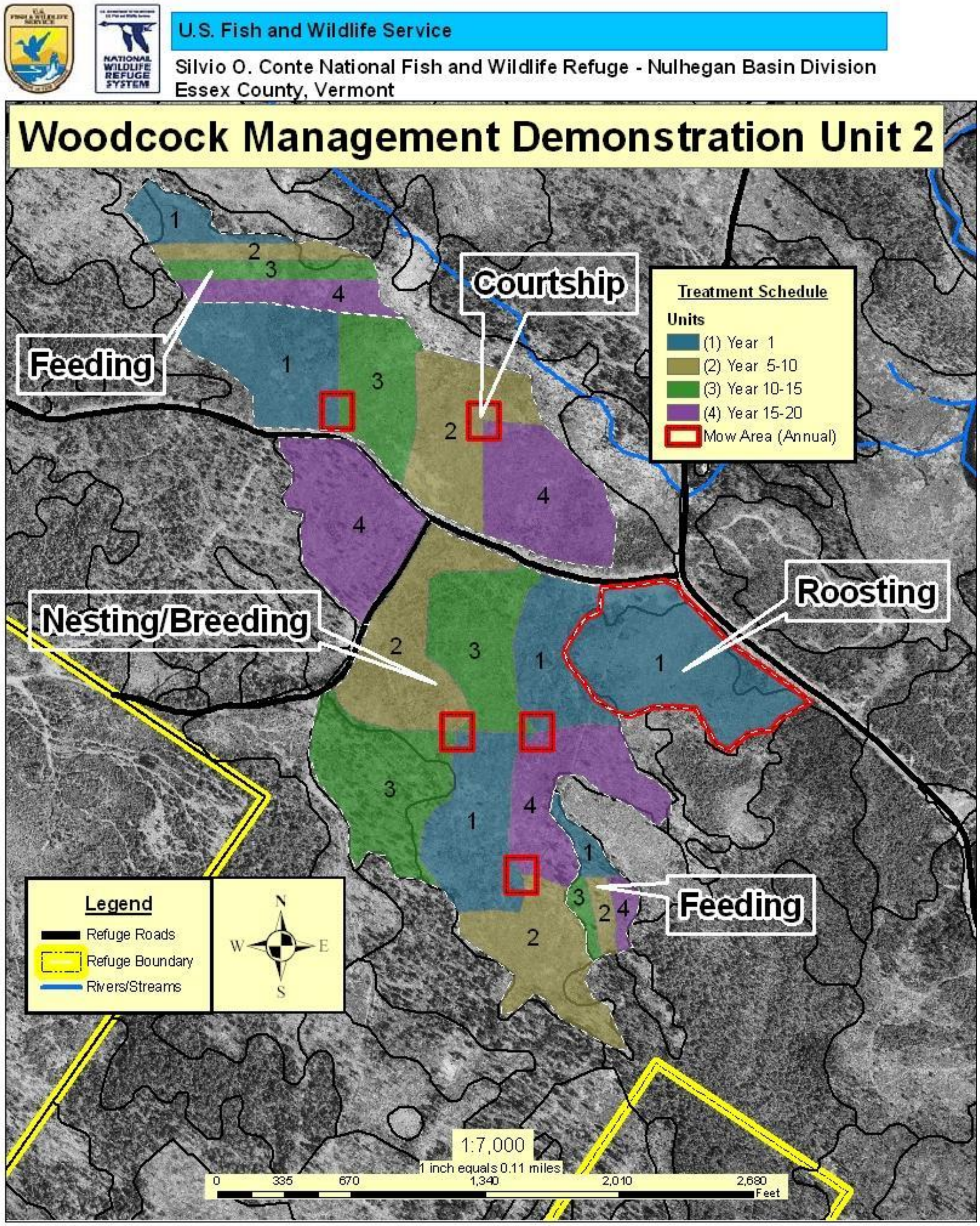


Figure 5: Management Demonstration Unit 3

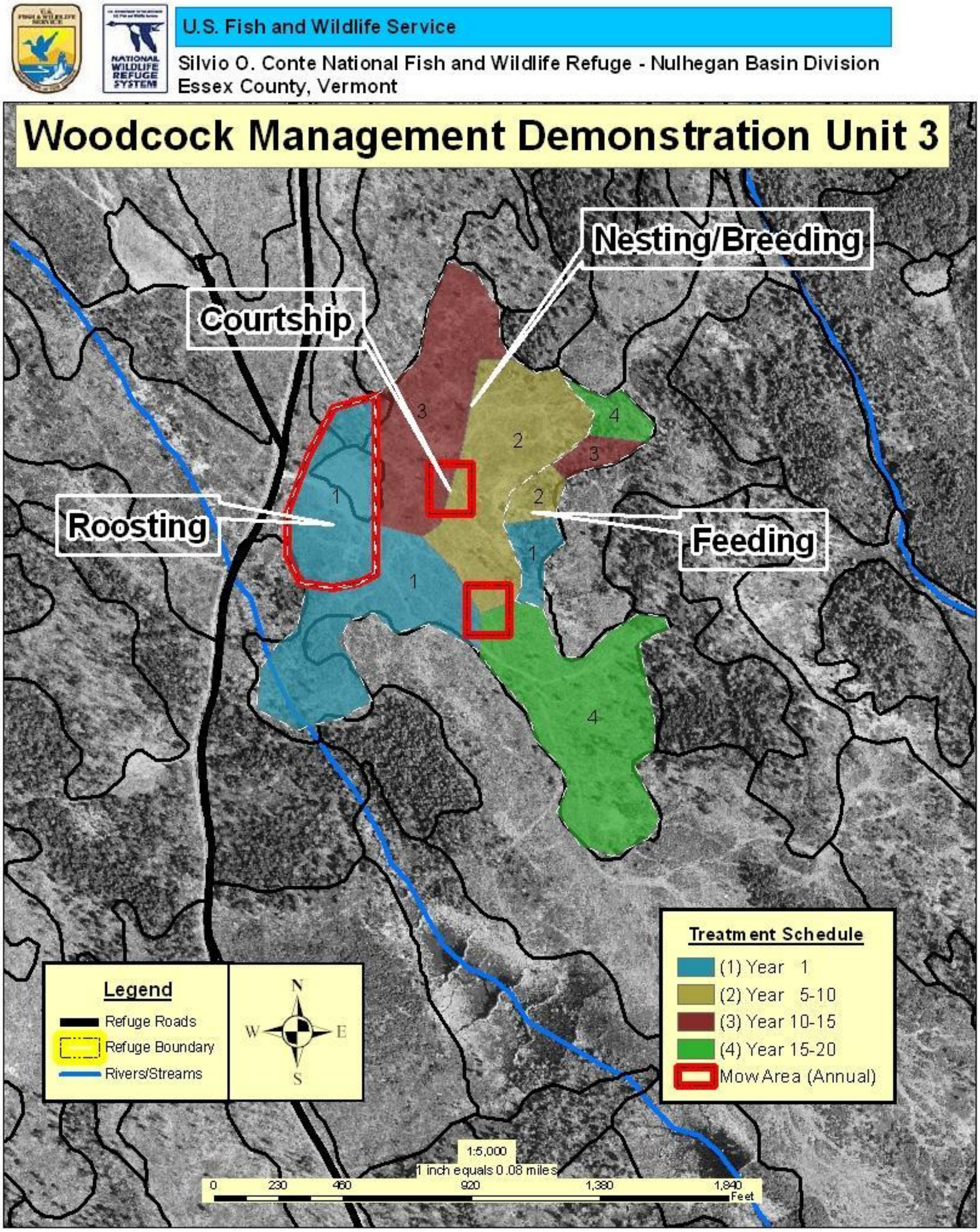


Figure 6. Map of the Current Refuge Woodcock Singing Ground Survey Locations

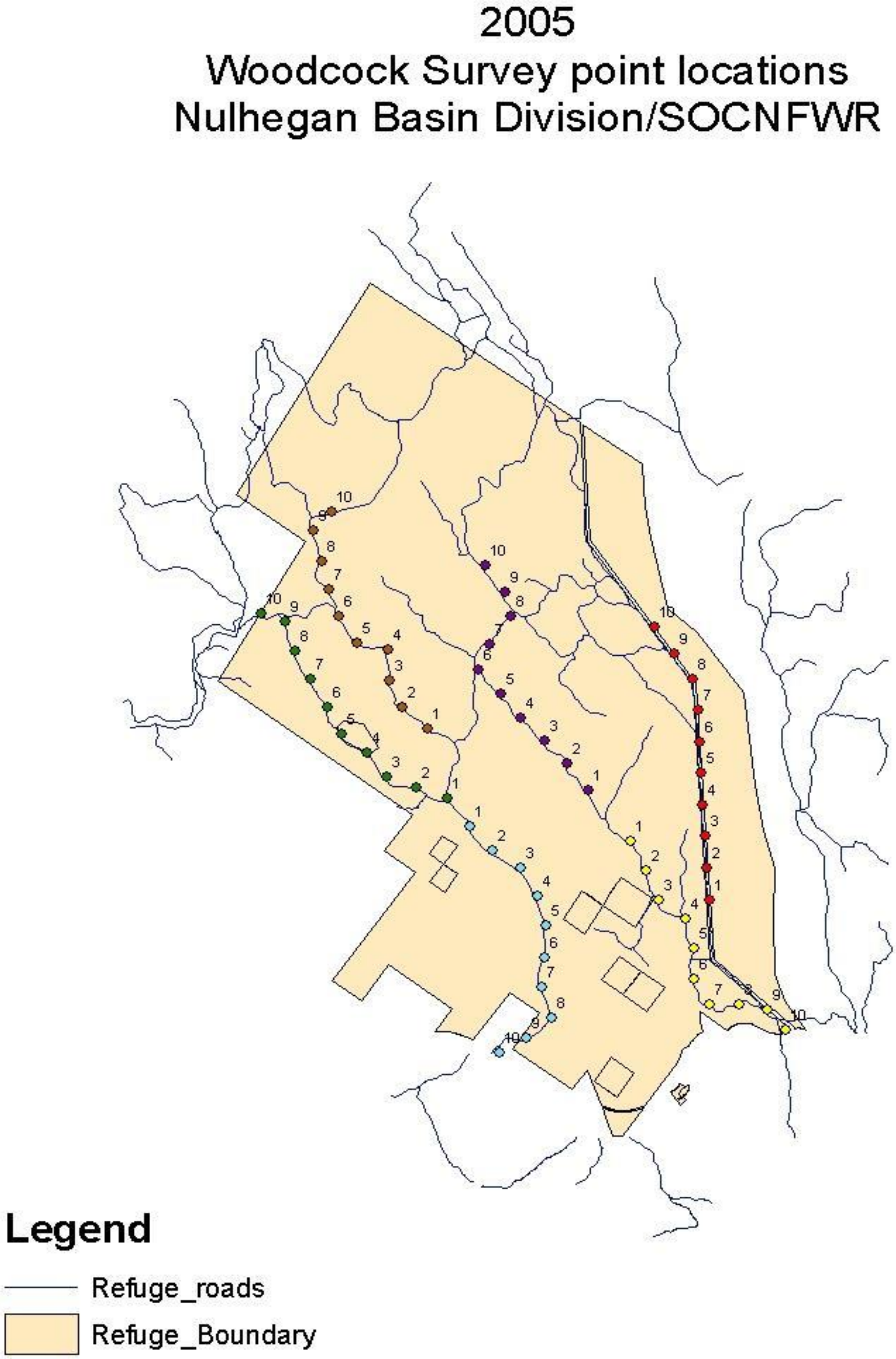


Table 1. Management Demonstration Unit (MDU) Treatment Schedule

<u>MDU 1</u>
<u>Treatment Cycles:</u>

Year 1:
Nesting/Breeding: 28.7 ac
Roosting: 4.9 ac
Courtship: 2.4 ac
Feeding: 2.4 ac
Total: 38.4 ac

Year 5-10:
Nesting/Breeding: 27.8 ac
Feeding: 2.5 ac
Total: 30.3 ac

Year 10-15:
Nesting/Breeding: 30.5 ac
Feeding: 2.4 ac
Total: 32.9 ac

Year 15-20:
Nesting/Breeding: 30.1 ac
Feeding: 2.2 ac
Total: 32.3 ac

<u>Mowing:</u>
Courtship Areas: 2.4 ac
Roosting Field: 4.9 ac
Total: 7.3 ac

<u>MDU 2</u>
<u>Treatment Cycles:</u>

Year 1:
Nesting/Breeding: 21.6 ac
Roosting: 12.5 ac
Courtship: 3.0 ac
Feeding: 3.7 ac
Total: 40.8 ac

Year 5-10:
Nesting/Breeding: 23.4 ac
Feeding: 2.9 ac
Total: 26.3 ac

Year 10-15:
Nesting/Breeding: 22.8 ac
Feeding: 3.1 ac
Total: 25.9 ac

Year 15-20:
Nesting/Breeding:24.6 ac
Feeding: 4.1 ac
Total: 28.7 ac

<u>Mowing:</u>
Courtship Areas: 3.0 ac
Roosting Field: 12.5 ac
Total: 15.5 ac

Summary:

MDU 1	**Acreage**
Nesting/Breeding	117.1
Roosting	4.9
Feeding	9.5
Courtship	2.4
Total	133.9

MDU 2	**Acreage**
Nesting/Breeding	92.4
Roosting	12.5
Feeding	13.8
Courtship	3
Total	121.7

MDU 3	**Acreage**
Nesting/Breeding	24.1
Roosting	3.9
Feeding	3
Courtship	1.2
Total	32.2

MDU 3
Treatment Cycles:

Year 1:
Nesting/Breeding: 5.5 ac
Roosting: 3.9 ac
Courtship: 1.2 ac
Feeding: 0.9 ac
Total: 11.5 ac

Year 5-10:
Nesting/Breeding: 5.7 ac
Feeding: 0.7 ac
Total: 6.4 ac

Year 10-15:
Nesting/Breeding: 5.3 ac
Feeding: 0.6 ac
Total: 5.9 ac

Year 15-20:
Nesting/Breeding: 7.6 ac
Feeding: 0.8 ac
Total: 8.4 ac

Mowing:
Courtship Areas: 1.2 ac
Roosting Field: 3.9 ac
Total: 5.1 ac

Appendix I. American Woodcock Population Status 2006

Contact Division headquarters for document details.

Appendix II. Wildlife Management Institute, American Woodcock Initiative

WILDLIFE MANAGEMENT INSTITUTE

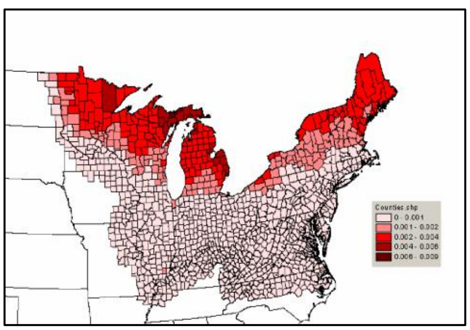
AMERICAN WOODCOCK INITIATIVE

ATLANTIC NORTHERN FOREST & SOUTHERN NEW ENGLAND BIRD CONSERVATION REGIONS

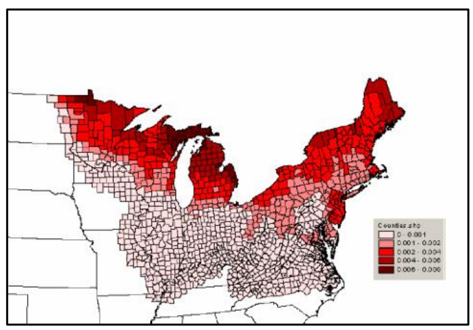
WOODCOCK ARE DECLINING AS YOUNG FOREST AND SHRUBLAND HABITATS DECLINE

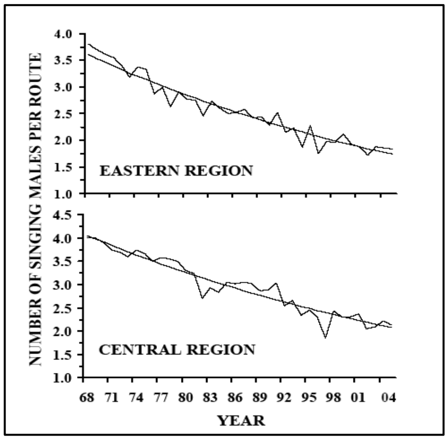
American Woodcock populations have declined 2 to 4 percent per year since the early 1970s. Research has documented that the loss of young forest and shrubland habitats is the primary cause of the decline.

1970's



2000's





<u>WILDLIFE WITH SIMILAR HABITAT REQUIREMENTS TO WOODCOCK ALSO ARE DECLINING</u>

Habitats used by woodcock also support other high priority species in need of conservation action. State Wildlife Action Plans list 59 species of "Greatest Conservation Need" that require young forest and shrubland habitats.

<u>CONSERVATION AGENCIES AND GROUPS HAVE RECOGNZIED THE PLIGHT OF WOODCOCK AND ARE PRIORITIZING RECOVERY ACTIONS</u>

The U.S. Fish and Wildlife Service has named American woodcock as one of eight national focus species. The states of Maine, Vermont, Rhode Island, New Hampshire, Massachusetts, Connecticut and New York have declared American woodcock to be a species of greatest conservation need within their respective Wildlife Action Plans. Partners In Flight and the North American Bird Conservation Initiative has ranked woodcock as a highest (global) priority species in need of conservation action.

<u>THE WILDLIFE MANAGEMENT INSTITUTE'S AMERICAN WOODCOCK INITIATIVE</u>

The Wildlife Management Institute has assembled the largest public/private coalition ever created to address and counter the decline of woodcock. Twenty-four cooperators have pledged cooperation to fulfill the objective and goals of the initiative.

<u>OBJECTIVE OF THE AMERICAN WOODCOCK INITIATIVE</u>

To recover American Woodcock populations to 1980 levels in the Atlantic Northern Forest and Southern New England regions by implementing woodcock habitat Best Management Practices (BMPs) on public and private lands, monitoring woodcock populations, and providing extensive outreach to private landowners to manage their lands for woodcock habitat.

Approach

This program is envisioned to benefit woodcock habitat on a landscape scale through coordinated research, further development of wildlife/forest management practices, implementation guidelines, and technical education assistance directed toward private landowners. The first project area overlaps with woodcock breeding range. Subsequent projects will address woodcock migration and wintering habitats.

Products

The American Woodcock Initiative will provide technical assistance, labor and funding to:

- create demonstration areas on state and federal lands
- monitor population size of woodcock on demonstration areas
- develop and implement woodcock habitat BMPs on each demonstration area. The suite of management activities will include regeneration strip-cutting of alder, patch cutting of uplands adjacent to riparian areas, apple tree release, and creation and maintenance of forest openings and herbaceous cover types.
- evaluate woodcock use of BMP habitats through telemetry
- monitor changes in woodcock population size following implementation of BMPs
- use demonstration areas as case histories within coordinated outreach efforts to inform and motivate private landowners in the areas surrounding each demonstration area , to encourage their consideration of changes to their land management to the benefit of woodcock
- make available to private landowners technical assistance, labor and machinery to improve American Woodcock habitat on their land
- evaluate approach for implementation on other public lands in other BCRs, with the goal of covering the range of woodcock in the United States

COOPERATORS

U. S. Fish and Wildlife Service
U. S. Geological Survey
Natural Resource Conservation Service
Northeastern Association of Fish and Wildlife Agencies
Maine Inland Fisheries and Wildlife Department
New York Department of Environmental Conservation
New Hampshire Fish and Game Department
Vermont Fish and Wildlife Department
Massachusetts Division of Fisheries and Wildlife
Connecticut Department of Environmental Protection
Rhode Island Department of Environmental Protection
Connecticut Woodcock Council
Ruffed Grouse Society
Audubon Society of New Hampshire
Friends of Moosehorn NWR
New Hampshire Wildlife Federation
Plum Creek Corporation
International Paper Corporation
Dartmouth College
Lyme Timber Company
The Conservation Fund
Essex Timber LLC
J.D. Irving Timberlands
Wildlife Management Institute

SPECIES OF GREATEST CONSERVATION NEED IN NEW ENGLAND THAT REQUIRE YOUNG FOREST AND SHRUBLAND HABITATS

N	SPECIES	Scientific Name
1	American Kestrel	*Falco sparverius*
2	American Redstart	*Setophaga ruticilla*
3	American Woodcock	*Scolopax minor*
4	Barn Owl	*Tyto alba*
5	Black Racer	*Coluber constrictor*
6	Blue-winged Warbler	*Vermivora pinus*
7	Broad-Winged Hawk	*Buteo platypterus*
8	Brown Thrasher	*Toxostoma rufum*
9	Chestnut-sided Warbler	*Dendroica pensylvanica*
10	Common Nighthawk	*Chordeiles minor*
11	Copperhead	*Agkistrodon contortrix*
12	Eastern Hognose Snake	*Heterodon platirhinos*
13	Eastern Kingbird	*Tyrannus tyrannus*
14	Eastern Pipistrelle	*Pipistrellus subflavus*
15	Eastern Red Bat	*Lasiurus borealis*
16	Eastern Screech-owl	*Otus asio*
17	Eastern Small-footed Myotis	*Myotis leibii*
18	Eastern Smooth Green Snake	*Opheodrys vernalis*
19	Eastern Towhee	*Pipilo erythrophthalmus*
20	Field Sparrow	*Spizella pusilla*
21	Golden-Winged Warbler	*Vermivora chrysoptera*
22	Gray Catbird	*Dumetella carolinensis*
23	Great Horned Owl	*Bubo virginianus*
24	Hoary Bat	*Lasiurus cinereus*
25	Hooded Warbler	*Wilsonia citrina*
26	Indigo Bunting	*Passerina cyanea*
27	Little Brown Myotis	*Myotis lucifugus*
28	Mourning Warbler	*Oporornis philadelphia*
29	New England Cottontail	*Sylvilagus transitionalis*
30	Northern Bobwhite	*Colinus virginianus*
31	Northern Harrier	*Circus cyaneus*
32	Northern Long-eared Bat	*Myotis septentrionalis*
33	Prairie Warbler	*Dendroica discolor*
34	Red-headed Woodpecker	*Melanerpes erythrocephalus*
35	Rough-legged Hawk	*Buteo lagopus*
36	Ruby-throated Hummingbird	*Archilochus colubris*
37	Ruffed Grouse	*Bonasa umbellus*
38	Savannah Sparrow	*Passerculus sandwichensis*
39	Silver-haired Bat	*Lasionycteris noctivagans*
40	Snowy Owl	*Nyctea scandiaca*
41	Southern Bog Lemming	*Synaptomys cooperi*

42	Spotted Turtle	*Clemmys guttata*
43	Whip-poor-will	*Caprimulgus vociferus*
44	White-eyed Vireo	*Vireo griseus*
45	White-throated Sparrow	*Zonotrichia albicollis*
46	Willow Flycatcher	*Empidonax traillii*
47	Wood Turtle	*Glyptemys insculpta*
48	Yellow-billed Cuckoo	*Coccyzus americanus*
49	Yellow-breasted Chat	*Icteria virens*
50	Canada Warbler	*Wilsonia canadensis*
51	Rufous-sided Towhee	*Pipilo erythrophthalmus*
52	Short-eared Owl	*Asio flammeus*
53	Black-billed Cuckoo	*Coccyzus erythropthalmus*
54	Northern bog lemming	*Synaptomys borealis*
55	Red bat	*Lasiurus borealis*
56	Small-footed bat	*Myotis leibii*
57	Big brown bat	*Eptesicus fuscus*
58	Common gray fox	*Urocyon cinereoargenteus*
59	Eastern Rat Snake	*Elaphe obsoleta*

Breeding Range Density Maps: Dr. John Sauer, U.S. Geological Survey
Population Trend Graph: Kelley, J.R., Jr., and R. D. Rau. 2005. American woodcock population status, 2005. U.S. Fish and Wildlife Service, Laurel, Maryland. 15pp.

Appendix III. Partial list of vertebrate species occurring on the Nulhegan Basin Division.

Waterfowl

Black duck	*Anas rubripes*
Wood duck	*Aix sponsa*
Hooded merganser	*Lophodytes cucullatus*
Mallard	*Anas platyrhynchos*
Ring-necked duck	*Aythya collaris*
Common goldeneye	*Bucephala clangula*
Common merganser	*Mergus merganser*
Green-winged teal	*Anas crecca*

Other birds

Common Loon	*Gavia immer*** [, p]
Great Blue Heron	*Ardea herodias**
Osprey	*Pandion haliaetus*** [, p]
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Northern Goshawk	*Accipiter gentilis*
Red-tailed Hawk	*Buteo jamaicensis*
Ruffed Grouse	*Bonasa umbellus* [,p]
Spruce Grouse	*Dendragapus canadensis*** [, p]
Wild Turkey	*Meleagris gallopavo*
Spotted Sandpiper	*Actitis macularia*
Common Snipe	*Gallinago gallinago*
American Woodcock	*Scolopax minor* [p]
Mourning Dove	*Zenaida macroura*
Great Horned Owl	*Bubo virginianus*
Barred Owl	*Strix varia*
Northern Saw-whet Owl	*Aegolius acadicus*
Ruby-throated Hummingbird	*Archilochus colubris*
Yellow-bellied Sapsucker	*Sphyrapicus varius* [,p]
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Black-backed Woodpecker	*Picoides arcticus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Olive-sided Flycatcher	*Contopus borealis* [,p]
Eastern Wood-Pewee	*Contopus virens* [,p]
Yellow-bellied Flycatcher	*Empidonax flaviventris*
Alder Flycatcher	*Empidonax alnorum*
Willow Flycatcher	*Empidonax trailii*
Least Flycatcher	*Empidonax minimus* [,p]
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Blue-headed Vireo	*Vireo solitarius*
Warbling Vireo	*Vireo gilvus*

Appendix III. (Continued)

Other birds (continued)	
Philadelphia Vireo	*Vireo philadelphicus**
Red-eyed Vireo	*Vireo olivaceus*
Gray Jay	*Perisoreus canadensis*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*
Tree Swallow	*Tachycineta bicolor*
Black-capped Chickadee	*Parus atricapillus*
Boreal Chickadee	*Parus hudsonicus* [,p]
Red-breasted Nuthatch	*Sitta Canadensis*
Brown Creeper	*Certhia americana*
Winter Wren	*Troglodytes troglodytes*
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Veery	*Catharus fuscescens* [,p]
Swainson’s Thrush	*Catharus ustulatus*
Hermit Thrush	*Catharus guttatus*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Cedar Waxwing	*Bombycilla cedrorum*
Nashville Warbler	*Vermivora ruficapilla* [,p]
Northern Parula	*Parula americana* [,p]
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pennsylvanica*
Magnolia Warbler	*Dendroica magnolia*
Black-throated Blue Warbler	*Dendroica caerulescens* [,p]
Black-throated Green Warbler	*Dendroica virens* [,p]
Blackburnian Warbler	*Dendroica fusca* [,p]
Palm Warbler	*Dendroica palmarum*
Bay-breasted Warbler	*Dendroica castanea**
Blackpoll Warbler	*Dendroica striata* [,p]
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Ovenbird	*Seiurus aurocapillus*
Northern Waterthrush	*Seiurus noveboracensis*
Mourning Warbler	*Oporornis philadelphia*
Common Yellowthroat	*Geothlypis trichas*
Canada Warbler	*Wilsonia canadensis* [,p]
Scarlet Tanager	*Piranga olivacea*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*
Lincoln’s Sparrow	*Melospiza lincolnii*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*

<u>Appendix III. (Continued)</u>

Other birds (continued)	
Dark-eyed Junco	*Junco hyemalis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Rusty Blackbird	*Euphagus carolinus*
Common Grackle	*Quiscalus quiscula*
Purple Finch	*Carpodacus purpureus* [,p]
White-winged Crossbill	*Loxia leucoptera*
American Goldfinch	*Carduelis tristis*
Evening Grosbeak	*Coccothraustes vespertinus*
Mammals	
Moose	*Alces alces*
Black bear	*Ursus americanus*
White-tailed deer	*Odocoileus virginianus*
Snowshoe hare	*Lepus americanus*
Porcupine	*Erethizon dorsatum*
Beaver	*Castor canadensis*
Muskrat	*Ondatra zibethicus*
River otter	*Lutra canadensis*
Fisher	*Martes pennanti*
Mink	*Mustela vison*
Short-tailed weasel	*Mustela erminea*
Raccoon	*Procyon lotor*
Eastern coyote	*Canis latrans*
Red fox	*Vulpes vulpes*
Bobcat	*Lynx rufus*
Striped skunk	*Mephites mephites*
Northern long-eared bat	*Myotis septentrionalis*
Little brown bat	*Myotis lucifugus*
Hairy-tail mole	*Parascalopus breweri*
Red squirrel	*Tamiasciurus hudsonicus*
Eastern chipmunk	*Tamias striatus*
Deer mouse	*Peromyscus maniculatus*
Red-backed vole	*Clethrionomys gapperi*
Meadow vole	*Microtus pennsylvanicus*
Meadow jumping mouse	*Zapus hudsonicus*
Woodland jumping mouse	*Napeozapus insignis*
Masked shrew	*Sorex cinereus*
Smoky shrew	*Sorex fumeus*
Pygmy shrew	*Sorex hoyi**
Water shrew	*Sorex palustrus**
Reptiles	
Common snapping turtle	*Chelydra serpentina*
Painted turtle	*Chrysemys picta*

Appendix III. (Continued)

Wood turtle	*Clemmys insculpta**
Ringneck snake	*Diadophis punctatus*
Redbelly snake	*Storeria occipitomaculata*
Common garter snake	*Thamnophis sirtalis*

Amphibians

Spotted salamander	*Ambystoma maculatum*
Northern dusky salamander	*Desmognathus fuscus*
Northern two-lined salamander	*Eurycea bislineata*
Spring salamander	*Gyrinophilus porphyriticus*
Northern redback salamander	*Plethodon cinereus*
Eastern newt	*Notophthalmus viridescens*
American toad	*Bufo americanus*
Gray treefrog	*Hyla versicolor*
Spring peeper	*Pseudacris crucifer*
Bullfrog	*Rana catesbeiana*
Green frog	*Rana clamitans*
Pickerel frog	*Rana palustris*
Mink frog	*Rana septentrionalis*
Wood frog	*Rana sylvatica*

Fish

Brook trout	*Salvelinus fontinalis*
Brown trout	*Salmo trutta*
Burbot	*Lotta lotta*
Creek chub	*Semotilus atromaculatus*
Fallfish	*Semotilus corporalis*
Blacknose dace	*Rhinichthys atratulus*
Longnose dace	*Rhinichthys. cataractae*
Slimy sculpin	*Cottus cognatus*
White sucker	*Catostomus commersoni*
Longnose sucker	*Catostomus catostomus*
Lake chub	*Couesius plumbeus*
Brown bullhead	*Ictalurus nebulosus*

Legend:
* = listed by the state as rare or uncommon (informational categories)

** = endangered (category established by law)

p =Partners in Flight priority species Physiographic Area 28

Appendix IV. Acceptable Management Practices For Maintaining Water Quality

Contact Division headquarters for document details.