Chapter 5

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Stream habitat restoration at Nulhegan Basin Division

Environmental Consequences

- Introduction
- Impact Analysis and Relationship to Scale
- Regional-scale Impacts
- Refuge-scale Impacts
- Cumulative Impacts
- Relationship Between Short-term Uses of the Human Environment and Enhancement of Long-term Productivity
- Unavoidable Adverse Impacts
- Potential Irreversible and Irretrievable Commitments of Resources
- Environmental Justice Impacts
- Summary of the Impacts of the Alternatives

Introduction

This chapter summarizes and compares the potential impacts of the four management alternatives described in chapter 4 on the socioeconomic, physical, and biological environment of the refuge and larger Connecticut River watershed. The environment affected by the alternatives is described in Chapter 3–Affected Environment. This impact analysis is designed to inform the decision-making process to ensure the final CCP promotes management activities that avoid or minimize adverse environmental impacts, while promoting the human environment to the fullest extent possible.

As described in chapter 4, the CCP describes and analyzes four management alternatives for the refuge:

- Alternative A — Current Management (which serves as a baseline for comparing against the other three alternatives).
- Alternative B — Consolidated Stewardship.
- Alternative C — Enhanced Conservation Connections and Partnerships (the Service-preferred alternative).
- Alternative D — Expanded Ecosystem Restoration.

In this chapter, we estimate the beneficial and adverse impacts of implementing the management objectives and strategies for each of the alternatives. We attempt to describe the direct, indirect, short-term, and cumulative impacts likely to occur over the 15-year life span of this CCP. Beyond the 15-year planning horizon—which we define as long-term impacts—our estimates of environmental impacts contain greater uncertainty due to the difficulty in projecting impacts beyond the 15-year horizon. Where detailed information is available, we present an educated comparison of the alternatives and their anticipated impacts on the environment. When detailed information is not available, we base comparisons on professional judgment and experience. At the end of this chapter, we summarize the impacts predicted for each alternative in tabular format, providing a side-by-side comparison.

To meet our obligations under NEPA and to comply with Service policies, we assess the *significance* of impacts of all alternatives based on their context, magnitude, duration, and intensity. The context of our impact analysis ranges from site-specific to regional and landscape-scale, and is dependent on how widely the impact of an action can be observed over the affected environment (see chapter 3). Certain actions may have direct impacts in a very local context (e.g., removal of invasive plants), while others may have impacts in a broader context (e.g., participation in regional partnerships) (see table 4.1 in chapter 4). It is important to note that local 'minor' actions implemented by the refuge may have cumulative impacts when incrementally combined with other similar actions over time on a local or regional landscape. For example, invasive plant control on a local scale, when combined with other non-Service control efforts across the landscape could result in cumulative beneficial impacts. Although the refuge land base is a small portion of the Connecticut River watershed and larger ecoregion, our three action alternatives B, C, and D were developed in part to contribute toward regional conservation goals. Our proposed conservation objectives and strategies for species and habitats are generally consistent with regional, state, and Service landscape-level plans identified in Chapter 1, including the Wildlife Action Plans for the four watershed states and the Bird Conservation Region plans for the Northern Forest (BCR 14) and the New England/Mid-Atlantic Coast (BCR 30).

Table 5.1 provides context for the analysis, including the size of the refuge area, major habitat types and their acreages, lengths of existing and proposed ADA-compliant trails, length of existing roads, and amount of area that is predicted to be disturbed during any new construction.

Table 5.1. Context for Impacts Analysis at Silvio O. Conte National Fish and Wildlife Refuge.

Geographic Context	Size
BCRs: Atlantic Northern Forest (14) and New England/Mid-Atlantic (30)	111 million acres
Vermont, New Hampshire, Massachusetts, and Connecticut	20.6 million acres
Connecticut River Watershed	7.2 million acres
Existing Refuge Lands	37,216acres
Existing Refuge Divisions (9)	36,627 acres
Existing Refuge Units (8)	589 acres
Forested Uplands and Wetlands in Entire Watershed	5.6 million acres
Forested Uplands on Existing Refuge Lands	35,214acres
Non-forested Uplands and Wetlands in Entire Watershed	367,685 acres
Non-forested Uplands and Wetlands on Existing Refuge Lands	1,534 acres
Inland Aquatic Habitats in Entire Watershed	162,487 acres
Inland Aquatic Habitats on Existing Refuge Lands	179 acres
Coastal Non-forested Uplands in Entire Watershed	111acres
Coastal Non-forested Uplands on Existing Refuge Lands	0 acres
Coastal Wetlands and Aquatic Habitat in Entire Watershed	2,627 acres
Coastal Wetlands and Aquatic Habitat on Existing Refuge Lands	2 acres
Conserved Lands in Entire Watershed	1,924,620acres
Length of Existing Refuge Trails	51.3 miles
Length of Existing Refuge Roads	134 miles

Many impacts are not considered significant, but are described as negligible, minor, or moderate. The magnitude of such changes is defined as follows:

- **Negligible—**Management actions would result in impacts that would not be detectable or if detected, would have impacts that would be considered localized, and short-term.

- **Minor—**Management actions would result in a detectable change, but the change would be slight and have only a local impact on the biotic community, the resource, or ecological processes. The change would be discountable, insignificant, and of little consequence and short-term in nature.

- **Moderate—**Management actions would result in a clearly detectable change. This could include changes to a local biotic population or habitat sufficient to cause a change in the abundance, distribution, or composition, but not changes that would affect the viability of populations or habitats. Changes to local ecological processes would be of a limited extent.

- **Significant—**Management actions would result in a clearly detectable change. The impacts would be substantial and highly noticeable and could result in widespread change. This could include changes in the abundance, distribution, or composition of local or regional populations or habitats to the extent that it would not likely continue in its previous condition or size. Significant ecological processes would be altered, and changes throughout the ecosystem would be expected. Thus, the impact would be long-term if not permanent.

Impact significance is defined in terms of intensity, the type, quality, and sensitivity of the resource involved, the location of a proposed projects, the duration of its effect (short- or long-term), and other considerations of context. It is not a value judgment, as some impacts can be beneficial for one species and adverse for another, or have a positive impact on visitor use but a negative impact on migratory birds.

In addition to the magnitude of impact (negligible, minor, moderate, or significant), the impacts of the management action on environmental attributes are described as *beneficial, adverse*, or *no impact*. Generally, an impact will be described as *beneficial* if we estimate it helps to improve the quality or quantity of native habitat, increase or enhance native species populations, or enhances the sustainability of biological diversity, integrity, or environmental health. Refuge actions can also be beneficial or adverse to physical and socioeconomic environments. An *adverse* impact arises from an action that we estimate would be detrimental to any aspect of the physical, socioeconomic, or biological environment, and that potentially could impede the intent of the CCP and its goals. When we say that there is *no impact* we mean there is no recognized or discernible beneficial or adverse impact.

Often the impacts of a proposed action have trade-offs, and it can be difficult to describe them as either solely beneficial or adverse. For example, refuge habitat management may benefit certain suite of species (forest-interior dwelling migratory birds), but may have adverse impacts to other species (grassland-nesting migratory birds). Factors that reduce the population of a predator may be adverse for the predator and positive for the prey. Therefore, sometimes our impact analysis does not describe impacts as either beneficial or adverse.

The duration of identified impacts and their consequences varies from those occurring for a brief period in the 15-year life of this plan (e.g., direct impacts of new construction), to those occurring more frequently during the year like mowing or invasive plant control. The duration of identified impacts and their consequences varies from short-term—lasting a matter of days or weeks (e.g., construction noise)—to permanent such as the presence of new infrastructure.

Estimates of impacts—whether beneficial or adverse—were based upon the following criteria:

- The expected degree or percent of change from current conditions in the resource, assuming it is quantifiable.

- The frequency, duration, and magnitude of the impact.

- The sensitivity of the resource to such an impact, or its resiliency to recover from such an impact, or its ability to respond positively to a management action.

- The potential for implementing preventive or mitigating measures to avoid or lessen adverse impacts.

Nulhegan Basin Division visitor contact station

Mark Maghini/USFWS

Finally, we consider the following:

- Cumulative impacts, defined by CEQ (1997) as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes the actions."

- The relationship between short-term uses of the human environment and the enhancement of long-term productivity. This relates to the balance or trade-off between the impacts from short-term (within the 15-year CCP timeframe) uses of the environment and the environment's long-term productivity (beyond the 15-year timeframe).

- The potential irreversible and irretrievable commitments of resources. Irreversible commitments are those that cannot be reversed. Irretrievable commitments are those that can be reversed, given sufficient time and resources, but that represent a loss for a period of time.

- Environmental justice impacts, including "identifying and addressing, as appropriate, any disproportionately high and adverse human health or environmental effects of the proposed action on minority populations and low-income populations (Executive Order 12898; 2/11/1994)."

For this discussion our baseline is the condition of the refuge as of mid-2013, represented by alternative A. At that time, the refuge was approximately 36,000 acres in size. Chapter 3 provides a description of the current refuge and watershed's socioeconomic, physical, and biological environments. It also describes current refuge staffing, administration, recreational offerings, and public use infrastructure.

There are certain classes of actions proposed in Chapter 4, "Alternatives, Including the Service-preferred Alternative," that do not require additional NEPA analysis because they are "categorically excluded" from further analysis or review. As such, their potential impacts are not analyzed in this chapter. These

include aspects of management that are both common to all alternatives, and are thought to have no significant impact either individually or when taken together (i.e., cumulatively), on the quality of the human environment. The following would qualify under the Service's list of categorical exclusions (as listed in 516 DM 8.5A), if individually proposed:

- Environmental education and interpretive programs (unless major construction is involved or significant increase in visitation is expected).
- Research, resource inventories, monitoring, and other resource information collection.
- Operations and maintenance of existing infrastructure and facilities (unless major renovation is involved).
- Certain minor, routine, recurring management activities and improvements.
- Small construction projects (e.g., kiosks and interpretive signs).
- Native vegetation planting.
- Minor changes in amounts and types of public use.
- Issuance of new or revised management plans when only minor changes are planned.
- Law enforcement activities.

We recognize that we cannot fully address all the potential impacts associated with the alternatives through this planning process. We describe in chapter 4 under the section "Actions Common to All Alternatives; Additional NEPA Analysis" section, those future management decisions that may require more detailed analysis before they are implemented. We attempt to analyze the impacts of some of the available options in this document to the extent possible, but a more detailed analysis will be required to inform the final decision. For specific projects evaluated in the future, NEPA documents would be prepared that address and fully analyze the potential adverse and beneficial impacts. Our goal is to develop and implement all future plans to minimize adverse impacts while maximizing the long-term benefits to each resource. Each additional NEPA analysis will include compliance with applicable Federal laws and mandates including the Endangered Species Act, the National Historic Preservation Act, and the Coastal Zone Management Act, as appropriate. Although not a comprehensive list, we recognize that further analysis would be required for these projects:

- Habitat Management Plans (HMPs) for refuge divisions and units.
- Hunt Plans for refuge divisions and units by respective state (currently we have a completed hunt plan for existing refuge lands in Vermont—Nulhegan Basin Division and the Putney Mountain Unit—and for the Pondicherry Division). We will develop plans to cover all divisions/units in each of the remaining three watershed States Fishing Management Plans for refuge divisions and units by each watershed state.
- Fire Management Plan (following individual Division HMP completion).
- Visitor Services Plan.
- Integrated Pest Management Plan.

Impact Analysis and Relationship to Scale

We have organized this section by two major resource headings: "Regional-scale Impacts" and "Refuge-specific Impacts." Regional-scale analysis addresses impacts to several resources areas we felt were best addressed at the larger regional scale. This includes impacts to the socioeconomic environment and physical environment, such as air quality, hydrology and water quality, and climate change. As noted in the discussion of context for this impact analysis, the regional-scale context includes the Connecticut River watershed and portions of the four watershed states: Connecticut, Massachusetts, Vermont, and New Hampshire. Refuge-specific impacts encompass aspects of the physical, biological, and socioeconomic environment, but at a smaller scale (table 5.2).

Each section addresses the projected types of impacts, adverse and beneficial, potentially resulting from CCP management actions presented in the different alternatives. We also describe, when possible, how impacts differ across alternatives. In doing so, impacts can more clearly be compared and evaluated. Last, concluding summary statements about impacts are provided for each section analyzed.

Table 5.2. Format of Impact Analysis

Resource Impacted	Resource Aspect	Regional-scale	Refuge-specific
Physical	Air quality	✔	✔
	Hydrology and water quality	✔	✔
	Climate change	✔	
	Soils		✔
Biological	Freshwater wetlands		✔
	Upland habitats		✔
	Biological integrity, diversity, and environmental health		✔
	Federal and state threatened and endangered species		✔
	Birds		✔
	Mammals		✔
	Reptiles, amphibians, fish, and other aquatic species		✔
	Other native fauna and flora		✔
Socioeconomic	Refuge revenue sharing	✔	✔
	Refuge visitor expenditures in local economy	✔	✔
	Refuge administration	✔	✔
	Habitat management	✔	✔
	Land use	✔	✔
	Environmental justice	✔	✔
	Public use and access	✔	✔
	Archaeological, historical, and cultural	✔	✔

Hunter check

Brett Billings/USFWS

Background and Context for Alternatives

The following provides some context for our analysis by highlighting the major distinctions between the four alternatives. As of 2013, the refuge was 37,000 acres in size. Under alterative A, we would continue to acquire additional refuge lands as described in the refuge's 1995 EIS and subsequent NEPA documents (up to 97,830 acres). Under alternatives B, C, and D we also propose to acquire additional refuge lands. Under alternative D we propose the largest refuge expansion; followed by alternative C. Table 5.3 depicts the differences in the proposed refuge acquisition boundary by alternative. For the locations of the proposed CFAs by alternative, see maps 4.20 to 4.40 in chapter 4. Over the 15-year life of the CCP, we expect to acquire approximately the same number of acres regardless of the alternative chosen. We estimate that we will continue to acquire new refuge lands at approximately the same rate as we have previously. On average, we have acquired an average of 2,117 acres, annually, although the average for the past 5 years is 647 acres annually. It is only in the long term, far beyond 15 years, that we expect larger differences in the size of the refuge.

Alternative A is referred to as a 'no-action' alternative because it assumes no change in current habitat management, including continuing current habitat management on about 455 acres, encouraging floodplain and riparian restoration, and control of invasive plants. In contrast, the 'action' alternatives B, C, and D propose different habitat management scenarios. Each of the alternatives differs in the amount and intensity of proposed active habitat management activities (table 5.4), which will be discussed throughout this analysis. In order to reduce redundancy, throughout the chapter we refer the reader back to table 5.4 for a summary of proposed active habitat management. Readers can also refer to the following impact sections below where we provide more detailed information on active habitat management: air quality, upland habitats, wetland habitats, federally listed species, and all other wildlife sections. Also, appendix A provides much more detailed information on our proposed habitat management for each CFA under alternatives B and C.

Similarly, alternative A also continues existing public use programs. The three other alternatives differ in the types of recreational activities offered and the projected amount of refuge visitation (Table 5.5).

Table 5.3. Comparison of Refuge Acquisition Boundary Under Each Alternative.

Acres	Alternative A	Alternative B	Alternative C	Alternative D
Current Refuge Lands (As of February 1, 2016)	37,000			
Additional Acres Proposed for Acquisition	60,830	60,772	160,330	164,307
Total Acres	**97,830**	**97,772**	**197,337**	**231,307**

Table 5.4. Approximate Acres to Be Actively Managed by Alternative to Provide Habitat for Priority Refuge Resources of Concern*

Habitat Management Activity	Approximate number of acres to be actively managed *			
	Alternative A	Alternative B	Alternative C	Alternative D
Forest (Wetland or Upland)				
Even-aged management	195 acres (60 to 65 acres/5 years)	1,560 acres (520 acres/5 years)	1,950 (650 acres/5 years)	0
Uneven-aged management	45 acres (3 acres/year)	4,500 acres (250 to 300 acres/year)	7,500 acres (350-500 acres/year)	0
Tree planting	15 acres (1 acre/year)	1,600 acres (320 acres/2 to 3 years)	2,100 acres (420 acres/2-3 years)	0
Forest total	*255*	*7,660*	*11,550*	*0*
Grassland**				
Mowing or burning	200 acres (all acres treated at least once every 3 years)	422 acres (all acres treated at least once every 3 years)	548 acres (all acres treated at least once every 3 years)	0
Shrubland ***				
Brushhog or Brontosaurus	0	775 acres (all acres treated at least once each 15 years)	775 acres (all acres treated at least once each 15 years)	0
Total Managed Acres	**455 acres (less than 1 percent of potential refuge)**	**9,312 acres (about 9 percent of potential refuge)**	**12,873 acres (about 6.5 percent of potential refuge)**	**0 acres (0 percent of potential refuge)**

* *This* **approximation of acres** *to be managed for habitat assumes full implementation of the CCP (e.g. staffing, funding, and land acquisition) over the 15-year CCP timeframe and beyond, and is based on limited, available resource information on refuge lands yet to be acquired. As new lands are acquired, and we assess habitat conditions, we will likely need to adjust these acres. All subsequent habitat management actions will conform to a site-specific Habitat Management Plan (HMP) derived from the management objectives prescribed in the final CCP*

** *Grassland acres by alternative represents the full footprint of grassland habitat for the refuge*

** *Shrubland acres by alternative represents the full footprint of shrubland habitat for the refuge; the majority of this habitat type to be managed to benefit New England cottontail.*

Table 5.5. Estimated Annual Visits on Refuge Lands, Refuge Educational Venues, and Refuge Events by Alternative.

Current and Projected Visitor Use	Alternative A	Alternative B	Alternative C	Alternative D
Total Visitation	**206,677**	**252,995**	**318,199**	**257,826**
Change from alternative A	0	+46,318 (+22%)	+111,522 (+54%)	+51,149 (+25%)
Visitation per Refuge activity:				
Hunting	2,105	5,880	11,820	14,160
Fishing	210	565	1,149	1,306
Wildlife Observation & Photography	5,786	26,190	53,190	37,600
Environmental Education and Interpretation	11,576	31,360	63,040	37,760
Snowmobiling	20,000	22,000	22,000	0
Sub-total On-refuge Visitation	**39,677**	**85,995**	**151,199**	**90,826**
Great Falls Discovery Center	7,500	7,500	7,500	7,500
Montshire Museum of Science	117,000	117,000	117,000	117,000
Wildlife on Wheels	6,000	6,000	6,000	6,000
Cabela's Conte Corner	36,500	36,500	36,500	36,500
Springfield Museum Conte Corner*	–	–	–	–
Sub-total Off-Refuge Visitation	**167,000**	**167,000**	**167,000**	**167,000**

** no data for Conte Corner at Springfield Museum, MA*

Regional-scale Impacts

Socioeconomic Impacts

Economists from the U.S. Geological Survey (USGS) conducted an analysis of the anticipated socioeconomic impacts of actions proposed in the four alternatives. Their full report (appendix I) provides information on the socioeconomic setting in the Connecticut River watershed, and discusses the potential benefits and adverse socioeconomic impacts of the four management alternatives.

Because of the vastness of the watershed, we decided to focus USGS's analysis on six sub-regions of the watershed where the refuge may have the greatest effect. We selected these six subregions based upon existing refuge lands and proposed future acquisitions:

(1) Northern Sub-region: Essex County, Vermont and Coos County, New Hampshire.

(2) White River Junction Sub-region: Orange County, Vermont, Windsor County, Vermont, and Grafton County, New Hampshire.

(3) Tri-State Border Sub-region: Windham County, Vermont, Cheshire County, New Hampshire, and Franklin County, Massachusetts.

(4) Greater Amherst Sub-region: Hampshire County, Massachusetts.

(5) Greater Hartford Sub-region: Hartford County, Connecticut.

(6) Southern Connecticut Sub-region: Middlesex County, Connecticut.

USGS estimated and compared potential socioeconomic impacts to each of the sub-regions from the four alternatives using a modeling system developed by the U.S. Forest Service called "Impacts Analysis for Planning" or IMPLAN. They analyzed economic effects in the following five categories:

(7) Refuge's purchase of goods and services:
The refuge purchases a wide variety of supplies and services for operation and maintenance activities (i.e., non-salary expenditures), many of which are purchased within the local area of each sub-region. Service purchases made within each sub-region contribute to the local economic impacts associated with the refuge.

Currently, in the Northern Sub-region, the majority (approximately 80 percent) of current non-salary expenditures are spent on cooperative agreements to fund the YCC program, environmental education and interpretive programs, and the WoW Express mobile environmental education center. In both the Tri-State Border and Greater Amherst Sub-regions, the majority of non-salary expenditures are spent on overhead and administration costs, while in the Southern Connecticut Sub-region a majority of these expenditures is spent on habitat management and infrastructure maintenance. In 2012, annual non-salary refuge expenditures totaled approximately $248,000 in the Northern Sub-region, $95,000 in the Tri-State Border Sub-region, $27,000 in the Greater Amherst Sub-region, and $2,000 in the Southern Connecticut Sub-region.

(8) Refuge personnel salary spending:
Refuge employees reside and spend their salaries on daily living expenses in the communities within the sub-regions where they live and work, thereby generating impacts within the local economy. Household consumption expenditures consist of payments by individuals and households to industries for goods and services used for personal consumption. Salary expenditures made by refuge personnel contribute to the local economic impacts associated with the refuge.

Currently, refuge salaries total over $1.21 million per year across three sub-regions. The Greater Amherst Sub-region receives a majority of the funds, with an average of $550,500 spent annually in the region. Salary expenditures in the Northern Sub-region and Tri-State Border Sub-region total $266,500 and $397,100, respectively.

(9) Refuge revenue sharing payments:
Although, the Federal government does not pay property taxes on lands it manages, the Service does provide annual "refuge revenue sharing payments" to towns and/or counties where national wildlife refuges are located. The purpose of these refuge revenue sharing payments is to lessen economic hardship to communities from the loss of tax revenue. Congress has the discretion to appropriate funds for refuge revenue sharing.

In 2012, the refuge made over $53,000 in refuge revenue sharing payments to 18 different municipalities. For more information on recent refuge revenue sharing payments, see table 3.7 in chapter 3.

(10) Refuge visitor spending:
Refuge visitors often buy a wide range of goods and services while visiting the area, including expenditures such as lodging, restaurants, supplies, groceries, and recreational equipment rental.

Currently, approximately between 20,000 and 30,000 visits occur on the existing refuge divisions and units annually. Off-refuge visitation, including visits to the Great Falls Discovery Center, Montshire Museum of Science,

Wildlife on Wheels, Cabela's Conte Corner, and the Springfield Museum Conte Corner, reach an additional 150,000 to 200,000 people annually. In the Northern Sub-region, non-local visitation accounts for about three jobs and about $283,500. Non-local visitor spending in the Tri-State Border Sub-region accounts for one job and about $95,900. In the Greater Amherst Sub-region, the total economic impact of non-local visitor spending is less than one job and about $3,700. Finally, in the Southern Connecticut Sub-region, the total economic impact of non-local spending is less than one job and about $5,000.

(11) Economic contribution of habitat management on the refuge (e.g., timber harvesting and agriculture):
Some refuge management actions can produce merchantable products such as timber and hay. The sale of these products can contribute to local economies. Conversely, refuge acquisition can remove productive land from economic uses. In order to achieve refuge wildlife and habitat goals, these lands may no longer be actively managed to produce agricultural and wood products. The refuge may continue to harvest products from some of these lands, but it would likely be at a much smaller scale than previously. The loss of these working lands may affect local economies.

Under all alternatives, there are several factors that would potentially moderate the effects to local communities from the refuge's acquisition of commercial forest land. These factors make it difficult to accurately predict our exact contributions to the local economy from habitat management. These factors include:

a. The employment associated with forest-based recreation and tourism is likely to remain unchanged or increase as these activities will still be taking place on refuge managed lands and demand for these services and goods will continue at current levels, if not increase.

b. We will only acquire lands from willing sellers.

c. Sometimes private landowners harvest some of their forest lands prior to sale to the refuge. In those cases, some economic gains would be realized by the private owner prior to Service ownership.

d. Landowners are financially compensated when they enter into a purchase agreement with the Service. Though it is unknown how those dollars would be spent, it is likely that some of the money would be injected into the local economy through the purchase of equipment, goods, and services from local retailers or by the purchase of additional lands.

e. Where appropriate and compatible, the intention of the refuge is to actively manage forests and grasslands for wildlife habitat using commercial means as the preferred management technique.

f. As we actively manage refuge lands for wildlife habitat, we will continue to produce some products that will be purchased within local economies (e.g., forest products, hay, etc.).

g. The amount and location of commercial forestry land to be acquired is highly uncertain, and acquisition is expected to occur gradually over the next several decades. The rate of Federal acquisition would depend on willing sellers and available budgets.

Again, the acquisition of these lands is highly variable and as such, it is not appropriate to model the economic impacts due to the high level of speculation

on where these acquisitions may occur as well as the timeframe in which they will occur.

Here we summarize the USGS report findings. Most of their analysis focused on short-term impacts (over the next 15 years). For more detailed information, please refer to appendix I for their full report.

Under all alternatives, we predict off-refuge visits will remain the same as current numbers. As visitation increases, we expect a commensurate increase in visitor spending.

Under all alternatives the refuge will continue to pay refuge revenue sharing payments to towns and counties. Because Congress annually sets the formula for calculating refuge revenue sharing payments, we cannot accurately predict the amount we will pay to towns and counties in the future. Unfortunately, in recent years funds available and revenue sharing payments to towns and counties have been decreasing. We plan to use a combination of conservation easements and fee-title acquisition. This will help mitigate the refuge's impact to local tax revenues; lands where we acquire conservation easements will continue to stay on local tax rolls, although property taxes often are reduced based upon the terms of a conservation easement. Our target is to acquire an average of 65 percent of future acquisitions through fee-title and the remaining 35 percent through conservation easements. We cannot guarantee that actual percentage of fee-title versus conservation easement acquisition, which will depend on willing sellers' preferences. We predict that we will be more likely to acquire conservation easements in the more northern sub-regions as compared to the more southern sub-regions.

Artist at the Pondicherry Division

David Govatski

Socioeconomic Effects of Alternative A

Purchase of goods and services under Alternative A

As compared to current levels, we estimate that over the 15-year life of the CCP non-salary expenditures will decrease in some sub-regions, while increasing in others. We anticipate that non-salary annual expenditures will decrease in the Northern (-$8,500) and Tri-State Border (-$63,600) Sub-regions under alternative A. Non-salary expenditures are expected to increase across the remaining sub-regions. Within the Greater Amherst and Southern Connecticut Sub-regions, expenditures are expected to increase by nearly $30,000 and $26,000, respectively. Currently the refuge does not spend money in the White River Sub-region or the Greater Hartford Sub-region because we do not currently own any refuge lands in these areas. Under alternative A, as lands are acquired in these areas, the refuge may potentially spend up to approximately $4,000 annually in the White River Sub-region and up to $40,000 annually in the Greater Hartford Sub-region.

Refuge personnel salary spending under Alternative A

Under alternative A, staffing would remain the same as current levels across the refuge and, therefore, we would expect personnel salary spending to continue at similar levels.

Refuge revenue sharing payments under Alternative A

We will pay additional refuge revenue sharing payments as we acquire new lands under alternative A (up to a total of 97,830 acres).

Refuge visitor spending under Alternative A
Under alternative A, overall visitation (both on and off refuge) is projected to be about 206,677 visits. This is an increase to on-refuge visits over current numbers, and is the smallest projected total visitor use among the proposed alternatives.

We predict the increases in visitation will differ by economic sub-region. Visitation is expected to remain largely the same in the Northern, White River Junction, and Tri-State Border Sub-regions. In the Greater Amherst Sub-region, once we complete the Fort River accessible trail (anticipated formal opening is in fall 2014) we expect annual visitation to increase tenfold (to approximately 3,000 visits). In the Greater Hartford Sub-region, as we acquire lands, we expect to complete up to two universal access ADA-compliant trails, which would add approximately 12,000 annual visits. Current visitation is also expected to increase in the Southern Connecticut Sub-region as land acquisitions occur. The additional land purchased is expected to draw about 4,000 visitors annually to the sub-region.

Based on these visitation projections, we expect visitor spending will increase in the Greater Amherst Sub-region, Greater Hartford, and Southern Connecticut Sub-region. Visitor spending in the other sub-regions will likely be similar to existing spending.

Economic contribution of habitat management on the refuge under Alternative A
Under all alternatives, we may acquire up to an additional 32,000 acres of commercial forest lands across several sub-regions over the next 15 years. We predict that more than half of those newly acquired forest lands would be spread across the Northern, White River Junction, and Tri-State Border sub-regions. We would continue to manage the woodcock management demonstration units in the Northern Sub-region and up to 200 acres of grassland each year across the Northern and Greater Amherst Sub-regions for migratory birds and other wildlife. As part of this management we may generate some timber products and hay.

Socioeconomic Effects of Alternative B
Purchase of goods and services under Alternative B
Under alternative B, refuge staff expects total non-salary expenditures to remain the same as under alternative A, but expenditures across regions will shift. While it is anticipated that under alternative B fewer purchases of goods and services will occur in the Northern and Greater Amherst Sub-regions, additional expenditures are expected in the White River Junction, Tri-State Border, Greater Hartford, and Southern Connecticut Sub-regions.

Refuge personnel salary spending under Alternative B
Same as alternative A.

Refuge revenue sharing payments under Alternative B
We expect that over both the short term and long term that refuge revenue sharing payments under B would be similar to alternative A. This is because we are proposing to purchase similar amounts of land under alternatives A and B (up to a total of 97,830 acres under A and up to a total of 97,772 acres under B). We also anticipate acquiring a similar 65/35 percent ratio of fee-title acquisitions and conservation easements as under alternative A.

Refuge visitor spending under Alternative B
Under alternative B, overall visitation (both on and off refuge) is projected to be about 252,995 visits. This is a projected increase of 46,318 (22%) over alternative A. Under alternatives C and D, we would expect larger increases in visitation. As visitation increases, we expect a commensurate increase in visitor spending.

In the Northern Sub-region, it is estimated that visitation, and therefore visitor spending, will not change under alternative B. Visitation in the White River Junction Sub-region is expected to increase by an additional 4,500 visits annually as additional land is acquired and universal trail access is established at the Ompompanoosuc River Division. Similarly, visitation in the Tri-State Border Sub-region is expected to increase by 3,000 annual visits as additional lands are acquired and trail access improved. In the Greater Amherst Sub-region it is estimated that annual visitation will be 4,000 as universal trail access is established at the Dead Branch, Westfield River, and Mill River Divisions. In the Greater Hartford Sub-region, visitation is expected to increase by an estimated 1,500 visits annually as universal trail access is added to the Farmington River Division. Finally, visitation in the Southern Connecticut Sub-region under alternative B is predicted to be the same as under alternative A.

Economic contribution of habitat management on the refuge under Alternative B
In the short term, the economic contribution would be similar to alternative A. When fully implemented (i.e., the refuge acquires the total proposed 97,772 acreage), we would harvest an average of 60 to 65 acres of forest every 5 years in the 300 acre woodcock management unit in the Northern Sub-region. We will continue to maintain the existing 200 acres grassland acres on the refuge (Northern and Greater Amherst Sub-regions) by periodic mowing.

Socioeconomic Effects of Alternative C
Purchase of goods and services under Alternative C
Under alternative C, refuge staff expect an increase in total goods and services purchases of about $175,000 annually. Under alternative C, the purchase of goods and services is expected to increase across all sub-regions with the exception of the Northern Sub-region. The greatest increase in expected non-salary expenditures will occur in the Tri-State Border and White River Junction Sub-regions, with both regions having an expected increase of greater than $100,000, annually.

Refuge personnel salary spending under Alternative C
Under alternative C, an additional ten positions are projected for the Tri-State Border Sub-region and six additional positions are projected for the Northern Sub-region. Similar to alternatives A and B, under alternative C, new staff will not be hired in the White River or Greater Hartford Sub-regions. The hiring of new staff will be dependent on budgets and will vary depending on availability of funds. We cannot predict which sub-region new staff will live and subsequently spend their salaries and as a result, the economic impacts of new staff cannot be reasonably allocated to a specific region.

Refuge revenue sharing payments under Alternative C
In the short term (within the 15-year timeframe of the CCP), we expect refuge revenue sharing payments under alternative C to be similar to alternatives A and B. Over the longer term, we expect to pay a greater amount of refuge revenue sharing payments to a higher number of towns and counties under alternative C as compared to alternatives B and C. This is because we are proposing to acquire more lands in more sub-regions of the watershed under alternative C (up to 197,337 acres). We also anticipate acquiring a similar 65:35 ratio of fee-title acquisitions and conservation easements under alternative C as under alternatives A and B.

Refuge visitor spending under Alternative C
Under alternative C, overall visitation (both on and off refuge) is projected to be about 318,199 visits. This is a projected increase of 111,522 compared to alternative A, and the greatest increase compared to the other alternatives (54%). As visitation increases, we expect a commensurate increase in visitor spending.

Similar to alternative B, under alternative C visitation in the Northern Sub-region is not expected to change. Under alternative C, visitation in the White River Junction Sub-region is expected to increase similarly to alternative B, plus an additional 1,500 visitors due to the establishment of a trail at the Sprague Brook Division, for a total of 6,000 additional visitors to the sub-region over alternative A. Visitation to both the Greater Amherst and Greater Hartford Sub-regions is expected to increase similarly under alternative C as estimated for alternative B. Under alternative C, visitation to the Southern Connecticut Sub-region is expected to be the same as alternatives A and B.

Economic contribution of habitat management on the refuge under Alternative C
In the short-term, the impacts under alternative C would be similar to alternatives A and B. Compared to the other alternatives, alternative C would generate the greatest amount of commercial products from habitat management (such as timber products and hay) over the long term. When fully implemented (i.e., the refuge acquires the total proposed 197,337 acreage), we would harvest approximately 500 acres of forest per year (including those currently harvested for woodcock at the Nulhegan Basin Division). We also anticipate mowing or burning approximately 550 acres of grasslands. These 550 acres would be treated rotationally, either annually or every 2 or 3 years. Similar to alternative B, as we acquire new refuge lands that are in early-successional habitat, we will evaluate whether continue to maintain them as early-successional habitat through forest harvesting. We will also develop a HMP with more details on our proposed habitat management.

Socioeconomic Effects of Alternative D
Purchase of goods and services under Alternative D
The purchase of goods and services under alternative D is quite similar to those expected under alternative C. Again, it is expected that all sub-regions, with the exception of the Northern Sub-region, will experience an increase in the purchase of goods and services by the refuge. Under alternative D, the greatest increase will occur in the White River Sub-region, due to our proposed refuge expansions in that area. All non-salary expenditures will be highly dependent on the location of land acquisitions, which are unknown at this time; therefore, USGS did not model estimates of future expenditures.

Refuge personnel salary spending under Alternative D
Same as alternative C.

Refuge revenue sharing payments under Alternative D
In the short term (within the 15-year timeframe of this CCP), we expect refuge revenue sharing payments under alternative D to be similar to alternatives A, B, and C. Over the longer term, we expect to pay a greatest amount of refuge revenue sharing payments to a higher number of towns and counties under alternative D as compared to the other alternatives. This is because we are proposing the greatest refuge expansion under alternative D (up to 231,307 acres).

We also anticipate acquiring a similar 65:35 ratio of fee-title acquisitions and conservation easements as under alternative D as under alternatives A, B, and C.

Refuge visitor spending under Alternative D
Under alternative D, overall refuge visitation (both on and off refuge) is projected to be about 257,826 visits. This is a projected increase of 51,149 over alternative A. The total number of predicted annual visits is slightly higher under alternative D compared to alternative B, but is much less than under alternative C. As visitation increases, we expect a commensurate increase in visitor spending.

Under alternative D, visitation in the Northern Sub-region is expected to decrease by approximately 16,000 visitors as 35 miles of snowmobile trails will be eliminated. Total visitation is estimated to be about 6,000 visitors. Alternative D does not include the construction of developed trails, so visitation in the White River Junction and Greater Amherst Sub-regions, is expected to increase annually by only 2,000 visits and 1,500 visits, respectively. Although trail development in the Greater Hartford Sub-region is also not included under Alternative D, due to the region's close proximity to Hartford and its expanding population, visitation is expected to increase by 4,500 visitors. Finally, in the Southern Connecticut Sub-region, a trail development is planned once acquisition of the Whalebone Cove Division is completed. This is expected to result in an additional 1,500 visits, annually.

Economic contribution of habitat management on the refuge under Alternative D
Alternative D would generate the smallest economic contribution from habitat management. Under alternative D, we would not actively manage any refuge lands, except under extreme circumstances (e.g., to reduce dangerous fuel loads after catastrophic natural disturbances such as fires, pest outbreaks, hurricanes, or ice storms).

Impacts to Air Quality

Introduction to Air Quality Impacts
Chapter 3, "Affected Environment" presents the status of air quality in the surrounding refuge landscape and Connecticut River watershed. We evaluated the management actions proposed in each alternative for their impacts on air quality, including their potential to help improve local and regional air quality. In addition, gases that affect air quality from a health perspective also contribute to climate change. These gases include carbon dioxide, methane, nitrous oxides and ozone, and are addressed in this section. The changes in greenhouse gasses will be reflective of impacts to climate change. A discussion of how the effects of climate change will impact Conte Refuge's ability to execute the CCP and modify the impacts from CCP implementation is included in the section *Climate Change Impacts*, below.

The benefits we considered included:

- Improved air quality from habitat protection and management actions.
- Reduction in the refuge's contribution to emissions as a result of adopting energy efficient practices.

The potential adverse effects of the management alternatives that were evaluated included increases in:

- Poor air quality from certain habitat management actions.
- Emissions, including greenhouse gas emissions[1] from buildings, construction, equipment use, and from refuge staff and visitor vehicles.
- Particulates and greenhouse gases from prescribed burning for habitat management.

[1] Greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide(NO_x), hydrofluorocarbons, perfluorocarbons, nitrogen triflouride, and sulfur hexafluoride, per Executive Order 13693.

Air Quality Impacts That Would Not Vary By Alternative
Beneficial Impacts on Air Quality from habitat protection and management
We expect refuge land conservation and management across all alternatives to help reduce any future direct and indirect adverse impacts by maintaining and enhancing natural vegetative cover. Air quality is enhanced by maintaining forests, wetlands, and grasslands in vegetative cover (Dwyer et al. 1992).

Our analysis of air quality impacts considered only how the Service's actions at the refuge might affect criteria air pollutants, visibility, and global warming, focusing on the potential for localized beneficial or adverse air quality impacts. Across all alternatives, our professional judgement is that these habitat conservation and management actions lead to lower levels of emissions in areas near the refuge and higher air quality due the air pollutant filtering function of vegetation on the existing 37,000-acre refuge (Daily et al. 1997(a)). We anticipate negligible beneficial air quality impacts from permanently protecting additional refuge lands. By preventing further development on these lands, we expect a reduction in local emission sources and pollution from industrial, commercial, and residential development (e.g., air-borne particulates, fossil fuel emissions). Based on past rates, land acquisition over the 15-year CCP timeframe is likely to be on the order of 9,000-32,000 acres, so the beneficial impacts on air quality over the next 15 years may be the same regardless of alternative selected.

Over the 15-year life of the CCP, we expect to acquire land under each alternative at a pace similar to our historical acquisition pattern. Therefore, beneficial impacts to air quality from land protection are expected to be the same across all alternatives. However, in the longer term, we anticipate that alternatives C and D will have greater benefits than alternatives A and B.

Beneficial Impacts on Air Quality from adopting energy efficient practices
Across all alternatives the refuge would seek to employ other alternative energy sources, such as solar panels and small-scale wind turbines, in order to reduce its direct and indirect contribution to greenhouse gas emissions. Additional beneficial impacts also would derive from energy efficiency and conservation at all refuge facilities, and in maintaining fuel efficient vehicles.

The Nulhegan Basin Division's headquarters/visitor contact station was the first in the Service to receive an ENERGY STAR designation, indicating that the facility performs better than at least 75 percent of similar buildings nationwide. Other existing buildings used by the refuge have not earned this designation, including quarters and maintenance buildings. The refuge has determined that these buildings are not suitable for upgrading to LEED or ENERGY STAR. No changes are proposed in the CCP; therefore impacts are not expected to vary among alternatives.

Adverse Impacts on Air Quality from emissions and pollution
There are no major stationary (e.g., power plant) or mobile (e.g., automobile) sources of air pollution present on refuge lands that would exceed EPA's New Source Performance Standards (NSPS), nor would any be created under any of the alternatives. Additionally, in the long term (beyond 15 years) there are no expectations that any major source of air pollution would be generated from the refuge.

There are three Class I airsheds located within the Connecticut River watershed: the Great Gulf Wilderness (5,552 acres) and Presidential Range-Dry River Wilderness (20,000 acres) areas in the White Mountain National Forest (New Hampshire) and the Lye Brook Wilderness area (12,430 acres) designated in the Green Mountain National Forest (Vermont). None of the proposed refuge activities (e.g., vehicle fleet use, forest harvesting, new trail construction) would

Snowmobilers at kiosk

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have any significant adverse impacts, either during the 15-year period covered by the CCP or the long term beyond it, on these airsheds.

The Service restricts human uses of the refuge to appropriate and compatible uses (usually wildlife-dependent uses), and thus limits human-derived uses that may impair air quality. Alternative C projects the highest levels of visitation, followed by alternatives D, B, and A (Table 5.5). Across these alternatives, impacts from non-snowmobile visitation are expected to be similar and negligibly adverse, over both the 15-year CCP horizon and the long term. Refuge vehicles (eight trucks, four SUVs (one hybrid), one mini-van, two ATVs, six snowmobiles, and one farm tractor), as well as contract heavy equipment, are estimated to average 100,000 miles traveled together on an annual basis. Treating all vehicles as equivalent, the EPA estimate for total annual CO2 emissions is 411 metric tons (EPA 2016). Emissions from public vehicles driven by visitors and volunteers are also projected to be very small, based on past use. Across the four alternatives, we anticipate that visitation to off-refuge sites, such as the Great Falls Discovery Center, Montshire Museum of Science, and the Wildlife on Wheels (WoW), will continue at existing levels (about 167,000 visits per year, Table 5.5). The air quality impacts of maintaining these facilities is expected to be negligible. Current CEQ guidance indicates that annual CO2-equivalent emissions below 25,000 metric tons do not warrant a detailed quantitative analysis.

Although the alternatives differ in the total amount of land the refuge is allowed to acquire, the history of the refuge indicates that we would likely not acquire all proposed new lands within the 15-year timeframe of the CCP. Since the refuge's inception, we have acquired an average of 2,117 acres per year, and the average for the past 5 years is only 647 acres. Therefore, non-snowmobile refuge use and visitation would not vary dramatically across alternatives.

Adverse Impacts on Air Quality from fire and associated smoke
Wildfire is not a substantive concern on the existing refuge or proposed new refuge lands because of the natural fire frequency regimes of the major

vegetative and forest types within the Connecticut River watershed. The watershed is dominated by vegetation that falls within Fire Regime Groups III, IV, and V. FRG III, in the central and southern Connecticut River valley, indicates a regime characterized by low and mixed severity fire at return intervals between 35 and 200 years . FRG IV, in the foothills, is characterized by high severity fire at return intervals between 35 and 200 . FRG V, which includes the Berkshires, Green Mountains, and Northern Forest, is characterized by fires of any severity at return intervals greater than 200 years. Salt marsh within the watershed is classified as FRG II, indicating a regime characterized by high severity fires at return intervals of fewer than 35 years (Landfire 2012). Because wildfire emissions are so unlikely, none of the alternatives propose regular fuel-load management. Therefore there are no likely adverse impacts, and this holds for all alternatives.

Under all alternatives, there is the potential for negligible (short term, localized) adverse impacts from seasonal wood burning at 30 private cabins at the refuge's Nulhegan Basin Division. Although alternatives B, C, and D propose the acquisition of an additional eight cabins, these cabins are currently in use and are thus not expected to generate air pollution above current levels over both the 15-year period covered by the CCP and longer time frames.

Adverse Impacts on Air Quality from other habitat management
Forest management activities are performed by logging contractors under supervision of the refuge forester. Emissions from heavy equipment used during logging operations may present a negligible adverse impact to air quality. An analysis of the effect of vegetation treatments across multiple forests found that while prescribed fire had little impact on forest carbon budgets in eastern forests, mechanical or combination treatments converted the forests from net sinks to sources in the first years following treatment. The degree of the change depends on the forest structure and composition prior to treatment as well as the type of treatment used. As forests re-establish, they can again become sinks (Depro et al. 2008). There is high uncertainty associated with the effect of different management strategies to sequester carbon (McKinley et al. 2011).

Air Quality Impacts Common to Alternatives A, B, and C
Adverse Impacts on Air Quality from emissions
Currently, there are an estimated 20,000 snowmobile visits annually on the Nulhegan Basin, Pondicherry, and Dead Branch Divisions (Table 5.5), thus subjecting these divisions to some short-term and long-term adverse impacts due to the emission of exhaust hydrocarbons from snowmobiles. Under alternative A, we would expect snowmobiling to continue at these levels. Air pollution from snowmobiles is well documented and can result in a number of health problems. Two-stroke engines are highly polluting and can emit high levels of carbon monoxide (CO), unburned hydrocarbons (HC) and smoke (NPS 2000). Figures submitted to the California Air Resources Board by the snow machine industry show that one two-stroke snowmobile emits the same volume of hydrocarbons and nitrous oxides as 1,000 cars, and as much carbon monoxide as 250 to 500 automobiles (Gierzynski 2008). However, newer four-stroke snowmobile engines reduce the amount of emissions somewhat. Large numbers of snowmobiles in one area (such as parking lots), cold, stable weather conditions, and low wind speed all increase the accumulation of fossil fuel toxins and increase the risk of adverse health effects (NPS 2000). Additionally, riding in groups of snowmobiles exposes the rider to emissions from the snowmobiles in front of them (Janssen and Schettler 2003).

Snowmobile trails on new lands to be acquired under these alternatives may be maintained, and in select situations closed trails may be opened to promote

wildlife-dependent public uses. If we acquire any new refuge lands with existing snowmobile trails that are part of a regional or state trail network, we may decide to allow the trails to remain open to help promote access to the refuge and to support wildlife-dependent public uses. Prior to allowing snowmobiling on new refuge lands, we would first determine that snowmobiling is appropriate and compatible on those lands. Although snowmobiling can introduce petroleum hydrocarbons to wild lands, it is unlikely that the potential short-term and long-term adverse impacts would be more than negligible to minor. Current snowmobile emissions do not cause the area to exceed federal or state air quality standards. None of the alternatives include an expansion of the existing snowmobile trail system, and thus do not represent an additional environmental impact. For further information, see the compatibility determination for snowmobiling in Appendix D, "Findings of Appropriateness and Compatibility Determinations."

Air Quality Impacts under Alternative A

Alternative A would continue current active management of forest and grassland habitats on 455 acres of habitat (1% of current refuge lands, see table 5.4), including 255 acres forest, 200 acres of grassland, and 0 acres of shrubland.

Forested habitat management under alternative A would focus on creating habitat for American woodcock and other species with similar habitat needs, continuing to implement the existing habitat management plan. We would harvest approximately 60-65 acres of forest every 5 years to conduct even-aged management across at total of 195 acres. In addition, uneven-aged management will continue on 45 acres, and tree planting will occur on 15 acres (4 acres/year, total). Habitat management under alternative A is designed to improve habitat structure for woodcock and other priority refuge resources of concern.

A total of 200 acres of grassland habitat are mowed or brush-hogged using a diesel-powered tractor at least once every 3 years within three refuge divisions: the Fort River, Nulhegan Basin, and Pondicherry Divisions. Grassland management under alternative A would be maintained to provide for priority refuge resources of concern grassland birds (e.g., bobolink, upland sandpiper, and breeding woodcock).

The refuge currently manages 20 miles of trails (e.g., Mud Pond Trail at Pondicherry Division, an ADA-compliant trail at Fort River, and Mollie Beattie Trail at Nulhegan Basin Division), 42 miles of gravel road (40 public, 2 administrative), and two overlooks.

Neutral Impacts. We do not plan to expand the trail system on current refuge lands under alternative A. Prescribed burning is not practiced or employed to manage habitats (except for hazardous forest fuel reduction), thus eliminating any potential for emission release. Our current invasive plant control does not use prescribed burning, relying instead on cutting, pulling by hand, and approved herbicides.

Beneficial Impacts. Over the 15-year CCP timeframe and beyond, there may be additional negligible to minor beneficial air quality impacts from vegetation on further land acquisitions up to a total of 97,830 acres within the original Special Focus Areas (SFAs).

Timber harvesting under alternative A has negligible beneficial impacts on air quality from carbon sequestration in regrowing vegetation. The benefit of carbon storage in forests is offset by how the harvested timber is used (McKinley et al. 2011), which is not within the refuge's control.

Adverse Impacts. Alternative A would include few and minor ground disturbing activities that could cause increases in fugitive dust (e.g., mowing, haying, limited forest management operations, hiking disturbance, or trail maintenance), consistent with past management, and introduce few emission sources (e.g., diesel emission from heavy equipment).

Alternative A is thought to have the lowest potential for annual on-refuge visitor increase (Table 5.5), since no expansion of hiking trails and visitor use is proposed. Using heavy equipment to maintain the current 20-mile hiking trail system is expected to have negligible adverse impacts to air quality.

We expect there to only be minor adverse air quality impacts from refuge staff driving vehicles to additional lands acquired during the lifetime of the CCP; these effects will vary depending on the location and management needs of any parcels acquired in the future.

We do not plan to increase capacity for snowmobiling within alternative A; rather, we plan only to maintain existing use levels, thereby minimizing any potential adverse air quality impacts beyond those described in the section *Impacts Common to Alternatives A, B, and C.*

The scope of impacts from forest management is described in the section *Air Quality Impacts that would not vary across alternatives*. Under alternative A, we propose to manage approximately 60 to 65 acres of forest every 5 years to improve habitats across refuge lands. The emissions and fugitive dust from timber harvest and tree planting activities is expected to be negligible (short-term and localized). The contribution of managed lands to carbon sequestration is highly uncertain. In general, the effect of harvest and other vegetation management releases carbon, while unmanaged lands, which make up the majority of the refuge, are more likely to be a carbon sink (Depro et al. 2008).

Because grassland management occurs infrequently and the treatment occurs on relatively small tracts of land (Fort River being the largest at 105 acres), in our professional judgement it will not have a greater than negligible adverse impact to local or regional air quality, either during the 15-year timeframe for the CCP or beyond.

Air Quality Impacts under Alternative B

Over the 15-year CCP horizon, we propose to actively 9,312 acres of habitat (compared to 455 acres under alternative A, and totaling 26% of current refuge lands), including 7,660 acres forest, 422 acres grassland, and 775 acres shrubland (Table 5.4).

Forest habitat management for American woodcock under alternative B would occur on 1,560 acres, harvesting approximately 520 acres every 5 years to create patches of early-successional forest. Forest management for other priority refuge resources of concern would take place on the remaining 6,100 acres of forest.

A total of 422 acres of grassland habitat may be mowed using a diesel-powered tractor, of which up to 100 acres may be prescription burned, at least once every 3 years within three refuge divisions: the Fort River, Nulhegan Basin, and Pondicherry Divisions. 775 acres of shrubland habitat may be brushogged, also using diesel-powered equipment, at least once every 15 years in the same Divisions. Grassland management under alternative B is intended to provide for priority refuge resources of concern, especially grassland birds (e.g., bobolink, upland sandpiper, and breeding woodcock). Shrubland management is intended

to provide for priority refuge resources of concern, including shrubland birds and New England cottontail.

Under alternative B, we propose to construct an approximately 1-mile-long, ADA-compliant hiking trail at each of the 19 CFAs. This would equate to the clearing and grooming of about approximately 2 acres of land for each trail mile, given that the trails would be between 4 and 8 feet wide. The direct impact from this work would affect up to 38 acres. We also propose adding 19 miles of new hiking trails, for a total of 58 miles of trails (Table 5.5).

Beneficial Impacts. Similar to the other alternatives, there would be short-term negligible to minor benefits to air quality from continuing to maintain the refuge's existing 37,000 acres of vegetation. Over the 15-year CCP timeframe and beyond, there may be negligible to minor beneficial air quality impacts from vegetation on further land acquisitions up to a total of 96,703 acres within the new more consolidated and generally larger 19 CFAs. These would be similar in scope although varying in location compared to alternative A because the total acreage proposed for acquisition is almost identical.

Alternative B would actively manage more acres than alternative A. The increase in habitat restoration may have a negligible positive, long-term impact on local air quality by favoring young, fast growing trees capable of rapidly sequestering carbon (Birdsey 1992). Consequently, we conclude that difference in benficial impacts to air quality between alternatives A, B, and C are negligible to minor.

Adverse Impacts. The adverse impacts of alternative B would be similar in kind to those described for alternative A. Although there would be a modest increase in management activity and visitation within the 19 CFAs, none of the management actions (described below) or emissions related to visitor use would tip adverse air quality impacts into a detectable level, particularly since activities would be conducted over time and over a larger landscape.

Maintaining the trail system is expected to have negligible short-term and long-term adverse impacts to air quality. Trail construction may release small amounts of fugitive dust, particulates, and hydrocarbon emissions to the new trail environment (e.g., from chainsaw operation, etc.). These adverse impacts are viewed as extremely short-term and negligible, and would have no detectable adverse impact over the long term. Public use trails and vehicle parking lots are carefully placed and managed to avoid or minimize adverse impacts to the refuge's air quality and diverse habitats. Moreover, given future funding expectations, it is not likely that the full extent of trails proposed in alternative B would be achieved within the CCP 15-year period, in which case these adverse impacts would be reduced. Long term impacts beyond that horizon are likely to have negligible adverse impacts.

Under alternative B, there would be an estimated 22,000 snowmobile visits annually to the Nulhegan Basin, Pondicherry, and Dead Branch Divisions. This represents an estimated increase of 2,000 visits over alternative A (Table 5.5). Most of the increased visitation is projected to occur in the new, approximately 1.4-mile spur trail that accesses to the Nulhegan Basin Division visitor contact facility. Management of existing snowmobile trails on refuge lands, and lands subject to potential acquisition, would be managed as described in *Air Quality Impacts Common to Alternatives A, B, and C.* We do not expect a noticeable change from current levels in emissions from snowmobiling. Although we may close some existing snowmobile routes where appropriate, such restrictions may not necessarily reduce vehicular emissions within the local area. Users

are quick to adapt to alternate routes, some of which maybe be longer or are on lands adjacent to the refuge. Consequently, we believe the potential adverse impacts from snowmobiling under this alternative would be comparable to those described in alternatives A and C, but potentially much greater than in alternative D (which prohibits all snowmobiling).

Compared to alternative A, we expect increases in refuge visitation stemming from the acquisition of additional refuge lands and increased trail mileage (Table 5.5). However, the projected increases would not pose any detectable increase in air emissions and pollutants due to public vehicles used on the refuge, or in any of the off-refuge environmental education activities (e.g., WoW Express). Overall, impacts from public vehicles under alternative B would be larger than alternative A, comparable to alternative C, but larger than alternative D (which eliminates snowmobiling on refuge lands). Since this alternative proposes fewer, more consolidated CFAs (19), there would be less refuge vehicular use, and therefore emissions, from refuge staff traveling between refuge lands, as compared to alternative A (65 SFAs). Emissions levels would likely be similar to alternatives C (22 CFAs) and D (22 CFAs).

The scope of impacts from forest management is described in the section Air Quality Impacts that would not vary across alternatives. Under alternative B, we propose varying forest management strategies (see table 5.4) affecting several hundred acres per year on average, in order to improve habitats across refuge lands. The emissions and fugitive dust from timber harvest and tree planting activities is expected to be negligible (short-term and localized). The contribution of managed lands to carbon sequestration is highly uncertain. In general, the effect of harvest and other vegetation management releases carbon, while unmanaged lands, which make up the majority of the refuge, are more likely to be a carbon sink (Depro et al. 2008). These impacts to air quality from forest management would be greater under alternative B than alternatives A or D, but less than under alternative C.

Because grassland management occurs infrequently and the treatment occurs on relatively small tracts of land (Fort River being the largest at 105 acres), in our professional judgement it will not have a greater than negligible adverse impact to local or regional air quality, either during the 15-year timeframe for the CCP or beyond. Compare to the other alternatives, the impacts will be much greater than alternative D, twice as large as alternative A, and smaller than under alternative C.

Under alternative B, we would occasionally use prescribed burning to manage refuge habitats. We anticipate using prescribed burning on 100 or fewer acres per year. As we acquire additional refuge lands and develop HMPs, we will consider use of additional prescribed burning as necessary. Such burning would be conducted under conditions outlined in a Fire Management Plan (FMP) (to be developed under NEPA compliance after the CCP). Adverse short-term impacts to air quality from prescribed burning operations (e.g. particulates, CO, CO_2, hydrocarbons, and small quantities of NO_x) are expected to be direct and local, with an overall minor impact. The air quality impacts from prescription burning are similar to that of other habitat maintenance (e.g., emissions from vehicles, chainsaws, etc.). The primary additional impact from prescribed fire comes from the air pollution that results from combustion; if air quality in a given region is approaching the standard for particulate matter, prescribed burning could cause that region to exceed the daily limits (Monroe et al. 2013). Burning vegetation can result in the release of a variety of air pollutants including aerosols of organic acids and hydrocarbons, and particulate matter of various size fractions. The type of pollutants varies with the type of fuel, its moisture content, the

temperature of the fire, and the length of time materials continue to smolder after the fire. The long-term impacts to air quality will be negligible given the infrequency of burn applications. We would generally use prescribed burning in forest habitats in a way that mimics the historical fire regime (e.g., frequent low severity fires in pitch pine forests in Massachusetts and Connecticut). We would also use prescribed fire to maintain some patches of grasslands. Smoke and other particulates will be minimized through using BMPs and smoke dispersion models. We will use BMPs and follow prescribed burn plans, which consider smoke dispersion models and address smoke management and other environmental and geographical factors, to minimize adverse air quality and visibility impacts on surrounding communities. Alternative B proposes constructing an outdoor classroom at the Fort River Division. A separate NEPA analysis will be conducted prior to constructing any additional structures, which would consider air quality impacts associated with that activity.

Air Quality Impacts under Alternative C

Over the 15-year CCP horizon, we propose to actively manage approximately 12,873 acres of habitat to improve habitat for priority wildlife, fish, and plant species (compared to 455 acres under alternative A), including 11,550 acres forest, 548 acres grassland, and 775 acres shrubland (table 5.4).

Forest habitat management for American woodcock under alternative C would occur on 1,950 acres, harvesting approximately 650 acres every 5 years to create patches of early-successio*nal forest*. Forest management for other priority refuge resources of concern would take place on the remaining 9,600 acres of forest.

A total of 548 acres of grassland habitat may be mowed using a diesel-powered tractor, of which up to 100 acres may be prescription burned, at least once every 3 years within three refuge divisions: the Fort River, Nulhegan Basin, and Pondicherry Divisions. 775 acres of shrubland habitat may be brushogged, also using diesel-powered equipment, at least once every 15 years, in the same Divisions. Grassland management under alternative C is intended to provide for priority refuge resources of concern, especially grassland birds (e.g., bobolink, upland sandpiper, and breeding woodcock). Shrubland management is intended to provide for priority refuge resources of concern, including shrubland birds and New England cottontail.

Under alternative C, we propose to construct an approximately 1-mile-long, ADA-compliant hiking trail at each of the 19 CFAs. This would equate to the clearing and grooming of about approximately 2 acres of land for each trail mile, given that the trails would be between 4 and 8 feet wide. The direct impact from this work would affect up to 38 acres. We also propose adding 22 miles of new hiking trails, for a total of 61 miles of trails (Table 5.5).

Beneficial Impacts. Similar to the other alternatives, there would be negligible to minor benefits to air quality from continuing to maintain the refuge's existing 37,000 acres of vegetation. Over the 15-year CCP timeframe and beyond, there would be an additional benefit from acquiring up to 197,337 acres within the new more consolidated and generally larger 22 CFAs, compared to alternative A's 65 SFAs.

Alternative C would actively manage the most acres among the four alternatives. The types of beneficial impacts under alternative C would be similar to those described under alternatives A and B, particularly over the 15-year CCP timeframe, but they would be realized across a considerably larger land area and have twice the beneficial impacts over the long-term (greater than 15 years).

These beneficial impacts are negligible to minor, but would be greater under alternative C than the other alternatives.

Adverse Impacts. The adverse impacts of alternative C would be similar in kind to those described for alternatives A and B. Although a modest increase in management activity and visitation within the 22 CFAs is projected, none of the management actions (described below) or emissions related to visitor use would cause adverse air pollution to exceed state standards, particularly since activities would be conducted over time and over a larger landscape.

Maintaining the trail system is expected to have negligible short-term and long-term adverse impacts to air quality. Trail construction may release small amounts of fugitive dust, particulates, and hydrocarbon emissions to the new trail environment (e.g., from chainsaw operation, etc.). These adverse impacts are viewed as extremely short-term and negligible, and would have no detectable adverse impact over the long term. Public use trails and vehicle parking lots are carefully placed and managed to avoid or minimize adverse impacts to the refuge's air quality and diverse habitats. Moreover, given future funding expectations, it is not likely that the full extent of trails proposed in alternative C would be achieved within the CCP 15-year period, in which case these adverse impacts would be reduced. Long term impacts beyond that horizon are likely to have negligible adverse impacts.

Under alternative C, there would be an estimated 22,600 snowmobile visits annually to the Nulhegan Basin, Pondicherry, and Dead Branch Divisions, representing an increase of 2,600 visits over alternative A and 600 visits over alternative B (Table 5.5). Most of the increased visitation is projected to occur in the new, approximately 1.4-mile spur trail that will access to the Nulhegan Basin Division visitor contact facility. Management of existing snowmobile trails on refuge lands, and lands subject to potential acquisition, would be managed as described in *Air Quality Impacts Common to Alternatives A, B, and C.* We do not expect a noticeable change from current levels in emissions from snowmobiling. Although we may close some existing snowmobile routes where appropriate, such restrictions may not necessarily reduce vehicular emissions within the local area. Users are quick to adapt to alternate routes, some of which

Green winged teal

Donna Dewhurst/USFWS

maybe be longer or are on lands adjacent to the refuge. Consequently, we believe the potential adverse impacts from snowmobiling under this alternative would be nearly identical to those described in alternatives A and B, but much greater than in alternative D (which prohibits all snowmobiling).

We project the highest level of visitation under alternative C, due to the acquisition of additional refuge lands and increased trail mileage (Table 5.5). However, the projected increases would not pose any detectable increase in air emissions and pollutants due to public vehicles used on the refuge, or in any of the off-refuge environmental education activities (e.g., WoW Express). Overall, impacts from public vehicles under alternative C would much larger than under the other alternatives. Since this alternative proposes fewer, more consolidated CFAs (22), there would be less refuge vehicular use, and therefore emissions, from refuge staff traveling between refuge lands, as compared to alternative A (65 SFAs). Emissions levels would likely be similar to alternatives B (19 CFAs) and somewhat greater than D (22 CFAs).

The scope of impacts from forest management is described in the section *Air Quality Impacts that would not vary across alternatives*. Under alternative C, we propose varying forest management strategies (see table 5.4) affecting 600-800 acres per year on average, in order to improve habitats across refuge lands. This is the largest total acreage among the alternatives analyzed. The emissions and fugitive dust from timber harvest and tree planting activities is expected to be negligible (short-term and localized). The contribution of managed lands to carbon sequestration is highly uncertain. In general, the effect of harvest and other vegetation management releases carbon, while unmanaged lands, which make up the majority of the refuge, are more likely to be a carbon sink (Depro et al. 2008). These impacts to air quality from forest management would be greater under alternative C than alternatives A, B, or D.

Because grassland management occurs infrequently and the treatment occurs on relatively small tracts of land (Fort River being the largest at 105 acres), in our professional judgement it will not have a greater than negligible adverse impact to local or regional air quality, either during the 15-year timeframe for the CCP or beyond. Compare to the other alternatives, the impacts will be increasingly greater than under alternatives D, A, or B.

Under alternative C, we would occasionally use prescribed burning to manage refuge habitats. We anticipate using prescribed burning on 100 or fewer acres per year. As we acquire additional refuge lands and develop HMPs, we will consider use of additional prescribed burning as necessary. Such burning would be conducted under conditions outlined in a Fire Management Plan (FMP) (to be developed under NEPA compliance after the CCP). Adverse short-term impacts to air quality from prescribed burning operations (e.g. particulates, CO, CO_2, hydrocarbons, and small quantities of NO_x) are expected to be direct and local, with an overall minor impact. The air quality impacts from prescription burning are similar to that of other habitat maintenance (e.g., emissions from vehicles, chainsaws, etc.). The primary additional impact from prescribed fire comes from the air pollution that results from combustion; if air quality in a given region is approaching the standard for particulate matter, prescribed burning could cause that region to exceed the daily limits (Monroe et al. 2013). Burning vegetation can result in the release of a variety of air pollutants including aerosols of organic acids and hydrocarbons, and particulate matter of various size fractions. The type of pollutants varies with the type of fuel, its moisture content, the temperature of the fire, and the length of time materials continue to smolder after the fire. The long-term impacts to air quality will be negligible given the infrequency of burn applications. We would generally use prescribed burning

in forest habitats in a way that mimics the historical fire regime (e.g., frequent low severity fires in pitch pine forests in Massachusetts and Connecticut). We would also use prescribed fire to maintain some patches of grasslands. Smoke and other particulates will be minimized through using BMPs and smoke dispersion models. We will use BMPs and follow prescribed burn plans, which consider smoke dispersion models and address smoke management and other environmental and geographical factors, to minimize adverse air quality and visibility impacts on surrounding communities.

Air Quality Impacts under Alternative D

Over the 15-year CCP horizon, we propose to actively manage 0 acres of habitat for priority wildlife, fish, and plant species (compared to 455 acres under alternative A), including 0 acres forest, 0 acres grassland, and 0 acres shrubland (table 5.4).

Under alternative D, we would conduct limited construction of public access infrastructure within the CFAs. We would construct 1-mile-long native surface trails rather than ADA-compliant trails on each of the proposed 22 CFAs. This equates to the clearing and grooming of about 1 acre of land per one mile of trail, maximum, for each CFA. The direct impact of this work would affect up to 22 acres. The length of the road and trail network under this alternative is 42 miles. The refuge currently manages and would continue to manage 20 miles of trails (e.g., Mud Pond Trail at Pondicherry Division, an ADA-compliant trail at Fort River, and Mollie Beattie Trail at Nulhegan Basin Division), 42 miles of gravel road (40 public, 2 administrative), and two overlooks.

Beneficial Impacts. Similar to the other alternatives, there would be negligible to minor benefits to air quality from continuing to maintain the refuge's existing 37,000 acres of vegetation. Over the 15-year CCP timeframe and beyond, there would be an additional benefit from acquiring up to 231,307 acres within the new more consolidated and generally larger 22 CFAs, compared to alternative A's 65 SFAs. If the refuge acquires the maximum possible acreage, this alternative would have the largest relative beneficial impact on air quality that stems from the conservation of vegetated landscapes. Because this alternative includes no active forest management, there are no beneficial impacts to air quality from the regrowth of harvested timber, but there may be increased carbon sequestration as meadows and shrublands revert to forest.

This alternative would also eliminate snowmobiling on all refuge lands, eliminating refuge-derived snowmobile hydrocarbon exhaust, and the local air quality impacts from visitors accessing the refuge by private vehicle in order to snowmobile. This beneficial impact to refuge air quality would be negligible over the short and long term. It is unknown how large the reduction in pollution from this step would be at the watershed scale because the effect may be to displace snowmobile use elsewhere in the watershed.

Adverse Impacts. We anticipate the fewest adverse air quality impacts under alternative D because we would discontinue active habitat management and construct less developed public use trails. This alternative would promote a reduced human induced footprint, emphasizing low-density public use opportunities.

Maintaining the road, trail, and parking lot system is expected to have negligible short-term and long-term adverse impacts to air quality. Trail construction may release small amounts of fugitive dust, particulates, and hydrocarbon emissions to the new trail environment (e.g., from chainsaw operation, etc.). These adverse

impacts are viewed as short-term and negligible, and would have no detectable adverse impact over the long term. Public use trails and vehicle parking lots are carefully placed and managed to avoid or minimize adverse impacts to the refuge's air quality and diverse habitats. Moreover, given future funding expectations, it is not likely that the full extent of trails proposed in alternative D would be achieved within the CCP 15-year period, in which case these adverse impacts would be reduced. Long term impacts beyond that horizon are likely to have negligible adverse impacts. Adverse impacts to air quality from this maintenance would be greater than under alternative A, but less than under alternatives B and C.

Visitation under alternative D is projected to be comparable to B, but distributed differently (Table 5.5). Snowmobile use would be eliminated on refuge lands, but non-snowmobile recreation would increase sufficiently to more than make up for the decrease in visitation from snowmobilers. Thus there would be a significant decrease in adverse impacts to air quality from snowmobiles. An increase in emissions from private vehicles would not be equivalent to this, so we predict adverse impacts to air quality related to refuge visitation would be lower under alternative D than alternatives B or C, but potentially similar to alternative A overall. No detectable increase in air emissions and pollutants is expected from any of the off-refuge environmental education activities (e.g., WoW Express). Since this alternative proposes fewer, more consolidated CFAs (22), and little to no active management of refuge lands, there would be less refuge vehicular use, and therefore emissions, from refuge staff traveling between refuge lands, as compared to the other alternatives.

USFWS

Snowy egret

Summary

Each alternative proposes the acquisition and protection of lands beyond the current refuge acreage of 37,000 acres. Additional acres range from approximately 60,000 acres (alternative A) to almost 200,000 acres (alternative D). Proposed refuge management activities–forest management, prescribed burning, trail construction, and snowmobile use–may be allowed in one or more of the alternatives presented, but are predicted to have a negligible to minor impacts, both beneficial and adverse, on air quality at the local and regional scales. Management under each alternative will meet or exceed EPA standards and comply with the Clean Air Act. By acquiring additional lands and permanently protecting them from further development, it is assumed the filtering function of intact forests will prevent a reduction in air quality within the watershed.

Impacts to Regional Hydrology and Water Quality

Introduction to Water Quality and Hydrology Impacts

Chapter 3, "Affected Environment" presents the status of water quality in the Connecticut River watershed. Management actions under each alternative were compared and their impacts to water quality and hydrology are discussed below. This included assessing management actions in each alternative for their potential benefits to water quality and hydrology locally and regionally, as well as those actions that pose potential adverse impacts.:

The benefits we considered included:

- Provision of areas for groundwater recharge and maintenance of natural watershed functions, including purifying and filtering surface and ground water, from the conservation of lands as part of the refuge.
- Mitigating potential pollution sources into waterways (e.g., NO_x, SO_2).
- Benefits to priority species obtained from the promotion of free-flowing rivers, stemming from work with diverse partnerships (whose members include State Fish and Game agencies and Trout Unlimited).

The potential actions leading to adverse impacts of the management alternatives considered included:

- Improper maintenance and construction of buildings and infrastructure.
- Particulate deposition into surface water from vehicle and equipment emissions.
- Improper spill management or inappropriate burning.
- Soil erosion leading to sedimentation stemming from improper forest management activities, road construction, or trail construction.
- Pet waste along refuge trails.

Our analysis of water quality impacts considered how the Service's actions at the refuge (and potential new refuge lands) might affect water quality impairment criteria (biological, physical, and chemical) used by states and EPA to determine whether designated uses of water are being achieved. Collectively, these refuge habitat conservation and management actions proposed in the alternatives would preserve and promote hydrologic function and thus help reduce and minimize the potential for water quality impairments as defined by the EPA (*https://www.epa.gov/waterdata/assessing-and-reporting-water-quality-questions-and-answers*; accessed August 2016).

Current Conditions

Recent (2010) water quality assessments for New Hampshire, Vermont, Massachusetts, and Connecticut indicate a range of water quality within listed water bodies. A water body is considered 'good' if it meets all the criteria (i.e., supports aquatic life, safe drinking water, safe fish consumption) for which it was assessed. Impaired waters exist when any one of the criteria is not met. Pathogens were the most common impairment reported by Connecticut, Massachusetts, and Vermont. Waterbodies impaired by polychlorinated biphenyls (PCB) were reported by Vermont and Massachusetts. New Hampshire detected problems with mercury (Hg) and pH. All surface waters in New Hampshire (16,896 miles) are listed as impaired for fish/shellfish consumption due to elevated mercury levels (EPA 2014).

Water Quality Impacts That Would Not Vary By Alternative

We estimate that proposed refuge management activities would neither significantly benefit nor adversely impact local and regional water quality. Our management actions would not contribute to the impairment of streams or rivers within SFAs, CFAs, CPAs, or the broader watershed. We hope to work with States on projects with potential to benefit water quality, stream flow, and hydrologic functions.

Beneficial Impacts. We expect refuge land acquisition and management under all alternatives to maintain natural hydrologic functions that mitigate adverse water quality and hydrologic impacts. These include minimizing erosion and impervious surfaces; filtering of pesticide and herbicide applications, heavy metal and petrochemical runoff, and sewage; minimizing high water turbidity and lowered dissolved oxygen; preventing the filling of wetland; and reducing stream blockages, stream bank sloughing, and flooding. We expect that refuge management activities will maintain or improve the native vegetative and soil cover, allowing water and nutrient cycling, water infiltration, stream flow stability, soils integrity, temperature attenuation, habitat structure, waste assimilation, and microbial nutrient processing (Postel and Thompson 2005).

Under all alternatives, we expect these benefits to occur across all existing refuge lands. Also, in the short term (within 15 years), we would likely acquire similar amounts of land under all the alternatives, thus beneficial impacts would be similar across all alternatives in the short term.
Under all alternatives, the refuge would join partnerships to identify and remove barriers (e.g., dams, undersized culverts, etc.) in rivers and streams in the watershed to restore natural inflow regimes for improved spawning and foraging habitat for aquatic resources. Roads that remain open to provide public and management access will be maintained according to BMPs. Where appropriate, we would retire and restore unnecessary forest interior and secondary roads to promote watershed and resource conservation. Roads may be upgraded, reopened, or maintained to improve access for habitat management.

Regardless of alternative, management decisions about water quality concerns will be driven by scientific data. We will work with state agencies and other conservation partners to identify sources of point and non-point sediment and nutrient loading (e.g., trail erosion, stream blockages) influencing refuge habitats and address these sources where possible.

Adverse Impacts. Management of refuge lands under all alternatives would include monitoring routine activities to reduce the probability of chemical contamination of water. This includes use of motorized vehicles and equipment, control of weeds and insects near buildings, and pesticide use for invasive species control. Pouring or mixing of chemicals or petroleum products would be conducted no closer than 50 feet from surface water. All staff would be trained in spill prevention and spill response. Additionally, we will work with appropriate state agencies to minimize the risk of unintentionally mobilizing currently stable toxins.

Regardless of the alternative selected, pesticides, most often herbicides, may be part of an integrated pest management program. Pesticides will only be used if it is the most effective management technique, and will be combined with other management tools. Pesticides must be approved by the Regional Contaminants Specialist, who is responsible for upholding Federal standards for water quality and soil protection. The refuge will also develop and implement an Integrated Pest Management Plan that addresses environmentally safe application procedures and requirements.

The Service carefully regulates human uses of the refuge to minimize potential anthropogenic sources of water quality impairment (e.g., trail erosion in steep terrain), or disruption of hydrologic processes (e.g., collapsed or perched culverts). All alternatives predict an increase in annual visitors (Table 5.5). Alternative A predicts the lowest annual increase, since no expansion of hiking trails and visitor use is proposed, while alternative C predicts the highest increase due to its large refuge expansion proposal with 22 miles of trails potentially modifying and disturbing up to 44 acres of habitat; similarly, alternative D proposes modification and disruption of up to 22 acres with the development of 22 miles of trails (1 acres disturbance per mile). We do not plan to increase opportunities for snowmobiling on existing refuge land under alternatives A, B, and C. Rather, we plan only to maintain existing use levels; under alternative D we would eliminate snowmobiling. Existing snowmobile trails on new lands to be acquired under alternatives A, B, and C may be maintained if they are part of a statewide or regional mapped and maintained snowmobile network, yet this is not viewed as an increase in snowmobile capacity for refuge lands since it would simply maintain existing local or regional levels. In select situations, newly acquired connector trails, or currently closed trails may be opened to promote wildlife-dependent public uses. However, we would not

propose to construct any new trails and therefore the number of users using the entire trail network would not increase.

Dogs are allowed on the refuge to facilitate hunting and as companion animals. Decaying pet waste consumes oxygen in waterbodies and sometimes releases ammonia. Pet waste carries bacteria, viruses, and parasites that can threaten the health of humans and wildlife (EPA 2001). There are no known dog waste problems on any refuge division or unit nor are any significant increases in pet use on the refuge expected; we will continue to monitor any potential adverse impacts. Also, under all alternatives, we require pet owners to pick up after their pets. Consequently, current pet activities on the refuge are considered of negligible adverse impacts to refuge water quality.

Air deposition and smoke particulates can contribute to water quality impairment, typically with uncontrolled wildfire. We would conduct prescribed burning in compliance with an approved burn plan that takes into account atmospheric conditions and smoke dispersal. Any prescribed burning activities, whether for habitat manipulation or hazardous fuel loads (alternatives B and C) or protection of life or property, including the wild land urban interface (all alternatives), would be addressed in the refuge Fire Management Plans (which will be completed following the CCP).

As a natural resource agency, the Service strives to serve as a model for water use conservation. The refuge is required, where feasible, to employ water-saving technologies. For example, the headquarters building at the Nulhegan Basin Division has employed low-flow fixtures and non-irrigated landscaping.

Water Quality Impacts under Alternative A

Beneficial Impacts. Over the short term (15 years), there would be negligible to minor benefits to regional and local water quality from maintaining vegetation and hydrological functioning on the refuge's existing 35,898 acres. Over the long term (greater than 15 years), we may conserve up to an additional 60,830 acres of habitat. Short-term and long-term beneficial impacts would be expected to extend beyond refuge boundaries and spread through the local and regional watershed.

Most of the lands the refuge proposes to acquire are currently undeveloped and therefore already providing these beneficial impacts to regional and local water quality. Some of these lands would continue to provide these benefits into the future, while others may be developed prior to potential acquisition by the refuge. However, any acquisition by the refuge (or conservation by another agency, organization, or individual) would ensure permanent protection from development and guarantee the continuation of these benefits over the long term. The permanent protection of habitat through the SFAs will directly benefit the long-term ability of nearby communities to maintain or improve water quality.

Adverse Impacts. Overall, alternative A would include few ground disturbing refuge management activities (e.g., mowing, haying, brush hogging, tree cutting, or road maintenance) and introduce few, if any, additional sources of water pollution.

We expect negligible impacts on water quality from continuing to maintain existing refuge buildings, trails, roads, and parking lots (e.g., from runoff, spills, and failed septic systems). The refuge maintains its refuge headquarters and parking lots in Sunderland, Massachusetts, and the Nulhegan Basin Division headquarters and visitor contact station. Both the Sunderland facility and the Nulhegan Basin facility maintain an approved septic system. We also would

continue to manage 20 miles of existing trails (Mud Pond at Pondicherry, Fort River Trail at Fort River, and Nulhegan River, Black Branch, and Mollie Beattie Trails at Nulhegan Basin) and 42 miles of existing gravel roads (40 public, 2 administrative), and two overlooks.

Woodcock habitat management at Nulhegan Basin Division

Mark Maghini/USFWS

Under alternative A, we proposed to manage active manage 455 acres, including 255 acres of forest and 200 acres of grassland (table 5.4). Forest management under Alternative A is driven by the decline in American woodcock populations (Askins 2001). Our management activities are designed to have beneficial impacts on our designated trust species over time and negligible impacts to water resources. Forest management could negligible adversely impact water quality by causing sedimentation into streams and rivers or from unintentional spills from equipment. However, we will follow best management practices for these activities to minimize impacts to water quality (e.g., leaving forested buffers along streams and river). Operations are performed by logging contractors under supervision of the refuge forester.

In general, forests produce the highest water quality and most stable streams of any land use (Myers et al. 1985). Whenever the structure of forest soils is disturbed, there is a chance for erosion along with subsequent sedimentation of nearby waterbodies. Disturbance of the forest floor may channelize water which increases its velocity and its ability to carry sediment. Improperly designed and installed stream crossings can be a source of sediment to streams. But the major cause of erosion and sediment is improperly designed landings and truck roads (Patric 1976, 1978). Woodcock management requires clearcutting forests in adjacent blocks to create a mosaic of size classes important to their breeding, roosting, and courtship (Sepik et al. 1981). It has long been known that clearcutting northern hardwood forests can lead to changes in the intrasystem hydrologic cycle (Bormann et al. 1968), discharges of dissolved nutrients (Likens et al. 1970), increased particulate matter output (Bormann et al. 1974), and increased stream flow (Bormann et al. 1968). Fortunately, most of the region's forest soils are not prone to erosion. Litter layers and organic horizons of the forest floor allow rain and snowmelt to rapidly infiltrate into the mineral soil, even under extreme rainfall intensities. Mineral soil horizons are mostly well-drained, coarse-textured, sandy loams with high infiltration capacities. As a result, erosion rates and sediment yields from undisturbed forests are among the lowest in the country (Patric 1976), and erosive overland flow seldom occurs (Patric et al. 1984; Pierce 1967). Forest research over the last 4 decades has produced guidelines to help loggers and foresters harvest timber without causing unacceptable erosion and degradation of water quality (Haussman 1960; Univ. N.H. Coop. Ext. Serv. 2010). This research will guide the refuge during the location of truck roads and skid trails, including specifications for grades, slopes, distances from streams, and stream crossings during management of the Woodcock Demonstration Areas. Studies also guide the retirement techniques used at the close of a sale including grooming, seeding and mulching of roads, trails, and landings (Kochenderfer 1970; Hartung and Kress 1977).

We would also continue to mow or brush-hog using a diesel-powered tractor approximately 200 acres of grasslands management for target grassland birds

(e.g., bobolink, upland sandpiper, and breeding woodcock). Such infrequency of treatment on relatively small tracks of land (Fort River being the largest at 105 acres) are not believed to be more than negligibly adverse in its impact to local or regional water quality, both in the short term and long term.

Periodic construction and trail maintenance projects would cause very short-term, negligible, and localized effects from construction vehicle and equipment exhausts that may precipitate into the local watershed. Visits to the refuge by motor vehicle, and use of the refuge for recreational snowmobiling, would cause a non-detectable to negligible increase in air emissions that may precipitate into the watershed. Our annual road maintenance often includes efforts to improve the handling of water within our road network. This may involve repair or construction of bridges, replacement of culverts, improvement of road-side ditches, etc. Replacing culverts, repairing ditch work, and maintenance of bridge abutments often lead to discharges of sediment into waterbodies. The refuge considers these discharges to be of negligible impact to ecosystem resources.

The use of off-road vehicles (e.g., motorized dirt bikes, motorized all-terrain vehicles (ATVs) and off-road bicycles) can contribute to soil erosion and consequent turbidity in nearby waterways (Foltz and Yanosek 2005). While the use of ATVs is not permitted on the refuge, we propose to allow bicycling on designated refuge roads (not trails), an activity that is expected to have negligible adverse impacts on water quality. Under alternatives A, B, and C we will continue to allow snowmobiling on several refuge divisions, which could have minor adverse impacts on refuge water quality. Under alternative D, we would eliminate all snowmobiling. To what extent the water bodies on the refuge are at risk of hydrocarbon pollution is unclear. A study of water quality impacts performed throughout locations in Vermont, including refuge study sites at the Nulhegan Basin Division did not document adverse impacts (VDEC 2011). A study in Yellowstone, where snowmobile use is much higher, found petroleum hydrocarbons in small shallow water bodies exposed to snowmobile exhaust (Arnold and Koel 2006). The concentration of hydrocarbons in snow is likely to be particularly high on trails where regular grooming constantly packs exposed snow (Ruzycki and Lutch 1999). Spring snowmelt may release those hydrocarbons into streams or other bodies of water. Adams (1975) found hydrocarbon levels and lead to be at high levels the week after ice out in a Maine pond where snowmobiles were driven over ice during the previous winter. However, lead, is no longer an additive in gasoline, and therefore, not a current concern. Most snowmobiles currently in use have two-stroke motors that pass 20 to 33percent of the fuel straight through the engine and out the tailpipe unburned. Standard two-stroke engines also require that lubricating oil be mixed with fuel, so lubricating oil makes up part of the exhaust. This creates most of the visible haze that snowmobiles produce in the form of particulate matter, which itself is composed primarily of volatile organic compounds and hydrocarbons (CO, hydrocarbons HC, and particulates) (*http://serc.carleton.edu/research_education/yellowstone/snowmobiles.html*, accessed August 2016). Yet, during the course of a study in Yellowstone National Park, volatile organic compound (VOC) concentrations of snowmelt runoff were below levels that would adversely impact aquatic systems (Arnold and Koel 2006). Also, some newer snowmobile models are being designed to reduce emissions, pollutants, and noise. The compatibility determinations for snowmobiling in appendix D "Appropriateness and Compatibility Determinations," provides additional references on snowmobiling impacts.

Water Quality Impacts under Alternative B

Beneficial Impacts. Water quality benefits under Alternative B would be very similar to those discussed under alternative A in both the short term and long term.

As new refuge lands are acquired, we would take all necessary efforts to correct or mitigate any water quality or hydrologic impairments on newly acquired lands (e.g., collapsed culverts, road erosion, etc.). The protection of habitat through the CFAs has the potential to directly benefit the long term ability of the immediate watershed to maintain clean water quality, or mitigate impaired water quality.

Over the 15-year CCP horizon, alternative B proposed to actively manage approximately 9,312 acres of habitat compared to 455 acres under alternative A (table 5.4). The beneficial impact of ecologically-based forest and grassland management to water quality is generally expected to occur over the long term as structural diversity and ecological integrity of currently degraded forests or grasslands (including future lands to be acquired) are improved. We assume the restoration of forests using ecological forestry techniques will enhance hydrologic functions and water quality on some refuge lands over the long term. These beneficial impacts are likely to be negligible in the short term and minor over the long term time within the refuge and region.

Adverse Impacts. The short-term and long-term adverse impacts of alternative B would be negligible to minor and similar to those described under alternative A. However, we expect slightly less adverse impacts to water quality under alternative B because we propose to protect larger, more connected blocks of habitat than under alternative A. Although there would be relatively minor increases in land disturbing management actions over time due to the proposed change from the 65 SFAs to 19 CFAs, none of the management actions (e.g., potential new trails, greater habitat management) would result in greater than negligible to minor adverse impact in the short and long term.

Alternative B proposes to create approximately 1 mile of new trail on each of the proposed 19 CFAs equating to the clearing and grooming of about 2 acres of land per mile of trail, maximum, for each CFA. All new trails would be constructed using best management practices designed to minimize adverse impacts to vegetation, soil, and drainage patterns (e.g., using gentle slopes and switchbacks, following ridgelines, avoiding wet areas, constructing boardwalks where necessary; *http://www.americantrails.org/resources/trailbuilding;* accessed August 2016). The full impact of trail-building (e.g., erosion and sedimentation) would not occur in the short term since trail construction would occur over time, and the full length of trails almost certainly would be completed beyond the 15 year horizon of the CCP. Ultimately, it could affect up to 38 acres of the potential 97,830 acre refuge (less than one-tenth of one percent). Any adverse impacts would be considered localized and negligible. Considering visitor use, one study suggests that 70 percent of hikers veer off-trail (Hockett et al. 2010), and the refuge would take corrective actions to mitigate any resulting water quality impairment with placement of natural obstructions. Under alternative B, we expect fewer hikers and associated adverse impacts than under alternatives C or D, but more than under alternative A.

Alternative B also proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis.

Under alternative B, we propose to actively manage approximately 9,312 acres of forest, grassland, and shrublands (table 5.4). The potential adverse impacts to water quality due to habitat management activities would be similar to those described under alternative A, although the level of impact is expected to be relatively larger due to the greater amount of habitat to be managed over time. Unlike alternative A the majority of forest management under Alternative B will not involve clearcuts, but rather use ecological forestry techniques (Flatebo et al. 1999, Seymour et al. 2002, Franklin et al. 2007) including un-even aged management. This approach leaves more downed woody debris, standing trees,

and a higher canopy closure reducing the risk of increased run-off, nutrient leaching, and erosion. Activities would include, as noted under alternative A, use of heavy machinery and other fossil-fuel powered equipment to conduct annual habitat management. Such activities would be conducted in areas scattered across the refuge CFA landscape. We expect these activities to have negligible to minor short-term adverse impacts on local water quality at scattered locations across the 19 CFAs, and they are not expected to have any long term or larger scale impacts.

Under alternative B, we would employ limited use prescribed burning to manage refuge habitats (e.g., pitch pine communities, grassland communities) and to reduce hazardous fuels. We estimate this to be about 100 acres annually on average. Such burning would be conducted under conditions outlined in a Fire Management Plan (FMP) (to be developed under NEPA compliance following the CCP). Fires can affect water quality and water cycle processes to a greater or lesser extent depending on fire severity, and changes in water quality are primarily the result of soil erosion but also include elevated stream flow temperatures, increased pH, and changes in chemical concentrations and aquatic organism populations. Severe wildfire can produce substantial effects on the stream flow regime of small streams and rivers; however, the effects of low severity fires on water resources are generally minimal and short-lived (Neary et al. 2005). As discussed under the 'Air Quality' section, wildfire is not a substantive concern on the existing refuge or proposed new refuge lands because of the natural fire frequency regimes of the major vegetative and forest types within the Connecticut River watershed. Any potential for water quality impairment from refuge prescribed fire activities should be short term and adversely negligible, both short term and long term.

Under alternative B, we estimate that there will be an increase in on-refuge visitation (about 45,000 additional visitors, Table 5.5). However, such projected use would not pose any detectable increase in water pollution (e.g., erosion and sedimentation) due to visitor activities.

Water Quality Impacts under Alternative C

Beneficial Impacts. Alternative C would increase the acquisition authority of the refuge to 197,337 acres across 22 CFAs representing well over double the acres described in alternatives A and B. The beneficial impacts of alternative C to hydrology and water quality would be similar if not identical to alternatives A and B in nature and substance; however, due to the proposed increase in refuge acres and related expanded opportunities for habitat management and restoration over the long term, the magnitude of benefit likely would be nearly twice that of the former alternatives. Within the watershed as a whole, there would be no measurably significant change in water quality and no violation of any state water quality standards. The refuge would take all necessary efforts to mitigate any water quality impairments on newly acquired lands.

With alternative C and its potentially larger, permanently protected habitat land base, it is apparent that, over the long term horizon, water quality impact benefits would be modest, encompassing a meaningful portion of the Connecticut River watershed (greater than 2 percent of watershed). The average size of an intact CFA under alternative C is 8,986 acres while the average SFA under alternative A is 1,346 acres (and the average CFA in alternative B is 4,288 acres), thus illustrating the potential to protect larger intact portions of the watershed and their hydrologic functions. Absent unforeseen exigencies, the protection of habitat through the CFAs has the potential to directly benefit the long term ability of the immediate watershed to maintain clean water quality, or mitigate impaired water quality. Since the refuge was founded, annual additions to the refuge average 2,117, although the average for the past five years is 647 acres.

Adverse Impacts. The adverse impacts of alternative C would be very similar in substance to the adverse impacts described in alternative A. Although there would be differences in management actions due to the proposed change from alternative A's 65 SFAs to 22 CFAs, none of the management actions (e.g., potential new trails, existing road maintenance, habitat management) would tip adverse impacts to water quality into a detectable impairment level. Alternative C proposes to create approximately one mile of new trail for each of the 22 CFAs equating to the clearing and grooming of about two acres of land, maximum, for each CFA. That adverse impact (i.e., habitat disruption, possible erosion) could affect up to 44 acres of the potential 197,337 acre refuge, a negligible amount, especially considering such activity would be done incrementally over time. Considering visitor use, one study suggests that 70 percent of hikers veer off-trail (Hockett et al. 2010), and the refuge would take corrective actions to mitigate any resulting water quality impairment with placement of natural obstructions. Under alternative C, we expect the most hikers and associated adverse impacts.

Over the 15 year CCP horizon, alternative C encompasses management of a minimum of 12,873 acres of habitat compared to 455 acres under alternative A: 11,550 acres forest, 548 acres grassland, and 775 acres shrubland, all designed to improve habitat for priority wildlife, fish, and plant species (table 5.4). Similar to the previous alternatives, this would include implementation of the woodcock habitat management plan at the Nulhegan Basin Division. We would actively manage much more forest under alternative C than under alternative A (255 acres), and 50 percent more than under alternative B. Similarly, over the lifespan of the CCP, alternative C would facilitate active management of a minimum of 548 acres of grassland, well over twice that of alternative A (and 126 acres over alternative B), and would enable active management of at least 775 acres of shrubland within the 15 year horizon of the CCP, mainly to benefit the New England cottontail. Under alternative C, we propose annually to manage approximately 350-500 acres of forest every 5 years to improve habitats across refuge lands. The amount of the refuge that would potentially be actively managed under alternative C would represent at least six percent of a much expanded refuge when fully acquired, and over time additional acres could become subject to active management if determined necessary through development of future HMPs. We would employ the same types of habitat management under alternative C as described in alternative B, including select use of prescribed burning as previously described (~100 acres annually).

As described under alternative A, the use of heavy machinery and other fossil-fuel powered equipment to conduct annual habitat management under this alternative C over a larger refuge landscape is likely to have minor to negligible, short-term impact on local water quality at scattered locations across 22 CFAs. Over the long term, we presume an increase in fossil fuel particulates and potential adverse water quality impacts under alternative C simply because we propose to actively manage considerably more habitat than currently done under alternative A (and moderately more than alternative B, table 5.4) Additionally, any potential for air-borne particulates and water quality impairment from prescribed fire smoke should be extremely short term and adversely negligible. These potential adverse water quality impacts would be limited to a non-detectable, negligible short and long term level because such active management would be done over time and over widely scattered CFAs.

Water Quality Impacts under Alternative D

Beneficial Impacts. Alternative D would increase the acquisition authority of the refuge to 231,307 acres across 22 CFAs and lands that would serve to connect CFAs, either directly or by closing important gaps in unprotected habitat lying between CFAs. The 231,307 acre level of acquisition authority represents well over double the acres described in alternatives A (and B), and would serve to provide for a more integrated and functional habitat system

within the watershed. Across the 22 CFAs, alternative D would employ no active habitat management (except for threatened or endangered species where refuge habitats are identified in a species recovery plan) and only limited construction of public access infrastructure within the CFAs so that natural habitat functions and processes would be allowed to occur with a bare minimum of refuge-related adverse impacts. The beneficial impacts to water quality of alternative D would be similar if not identical to the other alternatives in nature and substance; however, the level of benefit would be greater than any of the former alternatives due to insignificant land disturbance activities imposed by the refuge. Within the watershed as a whole, there would be no measurably significant change in water quality and no violation of any state water quality standards.

Alternative D represents 3 percent of the watershed, a meaningful contribution to habitat protection within the watershed. With that even larger, permanently protected land base, it is apparent that water quality impact benefits from alternative D are minor to modest over the long term. The average size of an intact CFA under alternative D is 10,819 acres while the average SFA under alternative A is 1,346 acres (and alternative C is 8,986 acres), thus further illustrating the potential to protect larger intact portions of the watershed and their hydrologic functions. As with alternatives B and C, and absent unforeseen exigencies, the protection of habitat through the CFAs has the potential to directly benefit the long term ability of the immediate watershed to maintain clean water quality, or mitigate impaired water quality. It is recognized, however, that acquisition of the 'yet-to-be-acquired' acres within this alternative (164,307 acres) would take many years, likely well beyond the 15 year horizon of this CCP. Given the acquisition history at the refuge, acres acquired annually average 2,117 although the average for the past five years is a modest 647 acres. As with the former alternatives, additional short and long term beneficial impacts also would derive from water conservation at all refuge facilities, and in managing a fleet of well maintained, fuel efficient vehicles.

The passive management approach is expected to have a minor beneficial impact to the Nulhegan Basin and Pondicherry Divisions due to the proposed elimination of snowmobiling and its suspected hydrocarbon pollution into refuge waterways. The beneficial impacts to the refuge cannot clearly be estimated, although it is likely that the elimination of direct hydrocarbon emissions on the refuge will promote cleaner trail-side and road-side habitats for native fish and wildlife.

Adverse Impacts. Alternative D would employ no active habitat management, and construction of public access infrastructure within its 22 CFAs so that habitat functions and processes would be allowed to occur more naturally and with a minimum of adverse impact, both short term and long term. This alternative would promote a reduced human induced footprint, emphasizing low-density, undeveloped public use. Under alternative D there would be no active habitat management (except for threatened or endangered species where refuge habitats are identified in a species recovery plan). Management steps would be taken to mitigate unexpected events that may pose safety hazards (e.g., repair of collapsed culvert causing flooding, clear trail blockages due to storm damage, eliminate hazardous fuel loads) or that impede natural succession or restoration (e.g., control serious outbreaks of invasive plants, hands-on restoration of highly impaired habitats through planting or other habitat management that may require the use of heavy equipment). Activities such as required road and parking lot maintenance would continue (e.g., roadside mowing, tree trimming on 42 miles of refuge roads).

Water quality adverse impacts due to a passive management approach would be greatly minimized and negligible in impact, both in the short term and long term. Visitor use under alternative D would be higher for non-snowmobile use than alternatives A and B, though much less than under alternative C (Table 5.5). It

is presumed adverse impacts would be mitigated due to decreased visitor use. Eliminating snowmobile access may lead snowmobilers to create longer alternate connector routes, potentially affecting water quality on adjoining lands.

The adverse impacts of alternative D management activities to water quality would be negligible, and nearly undetectable in both the short and long term. Select management actions (e.g., potential new trails, existing road maintenance) would not tip adverse impacts into a detectable level. Alternative D proposes to do limited clearing on existing old roads for use as trails, or create short primitive trails of less than 1 mile for each of the 22 CFAs. This activity coupled with limited clearings for small parking areas and information signs are expected to result in the clearing and grooming of about one acre of land, maximum, for each CFA. That impact could affect up to 22 acres of the potential 231,307 acre refuge, a negligibly adverse amount.

Summary

In summary, our management activities across alternatives would not significantly impact (either adversely or beneficially) refuge or regional hydrology and water quality; none of the alternatives would violate EPA or state water quality standards, and all would comply with the Federal Clean Water Act. All alternatives would facilitate the acquisition and protection of additional acres of refuge land beyond the current refuge acreage of 37,000 acres. Additional acres range from about 60,000 acres (alternative A) to nearly 200,000 acres (alternative D). With those potential additions of habitat to the refuge, there is an expectation on the maintenance of good to excellent water quality due to the land-filtering and nutrient processing functions of intact forests and wetlands. We note that acquisition of additional acres to full acquisition levels proposed in the alternatives will not occur within the short term framework of this CCP (15 years) but will continue in the long term well beyond the 15 year CCP cycle, thereby ameliorating all possible immediate short term impacts over time. Proposed refuge management activities–forest management, prescribed burning, trail construction–may be allowed in one or more of the alternatives presented, but in all situations described above, we would expect all to be of negligible adverse impact and in select cases minor adverse impact.

Introduction to Climate Change Impacts

Introduction to Climate Change Impacts

Climate change has been identified by the Service as a serious management concern, as detailed in chapter 3. Across the United States, we are already seeing a range of changes, from higher average air and water temperatures and greater extremes in precipitation events to accelerating sea level rise and an increase in storm intensity. Furthermore, these and other physical changes associated with climate change are having a significant biological impact across a broad range of natural systems (Frumhoff et al. 2007, Hayhoe et al. 2006). For managers at Conte NFWR and throughout the Refuge System, this means finding ways to address climate change by implementing conservation measures through a true adaptive management process. Developing a meaningful adaptation strategy for the refuge requires understanding the impacts, risks, and uncertainties associated with climate change and the vulnerability of the different features of relevant natural and human communities to those changes (Glick et al. 2011). Adding to this challenge is the fact that the ecological impacts associated with climate change do not exist in isolation, but combine with and exacerbate other stresses on the region's natural systems.

Over the 15 year timeframe of the CCP, the refuge will implement departmental and bureau policies about climate change including biological planning, landscape conservation, monitoring and research, becoming more carbon neutral in day-to-day refuge operations, collaborating with others on climate change, and educating the public. Step-down plans will include specific objectives and strategies for habitat management and public use. To reduce the adverse impacts of climate change stressors, the refuge intends to protect the structural

and functional dynamics of defined refuge habitats, promote diversity of species, promote landscape connectivity and corridors to facilitate migration, strengthen partnership support to address climate change, and promote effective environmental education and interpretation. In addition, the refuge will pursue carbon sequestration through habitat protection efforts and best management practices, which would benefit the ecosystems of the refuge and the Connecticut River watershed as a whole.

The refuge is continuing long-term monitoring of climate change and has goals in place for reducing greenhouse gas emissions from both refuge operations and visitors by 2020. Several inventory and monitoring projects occurring on the refuge would benefit our understanding of climate change impacts. Example projects include bird phenology monitoring, aerial photography analysis to detect forest compositional changes, and the Monitoring Avian Productivity and Survivorship (MAPS) program. These projects take place both on and off refuge lands in the watershed. The information collected will improve our ability to manage the threats of climate change and maintain flexibility in our management. Our continued efforts to reduce human-induced stressors are becoming more important in the face of climate change. Our early detection and rapid response approach for invasive species benefits refuge habitats and watershed-level control efforts. We will continue to work with federal, state, and NGO partners to implement monitoring of climate change impacts and develop strategies for mitigation and adaptation.

Impacts from Climate Change That Would Not Vary by Alternative
As discussed in Chapter 3, climate change manifests as alterations to the physical environment, which then have cascading effects on the biological environment. These changes have the potential to both beneficially and adversely impact the capacity of the refuge to implement the goals and objectives outlined in the CCP. Climate change may alter Conte Refuge's ecosystems, changing vegetation communities, habitats available for species, and the experience of refuge visitors. Because any adaptative management will need to respond to observed conditions on the ground, we refrain from speculating in great detail about methodological shifts in refuge management. Instead we highlight here relationships between projected changes to climate and the management goals and objectives that might be affected.

Changes to air temperature and CO_2 concentrations

- Higher average air temperatures, particularly in winter months.
- Increased levels of CO2 in the atmosphere
- A lengthening of the frost-free season and earlier date of last-spring freeze.

Beneficial Impacts: For some species, currently at the northern extent of their range, warmer temperatures and greater CO2 availability and may increase their growth rates and vigor. If those species, such as American Elm, are used in restoration projects, the success of restoration may be enhanced. Faster-growing plants may accelerate refuge-managed restoration efforts (Horton 2014, Manomet 2010b). Some species may experience range expansion, facilitating restoration and recovery efforts by Conte Refuge.

Adverse Impacts: However, invasive species such as kudzu, now confined to the southern United States, may also be able to move north and establish populations within the refuge. If native plant populations are excluded by the establishment of kudzu or other invasive plant species, there could be cascading effects throughout the food web. Many of the most aggressive weeds, such as kudzu, benefit from higher atmospheric carbon dioxide, and become more resistant to herbicide control. Research also suggests that glyphosate (for example, Roundup), the most widely-used herbicide in the United States, loses its efficacy on weeds grown at

the increased carbon dioxide levels likely to occur in the coming decades. Warmer winters and less snow cover in recent years have contributed to increased deer populations that degrade forest understory vegetation (Horton et al. 2014, CT DEEP 2015, NH FGD 2015.

Other pests, pathogens, and parasites currently excluded by cold weather, especially cold winters, may have an increasing impact on fish, wildlife, and plants. Higher winter temperatures may also increase susceptibility to cold damage just prior to a subsequent hard freeze, as plants may become less likely to develop cold weather protections. Another avenue for cold damage, even in a relatively warm winter, is when there is an extended warm period in late winter or early spring causing premature leaf-out or bloom, followed by a damaging frost event, as occurred throughout the Northeast in 2007 and again in 2012 (Horton et al. 2014, CT DEEP 2015, NH FGD 2015). To the extent that these susceptible plants are priority resources of concern, or provide habitat or food for priority resources of concern, warmer air temperatures may compromise and present new challenges to Conte Refuge's ability to fulfill Goal 1 – Wildlife and Habitat Conservation. In addition, in order to maintain early-successional forest, shrubland, and grassland habitats, more frequent forest management may be required, with the associated physical, biological, and socioeconomic impacts as described in other sections.

Changes in species distribution by elevation are occurring: a Vermont study found upslope shifts in the boundary between northern hardwoods and boreal forest on the Green Mountains between 1964 and 2004. Wildflowers and woody perennials are blooming earlier and migratory birds are arriving sooner. Because species differ in their ability to adjust, asynchronies (like a mismatch between key food source availability and migration patterns) can develop, increasing species and ecosystem vulnerability. Several bird species have expanded their ranges northward. (Horton et al. 2014, NH FGD 2015). These changes, already ongoing, are expected to accelerate in the coming decades, likely leading to large changes in the mix of plants and animals present in the local ecosystem, resulting in new communities that bear little resemblance to those of today (Joyce et al. 2014, VT FWD 2015). Forest, shrub, and grassland management practices proposed in the CCP are based on models of tree and other plant development that assume relative climate stability, and their accuracy and utility may be reduced as climate change proceeds, necessitating the development of new models under an adaptive management framework. Changes in species distributions, ideal species ranges, and the local competitive dynamics among birds and across taxa will complicate restoration and habitat management efforts.

The effect of climate change on phenology – the pattern of seasonal life cycle events in plants and animals, such as timing of leaf-out, blooming, hibernation, and migration – has been called a "globally coherent fingerprint of climate change impacts" on plants and animals. Observed long-term trends towards shorter, milder winters and earlier spring thaws are altering the timing of critical spring events such as bud burst and emergence from overwintering. This can cause plants and animals to be so out of phase with their natural phenology that outbreaks of pests occur, or species cannot find food at the time they emerge. Changes in the timing of springtime bird migrations are well-recognized biological responses to warming, and have been documented in the eastern United States. Some migratory birds now arrive too late for the peak of food resources at breeding grounds because temperatures at wintering grounds are changing more slowly than at spring breeding grounds (Joyce et al. 2014, CT DEEP 2015, VT FWD 2015). Where management activities on refuges are tied to phenological events, climate change may confound efforts to provide consistent management that has the effects intended by refuge staff.

James Welver/USFWS

Canada lynx kittens

Changes to water temperatures in both saltwater and freshwater systems.
Beneficial Impacts: Warmwater fish like eastern silvery minnow, pumpkinseed, and brown bullhead are likely to increase as water temperatures warm (Horton et al. 2014, NH FGD 2015, Manomet 2010b), and could provide an expanded food source for and contribute to population increases of predators of species like them.

Adverse Impacts: Suitable habitats will be shrinking for species such as coldwater fish like brook trout. It is difficult to predict what proportion of species will be able to move or adapt as their optimum climate zones shift (Horton et al. 2014, NH FGD 2015, CT DEEP 2015, Manomet 2010b). Some of the fish hosts endangered freshwater mussel species (e.g., dwarf wedgemussel and brook floater) are coldwater fish whose thermal habitat will likely diminish as climate warms, ultimately affecting the reproductive success of the mussels. Changes to lake ice duration and surface water temperatures will strongly affect primary productivity, dissolved oxygen, thermal habitat, and invertebrate and fish communities (NH FGD 2015). This makes the maintenance and restoration of habitat for coldwater species more challenging.

Changes in frequency, timing, and amount of annual precipitation

- More frequent heat waves and drought events
- An increase in the number and intensity of heavy rainfall events.
- Reduced snowpack and earlier peak snowmelt and spring peak flows.
- An increase in the intensity, duration, and destructiveness of hurricanes and winter storm events such as nor'easters

Beneficial Impacts: Less snow on Conte Refuge roads may lead to a decline in snowmobile use, resulting in positive impacts to air quality (as detailed in the Air Quality Impacts section above).

Adverse Impacts: Under projected climate conditions, rising temperatures could work together with forest stand characteristics and these other stressors to increase mortality. Recent die-offs have been more severe than projected. As temperatures increase to levels projected for mid-century and beyond, eastern forests may be at risk of die-off. New evidence indicates that most tree species can endure only limited abnormal water stress, reinforcing the idea that trees in wetter as well as semiarid forests are vulnerable to drought-induced mortality under warming climates (Joyce et al. 2014).

Across the entire U.S., precipitation amounts and intensity and associated river discharge are major drivers of water pollution in the form of excess nutrients, sediment, and dissolved organic carbon. At high concentrations, nutrients such as nitrogen and phosphorus can become pollutants and can promote excessive phytoplankton growth – a process known as eutrophication. Currently, many U.S. lakes and rivers are polluted (have concentrations above government standards) by excessive nitrogen, phosphorus, or sediment. There are well-established links among fertilizer use, nutrient pollution, and river discharge, and studies show that recent increases in rainfall in the northeastern United States have led to higher nitrogen amounts carried by rivers. Many important fish species such as

salmon and trout that lay their eggs in the gravel at the edges of streams are especially sensitive to elevated sediment fluxes in rivers. Sediment loading in lakes has been shown to have substantial detrimental effects on fish population sizes, community composition, and biodiversity (Joyce et al. 2014, EEA 2011).

Relatively small changes in the timing and amount of annual precipitation will influence the suitability and distribution of wetlands systems, particularly vernal pools and wet meadows, for many wetland-dependent amphibians, birds, and plants. Extended droughts that occur earlier in the breeding season along with elevated temperatures and lower groundwater tables may reduce the distribution and condition of wetlands statewide. These changes will mean that wetland-dependent species must either relocate via available corridors to other wetland systems or perish (CT DEEP 2015, VT FWD 2015, Manomet 2010c).

Some species, such as lynx and snowshoe hare, evolved traits that make them adapted for snowy winters. Decreased length of snow-covered ground and less snow is likely to be a competitive disadvantage for these species and others that are similarly adapted (VT FWD 2015).

The consequences of changing precipitation regimes may impact the Conte Refuge's ability to fulfill Goal 1 – Wildlife and Habitat Conservation because the effects of this pollution may harm both terrestrial and aquatic resources under refuge stewardship.

If roads are open to vehicular traffic other than snowmobiles for longer parts of the year, the potential exists to magnify the impacts of motorized vehicle use on refuge wildlife, habitat, and air quality. A longer season of road use may lead to increased sedimentation and increased need to maintain road networks, with all their associated impacts.

Ecosystems such as saltmarsh provide a buffering service to broader coastal ecosystems during storm events. Increased storm intensity, especially coupled with sea level rise and a decline in salt marsh, may overwhelm the capacity of such systems to protect the coast. Extreme weather events that produce sudden increases in water flow and the materials it carries can decrease the natural capacity of ecosystems to process pollutants, both by reducing the amount of time water is in contact with reactive sites and by removing or harming the plants and microbes that filter the pollutants (Joyce et al. 2014, CT DEEP 2015).

Extreme storm events also cause flooding inland, and interactions with human infrastructure can exacerbate damage to ecosystems. Over the last decade, there have been several storm events which have met the standards for 100-year flood state. Damage to culverts, roads, and stream banks (erosion) result in sediment and debris entering streams, rivers, lakes, and ponds, changing habitat structure and function (NH FGD 2015). Depending on how precipitation regimes change, it may be necessary to close, reroute, or construct new trails and roads on refuge-managed properties, which has its own additional impacts on fish, wildlife, and habitats, as described elsewhere in this chapter. Erosion increases sedimentation, washes away or covers spawning habitat, and can sweep animals downstream or kill them. Mussels are particularly sensitive to sedimentation, and can be buried under the load, which also clogs their filter feeding mechanisms, killing them. Stormwater also floods nest sites along the banks of rivers and ponds or in the saltmarshes downstream, affecting loons, wood turtles and others (NH FGD 2015).

Because storm events cannot be predicted at the very fine scale, there is no way to prioritize or amend restoration or habitat management efforts in advance of

highly intense storms, increasing the challenge for Conte Refuge staff to direct funding and staff to best achieve Goal 1 – Wildlife and Habitat Conservation. In addition, storms can damage management sites that are more vulnerable during active management, increasing the time needed for the systems in question to benefit from restoration as well as the impacts associated with the work itself (as described in other sections of this chapter).

Accelerating rate of sea level rise
Adverse Impacts: Beach and dune erosion, both a cause and effect of coastal flooding, is also a major issue in the Northeast. Since the early 1800s, there has been an estimated 39% decrease in marsh coverage in coastal New England. Impervious urban surfaces and coastal barriers such as seawalls limit the ability of marshes to expand inland as sea levels rise (Horton et al. 2014, CT DEEP 2015).

One of the most dramatic predicted effects of climate change in coastal habitats will be sea level rise. The predicted high water levels will inundate salt marshes, deepen estuaries, and convert marsh grass to mudflat and mudflats to subtidal zones. If the rate of sea level rise is rapid, affected habitats will be inundated more frequently, putting their associated species at high risk. Total habitat and species losses are particularly likely in developed areas where there are no natural habitat retreat areas to allow for salt marsh migration (NH FDG 2015, Manomet 2010a).

Dune and beach habitats are important for nesting and loafing seabirds, including Roseate terns, common terns, and marine mammals. Sea level rise may affect habitat availability and the timing of nesting and migration for seabirds. The sand and sediment making up coastal dunes will be driven inland by high tides and storm surges, with the lack of natural sediment movement and coastal development meaning that in many places dunes will be lost altogether. The degradation and loss of dunes will increase the impacts of storms and high tides further inland (NH FGD 2015).

As well as being inundated, salt marsh habitats may also lose pioneer species and salt pannes due to reduced incidence of ice scour. This habitat is also sensitive to changes in salinity from freshwater inputs. Rocky shores and islands will not be as affected except in low lying areas. Most intertidal species may shift to higher elevations but will be subject to more heavy surf during storms. Island-nesting birds may lose habitat or experience reduced productivity as a result of changes to available prey (NH FGD 2015).

Alterations to the health and total area occupied by salt marsh could affect the ecological justification for land acquisition in some CFAs, as well as impair Conte Refuge's ability to management for priority resources of concern associated with beach, salt marsh, and other coastal habitat.

Impacts from Climate Change That Would Vary by Alternative
The variation in how climate change is likely to impact the Service's ability to meet its goals and objectives under each alternative is influenced most by the spatial extent and configuration of lands owned and managed by Conte Refuge. Climate change adaptation and resilience strategies typically emphasize the conservation and protection of larger and more connected ecosystems whenever possible in order to provide the greatest potential climate resilience (MA DFG 2015). Based on this reasoning and the total acres proposed for acquisition within a certain number of CFAs, alternative A, is likely to face the greatest obstacles to effective fish, wildlife, and habitat conservation. Its relatively dispersed 65 SFAs are smaller, less contiguous, and less connected than the CFAs in the other

alternatives. The fragmented ownership under alternative A will have this effect both during the 15-year CCP plan horizon and over the longer term. The other three alternatives (B, C, D) propose similar CFAs, but vary in the total amount of land acquired. Over the 15-year planning horizon, assuming that similar amounts of land will be acquired, climate change impacts on the refuge's ability to achieve Goal 1 will be similar. However, over the long term, or in the event that acquisition rates increase dramatically, alternative D will experience the least impacts from climate change, followed by alternatives C and then D.

Under alternative B and C, prescribed burning would be used for habitat management where fire is needed to maintain target ecosystem composition, structure, and function. If significant changes to temperature and precipitation occur due to climate change, our ability to conduct prescribed burns, and the beneficial impact of prescribed burns on refuge ecosystems, may be inhibited.

Forested habitats on the refuge are managed to maintain and enhance the ecological resilience of these systems. Historically, three main factors, over-browsing by species such as white-tailed deer and moose, nonnative plant infestations, and damaging outbreaks of invertebrate pests, have been some of the most important stressors reducing forest resilience. Existing management approaches are likely to be important tools under climate change. These include adjusting the age structure of forest patches, managing deer densities, and intervening to eliminate invasive species and pests. The four alternatives propose differing levels of forest management to encourage resilience. The management methods proposed include promoting strucuturally diverse and species-rich areas of mature forest for retention and regenerating more homogeneous areas of second-growth trees to young forest habitat. This has the effect of establishing a mosaic of forest age classes and conditions on the landscape and could well be an important adaptation response to climate change. Diversifying the age structure and species composition of the forested landscape in advance of climate change could increase resilience of forested ecosystems and overall resistance to the impacts of a changing climate (Manomet 2010c). If so, alternative C, which includes the most active management, best positions the refuge to create resilient landscapes and adapt to a changing climate. Alternatives B and A follow. Under alternative D, which eliminates active management, the refuge is likely to be the most impacted by climate change, since none of the resilience-enhancing forest management will occur.

Summary

In summary, climate change is likely to significantly impact Conte Refuge's ability to achieve the goals and objectives outlined in the CCP. In some cases, these impacts will be beneficial, but based on current available scientific analysis, most impacts are projected to be adverse. Changes in air and water temperatures, precipitation frequency, amount and type, and sea level rise change may alter Conte Refuge's ecosystems, changing vegetation communities, habitats available for species, and the experience of refuge visitors. These impacts will affect Conte Refuge regardless of the alternative selected. Alternatives with more consolidated and larger acquired lands are likely to be more resilient and thus less impacted by climate change, as are alternatives that allow for active management across greater extents of the refuge.

Refuge-scale Impacts

Impacts to Soils

Introduction to Impacts on Soils

Soil is a living and life-giving substance essential to plants, wildlife, fish, and humans. Soils play key roles in regulating elements and nutrient cycles (carbon, nitrogen, and sulfur), seed protection, and serve as a fundamental basis of

the physical environment of all habitats on the refuge. Soil biotic communities consume wastes and the remains of dead organisms and recycle these into forms usable by plants. The amount of carbon and nitrogen stored in soils dwarfs that in vegetation. Carbon in soils is nearly double that in plant matter, and nitrogen in soils is about 18 times greater (Schlesinger 1991, Daily et al. 1997(b)). Soils are the structural matrix and nutrient source for plant productivity at the refuge and must be protected to sustain the variety of diverse habitats within the watershed that would meet our habitat and species management goals.

We evaluated and compared the management actions proposed for each of the refuge CCP alternatives on the basis of their potential to benefit or adversely affect refuge soils and soils of the refuge's general habitat types.

We compared the benefits of the alternatives from actions that would protect soils from erosion, compaction, or contamination or that would restore eroded, compacted, or contaminated soils, including the:

- Extent to which refuge land acquisition and conservation under the alternatives would limit the growth of nearby development or recreational use thereby reducing loss of forest vegetation and human disturbance and their potential soil impacts.
- Potential for restoration of degraded habitats, access roads, trails, and associated structures to provide opportunities to restore soils.

The potential adverse soil impacts of the refuge management alternatives that were evaluated included impacts from:

- Habitat management activities (e.g., mowing and haying grasslands, forest sivicultural actions).
- Construction of buildings, parking facilities, access roads, and interpretive trails.
- Road maintenance (grading, ditch maintenance, spreading gravel, removing boulders, roadside mowing/debrushing).
- Visitor use impacts on refuge trails and roads.
- Prescribed burning to manage habitats and/or reduce hazardous fuels.

Impacts to Soils That Would Not Vary by Alternative
Proposed refuge management activities would neither significantly benefit nor adversely impact current local and regional soil conditions. We expect refuge land conservation and management under all alternatives to help maintain undisturbed and natural beneficial soil functions that include nutrient cycling through healthy soil mycorrhizal fungi and microbial populations, plant stability and support, filtering water runoff, mitigating pesticide and herbicide applications, ameliorating heavy metal and petrochemical non-point runoff, reducing high water turbidity, recycling sewage (e.g., septic tank outflows), reducing outwash into wetlands and streams, and preventing flooding (*http://soilquality.org/basics/value.html*, accessed August 2016). Beneficial impacts are performed by natural soil functioning as noted. Under all alternatives, these functions would be protected on the refuge's existing 37,000 acres. Also, in the short term (within 15 years), we would likely acquire similar amounts of additional refuge lands under all the alternatives, thus beneficial

soil impacts would be similar across all alternatives in the short term. Over the longer term, we estimate differing amounts of beneficial soil impacts.

Across all alternatives, our management actions would not contribute to the permanent impairment of any lands and soils except for localized places where we plan to construct public use facilities (e.g., footbridges, kiosks, interpretative signage posts, occasional soil augmentation) or additional refuge administrative building. Therefore, we expect adverse impacts would be negligible. There are no plans for major facilities or new road construction, although there is a potential for an outdoor classroom at the Fort River Division under alternatives B, C, and D. Regardless of which alternative is selected, we would continue to use best management practices in all management activities that might impact refuge soils to ensure that we maintain refuge soil stability and productivity.

Bill Buchanan/USFWS

Gray squirrel

As we acquire additional refuge acres under each alternative, we would restore developed sites with unnecessary buildings or other infrastructure to natural topography and soil constituency and return to native vegetation. This would have negligible to minor impact benefit due to small dwelling site footprints.

As staffing and funding allow, we would repair and maintain roads to limit the potential for them to contribute sediment to waterways. Pending a positive compatibility finding, we expect to retain snowmobile trails that may exist on newly acquired lands if they serve are part of a statewide or regional trail network maintained by partners. If necessary for public access and a compatible use, we may provide additional and appropriate motorized access in proposed CFA expansion areas once an adequate land base is acquired. The compatibility determinations for snowmobiling in appendix D "Appropriateness and Compatibility Determinations," provide additional references on snowmobiling impacts.

The proposed forest management activities across alternatives are negligibly adverse to refuge soils in the short term and beneficial in the long term. These activities would be conducted using established best management practices to avoid soil compaction, soil displacement, rutting, erosion, and loss of soil productivity. All alternatives embrace a sizeable refuge land base, when fully acquired over the long term. Forest management will occur on an approximate annual average of approximately 60 to 65 acres (alternative A), approximately 250 to 300 acres for alternative B, approximately 350 to 500 acres for alternative C, and no managed acres for alternative D.

To minimize adverse impact to soils, we would closely monitor all routine activities that have the potential to result in chemical contamination from leaks or spills. These include use of motorized vehicles and equipment, herbicide control of weeds and insects around structures, use of chemicals for de-icing parking lots and walkways. Pouring or mixing of chemicals or petroleum products would be conducted carefully, and all staff would be trained in spill prevention and spill response. Management of pesticides for invasive species control would be conducted carefully as described in water quality impacts. As discussed in water quality impacts, there is some probability, although adversely minimal, that snowmobile hydrocarbon emissions may settle into roadside soils during spring melt.

The Service carefully considers public uses of the refuge, and we will only permit appropriate and compatible uses, such as wildlife-dependent recreational opportunities (fishing, hunting, hiking, environmental education, etc.). None of the uses allowed would be considered more than negligibly adverse to soil in the short and long term. At current levels and estimated future levels of visitation

(Table 5.5), we expect only negligible impacts to refuge soils (e.g., compaction and erosion on and along trails). We recognize, however, that there may off-trail impacts due to individuals veering off-trail for a variety of reasons (e.g., seek better views), and we would take known corrective actions to mitigate such activity such as placement of natural obstructions (Hockett et al. 2010). All of these trails are subject to soil compaction and minor soil disturbance, yet of short-term and long-term negligible adverse impact. Bicycling off of roads and all-terrain vehicles contribute to trail erosion. Neither of these activities are permitted on refuge lands, nor will they be on future acquisitions. Pets under control are permitted on refuge trails, yet their unchecked waste can cause negative adverse impacts to soils, similar to impacts discussed in water quality impacts. There are no known pet waste problems on any refuge division or unit, and future acquisitions will require pet waste removal by pet walkers. Pet waste across all alternatives would be considered a negligible adverse impact to soils in the short and long term.

Regardless of which alternative we select, we would take a number of steps to ensure that we have sufficient scientific data to support management decisions regarding refuge soil management and protection. We would work with the USDA Natural Resources Conservation Service, respective state agencies, and other conservation partners to help identify and correct any sources of soil erosion, compaction, or other impairment impacting refuge habitats and public visitation. Recognized best management practices would always be employed in any land disturbance activity.

Soil Impacts under Alternative A

Beneficial Impacts. In the short term, alternative A would continue to provide negligible to minor benefits from conserving soils on the refuge's existing 37,000 acres. Over the long term, we expect these benefits to increase as we protect up to 97,830 acres total. Most of the lands the refuge proposes to acquire are currently undeveloped and therefore already providing these local and regional beneficial soil stabilizing impacts (Daily et al. 1997(b)). Some of these lands would continue to provide these benefits well into the future, although others may be developed prior to potential acquisition by the refuge. However, any acquisition by the refuge (or conservation by another agency, organization, or individual) would ensure permanent protection of soils from development and guarantee its ecological functioning over the short and long term.

Alternative A would continue current habitat management on up to 455 acres (table 5.4). Habitat management measures under alternative A are generally expected to have negligible to minor beneficial impacts to soils of the refuge, principally over the long term. Harmon et al. (1986) note the importance of replenishing soil attributes and integrity by leaving large woody debris (tree stems, etc.) following active forest management operations. Under alternative A, prescribed burning is not used to manage habitats or reduce forest fuel loads, and therefore will not have any impact on refuge soils.

Adverse Impacts. Alternative A would include relatively few ground disturbing activities that might adversely impact refuge soils. These include road maintenance (40 miles public, 2 miles administrative), and visitor use impacts (e.g., 20 miles of trails). Both regionally and refuge-specific, these activities are of negligible adverse impact, both in the short and long term. Best management practices are implemented in all ground disturbing activities. Visitation under alternative A would not appreciably change over current levels and is expected to be lower than any of the other alternatives except alternative D (which eliminates snowmobiling) (Table 5.5). Current snowmobile use is not expected to have more than negligible adverse impact in the short term and long term. During the time

that snowmobiles and trail groomers operate, the trails are covered with several inches to a foot or more of snow, thus protecting soils. One study indicated that compaction of snow cover had little effect on average soil temperature and frost penetration (Wentworth 1972). Snowmobile trail maintenance occurs in summer and fall, and includes mowing, culvert replacement, and bridge re-decking, as necessary. Because more than 98 percent of the snowmobile trail network overlays gravel roads, the majority of these maintenance activities likewise occur on or along roads. Consequently, any impacts to soils would be minimal and likely only involve previously disturbed soils. We expect an increase in hiking trail use with the newly constructed trail/boardwalk at the Fort River Division, but expect little or no associated adverse soil impact. Visitor activities that impact soils, such as hiking off designated trails, and snowmobile emissions (re: air quality section) would pose the lowest concern of all alternatives except for alternative D due to projected visitor use (Table 5.5).

All of the active habitat management actions proposed under alternative A are designed to improve habitat structure for woodcock and other priority refuge resources of concern. All active management would be performed by contractors under supervision of the refuge forester. 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 and Parkin 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 (Powers et al. 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, and recommended winter logging, use of track vehicles, placement of skid trails along land contours, and minimization of any practice that expose infertile mineral soils. Martin et al. (1986) 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 principals designed to minimize or eliminate adverse soil impacts, while accelerating forest regeneration for priority refuge resources of concern species. Refuge forest management aims 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 long term, and ultimately will serve to the benefit of refuge forest health and function.

Under alternative A, we would continue to manage 200 acres of grassland to provide habitat for grassland-dependent birds (e.g., bobolink, upland sandpiper, and breeding woodcock). Such infrequency of treatment on relatively small tracks of land are not believed to be more than negligibly adverse in its impact to local or regional soil quality, both in the short term and long term.

Under alternative A, prescribed burning is not practiced or employed to manage habitats or reduce forest fuel loads (except in emergency situations to protect life or property), and no campfires are permitted, thus eliminating any potential for fire related adverse impacts to soils.

Our current invasive plant control involves no burning, relying instead on cutting, pulling by hand, and use of approved herbicides. Uprooting invasive plants temporarily disturbs the soil layer, but is considered of direct negligible adverse impact, with no long-term impacts. Further details on the number of upland forest acres to be managed by alternative, and how habitat management priorities will be made annually are presented in the section "Impacts to Upland Habitats and Vegetation."

Soil Impacts under Alternative B

Beneficial Impacts. The beneficial impacts to soils under alternative B is similar to those described under alternative A. In the short-term, we would continue to protect soils on the 37,000 acres of existing refuge land. In the long term, we would protect up to 97,772 acres. Compared to alternative A, we expect alternative B to have slightly greater benefit because we proposed to protect larger, more contiguous blocks of habitat under alternative A.

Under alternative B, we propose to manage approximately 9,312 acres of habitat compared to 455 acres under alternative A (table 5.4). While the amount of habitat managed increases substantially between alternatives A and B, there may be an associated increase in the beneficial impact of such management with forest harvesting since 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 and long term both on the refuge and regionally.

Adverse Impacts. The adverse impacts of alternative B to soil quality would be similar in substance to the adverse impacts described for alternative A. Although there would be a modest increase in management activity within the 19 CFAs, none of the management actions (e.g., creating potential new trails, use of chainsaws, maintaining roads existing on newly acquired lands) would adversely degrade soils, particularly since activities would be conducted over time and over a larger landscape.

Alternative B proposes to create up to 1 mile of new hiking trail for each of the 19 CFAs equating to the clearing and grooming of about 2 acres of land for each trail mile, roughly 38 acres. Visitation under alternative B is project to increase 22 percent compared to alternative A (Table 5.5), but would offer greater visitor use opportunities. Visitor activities that might impact soils, such as hiking off designated trails, could pose local adverse impacts. Snowmobiling impacts would be essentially the same as described in alternative A. Hiking trail construction and use can adversely impact trail soils when inappropriately performed, especially where drainage is poor due to soil characteristics, slope, and trail location and configuration. The type of use (e.g., hikers, motorized vehicles, mountain bikes) impacts trail soils/surface in different ways, and use should be compatible with trail surface (e.g., smooth tread on easy trail, rough tread on back-country trails) (McPeake et al. undated).

Hikers and bicyclists can cause soil erosion along trails. Wilson and Seney (1994) found that hikers caused more sediment to be available on pre-wetted trails than bicyclist. Hikers and bicyclists can also cause soil compaction. To minimize the potential for adverse impacts, bicyclist are only permitted on refuge roads. Horses and all-terrain vehicles can also cause considerable erosion and compaction and are generally are not permitted on refuge lands; however, limited use may be authorized. Notably, all alternatives facilitate bicycling on refuge roads (not trails) and ATVs are prohibited altogether.

As new trails are constructed, we will use available trail planning methods and BMPs when constructing and maintaining hiking trails to minimize soil disturbance, erosion, and compaction. Given future funding expectations, it is not likely that the full extent of trails proposed in alternative B would be achieved within the CCP 15 year timeframe, thus short term direct impacts would be negligible. Long term impacts beyond that horizon also would be considered to be of negligible adverse impact. Overall, we estimate only about 38 acres of disturbance (about 2 acres per each 1-mile long, 8-foot wide ADA-accessible trail).

Alternative B also proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis.

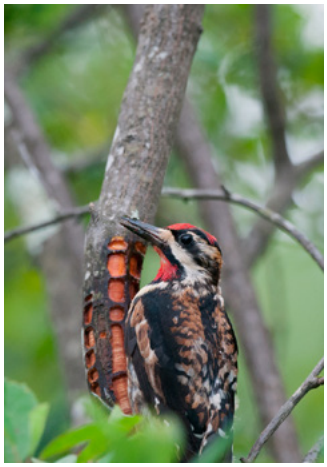
Under alternative B, we propose to manage approximately 9,312 acres of habitat compared to 455 acres under alternative A (table 5.4). There may be some potential for management activities (e.g., use of heavy equipment) to cause soil erosion and compaction. To minimize the potential for adverse impacts, we will use best management practices (e.g., conducting some forest management during the winter when soils are frozen and covered with snow, avoiding areas with sensitive and/or highly erodible soils, such as wetlands, leaving forested buffers along riparian areas to prevent sedimentation into rivers and streams). Compared to alternative A, we expect slightly greater adverse impacts because we propose to manage additional acres. Overall, we expect the benefits from active management to wildlife, plants, and soils to outweigh adverse impacts.

We may use prescribed burning under this alternative to maintain fire regime habitat communities (e.g., pitch pine) and to treat hazardous fuels. Prescribed and wildfires can affect nutrient cycling and the physical, chemical, and biological properties of soils (DeBano 1990, Certini 2005). The magnitude of the impact depends on the severity of the fire, the topography of the area burned, and the resiliency of the soil. Prescribed fires are generally low to moderate in severity and do not result in long-term irreversible impacts (Certini 2005). If plants are able to quickly recolonize the burned area, soil properties are generally recovered and sometimes even enhanced (Certini 2005). We anticipate using prescribed burning on 100 or fewer acres per year and therefore expect only negligible to minor impacts to soils in very localized areas.

Soil Impacts under Alternative C

Beneficial Impacts. In the short term, the beneficial impacts of alternative C to refuge and regional soils would be very similar to those of alternative A and B. In the long term, alternative C would likely provide the second highest level of beneficial impacts to soils compared to other alternatives, because it would protect soils on up to 197,337 acres across 22 CFAs. Alternative C promotes protection of a considerably larger and more intact lands and soils configuration within the larger watershed landscape. Similar to the previous alternatives, such protection helps to maintain essential ecosystem functions provided by soils.

Under alternative C, we propose to actively management about 12,873 acres of habitat (table 5.4). In the short term, we expect similar impacts alternative B and C. However, in the long term, we expect the potential for an increase in the beneficial impact of such management with forest harvesting since 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 particularly so over the long term, both refuge-specific and regionally.


USFWS

Yellow bellied sapsucker

Adverse Impacts. The adverse impacts to soils of alternative C is similar to alternative B, except there would be a slightly greater potential for adverse impacts from actively managing about 3,500 more acres of habitat (12,873 acres versus 9,312 acres; table 5.4) and constructing three additional 1-mile long, ADA-accessible trails (about an additional 6 acres of disturbance).

Soil Impacts under Alternative D

Beneficial Impacts. Alternative D is expected to provide the highest level of beneficial impacts to refuge soils in the long term because it would protect soils on up to 231,307 across 22 CFAs. Compared to alternative C, alternative D protects an even larger and more intact area within the larger watershed landscape.

Adverse Impacts. Compared to the other alternatives, the management activities proposed under Alternative D would have the least adverse impact on soils, promoting a low impact, passive management approach. Under alternative D there would be no active forest management designed for target priority refuge resources of concern wildlife that might periodically result in some soil disturbance. Management steps would be taken to mitigate unexpected events that may pose safety hazards and that may temporarily disturb soils (e.g., repair of collapsed culvert causing flooding, clear trail blockages due to storm damage, eliminate hazardous fuel loads) or that significantly impede natural succession or restoration (e.g., control serious outbreaks of invasive plants, hands-on restoration of highly impaired habitats through planting or other habitat management that may require the use of heavy equipment).

Activities such as required road and parking lot maintenance would continue (e.g., roadside mowing, tree trimming). The low impact, or passive management, approach by this alternative would have both short- and long-term negligible adverse impacts on soil quality.

Also, alternative D is expected to have a very low impact on soils due to the absence of ground-disturbing habitat management. It has the second-highest level of visitor use among the alternatives (Table 5.5). As such, visitor activities that might impact soils, such as hiking off designated trails, would pose almost the lowest and negligible soil adverse threat of all alternatives. The refuge recognizes, however, that much of this reduced use is due to the elimination of snowmobiling, an activity that is not expected to have any more than negligible adverse impacts to refuge soils as discussed prior.

We do predict a slight increase in other forms of use from the eventual creation of 22 1-mile long “back country” trails (Table 5.5). We expect slightly less impacts to soils from constructing these “back country” trails compared to the ADA-accessible trails proposed under alternatives B and C because the trails would be narrower and less developed. We predict about 1 acre of disturbance per each trail mile (total of about 22 acres of disturbance).

Summary

In summary, our management activities across alternatives would not significantly impact (either adversely or beneficially) refuge or regional soils. All alternatives propose acquisition and protection of additional acres of refuge land (table 5.4). With those potential additions of habitat to the refuge, in concert with currently protected lands, there is an expectation on the maintenance of good to excellent soil quality due to soil protection and natural soil accretion, maintenance of the land-filtering and nutrient processing functions of the soil layer. We expect all proposed refuge management activities under all

alternatives—forest management, prescribed burning, trail construction, visitor use—to be of minor to negligible adverse impact.

Impacts to Freshwater Wetland Habitats and Vegetation

Generally, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface (Cowardin et al. 1979). Freshwater wetlands are valuable natural resources that:

- Serve as important breeding, foraging, and migration habitats for wildlife.
- Contribute to nutrient recycling.
- Help purify drinking water supplies.
- Promote groundwater recharge.
- Mitigate flooding.
- Serve as important aquatic spawning areas.
- Offer unique recreational opportunities for the public.

These ecological functions are widely recognized. Activities that involve filling, excavating, or otherwise altering wetlands can impair wetland functions and values. For many years, these functions and values have been protected by Federal and state laws and regulations, and even town bylaws (e.g., Massachusetts). Overall, freshwater wetlands on the refuge are productive and in good condition.

The Service's Northeast Region has identified a number of important representative species and habitat types within their North Atlantic Land Conservation Cooperative (LCC). The LCC habitat types are used within this final CCP to define habitats to be acquired and actively or passively managed under the CCP, depending upon alternatives, to advance conservation of priority refuge resources of concern species associated with freshwater wetland habitat (Table 5.6) (derived from appendix A). This analysis on freshwater habitats and vegetation considers all wetland types found within the acquisition boundaries

Wood frog

Andrew MacLachlan/USFWS

of each alternative (see Table 3.4). Although freshwater wetlands encompass a vast majority of wetlands covered by this impact analysis, we also include consideration of the small amount of brackish and salt marsh that potentially could be acquired in the Whalebone Cove CFA. We evaluated and compared the management actions proposed for each of the refuge CCP alternatives based on their potential to benefit or adversely impact refuge freshwater wetlands.

Table 5.6. Comparison of Impacts to Freshwater Wetlands and Target Wildlife by Alternative

Major Freshwater Wetland Habitat	LLC Habitat[1]	PRRC Resources[2]	Acres of Freshwater Wetlands by Alternative			
			Alt. A	Alt. B	Alt. C	Alt. D
Forested Uplands and Wetlands	Conifer Swamps	Canada Warbler	undetermined	4,191	5,683	6,031
	Hardwood Swamps	Northern waterthrush Canada warbler	undetermined	2,008	2,639	5,993
	Shrub Swamp and Floodplain Forest	Laurentian-Acadian wet-meadow shrub swamp American woodcock American black Duck New England cottontail Little Brown bat Tri-colored bat Northern long-eared bat Eastern small-footed bat	undetermined	1,638	2,804	3,477
Non-forested Uplands and Wetlands	Freshwater Marsh	Laurentian-Acadian freshwater marsh American black duck Semi-palmated sandpiper	undetermined	962	2,053	2,401
	Peatlands	American black duck	undetermined	922	1,098	1,099
Inland Aquatic Habitats	Open Water[3]	American black duck Brook trout Atlantic salmon Alewife American eel Dwarf wedgemussel Brook floater	undetermined	2,155	2,972	3,783
Coastal Wetlands and Aquatic Habitats	Salt Marsh	Northern Atlantic coastal plain salt marsh.	undetermined	7	7	474
Total			**41,455**[4]	**11,883**[5]	**17,256**[5]	**23,258**[5]

[1] *LCC – Land Conservation Cooperative*

[2] *PRRC – Priority Refuge Resource of Concern*

[3] *Open water data likely to be under estimated.*

[4] *Estimate from 1995 Conte Final EIS-Action Plan, which is likely to be a high estimate.*

[5] *Figure does not include Quonatuck CFA acres and therefore is an underestimation*

The following management activities are most likely to impact the refuge's freshwater wetland habitats and vegetation:

Activities with the potential to benefit refuge freshwater wetlands include:

- Land acquisition and conservation that reduce loss of and impairment to freshwater wetlands by preventing further development.
- Wetland restoration, invasive plant control, and other management activities that improve wetland functions and values.

Activities with the potential to adversely impact refuge freshwater wetlands include:

- Forest management activities.
- Beaver and muskrat trapping.
- Moose and deer herbivory.
- Construction of buildings, parking facilities, access roads, and interpretive trails.
- Road maintenance (grading, ditch maintenance, roadside mowing).
- Visitor use impacts on wetlands adjacent to refuge trails and roads, or boardwalks through wetlands.

Impacts to Freshwater Wetlands That Would Not Vary by Alternative. Proposed refuge management activities would neither significantly benefit nor significantly adversely impact current local and regional freshwater wetlands. We expect the habitat conservation and management measures proposed in all alternatives would help protect and enhance natural beneficial functions, such as habitat for aquatic fish and wildlife, nutrient cycling, groundwater recharge, water filtration (in some cases ameliorating heavy metal and petrochemical non-point runoff), reduce high water turbidity, reducing high-flow outwash into streams and tributaries, and mitigate impacts due to storm flooding (*http://water.epa.gov/type/wetlands/;* accessed August 2016). All of these functions and values will be promoted on wetlands on existing and future refuge lands. In the short term (within 15 years), we would likely acquire similar amounts of land under all the alternatives, thus beneficial impacts would be similar across all alternatives in the short term. Greater beneficial freshwater wetland impacts would be expected to occur over the long term within alternatives C and D.

Across all alternatives, our management actions would not contribute to the long-term or permanent impairment of any freshwater wetlands, except when constructing structures for public use, use elevated boardwalks and observation platforms. These structures would be built to last beyond the 15-year timeframe of the CCP, but they could be dismantled when warranted. Direct impacts from these activities would be adverse, but negligible in the short term. There are no plans for major facilities or new road construction in or near wetland areas. Regardless of which alternative is selected, we would continue to use best management practices in all management activities that might impact refuge wetlands (e.g., maintaining appropriate wetland buffers, conducting habitat management actions on frozen soil).

As funding allows, we would strive to restore natural hydrology to impaired wetlands we acquire (e.g., replacing undersized culvers), to restore natural topographies, soils, and wetland vegetation. Restoration would include removing dwellings and other small infrastructure on property acquired by the refuge

in developed areas. We may also reduce the number of roads to minimize soil erosion into streams and rivers. Roads essential for management access may be improved, maintained, or re-opened. Skid trails created during forest habitat management operations would follow each state's best management practices.

Habitat management within the refuge's freshwater wetlands will be negligible, and would typically involve degraded lowland spruce-fir forest. Habitat management in any forested wetland area would follow appropriate best management practices, 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. We would take steps, as appropriate, to insure that our forest management practices, including passive management, do not contribute to the accumulation of hazardous fuel loads that may burn across wetland areas during dry seasons or droughts. Fortunately, the risk of catastrophic fire is fairly low in the forests of the watershed.

Logging may disturb refuge visitors, cause safety issues, or detract from visitors' aesthetic experience. When safety considerations warrant, areas of the refuge undergoing active management will be temporarily closed. Trails will either be closed or shared with logging trucks depending on the availability of feasible alternatives. Because small portions of the refuge's acreage will be actively harvested at any one time, disruptive adverse impacts to visitors will be minimal. Across all alternatives we will take appropriate management action to help recover any Threatened or Endangered species if new lands acquired are known habitat areas for these species, and such lands are identified as needing protection and management in an approved recovery plan. Such management actions would be taken after appropriate review and consultation with recognized experts and Service approval.

Circumstances may require the use of pesticides, such as herbicides to control invasive plants growing in freshwater wetlands. In these situations, the refuge management would follow an approved Integrated Pest Management Plan. A Pesticide Use Proposal (PUP) is required by the Service before application of a pesticide (including herbicides) on Service property. It is a protective measure to ensure the proper use of pesticides on Service lands. When required, the Regional Contaminants Specialist would review our Pesticide Use Proposals and approve chemical herbicide use.

The Service regulates human uses of the refuge to appropriate and compatible uses (usually wildlife-dependent uses). We expect visitation to increase over time across all alternatives, as we acquire additional refuge lands and construct public use facilities, especially trails. The increase varies due to each alternative's respective refuge expansion level. Public use trails are constructed and managed to avoid or minimize adverse impacts to freshwater wetlands. Impacts to freshwater wetlands from the construction of new trails are expected be largest for alternatives B and C, which both propose constructing ADA-accessible trails. Impacts from alternative C will be slightly more than under alternative B. Impacts from alternative D follow, since this alternative still proposes the construction of many miles of new trails. Alternative A is associated with the fewest adverse impacts to wetlands from trail construction. Impacts from actual visitor use of these trails will likely track the impacts from construction, and will vary based on the popularity of each trail system. We expect trail construction and visitor hiking activity to have both short-term and long-term, negligible impacts to freshwater wetlands on the refuge.

Pets are allowed as companion animals and to facilitate hunting. Decaying pet waste consumes dissolved oxygen (DO) in water bodies and sometimes releases

ammonia (NH_3). Pet waste carries bacteria, viruses, and parasites that can threaten the health of humans and wildlife (EPA 2001). There are no known pet waste problems on any refuge division or unit, and future acquisitions will be carefully managed. Bicycling can contribute to soil erosion into wetlands; while the use of all-terrain vehicles (ATVs) is not permitted on refuge lands; we propose to allow bicycling on refuge roads (not trails).

Regardless of which alternative we select, we would take a number of steps to insure that we have sufficient scientific data to support management decisions regarding refuge freshwater wetland management and protection. We will work with Service's Division of Ecological Services, the USDA Natural Resources Conservation Service, respective state agencies, and other conservation partners to help identify and correct any impacts to freshwater wetlands.

Impacts to Freshwater Wetlands of Alternative A

Beneficial Impacts. Alternative A would provide short-term and long-term beneficial impacts from protecting freshwater wetlands on existing and future refuge lands. Table 5.6x estimates the total amount of wetlands protected under alternative A and lists the priority resources of refuge concern that would benefit from this conservation. The protection of these acres will provide benefits to wetlands from helping maintain essential wetland functions and values (e.g., fish and amphibian habitat, groundwater recharge, nutrient processing, and flood mitigation).

Overall, alternative A would continue current management of forest and grassland habitats on to 455 acres (table 5.4). Some forest management is expected to occur in forested wetlands (e.g., lowland spruce-fir) where habitat improvement is necessary, and is expected to have a number of beneficial impacts, both short-term and particularly long-term. Forest management can improve and accelerate development of historic forest structure and species composition (Seymour et al. 2002, Keeton 2006, Franklin et al. 2007, North and Keeton 2008, Raymond et al. 2009, Arseneault et al. 2011). 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 priority refuge resources of concern species (for more detail, see appendices D and J).

Adverse Impacts. Under alternative A, we propose very few activities that would adversely impacts wetlands. Heavy equipment used for habitat management, trail and road maintenance, and other routine construction may cause some disturbance to wetlands (e.g., soil erosion and compaction of vegetation and soils). In general, we would avoid conducting these activities wetland areas, expect where necessary to enhance or restore wetland habitats for priority refuge resources of concern. However, some habitat management would occur in close proximity to wetland areas, or in forested wetlands such as the lowland spruce-fir forests at the Nulhegan Basin, Pondicherry, and Blueberry Divisions. We would follow best management practices to reduce the potential of these impacts, taking measures such as leaving forested buffers along wetlands and avoiding sensitive wetland areas.

In total, 200 grassland acres are managed within three CFA areas: Fort River, Nulhegan Basin, and Pondicherry. Management activities include periodic (2 to 3 years rotation) mowing, haying, and brush hogging with diesel fueled tractors, so

emission drift or fuel spills may enter nearby wetland areas and potentially could cause very localized, short-term adverse impacts. Such infrequency of treatment on relatively small tracks of land, and where such treatments are generally designed to be distant from known wetlands, are all refuge habitat management activities believed to be negligibly adverse in their impact to local or regional wetland integrity, both in the short term and long term.

Other management activities would include controlled herbicide use on about 60 acres, maintenance of six buildings, and trail and road maintenance with some tree cutting (about 20 miles of trails and 40 miles of public roads and 2 miles of administrative roads). We would also follow best management practices for these activities to minimize impacts to wetlands. In wetland areas, we would only use herbicides that are approved for use near wetlands and only where they are the most effective control for invasive species.

We are not currently using prescribed burning to manage refuge habitats and under alternative A we would only use prescribed burning to reduce hazardous fuels. Both regionally and refuge-specific, these activities would be of negligible adverse impact to freshwater wetlands. Best management practices to protect wetlands are implemented in all ground disturbing activities.

Visitation under alternative A would not appreciably change over current levels and is expected to be lower than any of the other alternatives. We note, however, there likely will be more visitation at the Fort River Division due to the new 1.2 mile (flat terrain) ADA-accessible trail and wetland boardwalk system, yet that potential increase would be modest and considered of negligible short-term and long-term adverse impact since most visitors will remain on the trail.

Alternative A would continue to allow managed furbearer trapping in freshwater wetlands at the Nulhegan Basin Division. This activity conducted from 2001 to 2012 resulted in a harvest of 65 beaver, 77 muskrat, 41 mink, and 13 river otter, averaging about 16 beaver, 8 muskrat, less than 4 mink, and 1 otter annually. The average number of annual trap-days spent by individuals in the wetland environment was 64. The impact of managing the populations of these species is considered negligible and the benefits beaver provide in creating and maintaining dynamic forested wetlands is maintained. Managed trapping helps to reduce damage by beaver and muskrats on refuge roads near freshwater wetlands. During five winter trapping seasons (2004/5 and 2007/8 to 2010/11), a total of 66 beaver and 46 muskrats were taken in the Moorehen Marsh vicinity of the Pondicherry CFA/Division by permitted trappers, thus averaging about 13 beaver and 9 muskrat in any one trapping season. This was a cooperative effort with the New Hampshire Bureau of Trails which manages the recreational rail-trail bordering Moorhen Marsh. Beavers and muskrats were plugging outlets under the rail-trail resulting in trail flooding which created sheet ice in winter, a safety hazard on this popular snowmobile trail. It is also likely that some of these recorded animals were actually taken off-refuge in the rail-trail ROW where the same trappers operated. Although over-browsing by ungulates has been documented at the Nulhegan Basin Division, there are currently no known over-browsing issues within forested wetlands at other refuge divisions.

As described prior, we do not plan to increase capacity for snowmobiling. Current trails do not impact wetlands. Snowmobile trails on new lands to be acquired under alternative A may be retained, and in select situations a closed trail may be opened to promote wildlife-dependent public uses, but these areas would not involve wetlands. Concerns have been voiced about the potential adverse impacts of snowmobile exhaust on aquatic systems: some suggest that fish can acquire and accumulate hydrocarbons, and repeated packing of snow during

grooming can accumulate pollutants on developed trails which are then released during snowmelt and spring runoff (Ruzycki and Lutch 1999, Oliff et al. 1999). A statewide 2010 study (VHB Pioneer 2010) evaluated snowpack chemistry to detail the presence or absence of impacts from snowmobile traffic on the chemical composition of snowpack, soil, and runoff in the proximity of heavily traveled snowmobile trails. Two of the sample sites were on Nulhegan Basin Division refuge trails. Snowmelt and runoff chemistry monitoring indicated no detectable levels of volatile organic compounds or total petroleum hydrocarbons in surface waters located immediately down-gradient of the snowmobile trails. Furthermore, snowpack chemistry monitoring indicated no detectable levels of volatile organic compounds or total petroleum hydrocarbons in background or on-trail snow sampling stations. Results showed no change in water chemistry for any of the sites sampled, including those on the refuge. Although this was a wide-ranging study, it only covered a single season. Therefore, additional replication would be useful to further assess the risk of hydrocarbon to refuge waters. However, based on the available data with a representative sampling of snowmobile use on the refuge, improvements in snowmobile technology to favor 4-stroke engines, and the substantial water volumes involved, the pollutant impacts to waters are expected to be negligible.

Impacts to Freshwater Wetlands of Alternative B

Beneficial Impacts. In the short term, the beneficial impacts of alternative B would be similar to those described under alternative A. Over the long term, we predict slightly greater benefits from protecting larger, more contiguous CFAs as opposed to protecting more scattered, smaller SFAs. By protecting larger, more contiguous CFAs, we expect to have a greater potential to protect natural wetland functioning and to ensure a wide buffer of undeveloped land surrounding wetlands.

Adverse Impacts. In the short term, adverse impacts to wetlands would be similar to those described under alternatives A and B. Over the long term, we expect a greater potential for adverse impacts to wetlands from expanded active habitat management (table 5.4). As described under alternative A, we will use best management practices to protect wetlands and to ultimately enhance habitat structure and functioning for priority refuge resources of concern. As we acquire new lands, we will develop HMPs that provide more detailed information on proposed active management and predicted impacts.

Visitation under alternative B would potentially increase by 22 percent over alternative A levels (Table 5.5), due in large part to an expanded 19-mile trail system. As such, increased visitor activities that might impact wetlands, such as hiking off designated trails would pose a minor concern, as visitors tend to spend most time in uplands, except when using existing wetland boardwalk trails. Boardwalk trails over wetlands would continue to be a potential management option, and all would be constructed using BMPs to avoid or minimize short-term and long-term adverse impacts to wetlands.

Alternative B also proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis.

Impacts to Freshwater Wetlands of Alternative C

Beneficial Impacts. In the short term, the beneficial impacts of alternative C would be similar to those described under alternatives A and B. Over the long term, we predict greater benefits from protecting more acres of wetland habitat.

Adverse Impacts. In the short term, adverse impacts to wetlands would be similar to those described under alternatives A and B. Over the long term, we expect a greater potential for adverse impacts to wetlands from expanded active habitat management (table 5.4). As we acquire new lands, we will develop HMPs that provide more detailed information on proposed active management and predicted impacts. As described under alternative A, we will use best management practices to protect wetlands and to ultimately enhance habitat structure and functioning for priority refuge resources of concern. These management impacts would be considered local and of negligible adverse impact in the short term and of no impact over the long term.

Visitation under alternative C would increase 54 percent (Table 5.5) compared to alternative A, offering greater visitor use opportunities over the short term and long term due to an expanded, accessible trail system. Potential adverse impacts would be similar in kind and slightly greater in total impact to those discussed under alternative B, due to a 22-mile trail system in alternative C compared to a 19-mile trail system in alternative B.

Similar to alternative B, alternative C proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis.

Bill Buchanan/USFWS

Bullfrog

Impacts to Freshwater Wetlands of Alternative D

Beneficial Impacts. In the short term, the beneficial impacts of alternative D would be similar to those described under alternatives A, B, and C. Over the long term, we predict the greatest benefits under alternative D from protecting the greatest amount of habitat. Also, the CFAs under alternative D are the largest and most contiguous, so we expect the greatest potential to protect natural wetland functioning and process.

Adverse Impacts. In the short term, adverse impacts to wetlands would be similar to those described under alternatives A, B, and C. Over the long term, we expect the least potential for adverse impacts to wetlands because we propose no active habitat management, except for federally threatened and endangered species. We would continue to work with the Service's New England Field Office to determine whether active management is needed for federally listed species. We would also take management steps to mitigate unexpected events that may pose safety hazards (e.g., repair of collapsed culvert causing flooding, clear trail blockages due to storm damage, eliminate hazardous fuel loads) or that significantly impede natural succession or restoration (e.g., control serious outbreaks of invasive plants, hands-on restoration of highly impaired habitats through planting or other habitat management that may require the use of heavy equipment

Activities such as required road and parking lot maintenance would continue (e.g., roadside mowing, tree trimming). 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. In contrast to a passively managed forest, it is possible that an actively managed forest as described in other alternatives, where harvests act to mimic natural disturbances that create openings for new generations of trees while retaining some larger, older trees, may accelerate the improvement of natural forest structure and age or size classes important to focal species into the future.

Visitation under alternative D is projected to be lower than alternative C, but higher than under alternatives A or B. Its scope is different because snowmobile

use will be eliminated. Trails constructed under this alternative will be native-surface and thus less impactful on the surrounding vegetation. Trails will be designed to avoid wetlands, or to carefully incorporate trails and boardwalks into wetlands areas that promote environmental education and interpretation.

Visitor activities that might impact wetlands, such as hiking off designated trails or not removing pet waste, would pose negligible wetland adverse impacts in the short and long term. One study suggests 70 percent of hiking individuals veer off-trail (Hockett et al. 2010), and we would take known corrective actions to mitigate such activity such as placement of natural obstructions. Due to the passive management approach for alternative D, there would be no managed furbearer trapping at the Nulhegan Basin Division (CFA), which may adversely impact refuge habitats in the short and long term from not controlling species like beaver and muskrat, and their potential to adversely impact wetland habitats.

There is evidence that over-browsing in wetland systems has occurred in forests of the Nulhegan Basin Division, and Northeast Kingdom in general, although it is believed the current ungulate populations are at an acceptable level. Current refuge hunts (e.g., 350 annual hunt visits at Nulhegan Basin Division) are believed to help mitigate any potential problem, and the potential adverse impact from over-browsing in wetlands is considered negligible in the short term, yet the long-term impacts will have to be monitored.

Similar to alternatives B and C, alternative D proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis.

Summary

In summary, our management activities across alternatives would not significantly adversely or beneficially impact refuge freshwater wetlands. As previously noted, all propose acquisition and protection of additional acres of refuge land. The continued conservation of existing refuge wetlands and the long-term potential to acquire and permanently protect more will be of direct and long-term beneficial impacts to wetland wildlife. Maintaining and protecting wetlands will help to guarantee their beneficial ecosystem functions that serve wildlife (e.g., habitat) and society at large (e.g., groundwater recharge, flood attenuation). We expect all proposed refuge management activities under all alternatives—forest management, prescribed burning, trail construction, visitor use—to be of minor to negligible adverse impact.

Impacts to Upland Habitats and Vegetation

Uplands typically are well-drained lands generally of higher elevation. Unlike wetlands, uplands do not have water as a defining feature determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Upland habitats and vegetation are the predominant plant communities in the Connecticut River watershed (Table 5.7). Like freshwater wetlands, uplands are valuable natural resources. They serve as important breeding, foraging, and migration habitats for a wide variety of plants and wildlife and are essential to the water and nutrient cycles. The Service's Northeast Region has identified a number of important representative species and habitat types within their North Atlantic Land Conservation Cooperative (LCC). The LCC habitat types are used within this final CCP to define habitats to be acquired and actively or passively managed under the CCP, depending upon alternative, to advance conservation of priority refuge resources of concern species (Table 5.5). This analysis on upland habitats and vegetation includes consideration of all LCC upland types that occur on the refuge, including spruce-fir forest, hardwood forest, woodlands, pasture, hay and grassland, old field and shrubland, cliff and talus, rocky outcrop, and rocky coast and islands.

We evaluated and compared the management actions proposed for each of the refuge CCP alternatives on the basis of their potential to benefit or adversely impact refuge upland habitat and vegetation. The following management activities are most likely to affect the refuge's upland habitat and vegetation:

Table 5.7. Comparison of Impacts to Upland LCC Habitats and Priority Refuge Resources of Concern Species by Alternative.

Major Upland Habitat	LCC Habitat	PRRC Wildlife	Alternative B: 19 CPAs	Alternative C: 22 CPAs	Alternative D: 22 CPAs
Forested Uplands and Wetlands	Spruce-fir Forest	Blackburnian warbler Rusty blackbird Canada warbler	18,231	22,707	23,784
	Hardwood Forest	American woodcock, Wood thrush Bald eagle Blackburnian warbler Chestnut-sided warbler Canada warbler Black-throated blue warbler Louisiana waterthrush New England cottontail Little brown bat Tri-colored bat, Northern long-eared bat, Eastern small-footed bat Osprey	61,212	150,927	195,578
	Woodlands	Woodland pine-oak community	221	476	649
Non-forested Uplands and Wetlands	Pasture, Hay and Grassland	American woodcock, New England cottontail	5,061	9,637	11,255
	Old Field and Shrubland	New England cottontail	37	52	99
	Cliff and Talus	Four unique plant communities Peregrine falcon	445	1,868	2,094
	Rocky Outcrop	Two unique plant communities	590	2,098	2,387
Coastal Non-forested Uplands	Rocky Coast and Islands	Acadian North Atlantic Rocky Coast	19	41	41
Total acres			**85,816**	**187,806**	**235,887**

The potential beneficial impacts to upland habitat and vegetation resulting from refuge management activities described in the alternatives include:

- Extent to which refuge land acquisition and conservation under the alternatives would reduce loss of or impairment to upland habitat and vegetation through development activities.
- Extent to which the potential refuge management actions on current and acquired upland habitats and vegetation would improve upland habitat functions and values to priority refuge resources of concern species.

The potential adverse upland habitat and vegetation impacts of the refuge management alternatives that were evaluated included impacts from:

- Habitat management activities designed to improve habitat structure for priority refuge resources of concern species.
- Impacts to non-priority wildlife due to management for priority species.
- Construction of buildings, parking facilities, access roads, and interpretive trails.
- Road maintenance (grading, ditch maintenance, spreading gravel, removing boulders, roadside mowing/debrushing).
- Visitor use impacts on uplands adjacent to refuge trails and roads.
- Prescribed burning in appropriate fire-regime habitats, or for habitat management and hazardous fuel reduction.

Estimated Acreage Subject to Habitat Management Activities
The acreage figures we propose for habitat management largely are to be conducted in upland habitats. The estimated acres to be managed are presented in table 5.4 above. We believe these estimates under each alternative offer reasonable estimates of average annual treatments, and provide the public, partners, and other stakeholders interested in this refuge management activity with a basis on which to evaluate and compare the proposed final CCP/EIS alternatives. These estimates assume full implementation of the CCP (e.g. staffing, funding, and land acquisition) over the 15-year CCP timeframe and beyond. They are based on limited, available resource information on refuge lands yet to be acquired. As new lands are acquired, and we assess habitat conditions, we will likely need to adjust these acres.

All subsequent habitat management actions will conform to a site-specific Habitat Management Plan (HMP) derived from the management objectives prescribed in the final CCP. Grassland acres by alternative (200, 422, 548, and 0 acres, respectively) represents the full footprint of grassland habitat to be managed by the refuge, and similarly, shrubland acres by alternative (0, 775, 775, and 0 acres, respectively) represents the full footprint of shrubland habitat to be managed by the refuge. We will initiate HMPs for each respective CFA/ refuge division once the Service has acquired a manageable land interest, and after we have conducted field inventories and assessments. Guided by an HMP, we will more specifically base our annual acreage estimates on potential habitat management opportunities and staff capabilities to oversee such actions that year. We will design and implement habitat management activities to achieve the respective HMP's objectives (and CCP Goal 1) while recognizing the need to accommodate unforeseen circumstances (e.g., difficult site topography, poor weather, constrained budgets, and staffing) that may result in annual variations in treatment acres. As such, we consider these annual estimates and not quotas or limitations. In addition, we expect that the average acres to be managed annually will be lower in the short-term (e.g. within the 15-year timeframe of the CCP), as compared to the long term when the refuge would potentially have reached its full authorized size encompassing a much larger land base.

Impacts to Upland Habitats That Would Not Vary by Alternative.
Proposed refuge management activities would benefit current local and regional upland habitats. We expect refuge land conservation and management within all alternatives over the long term to help maintain and promote regeneration

Bill Thompson

Snowy owl

of natural beneficial upland functions and values that include habitat for terrestrial fish and wildlife, nutrient cycling, groundwater recharge, filtering water, in some cases ameliorating heavy metal and petrochemical non-point runoff, retarding down-stream turbidity, reducing anthropogenically exacerbated high-flow outwash into streams and tributaries, and diminishing adverse weather impacts (e.g., storm winds, heavy precipitation). Priority refuge resources of concern will benefit from upland habitat protection.

All of these upland functions and values will be promoted on the existing 37,000 refuge acres, potential completion of its current authorized acquisition level (alternative A; 97,830 acres), reconfiguration of its current acquisition level (alternative B, 97,772 acres) into the proposed CFA structure, or any expansion of refuge size as proposed by alternatives C and D, the latter two which would authorize expansion to 197,337 and 231,307, respectively. Greater upland benefits would be derived from either of the refuge expansion alternatives (C and D) since they would permanently protect these often desirable building sites and preclude them from potential development projects. Since the refuge was founded, the average annual expansion has been 2,117 acres, although the average for the past five years is a modest 647 acres. Consequently, in the short term (within 15 years), we would likely acquire similar amounts of uplands under all the alternatives, thus beneficial upland habitat impacts would be similar and minor across all alternatives in the short term. Greater upland habitat beneficial impacts would be expected to be modest over the long term.

There are no explicit plans for major facilities or new road construction in upland habitats; however, action alternatives (B, C, and D) propose a potential outdoor classroom at the Fort River Division. Impacts to upland habitats from any outdoor classroom structures would be subject to separate NEPA analysis. Regardless of which alternative is selected, we would continue to use best management practices in all management activities.

Across all alternatives, we would restore natural slope and gradient to any impaired upland that may exist on acquired developed sites having unnecessary roads, buildings, or other infrastructure nearby thus promoting natural topography, soil constituency, and native upland vegetation. Restoration would include removing dwellings and other small infrastructure on property acquired by the refuge in developed areas. Reducing road use may eliminate air-borne dusts and minimize soil erosion into lower streams and rivers. As needed, roads will remain open to provide motorized and non-motorized access to visitors, and to benefit management access. Where appropriate, roads may be closed to visitor access. Roads no longer required for management activities and not suitable for public use may be closed to improve local soil and hydrology. Roads may be upgraded, re-opened, or maintained to improve access for active habitat management.

Within the regional and refuge specific upland landscape, habitat management impacts across alternatives are negligibly adverse in the short term and beneficial in the long term. Habitat management in any upland area would be conducted to create habitat structure to fulfill known needs of priority refuge resources of concern. The level of upland habitat management by acres changes considerably across alternatives (Table 5.4), but such management results in an altered and improved habitat structure, never permanent impairment. Impacts

from these activities (e.g., use of heavy equipment, chainsaw cutting, tractor mowing) would be negligibly adverse in the immediate short term (days to a few years) but beneficial in the longer term (one year or more). Operations performed by contractors will have oversight from the refuge staff.

Forest management is expected to have a number of beneficial impacts, both short-term and particularly long-term, by improving and accelerating growth of historic forest structure and species composition within currently degraded forests (Seymour et al. 2002, Keeton 2006, Franklin et al. 2007, North and Keeton 2008, Raymond et al. 2009, Arseneault et al. 2011). Although silviculture does not create forests that are ecologically identical to natural old-growth forests (Aber et al. 2000), we can mimic structures found in old-growth forest and conduct restoration. In the absence of active management, the development of wildlife habitat to serve the needs of priority refuge resources of concern in degraded forests may take longer or not occur, 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 priority refuge resources of concern species.

Ground-disturbing activities associated with forest management have some potential to adversely impact upland habitats, primarily in the immediate short term when heavy equipment is in use, particularly during forest harvest operations or grassland mowing/brushhogging. Forest habitat management under alternatives A, B, and C would continue implementation of the woodcock habitat management plan on 300 acres designated as woodcock demonstration areas at the Nulhegan Basin Division. Management techniques will include various forms of even-aged and uneven-aged management. Harvest operations will be performed by contractors under supervision of the refuge forester, and recognized BMPs will be employed throughout such operations to minimize short term adverse impacts to residual trees, soils, drainage patterns, streams, isolated wetlands, fuel/oil spills, etc.

The 15-year scope of the CCP falls far short of the decades we expect it will take to create a diverse and mature forest. Our expectation is that much of the forest structure and species composition deemed important to our refuge focal species will take a minimum of 100 years to develop under the implementation of our forest management goals and objectives. Generally, our management will move stands towards a more ecologically mature forest structure characterized by the inclusion of trees that extend above the canopy; a vertically and horizontally diverse canopy; increases in standing dead trees (snags) and downed woody debris - particularly larger size classes; increases in the softwood component of mixed species stands; and the maintenance of a generally closed canopy. These conditions favor refuge focal species, including but not limited to wood thrush, blackburnian and black-throated blue warblers. Where appropriate an even-aged management approach will benefit other focal species including Canada warbler, New England cottontail, and American woodcock.

Regardless of the alternative selected, pesticides, most often herbicides, will be part of management. The refuge will develop and implement an Integrated Pest Management Plan that addresses environmentally safe application procedures and requirements. Pesticides will only be used if it is the most effective management technique, and will be combined with other management tools. Pesticides must be approved by the Regional Contaminants Specialist, who is responsible for upholding Federal standards for water quality and soil protection.

The Service carefully regulates human uses of the refuge to appropriate and compatible uses (usually wildlife-dependent uses) and thus reduces anthropogenic impacts related to upland habitats. We expect visitation to increase over time across all alternatives, as we acquire additional refuge lands and construct public use facilities, especially trails. The increase varies due to each alternative's respective refuge expansion level. Visitation is highest under alternative C, followed by alternatives D, B, and A. Because alternative D proposes native-material trails rather than ADA-compliant trails, impacts from trail construction is likely to do more damage to upland habitats in alternative B, but impacts from trail use could potentially be greater under alternative D. Public use impacts are expected to be negligibly adverse in the short and long term. Public use trails are carefully placed and managed to avoid or minimize adverse impacts to upland habitats. Trails most commonly are sited in stable upland areas where potential habitat related impacts (e.g., habitat fragmentation, wetland impairment, soil erosion and compaction, disruption of sensitive communities, conduits for invasive plants and animals) can be avoided or minimized.

Pets under leash control are permitted on refuge trails, yet their waste can cause negative adverse impacts to the immediate upland environment and indirectly to nearby freshwater wetlands and streams (EPA 2011). There are no known pet waste problems on any refuge division or unit, and future acquisitions will be carefully managed to authorize any pet walking so that their wastes are removed from refuge lands. We recognize that visitors, and visitor use activities can be a source of introducing invasive plant seeds (e.g., muddy boots, pet hair), and seek to minimize these potential impacts by carefully designing new trails and implementing appropriate restricted use or public education and awareness.

Regardless of which alternative we select, we would take a number of steps to ensure that we have sufficient scientific data to support management decisions regarding refuge upland habitat management and protection. We would work with the our own Service Division of Ecological Services, the USDA Natural Resources Conservation Service, respective state agencies, and other conservation partners to help identify and correct any negative impacts to uplands.

Impacts to Upland Habitats of Alternative A

Beneficial Impacts. Alternative A would provide short- and long-term beneficial impacts to upland habitat because it would conserve uplands on a refuge landscape of up to 97,830 acres (37,000 currently acquired) across 65 widely separated, often small SFAs.

Overall, alternative A would continue current management of forest and grassland habitats encompassing up to 455 acres (255 acres forest and 200 acres grassland) (Table 5.4). No shrubland habitat would be actively managed to remain as shrubland. Forest habitat management under alternative A would continue implementation of the woodcock habitat management plan on 300 acres designated as woodcock demonstration areas at the Nulhegan Basin Division, harvesting approximately 60 to 65 acres every 5 years. Benefits to upland habitats from these activities would be greater under alternatives B and C than under alternative A. No active management is planned under alternative D.

Grassland management will be conducted under alternative A. Grassland management is defined as the set of actions taken to maintain the structure and persistence of grassland communities by preventing natural vegetation succession to forest. Active habitat management actions will include mowing, mechanical clearing, selective cutting, and selective use of herbicides to eliminate invasive plants. Without these intervention techniques and in the absence of disturbance, early-successional grasslands will succeed to another stage, likely young forest. The consequence of this is the elimination of a critical habitat type for the

refuge and the northeast in general (Oehler et al. 2006). These management interventions are intended to maintain and improve early-successional grassland habitat for priority refuge resources of concern target species (e.g., bobolink and upland sandpiper).

Alternative A would continue to permit managed furbearer trapping on uplands at the Nulhegan Basin Division. This activity conducted from 2001 to 2012 resulted in a harvest of 54 fisher, 31 coyote, 2 raccoon, and 8 weasel, and 1 bobcat, averaging about 5 fisher and less than 3 coyote annually with other recorded species being taken irregularly. The average number of annual trap-days spent by individuals in the upland environment was 25. The impact of trapping and managing the populations of these species in upland habitats is considered of minor benefit in the short and long term.

Adverse Impacts. Overall, alternative A would continue current management of forest and grassland habitats encompassing up to 455 acres (255 acres forest and 200 acres grassland) (Table 5.4). No shrubland habitat would be managed. Adverse impacts from ground-disturbing activities under alternative A would be greater than under alternative D, but probably less than under alternatives B and C.

Under this alternative A, prescribed burning is not employed to manage habitats or reduce forest fuel loads, and no campfires are permitted. Prescribed burning may be employed, however, to reduce hazardous fuels.

Upland habitat management under alternative A would be maintained to provide for target grassland birds (e.g., bobolink, upland sandpiper, and American woodcock). In total, 200 grassland acres are managed at three CFAs: Fort River, Nulhegan Basin, and Pondicherry Divisions. Management activities include mowing, haying, and brush hogging with diesel fueled tractors. Management activities include periodic (2-3 years rotation) mowing, haying, and brush hogging with diesel fueled tractors, so emission drift or fuel spills may enter upland habitats and potentially could cause very local adverse impacts. Frequency of management application usually skips one or more years (Table 5.4), although mowing and haying at Fort River is conducted annually. Such infrequency of treatment on relatively small tracks of land are all refuge activities believed to be negligibly adverse in their impact to local or regional wetland integrity, both in the short term and long term.

Active management to create or maintain shrublands is not planned under this alternative. This would have negligible to minor adverse impacts on shrubland-dependent species, including priority refuge resources of concern such as the New England cottontail. At the regional scale, there are few shrublands existing within the refuge acquisition boundary, so the impacts from a lack of management will be relatively small.

Habitat management activities under alternative A also includes controlled herbicide use to set back invasive plants, maintenance of six buildings, road maintenance with some tree cutting (40 miles public, 2 miles administrative), and visitor use impacts (e.g., 20 miles of trails). Both regionally and refuge-specific, these activities are of negligible impact, both in the short and long term.. Our current invasive plant control involves no burning, relying instead on cutting, pulling by hand, and approved herbicides.

Visitation under alternative A would not appreciably change over current levels and is expected to be lower than any of the other alternatives (Table 5.5). As such, visitor activities that might impact upland habitats, such as hiking off designated trails would pose minimal concern.

We do not plan to increase capacity for snowmobiling on existing or future refuge uplands regardless of alternative (and alternative D would eliminate snowmobiling); rather, we plan only to maintain existing use levels. Snowmobile trails on new uplands to be acquired under alternatives B and C may be maintained, and in select situations closed trails may be opened to promote wildlife-dependent public uses. The concentration of hydrocarbons in snow is likely to be particularly high on trails where regular grooming constantly packs exposed snow. Spring snowmelt from upland areas may release those hydrocarbons into streams or other bodies of water. To what extent the water bodies on the refuge are at risk of hydrocarbon pollution is unclear. While technological advances have produced cleaner four-stroke engines, the vast majority of snowmobiles still use inefficiently burning two-stroke engines, which can heavily pollute air and waters (CO, hydrocarbons HC, and particulates) (*http://www.epa.gov/oms/recveh.htm*, accessed August 2016). Yet, during the course of a study in Yellowstone National Park, volatile organic compound (VOC) concentrations of snowmelt runoff were below levels that would adversely impact aquatic systems (Arnold and Koel 2006).

The most common impacts to vegetation attributable to snowmobiles are physical damage like bending and breaking when hit or run over (Stangl 1999), however, given that all trails overlay roads, such impacts are not expected. Additionally, plants are impacted during trail maintenance when shrubs and sapling trees are trimmed back; however, similar impacts occur in the process of maintaining roadsides and would be completed regardless of a snowmobile trail network. Most trimming associated with the snowmobile trail is done by tractor-mounted brushcutters which sets back growth, but often does not kill the plants. Brush cutting only occurs when woody plants encroach within the road corridor or are tall enough to protrude above the snow surface. Plants in the snowmobile trail probably end winter dormancy later and are less productive than those that are unaffected (Stangl 1999). No federal or state listed plants are known from the area encompassing the snowmobile trail. The amount of habitat directly affected by snowmobile trails represents a small percentage of similar habitats within refuge lands.

There is evidence that deer and moose over-browsing has occurred in forests of the Nulhegan Basin Division and neighboring private forest lands, within the past decade, although it is believed the current moose population is at an acceptable level. Current refuge hunts at the Nulhegan Basin and Pondicherry Divisions (e.g., approximately two to six moose harvested annually at Nulhegan Basin Division) are believed to help decrease potential problems, and the potential adverse impact from over-browsing in upland forests is considered negligible in the short-term, yet the long-term impacts will have to be monitored.

Impacts to Upland Habitats of Alternative B

Beneficial Impacts. Alternative B would provide short- and long-term beneficial impacts to upland habitat because it would conserve upland habitats on up to 85,816 acres, across 19 consolidated CFAs as compared to the current 65 widely separated, often small, SFAs. Upland habitats that could be acquired under alternative B include: spruce-fir forest (18,231 acres), hardwood forest (61,212 acres), woodlands (221 acres), pasture, hay, and grasslands (5,061 acres), old field and shrublands (37 acres), cliff and talus (445 acres), rocky outcrop (590 acres), and rocky coast and islands (19 acres). It is recognized, however, that acquisition of lands comprising the full potential refuge would take many years, likely beyond the 15-year horizon of this CCP, indicating that potential beneficial impacts on uplands over the CCP 15 year horizon would be minor over the short-term, but may be modest over the long term.

Beneficial impacts from habitat management are projected to be greater under alternative B than alternatives A or D (no active management occurs under

alternative D), but less than under alternative C (Table 5.4). These benefits primarily revolve around supporting or improving the ecological structure and functions of currently degraded forests, or maintain or expand early-successional grassland and shrublands.

Grassland management will be conducted under alternative B to maintain the structure and persistence of grassland communities by preventing natural vegetation succession to forest. Active habitat management actions will include mowing, mechanical clearing, selective cutting, and selective use of herbicides to eliminate invasive plants. Beneficial impacts from grassland management will be greater under alternative B than under alternative A, but less than under alternative C, assuming the relative amount of grassland treated tracks the proposed plans.

Regarding public use, alternative B would continue to permit managed furbearer trapping and hunting on uplands at the Nulhegan Basin and Pondicherry Divisions as described in alternative A while also offering potential new hunting opportunities on future land acquisitions. Beneficial impacts from hunting and trapping are more dependent on participants than on total available acres, so there is considerable uncertainty around the relative level of impacts from this alternative compared to the others.

Adverse Impacts. Over the 15 year CCP horizon, alternative B encompasses management of a minimum of 9,312 acres of habitat compared to 455 acres under alternative A: 7,660 acres forest, 422 acres grassland, and 775 acres shrubland, all designed to improve habitat for priority wildlife, fish, and plant species (Table 5.4), and over time additional acres could become subject to active management if determined necessary through development of future HMPs. Adverse impacts from ground-disturbing activities under alternative B would be greater than under alternatives A or D, but probably less than under alternative C, assuming that adverse impacts correlate with the number of acres management. These management impacts would be considered local and of negligible adverse impact in the short term and of no adverse impact over the long term.

Upland habitat management under alternative B would be maintained to provide for target grassland birds (e.g., bobolink, upland sandpiper, and American woodcock). Management activities include mowing, haying, and brush hogging with diesel fueled tractors. Management activities include periodic (2-3 years rotation) mowing, haying, and brush hogging with diesel fueled tractors, so emission drift or fuel spills may enter upland habitats and potentially could cause very local adverse impacts. Frequency of management application usually skips one or more years (Table 5.4), although mowing and haying at Fort River is conducted annually. Such infrequency of treatment on relatively small tracks of land are all refuge activities believed to be negligibly adverse in their impact to local or regional wetland integrity, both in the short term and long term.

Visitation under alternative B is expected to increase over time as refuges divisions are expanded and public access infrastructure is completed. Hiking off-trail may contribute to adverse impacts by degrading upland habitats. Assuming impacts are correlated with visitation, adverse impacts to upland habitats would be smaller under alternative B than alternatives C and D, but greater than under alternative A. Visitor activities that might impact uplands, such as hiking off designated trails and snowmobiling would pose a minor concern, as previously discussed, constituting a negligible adverse impact in the short and long term.

The most common impacts to vegetation attributable to snowmobiles are physical damage like bending and breaking when hit or run over (Stangl 1999), however,

given that all trails overlay roads, such impacts are not expected. Additionally, plants are impacted during trail maintenance when shrubs and sapling trees are trimmed back; however, similar impacts occur in the process of maintaining roadsides and would be completed regardless of a snowmobile trail network. Most trimming associated with the snowmobile trail is done by tractor-mounted brushcutters which sets back growth, but often does not kill the plants. Brush cutting only occurs when woody plants encroach within the road corridor or are tall enough to protrude above the snow surface. Plants in the snowmobile trail probably end winter dormancy later and are less productive than those that are unaffected (Stangl 1999). No federal or state listed plants are known from the area encompassing the snowmobile trail. The amount of habitat directly affected by snowmobile trails represents a small percentage of similar habitats within refuge lands.

Alternative B, like alternatives C and D, proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis .

Impacts to Upland Habitats of Alternative C

Beneficial Impacts. Alternative C would provide the second highest level of beneficial impacts to upland habitat compared to alternative A associated with conserving uplands on up to 197,337 across 22 CFAs, including the 19 CFAs proposed in alternative B that would be expanded in size within alternative C. Thus, alternative C promotes protection of a considerably larger and more intact and diverse upland configuration within the larger watershed landscape, encompassing 187,806 acres of upland habitat in total (Table 5.7). Priority refuge resources of concern wildlife benefitting from alternative B's upland habitat protection is illustrated in Table 5.7 above, and upland habitats subject to protection include: spruce-fir forest (22,707 acres), hardwood forest (150,927 acres), woodlands (476 acres), pasture, hay, and grasslands (9,637 acres), old field and shrublands (52 acres), cliff and talus (1,868 acres), rocky outcrop (2,098 acres), and rocky coast and islands (41 acres). These protected upland acres will also maintain essential upland habitat and ecosystem functions and values. It is recognized, however, that acquiring the full 187,806 upland habitat acres within this alternative would take many years, likely well beyond the 15 year horizon of this CCP, indicating that any potential upland gains over the CCP 15 year horizon would be minor in the short term, but may be modest over the long term.

Beneficial impacts from habitat management, including forest, shrubland, and grassland habitats, will be greatest under alternative C (Table 5.4), and is expected to benefit or improve the ecological structure and functions of currently degraded forests, or maintain or expand early-successional grassland and shrublands. Target priority refuge resources of concern species would receive some of these beneficial impacts.

Alternative C would continue to permit managed furbearer trapping and hunting on uplands at the Nulhegan Basin and Pondicherry Divisions as described in alternative A while also offering potential new hunting opportunities on future land acquisitions. . Beneficial impacts from hunting and trapping are more dependent on participants than on total available acres, so there is considerable uncertainty around the relative level of impacts from this alternative compared to the others.

Adverse Impacts. Over the 15 year CCP horizon, alternative C encompasses management of a minimum of 12,873 acres of habitat compared to 455 acres under alternative A: 11,550 acres of forest, 548 acres grassland, and 775 acres shrubland, all designed to improve habitat for priority wildlife, fish, and plant

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Wild turkey

species (Table 5.4), and over time additional acres could become subject to active management if determined necessary through development of future HMPs..

We would conduct a greater amount (+11,295 ac) of forest management under alternative C over alternative A (255 acres), which also is an additional +3,890 acres over alternative B; over time additional acres could become subject to active management if determined necessary through development of future HMPs. We increase grassland management by 348 acres, and initiate management of shrubland habitat (775 acres) (similar to alternative B), largely intended to benefit New England cottontail. Most forest management is expected to occur on uplands, although some will occur in wetland habitat as noted in the prior section. Management would be conducted as noted in alternative A to protect upland resources, and ultimately to enhance their structure and function. Adverse impacts from ground-disturbing activities under alternative C would the largest among the alternatives, assuming that adverse impacts correlate with the number of acres management. These management impacts would be considered local and of negligible adverse impact in the short term and of no adverse impact over the long term.

Visitation under alternative C is expected to be the highest when compared to the other alternatives (Table 5.5). Potential adverse impacts would be similar to those discussed under alternative B. Visitor activities that might impact uplands, such as hiking off designated trails and snowmobiling would pose a minor concern, as previously discussed, constituting a negligible adverse impact in the short and long term.

The most common impacts to vegetation attributable to snowmobiles are physical damage like bending and breaking when hit or run over (Stangl 1999), however, given that all trails overlay roads, such impacts are not expected. Additionally, plants are impacted during trail maintenance when shrubs and sapling trees are trimmed back; however, similar impacts occur in the process of maintaining roadsides and would be completed regardless of a snowmobile trail network. Most trimming associated with the snowmobile trail is done by tractor-mounted brushcutters which sets back growth, but often does not kill the plants. Brush cutting only occurs when woody plants encroach within the road corridor or are tall enough to protrude above the snow surface. Plants in the snowmobile trail probably end winter dormancy later and are less productive than those that are unaffected (Stangl 1999). No federal or state listed plants are known from the area encompassing the snowmobile trail. The amount of habitat directly affected by snowmobile trails represents a small percentage of similar habitats within refuge lands.

Like alternatives B and D, alternative C also proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis.

Impacts to Upland Habitats of Alternative D

Beneficial Impacts. Refuge activities proposed in alternative D (passive management) are expected to have minor short-term and moderate long-term beneficial impacts. Alternative D would provide the highest level of beneficial impacts from protecting habitat compared to all other alternatives, because, over the long term, it would protect up to 235,887 acres of uplands across 22 CFAs (Table 5.7). This alternative proposes a low-impact nearly passive form

of management. It is recognized that acquisition of the full potential refuge is likely to take decades, well beyond the 15 year horizon of this CCP. This passive management approach results in permanent protection, unaltered forest succession, increase in late-succession forest, increased structural diversity (e.g. snags, coarse woody debris), and the lowest annual planned budget needed to perform management. Priority refuge resources of concern wildlife benefitting from alternative D's upland habitat protection is illustrated in Table 5.7 above, and upland habitats subject to protection include: spruce-fir forest (23,784 acres), hardwood forest (195,578 acres), woodlands (649 acres), pasture, hay, and grasslands (11,255 acres), old field and shrublands (99 acres), cliff and talus (2,094 acres), rocky outcrop (2,387 acres), and rocky coast and islands (41 acres).

Alternative D would also create the greatest amount of connections between CFAs and other public conservation lands. As noted prior, these protected upland acres will also maintain essential upland habitat and ecosystem functions and values (e.g., wildlife habitat, groundwater recharge, nutrient processing, and storm mitigation). This approach is expected to have the lowest impact threshold of all alternatives proposed. Benefits to priority refuge resources of concern wildlife under passive management likely would not fully be realized for decades into the future due to the pace of natural forest succession, and such benefits over the long term would be more likely to benefit forest priority refuge resources of concern species vs. early-successional species.

Some beneficial impacts to upland habitats would be realized by eliminating snowmobiling on refuge lands. The most common impacts to vegetation attributable to snowmobiles are physical damage like bending and breaking when hit or run over (Stangl 1999), however, given that all trails overlay roads, such impacts are not expected. Additionally, plants are impacted during trail maintenance when shrubs and sapling trees are trimmed back; however, similar impacts occur in the process of maintaining roadsides and would be completed regardless of a snowmobile trail network. Most trimming associated with the snowmobile trail is done by tractor-mounted brushcutters which sets back growth, but often does not kill the plants. Brush cutting only occurs when woody plants encroach within the road corridor or are tall enough to protrude above the snow surface. Plants in the snowmobile trail probably end winter dormancy later and are less productive than those that are unaffected (Stangl 1999). No federal or state listed plants are known from the area encompassing the snowmobile trail. The amount of habitat directly affected by snowmobile trails represents a small percentage of similar habitats within refuge lands, so the beneficial impacts are highly localized in space.

Adverse Impacts. Alternative D represents the least impacting management activities, promoting a low impact, passive approach. This approach would result in extremely negligible short- and long-term adverse impacts to refuge upland habitats, although other impacts through natural processes (e.g., storms, floods) would occur. Under this alternative, the refuge generally would not respond to these natural events. Under alternative D there would be no active habitat management designed for target priority refuge resources of concern wildlife. Thus, there will be no regularly prescribed silvicultural operations, mowing, burning, or active management activities on upland habitats.

Management steps would be taken to mitigate unexpected events that may pose safety hazards (e.g., repair of collapsed culvert causing flooding, clear trail blockages due to storm damage, eliminate hazardous fuel loads) or that impede natural succession or restoration (e.g., control serious outbreaks of invasive plants, hands-on restoration of highly impaired habitats through planting or other habitat management that may require the use of heavy equipment). Activities such as required road and parking lot maintenance would continue (e.g., roadside mowing, tree trimming). In the absence of active management,

desired wildlife habitat may develop more slowly or not at all, depending on site characteristics, prior management history, and natural disturbance frequency. This could have adverse impacts on the priority refuge resources of concern dependent upon upland habitats, although there is considerable uncertainty around the degree of these impacts related to uncertainty in future disturbance events and forest development.

Visitation under alternative D is projected to the second largest, 25 percent greater than alternative A despite the elimination of snowmobiling (Table 5.5) and furbearer trapping. Potential adverse impacts would be similar to those discussed under alternative B.

Like alternatives B and C, alternative D also proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis.

Due to the passive management approach for alternative D, there would be no managed furbearer trapping at the Nulhegan Basin Division (CFA), which may adversely impact refuge habitats and infrastructure. The most likely adverse impact is the loss of upland habtiats to freshwater wetland habitats as a result of beaver activity. There is evidence that over-browsing in wetland systems has occurred in forests of the Nulhegan Basin Division, and Northeast Kingdom in general although it is believed the current ungulate populations are at an acceptable level. Current refuge hunts (e.g., 350 annual hunt visits at Nulhegan Basin Division), which would continue under alternative D, are believed to help lessen potential problem, and the potential adverse impact from over-browsing in wetlands is considered negligible in the short term, yet the long-term impacts will have to be monitored.

Summary

In summary, our management activities across alternatives would not *significantly* adversely or beneficially impact refuge upland habitats. As previously noted, all alternatives would facilitate the acquisition and protection of additional acres of refuge land beyond the current refuge acreage of 37,000 acres, ranging from about 60,000 acres (alternative A) to nearly 200,000 acres (alternative D). By continuing to protect and manage existing refuge uplands and proposing to acquire additional acres of habitat, we will have direct and long-term beneficial impacts on upland habitats and the species that rely on them. Maintaining and protecting uplands will help to guarantee their beneficial ecosystem functions that serve wildlife (e.g., habitat) and society at large (e.g., amelioration of climate change). We again note that acquisition of additional acres to full acquisition levels proposed in the alternatives will not occur within the short term framework of this CCP (15 years) but will continue in the long term well beyond the 15 year CCP cycle. Proposed refuge management activities–forest management, prescribed burning, trail construction, snowmobile use–may be allowed in one or more of the alternatives presented, but in all situations described above, we would expect all to be of negligible adverse impact.

Impacts to Biological Integrity, Diversity, and Environmental Health (BIDEH)

One of the Refuge System's mandates is to maintain the integrity, diversity, and health of trust species and populations of wildlife, fish, and plants. This mandate is outlined in the Refuge System's biological integrity, diversity, and environmental health policy (BIDEH, *http://www.fws.gov/policy/601fw3.html*; accessed August 2016). Consequently, the refuge recognizes that it must promote management actions that provide for representative,

redundant, and resilient populations of priority refuge resources of concern trust species (*representation*: conserving the genetic diversity of a taxon; *redundancy*: sufficient populations to provide a margin of safety; *resilience*: the ability to withstand demographic and environmental variation). The maintenance and enhancement of habitat connectivity is critical for all units of the refuge. This is particularly important as the Service and Refuge System shift land management priorities to better enable species to adjust to climate change. Increasing the size of the refuge land base is a prime theme of this final CCP, and that effort is driven by the assumption that a greater conservation landscape will better mitigate for the impacts of climate change on fish and wildlife.

- We evaluated the proposed alternatives for their potential to beneficially or adversely impact the principals of BIDEH. Our proposed management actions include conservation actions targeting a wide range of priority refuge resources of concern, including species and habitat types that reflect the refuge's commitment to conserving BIDEH. CFAs with BIDEH sub-objectives corresponding to specific habitat types are described in Table 5.8.

  The potential beneficial impacts to BIDEH resulting from refuge management activities described in the alternatives include:

  - Extent to which refuge land acquisition and habitat conservation would protect essential habitats from potential development, thus promoting BIDEH.
  - Habitat management and restoration activities designed to improve habitat structure and integrity for priority refuge resources of concern and BIDEH.
  - Invasive plant, invasive insect, and pathogen control.
  - Habitat recovery through removal of unneeded buildings and roads.
  - Partnership support.
  - Effective visitor interpretation.

  The potential adverse impacts of refuge management actions within the alternatives that were evaluated included impacts from:

  - Habitat management activities.
  - Invasive plant control.
  - Prescribed burning in appropriate fire-regime habitats, or for hazardous fuel reduction.
  - Visitor use impacts on refuge lands, trails, and roads (e.g., hiking, snowmobiles, and introduction of invasive species).
  - Construction, maintenance, and removal of trails, parking facilities, buildings, and roads.

Table 5.8. CFAs Having BIDEH Sub-objectives for Major Habitat Types as Identified for Action Alternatives B, C, and D (derived from appendix A).

Conservation Focus Area	Forested Uplands and Wetlands	Non-forested Uplands and Wetlands	Inland Aquatic Habitats	Coastal Non-forested Uplands	Coastal Wetlands and Aquatic Habitats
Maromas CT	✔	✔			
Pyquag CT	✔	✔			
Muddy Brook CT	✔	✔			
Salmon River, CT	✔	✔			
Scantic River CT					
Whale-bone Cove	✔			✔	✔
Farmington River CT/MA	✔	✔			
Dead Branch MA	✔	✔			
Fort River MA					
Mill River MA					
Westfield River MA	✔	✔			
Sprague Brook NH/MA*	✔				
Ashuelot NH	✔	✔			
Blueberry Swamp NH		✔			
Mascoma River NH	✔				
Pondicherry NH					
Nulhegan Basin VT		✔			
Ompompanoosuc VT		✔			
Ottauquechee River VT *	✔				
West River VT*	✔	✔			
White River VT	✔	✔			
Quonatuck CT, MA, NH, VT	✔	✔	✔	✔	✔

**Sprague Brook, Ottauquechee River, and White River are not included in Alternative B but are included in alternatives C and D.*

Impacts to BIDEH That Would Not Vary by Alternative

Proposed refuge conservation and management activities would neither *significantly* benefit nor adversely impact the current BIDEH on undeveloped lands of the Connecticut River watershed, nor current or expanded refuge lands. We expect refuge land conservation and management under all alternatives to help maintain and even improve current BIDEH (e.g., restoring stream connectivity, floodplain forest, re-establishing vegetative corridors, etc.). All of these BIDEH functions and values will be promoted on the existing 37,000 refuge acres and on future lands the refuge acquires. It is recognized, however, that acquisition of lands comprising the full potential refuge would take many years, likely beyond the 15-year horizon of this CCP. In the short term (within 15 years), we would likely acquire similar amounts of habitat under all the alternatives, thus beneficial impacts would be similar across all alternatives in the short term. Over the long term, alternatives C and D would have greater BIDEH benefits because

they would permanently protect a greater amount of habitat in larger, more connected blocks, from development.

Across all alternatives, our management actions only contribute to the permanent impairment of BIDEH when constructing new trails, parking lots, elevated boardwalks and observation platforms. We believe impacts from these activities would be negligibly adverse in the short and long term. There are no explicit plans for major facilities or new road construction in upland habitats; however, action alternatives (B, C, D) propose a potential outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis. Regardless of which alternative is selected, we would continue to use BMPs in all management activities that might impact refuge habitats (e.g., approved herbicide use for invasive plant control, maintaining appropriate wetland buffers, implementation of forest management BMPs).

Across all alternatives, the refuge would restore and protect rare and exemplary habitats, reduce or eliminate invasive plants and, where appropriate, insect populations through partnerships with CISMAs on- and off-refuge lands. Regarding invasive plants in this chapter–treatment could include mechanical, prescribed fire, USDA-approved biological controls, and herbicides, either singly or in combination. As noted prior, the Regional Contaminants Specialist, who is responsible for upholding Federal standards for water quality and soil protection, would review our Pesticide Use Proposals and approve any chemical herbicide use, although certain chemicals can be approved and used at the field station. All of these methods will eventually be incorporated in a refuge specific Integrated Pest Management plan.

Within the regional and refuge specific landscape, habitat management activities across alternatives are negligibly adverse in the short term and beneficial in the long term. Habitat management designed to improve habitat structure for priority refuge resources of concern would include recognized management techniques appropriate to the restoration of degraded habitat, or to the maintenance of early-successional habitats. Operations performed by contractors will be overseen by refuge staff.

The Service regulates human uses of the refuge to appropriate and compatible uses (usually wildlife-dependent uses) and thus curtails anthropogenic impacts that may impair BIDEH functions and values. All alternatives predict some increase in annual visitor numbers over time (Table 5.5). Increases vary due to each alternative's respective refuge expansion level and impacts are expected to be negligibly adverse in the short and long term. Alternative A predicts the second lowest annual increase (Table 5.5), since no expansion of hiking trails and visitor use is proposed, while alternative C predicts the highest increase due to its large refuge expansion proposal with 22 miles of new conventional trails potentially modifying and disturbing up to 44 acres of habitat; similarly, alternative D proposes modification and disruption of up to 22 acres to create 22 miles of 'back-country' trails. All of these trails, however, would be situated to minimize BIDEH impacts while still providing for priority public uses.

Pets on leash are permitted on most refuge trails, yet their waste can cause negative adverse impacts to refuge habitats and natural water quality. There are no known dog waste problems on any refuge division or unit, and land acquired in the future will be carefully managed — requiring dog walkers to clean up pet waste.

Visitors and visitor use activities can be a source of introducing invasive plant seeds, and the refuge seeks to minimize these potential impacts by appropriately restricting use and conducting public education and awareness activities. The refuge has a full time Invasive Plant Control Initiative Coordinator who works on educational and other partnership projects full time. Refuge staff were

instrumental in forming, and coordinating the New England Invasive Plant Group (NIPGro). This organization networks the many individuals, organizations and agencies interested in controlling invasive plants in the region and is working toward the end goal of comprehensive prevention and control to protect natural communities and native species. Additionally, supported by a six-year grant from the U.S. Department of Agriculture, three major partners in NIPGro (the University of Connecticut; the New England Wild Flower Society; and the Silvio O. Conte National Fish and Wildlife Refuge) have begun developing an early warning/rapid response system. It is based on the Invasive Plant Atlas of New England, or IPANE. The project has trained 600 volunteers to recognize a broad array of invasive plants and has deployed these volunteers to natural areas all over New England.

Under all alternatives, management steps would be taken to mitigate unexpected events that may pose safety hazards (e.g., flooding due to collapsed culvert, clear trail blockages due to storm damage, eliminate hazardous fuel loads) or that impede desired natural succession or restoration (e.g., control serious outbreaks of invasive plants, hands-on restoration of highly impaired habitats through planting or other habitat management that may require the use of heavy equipment). Activities such as required road and parking lot maintenance would continue (e.g., roadside mowing). Some short-term, negligible to minor adverse impacts on BIDEH may occur associated with such management steps.

Regardless of which alternative we select, we would take a number of steps to insure that we have sufficient scientific data to support management decisions regarding promotion of BIDEH. We would work with our own Service Division of Ecological Services and other appropriate partners to help identify and correct any impacts to BIDEH functions and values.

Impacts to BIDEH of Alternative A

Beneficial Impacts. Alternative A represents current management, building off the 1995 FEIS and Action Plan (USFWS 1995). Alternative A would provide short- and long-term beneficial impacts to the species and habitats outlined in the refuge purposes and the more recent BIDEH policy because it would protect up to 97,830 acres (37,000 acres currently acquired) across 65 widely separated, often small SFAs. The diversity of habitat types within the 65 SFAs are not quantified; however, species and habitat types benefitting are noted in appendix A of the FEIS. All of the habitat related management actions currently conducted under alternative A are essentially designed to promote refuge purposes and BIDEH. Forest management is designed achieve appropriate habitat structure for select priority refuge resources of concern species. Control of invasive plants promotes the establishment and persistence of native plants. Mowing and haying of grassland areas supports the existence of that special habitat. All of these activities, as noted in more detail in prior sections, are expected to have minor short- and long-term beneficial impacts on BIDEH at the refuge.

Adverse Impacts. Alternative A would include very few ground disturbing activities that might adversely impact the noted refuge purposes or BIDEH, both in the short and long term. These include management of the woodcock demonstration units at the Nulhegan Basin Division, the annual mowing and haying of grassland on the Fort River, Nulhegan Basin, and Pondicherry Divisions, controlled mechanical and herbicide use, maintenance of six buildings, roadside maintenance (40 miles public, 2 miles administrative), and visitor use impacts (e.g., 20 miles of trails). Both regionally and refuge-specific, these activities are of negligible short- and long-term adverse impact. Best management practices are implemented in all ground disturbing activities (e.g., habitat management, trail construction), as further described in prior sections. Over time, visitation under alternative A would not appreciably change over current levels and is expected to be lower than any of the other alternatives. As

such, visitor activities that might adversely impact BIDEH would pose negligible adverse impacts in the short and long term.

Promoting BIDEH would include removing unneeded infrastructure on property acquired by the refuge. Roads would remain open to provide motorized and non-motorized access by visitors, and to conduct habitat management actions. All road infrastructure will follow BMPs during their maintenance and use. We do not plan to increase capacity for snowmobiling regardless of alternative (and alternative D would eliminate snowmobiling); rather, we plan only to maintain existing use levels. Snowmobile trails on new lands to be acquired under alternatives B and C may be maintained, and in select situations closed trail may be opened to promote wildlife-dependent public uses. As noted under the Water Quality Impact section, snowmobiling can introduce petroleum hydrocarbons to wild lands; however, it is unlikely that the potential adverse impacts would be any more than minor, and in most locales negligible.

Impacts to BIDEH of Alternative B

Beneficial Impacts. Alternative B would likely result in short- and long-term beneficial impacts because it promotes BIDEH on up to 97,772 acres (37,000 currently acquired) but across 19 consolidated CFAs as compared to the current 65 widely separated, often small, and logistically difficult to manage SFAs. As noted in Rudnick et al. 2012, landscape connectivity, the extent to which a landscape facilitates the movements of organisms and their genes, faces critical threats from both fragmentation and habitat loss. Loss of connectivity can reduce the size and quality of available habitat, impede and disrupt movement (including dispersal) to new habitats, and affect seasonal migration patterns. These changes can lead, in turn, to detrimental effects for populations and species, including decreased carrying capacity, population declines, loss of genetic variation, and ultimately species extinction. Thus, alternative B promotes protection of a generally more intact and connected ecosystem. These beneficial ecosystem impacts would be considered minor in the short term and modest in the long term (assuming regular refuge expansion over time). Table 5.8 illustrates CFAs that have sub-objectives specifically addressing the BIDEH functions and values; these sub-objectives are derived from appendix A and, although designed specifically for alternative C (preferred alternative), would generally be applicable to alternative B.

Similar to alternative A, all of the habitat related management actions proposed in alternative B are designed to promote refuge purposes and BIDEH. All of these activities, as discussed in more detail in prior sections, are expected to have minor short-term and modest long-term beneficial impacts on the BIDEH of the refuge and its biological resources. Over the 15 year CCP horizon, alternative B encompasses management of a minimum of 9,312 acres of habitat (Table 5.4), and over time additional acres could become subject to active management if determined necessary through development of future HMPs. Such management would be designed to improve and enhance habitat structure, thus its function and value. In doing such, we plan to benefit BIDEH, expecting the impact to be minor in the short term and modest in the long term. These benefits would be greater under alternative B than under alternative A or D, but less than under alternative C.

Adverse Impacts. Similar to alternative A, alternative B would include relatively few ground disturbing activities that might adversely impact refuge BIDEH. Over the 15 year CCP horizon, alternative B encompasses management of a maximum of 9,312 acres of habitat compared to 455 acres under alternative A: 7,660 acres forest, 422 acres grassland, and 775 acres shrubland, all designed to improve habitat for priority wildlife, fish, and plant species (Table 5.4). Additional management action would be subject to additional NEPA review. Adverse impacts from ground-disturbing activities under alternative B would be greater than under alternatives A or D, but probably less than under alternative

C, assuming that adverse impacts correlate with the number of acres managed. These management impacts would be considered local and of negligible adverse impact in the short term and of no adverse impact over the long term.

Visitation under alternative B would increase about 22 percent over alternative A, less than under alternatives C or D (Table 5.5). Increased visitor activities that might impact BIDEH, such as hiking off designated trails and snowmobiling would pose a minor concern. Visitor activities that might impact BIDEH include disruption of trail-side plants or low nesting migratory birds, potential introduction of invasive plant seeds. These pose short- and long-term impacts to BIDEH functions and values, but nevertheless would be considered of negligible to minor.

Alternative B also proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis.

Impacts to BIDEH of Alternative C

Beneficial Impacts. Alternative C would promote similar beneficial impacts as those described in alternative B, and would provide the second highest level of beneficial BIDEH impacts compared to alternative A and other alternatives because it would conserve habitat and ecosystem functions on up to 197,337 across 22, including the 19 CFAs proposed in alternative B that would be expanded in size within alternative C.

Over the 15 year CCP horizon, alternative C encompasses management of a minimum of 12,873 acres of habitat compared to 455 acres under alternative A: 11,550 acres. forest, 548 acres grassland, and 775 acres shrubland, all designed to improve habitat for priority wildlife, fish, and plant species (Table 5.4), and over time additional acres could become subject to active management if determined necessary through development of future HMPs. Such management would be designed to improve and enhance habitat structure, thus its function and value. In doing such, we plan to benefit BIDEH, expecting the impact to be minor in the short term and modest in the long term. The beneficial impacts of alternative C would be identical in nature and substance to those discussed in alternative B but would be expected to be considerably higher due to the greater possibility of protecting diverse refuge and watershed habitats that are more ecologically intact due to the proposed CFA structure proposed in this alternative. These beneficial ecosystem impacts would be considered minor in the short term and modest in the long term.

Adverse Impacts. Similar to alternative A, alternative C would include relatively few ground disturbing activities that might adversely impact refuge BIDEH, particularly over the long term. Over the 15 year CCP horizon, alternative C encompasses management of a minimum of 12,873 acres of habitat compared to 455 acres under alternative A: 11,550 acres. forest, 548 acres grassland, and 775 acres shrubland, all designed to improve habitat for priority wildlife, fish, and plant species (Table 5.4), and over time additional acres could become subject to active management if determined necessary through development of future HMPs. Management (e.g., forest silviculture, grassland mowing, control of invasive plants) would be conducted as noted in prior sections to restore degraded habitats or create early-successional habitat for priority refuge resources of concern species. Adverse impacts from ground-disturbing activities under alternative C would be greater than under the other alternatives, assuming that adverse impacts correlate with the number of acres management. These management impacts would be considered local and of negligible adverse impact in the short term and of no adverse impact over the long term.

Visitation under alternative C is expected to be the highest when compared to the other alternatives (Table 5.5). Potential adverse impacts would be similar to those

discussed under alternative B. Visitor activities that might impact BIDEH, such as hiking off designated trails and snowmobiling would pose a minor concern, as previously discussed, constituting a negligible adverse impact in the short and long term.

Like alternative B, alternative C also proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis.

Impacts to BIDEH of Alternative D

Beneficial Impacts. Alternative D would promote similar beneficial impacts as those described in alternative B, and provide the highest level of short- and long-term beneficial impacts to BIDEH compared to all other alternatives from permanently protecting up to 231,307 acres across 22 CFAs. Table 5.8 illustrates CFAs that have sub-objectives under goals and objectives (appendix A) specifically for advancing BIDEH functions and values within action alternative C; these sub-objectives would also be applicable to action alternative D. Thus, alternative D promotes BIDEH functions and values to the greatest extent of the alternatives due to the potential protection of a considerably larger, more intact and connected ecosystem within the larger watershed.

Eric Engbretson/USFWS

Brook trout

None of the active habitat management regimes noted for alternatives A, B, and C would be employed in alternative D. Benefits to priority refuge resources of concern wildlife under passive management likely would not fully be realized for many decades into the future due to the unfettered pace of natural forest succession, and without significant natural intervention of plant succession (e.g., extensive fires, local hurricane blowdowns) such benefits over the long term may be more likely to benefit interior forest priority refuge resources of concern species vs. early-successional species on current and future refuge lands).

Adverse Impacts. Alternative D would not employ active habitat manipulation but would rely upon a natural, passive approach to sustaining BIDEH on refuge lands, except under uncontrollable, extenuating circumstances (e.g., in response to a major natural disturbance or disaster). Under alternative D there would be no active forest management designed for target priority refuge resources of concern wildlife. Consequently, for priority refuge resources of concern early-successional species such as American woodcock, bobolink, upland sandpiper, and New England cottontail, natural events may not be adequate to sustain foraging or breeding habitat on current and future refuge lands, and this may be a minor adverse negligible impact to such species.

Visitation under alternative D is projected to be the second largest, 25 percent greater than alternative A despite the elimination of snowmobiling (Table 5.5) and furbearer trapping. Potential adverse impacts would be similar to those discussed under alternative B. As noted prior, visitor activities on back-country trails that might impact native plants, breeding birds, and soil stability would pose direct and indirect adverse impact to BIDEH functions and values compared to the other alternatives, but nevertheless would be considered of negligible impact, both in the short and long term.

Alternative D also proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis.

Summary

In summary, our management activities across alternatives would not *significantly* impact BIDEH adversely or beneficially on refuge habitats or future habitats. As previously noted, all alternatives facilitate the acquisition and protection of additional acres of refuge land beyond the current refuge acreage of 37,000 acres, ranging from about 60,000 acres (alternative A) to nearly 200,000 acres (alternative D). With the potential addition of habitat to the refuge, in combination with currently protected lands (37,000 acres), we anticipate better protection of BIDEH functions. The continued maintenance of existing refuge uplands and the potential to acquire and permanently protect more will be of direct and long-term beneficial impacts to promoting BIDEH over the short and long term. Maintaining and protecting the defined LCC subhabitats will help to guarantee their beneficial ecosystem functions that serve wildlife (e.g., habitat) and society at large (e.g., biological diversity and ecosystem stability). Proposed refuge management activities — forest management, prescribed burning, trail construction, snowmobile use — may be allowed in one or more of the alternatives presented, but in all situations described above, we would expect all to be of negligible adverse impact to BIDEH.

Impacts to Federally Threatened and Endangered Species

The watershed hosts fourteen federally listed threatened and endangered species, and seven species proposed for federal listing (Table 5.9). All of these species could potentially benefit directly from land protection outlined in this proposal, although not all of these species' recovery plans specifically call for refuge land protection. Some recovery plans are over 20 years old, are in need of updating, and were developed at times where proposing additional Federal land protection was not a preferred option. Therefore, land protection was not considered in some of these recovery plans as a potential alternative or recovery strategy. However, as is the case with other priority species of conservation concern, where habitat loss or degradation is impacting population levels, Service protection of additional key habitat areas in the watershed will help temper those losses.

Table 5.9. Federally listed species and species proposed for listing

Species	Listing Status
Species with recovery or 5-year plans that specifically mention land protection	
Dwarf wedgemussel	Endangered
Jesup's milk-vetch	Endangered
Northeastern bulrush	Endangered
Puritan tiger beetle	Threatened
Other federally listed species	
Atlantic sturgeon	Endangered
Indiana bat	Endangered
Red knot	Endangered
Roseate tern	Endangered
Shortnose sturgeon	Endangered
Canada lynx	Threatened
Northern bog turtle	Threatened
Northern long-eared bat	Threatened
Piping plover	Threatened

Species	Listing Status
Small whorled pogonia	Threatened
Species proposed for listing	
Bicknell's thrush	Proposed
Brook floater	Proposed
Cobblestone tiger beetle	Proposed
Monarch butterfly	Proposed
Regal fritillary	Proposed
Tri-colored bat	Proposed
Yellow banded bumble bee	Proposed

There are numerous state-listed species that also exist within existing and proposed refuge lands. Appendix A presents tables of species of conservation concern for each CFA, which includes both federally and state-listed species.

We evaluated the proposed habitat management actions and strategies of all alternatives for their potential to impact, beneficially or adversely, the above species and their breeding, migration, and wintering habitats or where they may seasonally concentrate. Our proposed management actions include conservation targeting Federal and state endangered species, such as reducing forest fragmentation, restricting or minimizing public use in sensitive habitats, or enhancing early-successional shrub habitat.

We compared the benefits of the alternatives from actions that would protect federally threatened and endangered wildlife including:

- Refuge land acquisition and habitat conservation.
- Invasive plant and insect control.
- Refuge habitat management activities.
- Partnership support and collaboration in restoration activities.
- Effective visitor interpretation.
- The potential adverse impacts of refuge management actions within the alternatives that were evaluated included impacts from:
- Habitat management activities.
- Mowing and haying grasslands, and managing early-successional shrublands.
- Refuge construction activities or demolition of infrastructure.
- Road maintenance.
- Visitor use of refuge trails and roads
- Prescribed burning.

Under all alternatives we will monitor populations of listed and proposed species as appropriate and work with the Service's New England Field Office to

determine whether habitat management activities or modifications are warranted to benefit the species. Such activities would be documented in an HMP, and go through the NEPA process and Section 7 consultation. We will manage habitats specifically for listed and proposed species only after landscape conservation measures have been identified and the importance of refuge habitats has been determined.

Impacts to Listed and Proposed Species That Would Not Vary by Alternative
Within the watershed and regionally, there would be negligible to moderate beneficial impacts to listed and proposed species over the short and long term from the conservation of habitats within existing 37,000 acre refuge.

The refuge proposes no management action that would directly impact, adversely or beneficially, any of the listed or proposed species (Table 5.9). However, the refuge will be active in coordination with Federal and state partners and the Connecticut River Coordinator's Office to contribute to species conservation and recovery. Whenever new lands are acquired by the refuge that include known habitat for these species or could be managed to provide habitat, the refuge will take appropriate management action to help recover or sustain those species. Such management actions would be taken after appropriate review and consultation with recognized experts and Service approval, including Section 7 consultation where appropriate.

Disturbance resulting from public use could impact listed and proposed species. Across all alternatives, the refuge will prevent any direct impacts to federally listed beetles (Puritan tiger beetles, cobblestone tiger beetle) or plants (Jesup's milk-vetch, northeastern bulrush, small whorled pogonia) on any lands owned by the refuge by closing occupied areas to public use, monitoring known populations, and controlling vegetation where appropriate. For example, the Putney Mountain Unit in Vermont was purchased to protect a known population of the endangered Northeastern bulrush. The existing trail network is scheduled for expansion and efforts will be made to minimize impacts to the northeastern bulrush (USFWS 1993). There are no known current impacts to the species due to these activities, although the refuge will continue to monitor for any impacts, working with the Service's New England Field Office as needed.

The refuge manages 20 miles of trails, not including snowmobile trails, (e.g., Mud Pond at Pondicherry, the trail at Fort River, and the Nulhegan River Trail, the North Branch Trail, and the Mollie Beattie Bog Trail at Nulhegan Basin Division) and 42 miles of gravel road (40 public, 2 administrative); however, none of these public uses would infringe on any listed or proposed species. We do not predict adverse impacts on Canada lynx as a result of winter maintenance of roads and trails, along with snowmobiling and skiing. Although some have suggested that the packed snow trails created by these activities could allow coyotes access to traditional Canada lynx winter habitat and that this could reduce lynx population viability, a study to test this found no evidence that snowmobile trails significantly expanded coyote ranges, or that competition with coyotes, or other potential competitors such as bobcats, is negatively affecting Canada lynx populations (Kolbe et al. 2007).

The quantity of pesticides used during invasive plant control is minimal and varies from year to year, but would not be used where it could harm any of the listed or proposed species. Like other management actions, additional consultation and evaluation would be performed before implementing pesticide use in areas used by listed or proposed species.

The refuge is required to identify potential impacts to federally endangered species in a section 7 interagency endangered species consultation as an integral

part of the Service's annual pesticide use proposal program. These reviews assure that impacts are considered case-by-case and are avoided or minimized.

Impacts to Threatened and Endangered Species from Alternative A
Beneficial Impacts. There are additional yet negligible beneficial impacts from expanding the refuge up to a total of 97,830 acres within the original SFAs. Benefits to individual species could vary significantly over the short-term, depending on where additional refuge lands are acquired. The precise list of federally threatened, endangered, and candidate species that will benefit from lands and habitats protected in alternative A cannot be identified because of the lack of detailed descriptions of SFA boundaries. However, nearly all of the species listed in Table 5.9 would negligibly benefit under alternative A from proposed land protection and from refuge staff working with partners on larger conservation measures. Some of the proposed management actions (e.g., creating and maintaining early successional forest habitat) may promote habitat or benefit other species, leading to both indirect and direct benefits to listed or proposed species by improving their prey base or reducing intraspecific competition. Compared to the other alternatives, alternative A would likely have the least benefit to these federally threatened and endangered species as a group.

Adverse Impacts. Adverse impacts on listed or proposed species from the acquisition of additional acreage to bring the total within the refuge to 97,830 are expected to be minimal to non-existent (determined to either have no impact or unlikely to adversely impact).

None of the management activities are expected to have more than a short- and long-term negligible impact on listed species. Forest management under alternative A would be limited to promoting early successional vegetation in the woodcock habitat demonstration units at the Nulhegan Basin Division. Grassland management is also limited in scale and scope and is unlikely to adversely impact federally listed species. Grassland management already follows best management practices such as mowing only after July 15, in order to mitigate any threat posted to nesting birds. Grassland management is done with an understanding of the tradeoffs between disturbing the ground and maintaining adequate habitat for species dependent on grassland ecosystems (Wadsack and Tillmann 2011, Erb and Jones 2011).

Any changes or expansions to existing management activities will go through an HMP and/or Section 7 process to avoid adversely impacting any proposed or listed species. Our current understanding is that existing populations of proposed or listed species, such as Canada lynx and dwarf wedge mussel, are not being impacted by ongoing management. While some refuge activities, such as construction, traffic, and invasive plant control, could affect these species, we currently do not conduct such activities in areas listed species are known to occupy.

Compared to the other alternatives, alternative A has a lower likelihood of adversely affecting listed and proposed species than alternatives B and C, but greater than in alternative D, if one assumes that there is a linear relationship between active management and impact. If we accomplish our goal of having no impact on listed or proposed species from management, then adverse impacts from management will be the same for all alternatives. The same pattern would hold for adverse impacts stemming from visitor use.

Impacts to Threatened and Endangered Species from Alternative B
Beneficial Impacts. Regionally and within the watershed, the benefits to listed species of alternative B would generally follow those in alternative A. Benefits to individual species could vary significantly over the short-term, depending on

where additional refuge lands are acquired. The species listed in Table 5.9 would negligibly benefit under alternative B from proposed land protection and from refuge staff working with partners on larger conservation measures. Some of the proposed management actions (e.g., creating and maintaining early successional forest habitat) may promote habitat or benefit other species, leading to both indirect and direct benefits to listed or proposed species by improving their prey base or reducing intraspecific competition.

Compared to alternative A, alternative B offers several additional areas that contain habitat for the shortnose sturgeon (Maromas CFA), Atlantic salmon (Maromas, Ompompanoosuc, and West River CFAs), and dwarf wedgemussel (Ashuelot CFA). Alternative B consolidates lands across 19 CFAs, as compared to the current 65 widely separated, often small, SFAs. Compared to scattered SFAs under alternative A, the CFAs proposed under alternative B promote protection of a generally more intact and connected landscape. Although alternatives B and A protect similar amounts of acres of habitat, we predict that alternative B will provide better protection for listed and proposed species because it would protect larger blocks of habitat compared to alternative A. However, alternative B would protect less habitat than alternatives C and D.

Adverse Impacts. None of the management activities are expected to have more than a short- and long-term negligible impact on listed species. Forest management under alternative B would include forest management and potentially fuels reduction across more acres than under alternative A, although the focus would be continue to be on promoting early successional vegetation in the woodcock habitat demonstration units at the Nulhegan Basin Division. Grassland management is also limited in scale and scope and is unlikely to adversely impact federally listed species. Grassland management already follows best management practices such as mowing only after July 15, in order to mitigate any threat posted to nesting birds. Grassland management is done with an understanding of the tradeoffs between disturbing the ground and maintaining adequate habitat for species dependent on grassland ecosystems (Wadsack and Tillmann 2011, Erb and Jones 2011). Potential impacts from increased visitor use under this alternative include those from trail construction as well as from visitors themselves, but these will be designed to avoid impacts on any listed or proposed species.

Any changes or expansions to existing management activities will go through an HMP and/or Section 7 process to avoid adversely impacting any proposed or listed species. Our current understanding is that existing populations of proposed or listed species, such as Canada lynx and dwarf wedge mussel, are not being impacted by ongoing management. While some refuge activities, such as construction, traffic, and invasive plant control, could affect these species, we currently do not conduct such activities in areas listed species are known to occupy.

Compared to the other alternatives, alternative B has a lower likelihood of adversely affecting listed and proposed species than alternative C, but greater than in alternatives A and D, if one assumes that there is a linear relationship between active management and impact. If we accomplish our goal of having no impact on listed or proposed species from management, then adverse impacts from management will be the same for all alternatives. The same pattern would hold for adverse impacts stemming from visitor use.

Impacts to Threatened and Endangered Species from Alternative C

Beneficial Impacts. Regionally and within the watershed, the short- and long-term beneficial impacts to listed species of alternative C would be similar to alternative A, and almost identical to alternative B. Benefits to individual species could vary significantly over the short-term, depending on where additional

refuge lands are acquired. The species listed in Table 5.9 would negligibly benefit under alternative C from proposed land protection and from refuge staff working with partners on larger conservation measures. Some of the proposed management actions (e.g., creating and maintaining early successional forest habitat) may promote habitat or benefit other species, leading to both indirect and direct benefits to listed or proposed species by improving their prey base or reducing intraspecific competition.

Compared to alternative A, alternative C would offer several additional areas that contain habitat for the shortnose sturgeon (Maromas CFA), Atlantic salmon (Maromas, Ompompanoosuc, and West River CFAs), and dwarf wedgemussel (Ashuelot CFA). Alternative C consolidates lands across 22 CFAs, as compared to the current 65 widely separated, often small, SFAs. Compared to scattered SFAs under alternative A, the CFAs proposed under alternative C promote protection of a generally more intact and connected landscape. Though similar in the use of CFAs, alternative C would protect more habitat than alternative B and less habitat than alternatives D.

Adverse Impacts. None of the management activities are expected to have more than a short- and long-term negligible impact on listed species. Forest management under alternative C would include forest management and potentially fuels reduction across more acres than under the other alternatives, although the focus would be continue to be on promoting early successional vegetation in the woodcock habitat demonstration units at the Nulhegan Basin Division. Grassland management is also limited in scale and scope and is unlikely to adversely impact federally listed species. Grassland management already follows best management practices such as mowing only after July 15, in order to mitigate any threat posted to nesting birds. All habitat management is done with an understanding of the tradeoffs between disturbing the ground and maintaining adequate habitat for species dependent on grassland ecosystems (Wadsack and Tillmann 2011, Erb and Jones 2011). Potential impacts from increased visitor use under this alternative include those from trail construction as well as from visitors themselves, but these will be designed to avoid impacts on any listed or proposed species.

Any changes or expansions to existing management activities will go through an HMP and/or Section 7 process to avoid adversely impacting any proposed or listed species. Our current understanding is that existing populations of proposed or listed species, such as Canada lynx and dwarf wedge mussel, are not being impacted by ongoing management. While some refuge activities, such as construction, traffic, and invasive plant control, could affect these species, we currently do not conduct such activities in areas listed species are known to occupy.

Compared to the other alternatives, alternative C has a lower likelihood of adversely affecting listed and proposed species than the other alternatives if one assumes that there is a linear relationship between active management and impact. If we accomplish our goal of having no impact on listed or proposed species from management, then adverse impacts from management will be the same for all alternatives. The same pattern would hold for adverse impacts stemming from visitor use.

Impacts to Threatened and Endangered Species from Alternative D

Beneficial Impacts. Regionally and within the watershed, the benefits to listed species of alternative D would generally follow those in the other alternatives. Benefits to individual species could vary significantly over the short-term, depending on where additional refuge lands are acquired. The species listed in Table 5.9 would negligibly benefit under alternative D from

proposed land protection and from refuge staff working with partners on larger conservation measures.

Like alternatives B and C, this alternative would offer several areas that contain habitat for the shortnose sturgeon (Maromas CFA), Atlantic salmon (Maromas, Ompompanoosuc, and West River CFAs), and dwarf wedgemussel (Ashuelot CFA). Alternative D consolidates lands across 22 CFAs, as compared to the current 65 widely separated, often small, SFAs. Compared to scattered SFAs under alternative A, the CFAs proposed under alternative D promote protection of a generally more intact and connected landscape. Also, alternative D could potentially protect the greatest amount of habitat of all the alternatives.

In this alternative the refuge would still take steps to mitigate unexpected events that may pose safety hazards (e.g., flooding due to collapsed culvert, clear trail blockages due to storm damage or dead fall trees, eliminate hazardous fuel loads) or that impede natural succession or restoration (e.g., control serious outbreaks of invasive plants, hands-on restoration of significantly impaired habitats through planting or other habitat management that may require the use of heavy equipment). Activities such as required trail, road, and parking lot maintenance would continue (e.g., roadside mowing, tree trimming on less than 25 acres, use of heavy equipment). When such actions are necessary, the refuge would choose actions that not only address these issues, but also improve habitat conditions for proposed and listed species, where possible. For example, when culverts need to be repaired, the needs of Atlantic sturgeon, Shortnose sturgeon, Northern bog turtle, and brook floaters would be taken into account. Invasive plant control measures would be selected and prioritized to benefit listed and proposed species. Maintenance activities would also be designed to benefit these species wherever possible. Overall, there would be a negligible beneficial impact to listed and proposed species from such activities.

This alternative would eliminate snowmobiling. While the impact of snowmobiling on Canada lynx and other species has not been quantified on the Conte Refuge, it is unlikely that snowmobiling benefits these speices. Therefore the elimination of snowmobiling could have either no impact or negligible to minor beneficial impacts.

Adverse Impacts. Because alternative D is based on a passive management approach, it lacks the short- and long-term negligible adverse impact on listed species identified for the other three alternatives that is associated with active management. Such impacts include those stemming from travel through managed areas, the use of heavy equipment, prescribed burning, and the effects of the habitat alterations themselves.

Instead, the lack of active management could have a negligible adverse impact on listed species in cases where active management is the only way to ensure key habitat types exist. For example, Canada lynx need a mosaic of forest successional classes that includes early successional states, while the tri-colored bat and insect species proposed for listing need open habitat like grasslands or shrublands. Natural disturbances such as hurricanes or wildfires that would reset successional pathways are unpredictable. In the case of wildfire, disturbance is usually prevented to protect human life and property. As a result there is a high degree of uncertainty as to the likelihood that natural disturbance would be able to substitute for active management, and so we predict a negligible adverse impact due to ceasing active management that could increase if no natural disturbance occurs.

In this alternative the refuge would still take steps to mitigate unexpected events that may pose safety hazards (e.g., flooding due to collapsed culvert, clear trail blockages due to storm damage or dead fall trees, eliminate hazardous fuel loads) or that impede natural succession or restoration (e.g., control serious outbreaks of invasive plants, hands-on restoration of significantly impaired habitats through planting or other habitat management that may require the use of heavy equipment). Activities such as required trail, road, and parking lot maintenance would continue (e.g., roadside mowing, tree trimming on less than 25 acres, use of heavy equipment). We expect the infrequency of these activities, coupled with the use of best management practices to mitigate adverse impacts, to result in negligible adverse impacts to listed and proposed species over both the short and long term.

Visitation under alternative D is projected the second highest (after alternative C), as the elimination is snowmobiling is balanced by increased recreation on the much larger refuge (Table 5.5). Nevertheless, visitation under alternative D for other activities would be somewhat similar to that under the other alternatives. The 22-mile native material trail system would theoretically incur fewer adverse impacts to proposed and listed species in its construction and management than alternatives B and C. However, in all cases Section 7 consultation would be completed in order to eliminate adverse impacts, so the most likely scenario is that the impacts would not vary by alternative.

Compared to the other alternatives, alternative D has a lower likelihood of adversely affecting listed and proposed species than the other alternatives due to actions taken, but a higher likelihood that the outcome of not actively managing habitat would lead to adverse impacts. We currently lack a mathematical model to define an overall risk of adverse impacts from not conducting current management activities that can be directly compared to the other alternatives. However, if we accomplish our goal of having no impact on listed or proposed species from management, then adverse impacts from no management could be greater than from the alternatives utilizing active management.

Summary

The refuge proposes no management action that would directly impact, adversely or beneficially, any of the listed or proposed species (Table 5.9). Other refuge management-related activities could have negligible impacts on proposed or listed species, but no action would be taken that would knowingly adversely impact these species without first completing appropriate environmental review and acquiring necessary permits.

With increasing levels of habitat added to the refuge, we expect strengthened protections and management capability for listed and proposed species, notably where early-successional habitat would be actively managed. Continued management of existing refuge uplands, and the potential to acquire and permanently protect more will directly benefit these species over the short and long term. We will take appropriate management actions to aid recovery of these species if new lands acquired are known habitat areas for these species and are noted in recovery plans. Again, such management actions would be taken after appropriate review and consultation with recognized experts and Service approval. Habitat Management Plans subject to NEPA review and Section 7 consultations as required by the Endangered Species Act would be completed before engaging in any management that could harm listed or proposed species, or that takes place in areas where those species are known to occur.

Impacts to Bird Species

The diverse habitats within the expansive Connecticut River watershed provide breeding, migratory, wintering, and foraging areas for hundreds of resident and migratory bird species. The watershed is contained within two Bird Conservation Regions (BCRs) of the North American Bird Conservation Initiative, which have identified priority bird species needing conservation attention. Numerous state-listed bird species inhabit the defined CCP habitats. Table 5.10 identifies the priority refuge resources of concern birds and their LCC habitat types that may be impacted by activities described in the alternatives.

Table 5.10. Priority Refuge Resources of Concern Birds and the Associated Birds Known to use North Atlantic LCC General Habitat Types on Existing and Proposed Refuge Lands.

Major Habitat	LCC* General Habitat Types in CFAs	PRRC** Birds	Associated Birds ***
Forested Uplands and Wetlands	Spruce-fir Forest	Blackburnian warbler Rusty blackbird Canada warbler	Cape May warbler, boreal chickadee, purple finch, black-throated green warbler, spruce grouse, gray jay, black-backed woodpecker, bay-breasted warbler, white-throated sparrow, blackpoll warbler, brown creeper, Northern saw-whet owl, olive-sided flycatcher, palm warbler, pine grosbeak, sharp-shinned hawk, yellow-bellied flycatcher, Northern parula warbler
	Conifer Swamps	Canada Warbler	Blackburnian warbler, black-throated green warbler, Northern waterthrush, red-shouldered hawk, rose-breasted grosbeak, purple finch, veery, white-eyed vireo, willow flycatcher, wood duck, Northern parula
	Hardwood Forest	American woodcock Wood thrush Bald eagle Blackburnian warbler Chestnut-sided warbler Canada Warbler Black-throated blue warbler Louisiana waterthrush Osprey	Red-shouldered hawk, ovenbird, Eastern wood pewee, Northern flicker, yellow-bellied sapsucker, rose-breasted grosbeak, black-throated green warbler, American redstart, Baltimore Oriole, black and white warbler, prairie warbler, worm-eating warbler, blue-winged warbler, hooded warbler, cerulean warbler, black-billed cuckoo, broad-winged hawk, whip-poor-will, great-crested flycatcher, Acadian flycatcher, Northern goshawk, scarlet tanager, sharp-shinned hawk, Cooper's hawk, ruffed grouse, yellow-throated vireo, blue-headed vireo, barred owl, Eastern towhee, gray catbird, brown thrasher,
	Hardwood Swamps	Canada warbler	Red-shouldered hawk, black-throated green warbler, blackburnian warbler, rose-breasted grosbeak, purple finch, veery, white-eyes vireo, Northern parula warbler, wood duck Northern waterthrush,
	Shrub Swamp and Floodplain Forest	American woodcock, black duck	American woodcock, American bittern, warbling vireo, willow flycatcher, ruffed grouse, chestnut-sided warbler, American redstart, Canada goose, mallard, Eastern kingbird, gray catbird, Northern harrier, Eastern towhee, brown thrasher, alder flycatcher, green-winged teal, snowy egret, white-throated sparrow, rusty blackbird, common merganser, bufflehead, Canada goose, marsh wren, Virginia rail

Major Habitat	LCC* General Habitat Types in CFAs	PRRC** Birds	Associated Birds ***
Non-forested Uplands and Wetlands	Pasture, Hay and Grassland	American woodcock	Upland sandpiper, American kestrel, field sparrow, chestnut-sided warbler, bobolink, grasshopper sparrow, Eastern meadowlark, common night hawk, Eastern towhee, gray catbird, blue-winged warbler, prairie warbler, brown thrasher, Eastern kingbird, chimney swift, Northern harrier, indigo bunting, white-throated sparrow
	Freshwater Marsh	black duck, semi-palmated sandpiper	American bittern, marsh wren, Northern harrier, Virginia rail, great blue heron, snowy egret, short-billed dowitcher, lesser yellowlegs, wood duck, Canada goose, bufflehead, common loon, mallard, green-winged teal, gray catbird, willow flycatcher, warbling vireo, Eastern kingbird
	Old Field and Shrubland	American woodcock	Eastern towhee, gray catbird, bobolink, Eastern meadowlark, blue-winged warbler, prairie warbler, brown thrasher, field sparrow, Eastern kingbird, chimney swift, Northern harrier, indigo bunting
	Peatlands	black duck	Olive-sided flycatcher, palm warbler, black-backed woodpecker, Eastern kingbird, Northern harrier
	Cliff and Talus	peregrine falcon	
Inland Aquatic Habitats	Open Water	black duck	Canada goose, bufflehead, mallard, snowy egret, bald eagle, wood duck, green-winged teal

**LCC – Landscape Conservation Cooperative;*

***PRRC – Priority Refuge Resources of Concern (PRRC): species needing management attention that occupy habitats used by many associated birds; identified in Appendix A;*

****Associated Bird Species: species who habitat generally is similar to PRRC bird species and will benefit from any management activities for PRRC species.*

We compared the benefits of the alternatives from actions that would enhance the conservation of priority refuge resources of concern bird species:

- Refuge land acquisition and conservation for migratory birds
- Habitat management and restoration actions designed to promote birds considered priority refuge resources of concern.
- Invasive plant and insect control.
- Removal of surplus buildings and roads.
- Partnership support.
- Effective visitor interpretation.

The potential adverse impacts of refuge management actions within the alternatives that were evaluated included impacts from:

- Habitat management activities.
- Construction of buildings, parking facilities, access roads, and interpretive trails, or demolition of infrastructure.
- Road maintenance.

- Visitor use impacts.
- Prescribed burning.
- Conducting bird field research.
- Public use, including migratory bird hunting.

Impacts to Birds Common to All Alternatives.
Proposed refuge conservation and management activities would neither significantly benefit nor adversely impact the birds on undeveloped lands of the Connecticut River watershed, nor current or expanded refuge lands. We expect refuge land conservation and management within all alternatives to help maintain and improve current habitat conditions for the priority refuge resources of concern birds and their associated bird species. Bird habitat benefits will be promoted to varying degrees in the four alternatives under consideration. Greater bird habitat benefits would be derived from either of the refuge expansion alternatives (C and D) since they would permanently protect these larger habitat areas and preclude them from potential development projects. However, in the short term (within 15 years), beneficial impacts are expected to be similar across all alternatives in the short because we would likely acquire similar amounts of land under all the alternatives. Greater beneficial impacts to birds would be expected to accure under the different alternative scenarios over the long term, in proportion to the total land conserved as refuge lands.

While the bald eagle is no longer a federally listed species, the refuge uses the national bald eagle management guidelines for bald eagle management to implement time-of-year restrictions for nesting eagles. The guidelines do not permit any activity within 330 feet of an active nest during the breeding season, particularly where eagles are unaccustomed to such activity (USFWS 2007).

Impacts from protecting and restoring habitat
The positive impacts associated with all alternatives involve the value of protecting and restoring migrating birds habitat, and preventing habitat displacement through development. Strategic habitat protection of stopover neotropical migrant habitat (especially forest and shrub wetlands along the main stem of the river) within the Connecticut River watershed will significantly benefits these species during the spring migratory period.

Table 5.11. Comparison of LCC General Habitat Types that Could Support Priority Refuge Resources of Concern Birds By Alternative.

	Alternative B	Alternative C		Alternative D	
LCC Habitat	Acres	Acres	Percent increase over Alt. B	Acres	Percent increase over Alt. C
Conifer swamp/Spruce-fir	22,422	28,390	27%	29,815	5%
Hardwood Forest	61,212	150,927	147%	195,578	30%
Hardwood swamp	2,008	3,946	97%	5,993	52%
Shrub swamp/ Floodplain Forest	1,638	2,804	71%	3,477	24%
Cliff and Talus	445	1,868	320%	2,094	12%
Freshwater marshes	962	2,054	114%	2,401	17%
Old field and shrubland	37	52	41%	99	90%

LCC Habitat	Alternative B	Alternative C		Alternative D	
	Acres	Acres	Percent increase over Alt. B	Acres	Percent increase over Alt. C
Pasture/Hay/ Grassland	5,061	9,637	90%	11,255	17%
Peatland	922	1,098	19%	1,099	less than 1%
Open water	2,155	2,972	38%	3,783	27%

** LCC defined habitat acres are not available for SFA lands described in alternative A*

By protecting additional freshwater wetlands and saltmarsh, all alternatives may contribute over the long term toward waterfowl habitat objectives within the ACJV Waterfowl Focus Areas, and toward supporting breeding populations of waterfowl (Table 5.12).

Table 5.12. Potential Waterfowl Habitat Protection Contribution to Atlantic Coast Joint Venture Habitat Objectives Under Alternative C.

ACJV Waterfowl Focus Area	ACJV Waterfowl Habitat Objective (acres)	Acres of wetland habitat in CFAs (Percent of objective)		
		Alternative B	Alternative C	Alternative D
Connecticut River and Tidal Wetlands Complex – in CT	1,157	436 (38%)	878 (76%)	1,877 (162%)
Connecticut River – in NH	3,200	1 (<1%)	1 (<1%)	2 (<1%)
Connecticut River – in VT	250	2 (1%)	41 (16%)	41 (16%)
Lake Memphremagog – in VT	5,101	3,043 (60%)	3,913 (77%)	3,913 (77%)
Total for entire Atlantic Flyway	**1,577,594**	**11,884 (1%)**	**18,563 (1%)**	**23,257 (2%)**

** Acres of wetland habitat compared to waterfowl focus areas are not available for SFA lands described in alternative A.*

The refuge recognizes that management designed to benefit a priority refuge resources of concern species may represent a trade-off with habitat conditions for other species. For example, active management designed to benefit a priority refuge resources of concern birds by retarding natural successional forest growth (e.g., maintaining 422 acres of grasslands by mowing for bobolink and upland sandpipers, Table 5.4) may result in less habitat for mature forest associates (e.g., wood thrush, blackburnian warbler). Such trade-offs are common to any ecosystem management regime, and the refuge considers their impacts to non-priority refuge resources of concern species to be negligible.

Such management activities generally include management of the woodcock demonstration units at the Nulhegan Basin Division, which incorporate recognized silvicultural techniques designed to complement bird habitat objectives (Hagenbuch et al. 2011). They also include restoration of wetlands, mowing and haying of grassland on the Fort River Division, and controlled mechanical and herbicide use to treat invasive species. The refuge uses and employs best management practices in all habitat management operations that might impact refuge upland and wetland habitats (e.g., approved herbicide use for invasive plant control, mowing or cutting after July 15 to avoid the first nesting season, conducting forest management when ground is frozen).

Across all alternatives, we would restore and protect rare and exemplary habitats of high value to priority refuge resources of concern birds, and would selectively reduce or eliminate problematic invasive species. Pesticides, most often herbicides, may be used for restoration, in accordance with an Integrated Pest Management plan and Pesticide Use Proposal. The refuge will also develop and implement an Integrated Pest Management Plan that addresses

environmentally safe application procedures and requirements. We expect negligible adverse impacts on birds from pesticide use, and positive benefits from habitat restoration as a result of invasive plant reduction.

Within the regional and refuge specific landscape, forest management activities across alternatives are designed to improve habitat structure for priority refuge resources of concern birds, which should be negligibly adverse in the short term and beneficial in the long term. Silvicultural activities will be prescribed by the refuge forester, and will be designed to improve or create the habitat conditions required by priority refuge resources of concern species as described in an HMP, resulting in a beneficial impact. Adverse impacts will be limited due to the incorporation of best management practices, such as designing site-specific silvicultural treatments. Any areas proposed for burning would be done under an HMP and Fire Management Plan that would prescribe burns designed to enhance habitat over the long term.

Impacts from construction and maintenance of infrastructure
Across all alternatives, most management actions would not permanently impair habitat for priority refuge resources of concern birds. An exception is the construction of new infrastructure. Potential infrastructure includes trails, parking lots, stilted boardwalks and observation platforms for outdoor environmental education and interpretation. There are no plans for major facilities or new road or snowmobile trail construction on refuge lands. Building demolition could impact birds nesting in a building, but appropriate steps would be taken to avoid disturbing or taking individual birds. Maintening six buildings and continuing refuge road maintenance (grading, ditch maintenance, spreading gravel, removing boulders, roadside mowing/debrushing) with some tree cutting and mowing, is expected to have a negligible to minor adverse impact on birds.

We anticipate only negligible adverse short-term and long-term impacts to birds from the construction ADA-accessible trails under alternative B and C, or "backcountry" trails under alternative D. The trails will only disturb a small, concentrated amount of the habitat we proposed to acquire. Construction activities would be restricted to the non-breeding season.

Impacts from human presence on and use of the refuge
Human intrusion can affect bird behavior, distribution, habitat use, reproduction and survival (Knight and Gutzwiller 1995). Habitat loss and fragmentation are the major factors affecting bird populations at landscape scales, but human activity is a primary stressor of bird populations at local scales (Schlesinger 2008). The Service limits human uses of the refuge to those that are appropriate and compatible (usually wildlife-dependent uses) and thus curtails anthropogenic impacts that may impair bird use of available refuge habitats. Hunting migratory and resident game birds is currently allowed under state regulations on several divisions and units (e.g., Nulhegan Basin Division, Putney Mountain Unit), and this would be expanded to additional divisions (e.g., Honeypot Wetlands), CFAs, and units in the action alternatives following development of Hunt Plans for each watershed state (including NEPA review). We anticipate impacts to migratory birds from hunting to be negligible because our programs would adhere to state seasons and regulations and follow Federal and state harvest levels. These harvest levels are species-specific and are set annually to ensure that populations are sustained. Current and anticipated future hunting levels are also low.

All alternatives predict some increase in annual visitor numbers over time; however, the increase varies due to each alternative's respective refuge boundary configuration or expansion level. Impacts are expected to be negligibly adverse overall, although impacts will be greater as the number of actual visitors increases. Of the alternatives, A has the lowest projected impact, followed by

B, D, and C (see Table 5.5) The adverse impact will be negligible due to the refuge's efforts to mitigate impacts. For example, public use trails are placed and managed to avoid or minimize adverse impacts to birds relying upon the refuge's diverse habitats, for migration or breeding, especially ground nesting or under-story nesters. No impacts will occur from off-road bicycling and all-terrain vehicles as such activity is not permitted. In limited cases, potentially disturbing activities may be authorized.

For example, the public is allowed to drive on refuge roads. Bicycling may be permitted on refuge roads under alternatives B, C, & D, although the impacts are tiny compared to those of vehicles. ATV use may be authorized to assist disabled hunters access refuge lands. Use of these modes of transit would be authorized with appropriate conditions and safeguards (e.g., seasonal restriction) to avoid adverse impacts such as nest abandonment.

Pet-walking activities that might impact migratory bird habitats would pose negligible to minor impacts over the short term and long-term management of refuge migratory birds. Because dogs can contribute to breeding bird disturbance, especially for ground nesting and shrub and understory nesting birds (e.g., ovenbird, American woodcock, chestnut-sided warbler, black-billed cuckoo), dogs will be required to be on leash while on the refuge (UNSW 2007).

An indirect impact from hunters and hunting is lead exposure. For example, potential sources of lead exposure in woodcock include ingestion of lead-contaminated soil, and/or ingestion of lead-contaminated earthworms, most likely to occur in forage areas near roads (Scheuhammer et al. 1999).

Impacts from use of the refuge by researchers
Through the issuance of special use permits, all alternatives would promote bird monitoring and research on resident and migratory birds. A number of important projects and surveys already have been conducted or are ongoing: breeding bird surveys at Nulhegan Basin and Pondicherry, nest box use by American kestrel, American woodcock habitat preference, identification of stopover sites for migrating neotropical birds, breeding bird response to silvicultural treatments, mercury levels in Rusty blackbirds, Canada warbler habitat use in Northern forest, and others. These studies contributed to the refuge's knowledge base and provided information used to improve management. The refuge recognizes that field monitoring and research may adversely impact birds being studied largely due to the presence of humans, and sometimes direct contacts (e.g., banding, radio telemetry). In our judgement, there is a direct, negligible adverse impact on birds from research conducted on the refuge, and an indirect, beneficial impact on birds from improved understanding and management strategies that emerge from such research.

Impacts common to alternatives A, B, and C
We do not plan to increase capacity for snowmobiling in any of these alternatives. Snowmobile trails on new lands to be acquired under proposed alternatives B and C may be maintained, especially if they are connector trails, and in select situations closed trails may be opened to promote wildlife-dependent public uses. We do not anticipate habitat impacts related to snowmobiling on resident and over-wintering bird species. Because this activity is a pre-existing use, we do not expect a significant change in the use of habitats related to snowmobiling, and therefore do not expect impacts over either the short or long-term.

As noted under the water quality section, snowmobiling can introduce petroleum hydrocarbons to wild lands; however, it is unlikely that there would be any potential measurable adverse impacts to priority refuge resources of concern

birds and their associates, and none are known on refuge lands or potential refuge lands. The compatibility determinations for snowmobiling in appendix D 'Appropriateness and Compatibility Determinations,' provides additional impact analysis and references on snowmobiling impacts.

Impacts common to alternatives B, C, and D
Under these alternatives, the SFA structure put in place in the first Conte Refuge CCP would be eliminated. While the majority of the SFAs and their acreage would be retained in the new CFAs, Nineteen of 65 SFAs would not be included within the CFA structure, representing 36,915 acres of potential habitat that would not be available for inclusion into the refuge. The refuge recognizes that these SFAs continue to hold valuable habitat, and in some cases, important habitat for birds. Some of these areas have already been protected by other partners, and we would continue to encourage partners to pursue protection of these lands from willing sellers. Further details on wildlife benefits by the SFAs are provided by Appendices 3-10 of the 1995 FEIS (USFWS 1995).

The consolidation of SFAs into CFAs will promote the protection of large contiguous forest tracts that are connected (i.e., may function as corridors) to other tracts, have diverse and complex forest structure and composition, and support the structural integrity of forested wetlands.

Each of these alternatives proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis.

Impacts to Birds of Alternative A
Beneficial Impacts. Beneficial impacts from Alternative A are outlined in the section "Impacts to birds common to all alternatives," above. While habitat diversity is represented within the SFA structure, the extent and distributions in overall habitat representation, resiliency, redundancy, connectivity, and protection of ecosystem processes in likely to be somewhat less than other alternatives simply due to the scattered nature and greater disconnection among the many SFAs.

Adverse Impacts. Many adverse impacts from Alternative A are outlined in the section "Impacts to birds common to all alternatives," above. This alternative encompasses 65 widely separated, often small, and logistically difficult to manage SFAs. This difficulty could have a negligible to minor impact on birds, including those from Table 5.10, over all time scales.

Impacts to Birds of Alternative B
Beneficial Impacts. Many of the beneficial impacts from Alternative B are outlined in the section "Impacts to birds common to all alternatives," above. Alternative B consolidates most of alternative A's current 97,830 acre acquisition boundary into 19 CFAs, thus promoting larger, more diverse, and connected habitat system within the larger watershed landscape.

Alternative B offers considerable protection and management potential of spruce-fir/conifer swamp and hardwood forests (83,634 acres, table 5.11). With alternative B proposing considerable acquisition of spruce-fir/conifer swamp and hardwood forests, many priority refuge resources of concern species and their associates would be likely to benefit from protection of their habitat (Table 5.10).

Because it is smaller in total area than alternatives C and D, beneficial impacts from alternative B would be smaller than for C and D over the long term.

Adverse Impacts. Alternative B includes very few habitat and ground disturbing activities that might adversely impact migratory bird habitat, and none would be of any permanent adverse impact. Visitation under alternative B would potentially increase by 22 percent over alternative A levels (Table 5.5), due in large part to an expanded 19-mile trail system. The impacts from trail construction in alternative B are smaller than from alternative C, but probably larger than from alternative D.

The essential difference from alternative A is the potential for increased active management. This includes mowing and haying on newly acquired lands (422 acres or more), an expectation to initiate substantial management of shrubland acres (e.g., 775 acres, Table 5.4), and management of approximately 7,660 acres of forested acres over the 15 year time period of the CCP (annual average of 250 to 300 acres, Table 5.4). Adverse impacts from these activities will be lower under alternative B than alternatives C and D because the total area managed will be smaller. Prescribed burning would be used under this alternative to maintain fire regime communities (e.g., pitch pine) and to facilitate treatment of less than 100 acres annually. Best management practices are implemented in all habitat management activities, as noted in 'Impacts to birds common to all alternatives.'

Impacts to Birds of Alternative C

Beneficial Impacts. Many of the beneficial impacts from Alternative C are outlined in the section "Impacts to birds common to all alternatives," above. Alternative C consolidates most of alternative A's current 97,830 acre acquisition boundary into 22 CFAs, thus promoting larger, more diverse, and connected habitat system within the larger watershed landscape. Under this alternative, up to 197,337 acres of habitat (more than A and B, but fewer than D) would be protected. The alternative C land base further develops and expands the intent of alternative B CFAs to enhance and enrich components of strategic habitat conservation design and climate change adaptation. Habitat diversity, resiliency, redundancy, connectivity, and protection of ecosystem processes are dramatically increased.

As with alternative B, the full implementation of alternative C would likely have beneficial impacts on spruce-fir/conifer swamp and hardwood forests (179,317 acres, a >100% increase over alternative B, Table 5.11) and the wildlife species associated with such habitat. It also represents a commitment to protect sizeable increases of hardwood swamps, shrub swamp/floodplain forests, freshwater marshes, cliff and talus, pasture/hay/grassland, and rocky outcrop. Priority refuge resources of concern bird species and their associates that will benefit from all the lands and habitats protected in alternative C are listed in Table 5.10.

To assess the contribution of the proposed land acquisition in alternative C to population and habitat objectives for migratory birds, we estimated the potential suitable habitat for six of breeding birds. We used this value to estimate the population that could be supported within the proposed CFAs (Table 5.13y). Population estimates are derived from GIS data on coarse-scale and forest type; it is assumed the condition of the forest is suitable for the species listed, and therefore the estimate should be considered generous. The species analyzed are neotropical migrant species that are identified as priority refuge resources of concern species, representative species by the North Atlantic LCC, priority species within Atlantic Northern Forest (BCR 14), and New England/Mid-Atlantic Coasts (BCR 30) plans, and whose habitat requirements represent the range of upland and wetland habitat types within the CFAs.

We also considered contributions to waterfowl habitat, wood duck populations, and neotropical migrant stopover habitat. Details on the habitat and population

estimates for these species is presented in Appendix C. Population estimates for existing conserved lands within the Connecticut River watershed are included to provide contexton any additional benefits that would be provided to migratory birds by acquiring the proposed lands within the CFAs.

Table 5.13. Estimated Contribution of Alternative C to Select Priority Refuge Resources of Concern in a Range of LCC Upland and Wetland Habitat Types

Priority Refuge Resources of Concern Species	Approximate CFA Habitat Acres Suitable for Species	Estimated Population in proposed CFAs (Approximate number of Individuals)	Estimated Population in all Connecticut River Watershed Conserved Lands
Wood thrush	155,500	31,200	273,000
Canada warbler	210,000	4,800	42,000
Blackburnian warbler	180,000	26,600	224,000
Black-throated Blue Warbler	180,000	25,400	216,000
American woodcock	140,000	4,600	38,000
Bobolink	4,100	1,000	10,000

Assuming they are protected and managed appropriately for the species listed in Table 5.13, the acres proposed for protection under alternative C have the potential to contribute habitat to approximately 11 percent of the total population that the Connecticut River watershed may be able to support for each of these select priority refuge resources of concern species. We assume that other priority refuge resources of concern bird species and other species associated with the priority refuge resources of concern birds will benefit. However, over the 15-year lifetime of the CCP, we would likely acquire similar amounts of land under all of the alternatives. Consequently, we expect similar levels of short-term beneficial impacts among the alternatives A, B, and C, but potentially twice the long-term beneficial impacts under alternative C.

Alternative C's protections of freshwater wetlands and saltmarsh may contribute over the long term toward waterfowl habitat objectives within the ACJV Waterfowl Focus Areas, and toward supporting breeding populations of waterfowl. The beneficial impacts for waterfowl are greater under alternative C than under alternative B, but less than under alternative D.

Wood Duck is identified as a high priority species for the Federal-state Atlantic Flyway Council and as a continentally high priority species for the North American Waterfowl Management Plan (NAWMP). The Atlantic Northern Forest BCR 14 is recognized by the NAWMP as a high priority region for breeding need and the New England/Mid-Atlantic Coasts BCR 30 is considered a moderate priority region for breeding need for wood duck. While no regional population objectives have been established for wood duck, the regional priority rankings suggest that the Connecticut River watershed can make significant contributions to sustaining the Atlantic Flyway population at or above target levels for harvest management purposes (Table 5.14).

Table 5.14. Approximate Wood Duck Breeding Potential in all CFAs Proposed in Alternative C*.

State	Acres of Potential Wood Duck Breeding Habitat in all CFAs**	Potential Breeding Wood Duck Population Supported within CFAs***
CT	3,951	988
MA	1,613	403
NH	2,327	582
VT	909	227
Total	**8,800**	**2,200**

** Based on estimates of cavity densities presented in Dugger and Fredrickson. 1992. Life History and Habitat Needs of the Wood Duck in The Waterfowl Management Handbook. Fish and Wildlife Leaflet 13. U.S. Fish and Wildlife Service, Washington, DC. (www.nwrc.usgs.gov/wdb/pub/wmh/13_1_6.pdf; accessed October 2013)*

***based on freshwater wetland and forested wetland types as defined within the LCC habitat types*

****Number of breeding pairs, estimated at 0.25 pairs/acre of potential habitat*

Adverse Impacts. Alternative C includes few habitat and ground disturbing activities that might adversely impact migratory bird habitat, and none would be of any permanent adverse impact.

Visitation under alternative C would increase 54 percent (Table 5.5) compared to alternative A, offering greater visitor use opportunities over the short term and long term due to an expanded, accessible trail system. Potential adverse impacts would be similar in kind and slightly greater in total impact to those discussed under alternative B, due to a 22-mile trail system in alternative C compared to a 19-mile trail system in alternative B. Nevertheless, with such visitation activities being established across a much larger refuge landscape, the refuge concludes that there would be negligible impacts over the short term and long term to migratory birds.

The essential difference from alternative A would be the potential for increased mowing and haying on newly acquired lands (548 acres or more), an expectation to initiate substantial management of shrubland acres (e.g., 775 acres, Table 5.4), and management of approximately 11,550 of forested acres over the 15 year time period of the CCP (~annual average of 350-500 acres, Table 5.4). Managed acres under this alternative may increase over time as needs arise, being determined by development of future HMPs. More acres are managed under alternative C than alternative B, so the adverse impacts are somewhat increased, although the overall impact is expected to be negligible. Prescribed burning would be used under this alternative to maintain habitats that depend on fire to persist over time (e.g., pitch pine). Less than 100 acres would be treated annually.

Impacts to Birds of Alternative D

Beneficial Impacts. Many of the beneficial impacts from Alternative D are outlined in the section "Impacts to birds common to all alternatives," above. Alternative D consolidates most of alternative A's current 97,830 acre acquisition boundary into 22 CFAs, thus promoting larger, more diverse, and connected habitat system within the larger watershed landscape. Under this alternative, up to 231,307 acres of habitat (more than any other alternative) would be protected. The alternative D land base further develops and expands the intent of

Bill Thompson

Eastern towhee

alternative B and C CFAs to enhance and enrich components of strategic habitat conservation design and climate change adaptation. Habitat diversity, resiliency, redundancy, connectivity, and protection of ecosystem processes are dramatically increased.

In contrast to all other alternatives, alternative D would employ a passive management approach. This passive approach is thought to allow natural ecological functions and processes to operate without influence from active management as proposed in the other alternatives. Although we will not be actively managing habitats under alternative D, we expect that natural events and disturbances (e.g., floods, fire, disease, hurricanes, microbursts, drought) will create some habitat complexity over the very long term (i.e., decades to centuries).This habitat complexity will likely serve some of the needs of priority refuge resources of concern species over the long term. It is recognized that such an approach would eliminate the ability of the refuge to implement selective habitat improvements necessary for certain priority refuge resources of concern birds (e.g., woodcock, grassland birds, New England cottontail). Such a 'hands-off' approach also eliminates the refuge's ability to apply adaptive management which embraces planning, implementation, and evaluation of management actions (e.g., timber harvest, prescribed burns).

Similar to alternative C, alternative D offers a high level of protection and management potential of spruce-fir/conifer swamp and hardwood forests, and it advances a notable increase in protection of hardwood swamps (52% over alternative C, Table 5.11). The priority refuge resource of concern birds and their associates that will benefit from lands and habitats protected in alternative D are noted in Table 5.10 above. With alternative D proposing considerable acquisition of spruce-fir/conifer swamp and hardwood forests, species likely to benefit include those noted in alternative B. The other habitats that would increase under this alternative are similar to alternative C, and the same species listed there would also benefit with alternative D.

Alternative D's protections of freshwater wetlands and saltmarsh may contribute over the long term toward waterfowl habitat objectives within the ACJV Waterfowl Focus Areas, and toward supporting breeding populations of waterfowl. The beneficial impacts for waterfowl based on habitat protection alone have the potential to be greater under alternative D than under the other alternatives under the long-term.

Adverse Impacts. The adverse impacts discussed in the other alternatives apply to a lesser degree under alternative D. Under alternative D there would be no active forest management. Management steps would be taken to mitigate unexpected events that may pose human safety hazards (e.g., repair of collapsed culvert causing flooding, clear trail blockages due to storm damage, eliminate hazardous fuel loads) or that impede natural succession or restoration (e.g., control serious outbreaks of invasive plants, hands-on restoration of highly impaired habitats through planting or other habitat management that may require the use of heavy equipment).

Passive management means that natural processes would be allowed to alter the landscape unimpeded, creating habitat conditions that benefit some species likely at the expense of others. Allowing existing grasslands to revert to forest , for example, would eliminate habitat for grassland birds unless natural

processes opened new grassland areas. Forest interior nesting birds dependent upon complex forest structures may be adversely impacted without active management at CFAs that currently lack diverse multi-story structure due to past management activities (e.g., Nulhegan Basin and Pondicherry Divisions). However, forest structure within these CFAs may become more diverse over time depending on occurrence of natural disturbances that would alter forest structure or reset successional pathways. Activities such as required road and parking lot maintenance would continue (e.g., roadside mowing, tree trimming).

Visitation under alternative D is projected to be lower than alternative C, but higher than under alternatives A or B. Its scope is different because snowmobile use will be eliminated. Trails constructed under this alternative will be native-surface and thus less impactful on the surrounding vegetation. Like other alternatives, impacts from visitors are expected to be negligible over the short- and long-term.

Summary

In summary, our management activities across alternatives would not significantly adversely or beneficially impact birds in the Connecticut River watershed. As previously noted, all alternatives would facilitate the acquisition and protection of additional acres of refuge land beyond the current refuge acreage of 37,000 acres, ranging from about 60,000 acres (alternative A) to nearly 200,000 acres (alternative D). With those potential additions of habitat to the refuge, in concert with currently protected lands (37,000 acres), there is an expectation for strengthened protections and management capability for migratory and resident birds.

The continued maintenance of existing refuge uplands and the potential to acquire and permanently protect more will be of direct and long-term benefit to promoting listed species over the short and long term. We will take appropriate management action to help maintain and improve bird species known to be in decline (e.g., American woodcock, bobolink, blackburnian warbler, Canada warbler). Additionally, the refuge remains sensitive to contributing to the goals of the North American Waterfowl Management Plan and its associated Atlantic Coast Joint Venture, in the conservation of waterfowl. Maintaining and protecting the defined LCC subhabitats will help to guarantee their beneficial habitat functions for migratory and resident birds. We again note that acquisition of additional acres to full acquisition levels proposed in the alternatives will not occur within the short term framework of this CCP, but will continue in the long term well beyond the 15 year CCP cycle. Many of the impacts described here, especially the variance among alternatives, may not appear until beyond the 15 year CCP timeframe.

Proposed management activities — forest management, prescribed burning, trail construction, snowmobile use — may be allowed in one or more of the alternatives presented, but in all situations described above, we would expect all to be of negligible adverse impact to promoting bird conservation.

Impacts to Mammals

The diverse habitats within the expansive Connecticut River watershed provide breeding and foraging areas for 61 species of mammals, an assemblage that includes 7 shrew species, 3 mole species, 9 bats species, 4 rabbit/hare species, 21 rodents species, 14 carnivore species, as well as the opossum, white-tailed deer, and moose (DeGraaf and Yamasaki 2001). The New England Cottontail, northern

long-eared bat, little brown bat, tri-colored bat, and eastern small-footed bat are priority refuge resources of concern mammals. A number of mammal species are also associated with habitat condition similar to priority refuge resources of concern species within 15 of the 22 CFAs (Table 5.15). Mammal species most common within represented CFAs include the Eastern red bat, black bear, and bobcat, all of which rely upon hardwood forest. Table 5.15 identifies for each CFA the priority refuge resources of concern, associated mammals, and their habitats.

Table 5.15. Priority Refuge Resources of Concern and Associated Mammal Species, and Their LCC Habitats That May Be Impacted by Activities Described in the Alternatives (derived from appendix A).

CFA	PRRC Mammal Species (LCC Habitats)	PRRC Associated Mammal Species for Each CFA Subject to Impacts (derived from Appendix A).
Maromas CT		
Pyquag CT*		
Muddy Brook CT†		
Salmon River CT*	New England cottontail (hardwood forest, grassland, shrub-swamp)	Eastern red bat (hardwood forest)
Scantic River CT*		
Whalebone Cove CT*	New England cottontail (hardwood forest, grassland, shrub-swamp, old Field)	Eastern red bat (hardwood forest)
Farmington River CT/MA	New England cottontail (hardwood forest, grassland, shrub-swamp)	Eastern red bat, black bear (hardwood forest)
Dead Branch MA*		Eastern red bat, black bear, bobcat, moose (hardwood Forest)
Fort River MA*		
Mill River MA*		
Westfield River MA*		Eastern red bat, black bear, bobcat, moose (hardwood Forest)
Sprague Brook NH/MA†		Eastern red bat, bobcat (hardwood forest)
Ashuelot NH		Eastern red bat, bobcat (hardwood forest)
Blueberry Swamp NH*		American marten, Canada lynx (spruce-fir forest)
Mascoma River NH		Eastern red bat, bobcat (hardwood forest)
Pondicherry NH*		Eastern red bat (hardwood forest); American marten, Canada lynx (spruce-fir forest)
Nulhegan Basin VT*		Eastern red bat (hardwood forest); American marten, Canada lynx (spruce-fir forest)
Ompompanoosuc VT	Little brown bat Northern long-eared bat Tri-colored bat Eastern small-footed bat	Eastern red bat, black bear, bobcat (hardwood forest); water shrew (freshwater marshes, shrub-swamps, forested floodplains)
Ottauquechee River VT†	Little brown bat Northern long-eared bat Tri-colored bat Eastern small-footed bat	Eastern red bat, black bear, long-tailed weasel, woodland vole (hardwood forest)

CFA	PRRC Mammal Species (LCC Habitats)	PRRC Associated Mammal Species for Each CFA Subject to Impacts (derived from Appendix A).
West River VT		Eastern red bat, black bear, bobcat, long- tailed weasel, woodland vole (hardwood forest); water shrew (freshwater marshes, shrub-swamps, forested floodplains)
White River VT†	Little brown bat Northern long-eared bat Tri-colored bat Eastern small-footed bat	Eastern red bat, black bear, bobcat, long-tailed weasel, woodland vole (hardwood forest)
Quonatuck*	8,000 acres of tidal (salt, brackish, and fresh) wetlands, floodplain forest, and riparian areas within the Quonatuck CFA , running through the main stem River, will be protected but specific habitats cannot be determined at this time but will be selected using detailed criteria (re: Appendix C: Land Protection Plan).	

** CFA contains a SFA, part of alternative A*
† CFA not proposed under alternative B, only proposed under alternatives C and D

Impacts to Mammals That Would Not Vary by Alternative
Proposed refuge conservation and management activities would neither significantly benefit nor adversely impact the mammals within the Connecticut River watershed, nor current or expanded refuge lands as proposed. We expect refuge land conservation and management within all alternatives, however, to help maintain and even improve current habitat conditions for the priority refuge resources of concern mammals and associated mammals (e.g., bat hibernacula, den trees, beaver ponds, deer winter yards). All of these mammal habitat benefits will be promoted to varying degrees 1) on the existing 37,000 refuge acres, and through potential completion of its current authorized acquisition level (97,830 acres), 2) by reconfiguration of just below its current acquisition level boundary per 19 CFAs (97,772 ac; alternative B), or 3) by any expansion of refuge size per 22 CFAs as proposed by alternatives C and D, the latter two which would authorize expansion from 97,830 acres to 197,337 acres and 231,307 acres, respectively. Greater habitat benefits to refuge mammals would be derived from either of the refuge expansion alternatives (C and D) since they would permanently protect these larger habitat areas and preclude them from potential development projects. However, in the short term (within 15 years), we would likely acquire similar amounts of land under all the alternatives, thus beneficial impacts to mammals would be similar across all alternatives in the short term. Greater beneficial impacts to mammals would be expected to occur over the long term.

Across all alternatives, our management actions would not contribute to the permanent impairment of habitat for priority refuge resources of concern mammals or associated mammals, except when constructing infrastructure for outdoor environmental education and interpretation, notably new trails, parking lots, stilted boardwalks and observation platforms; impacts from these activities would be negligibly adverse in the short and long term. As noted above, we would remove dwellings and other small infrastructure on property acquired by the refuge and carefully manage roads near sensitive habitat areas. There are no plans for major facilities or new road or snowmobile trail construction on refuge lands. As needed, roads will remain open to provide motorized and non-motorized access to visitors, and to benefit management access. Where appropriate, roads may be closed to visitor access. Roads no longer required for management activities may be closed permanently to restore habitat and improve local soil and hydrology. Roads also may be upgraded, re-opened, or maintained to improve access for habitat management.

As noted under the “Impacts to Birds” section above, regardless of which alternative is selected, 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) (Degraaf et al, 2001, Darling Guidelines, unpublished). Eastern red bats, a migratory species, uses tree foliage to roost and rear their young, and often feed around forest edges and clearings (Davis and Lidicker 1956). New England cottontail require early-successional hardwood forests and shrublands. While Black bear and bobcat readily use a mix of deep hardwood forest, scattered fields, edges, and even dense regenerating forests. Similarly, Canada lynx and American marten rely upon a mosaic of deep mature spruce-fir forest and early-successional and maturing forests for shelter, den sites, and productive forage sites rich in snowshoe hare and rodents (DeGraaf and Yamasaki 2001). Forest management efforts under the CCP will provide a mosaic of habitat conditions within each CFA that will benefit priority refuge resources of concern species and associated mammals. Across all alternatives we will take appropriate management action to help recover any Threatened or Endangered species if new lands acquired are known habitat areas for these species, and such lands are identified as needing protection and management in an approved recovery plan. Such management actions would be taken after appropriate review and consultation with recognized experts and Service approval.

We would take steps, as appropriate, to insure that our forest management practices are not contributing to heavy fuel loads that may burn and damage refuge habitats; this would include potential fuel reduction activity under alternative D's passive management approach. As noted in previous sections above, and across all alternatives, we would selectively reduce or eliminate problematic invasive plant areas, on and off refuge, using mechanical and approved herbicidal treatment. The Regional Contaminants Specialist would review our proposals prior to field application, although certain routine chemicals can be approved and used at the field station.

The Service regulates human uses of the refuge to compatible uses (usually wildlife-dependent uses) and thus curtails anthropogenic impacts that may impair mammal use of available refuge habitats. By NWRS policy, hunting is a designated priority wildlife-dependent use (*http://www.fws.gov/policy/605fw2.html*; accessed August 2016). Hunting of game mammals would be permitted on all refuge lands where deemed compatible, and across all alternatives. The refuge generally believes alternative A's SFA structure may limit hunting opportunities compared to other alternatives since many SFAs are small and widely scattered. White-tailed deer, moose, black bear, coyote, and snowshoe hare, are the principal mammal species hunted, and gray squirrel and eastern cottontail are hunted further south in the watershed. Hunting has been a popular recreational activity across much of the watershed for generations. All hunting seasons and bag limits adhere to respective state regulations. Those regulations are set within each state based on what harvest levels can be sustained for a species without jeopardizing state populations. Measures are taken by each state to sustain populations of game mammals and avoid adverse impacts. Regulated hunting of white-tailed deer can be useful in attempting to maintain healthy populations. State wildlife management agencies and hosts of cooperators have achieved broad successes in managing deer populations at ecologically and socially acceptable levels, primarily through regulated hunting, but at high population densities deer can greatly alter the ecology of forest vegetation (McDonald et al., 2007, Winchcombe 1992), and can also spread invasive plant seed (Williams and Ward 2006). Today hunting has many social values, including recreation, subsistence, heritage, utilization of the harvestable surplus to benefit people, and control of overabundant wildlife populations. In addition, hunting regulated through licenses, stamps, permits, and taxes provides the major source of financing for habitat acquisition and improvement, research, and management

programs for all wildlife, both game and non-game (The Wildlife Society 2010). The compatibility determinations for hunting are contained in appendix D "Appropriateness and Compatibility Determinations," and provide additional references on snowmobiling impacts.

The refuge also employs certain restrictions to help sustain game population levels and assure for public safety. For example, the refuge prohibits bear baiting, nighttime hunting requires a special use permit, and all temporary blinds must be identified (name/address) when active and removed post season. "Hunter orange" is required at the Pondicherry CFA/Division, and snowshoe hare and coyote hunting end March 15 of each hunting year in advance of the State closure. Refuge restrictions at the Nulhegan Basin Division include no shooting from refuge roads. The refuge will determine whether additional restrictions are necessary at the Nulhegan Basin and Pondicherry CFAs/Divisions to prevent the accidental take of Canada lynx. By implementing state and refuge hunting regulations, hunting results in direct adverse impact due to individual losses. However, the projected total harvest would not adversely impact the viability of any harvested species' population, but would over the long term promote healthy and self-sustaining populations. Some disturbance to nontarget wildlife species may occur while hunters are in the field; however, those impacts should be minimal because hunting pressure is light. Any adverse impacts due to hunting are considered negligible.

Under all alternatives except alternative D, the refuge would employ a furbearer management program that would include trapping as a management tool in addition to non-lethal control mechanisms (e.g., beaver barriers); there would be no furbearer management program under alternative D's passive management approach. The furbearer management program used in alternatives A, B, and C would not be designed to eliminate targeted furbearer species, but rather, remove individuals in those areas where a surplus exists or individual animals are causing problems. Our program would adhere to state trapping regulations, which are set to ensure sustainable population levels. Harvest of beaver and muskrat, for example, can be both positive and adverse. Muskrats dig bank dens into embankments, causing considerable damage and adding costs to the operations of the refuge. Beaver will sometimes plug culverts and water control structures, causing damage to infrastructure, limiting access, and compromising the capability of refuge staff to manage habitat. Conversely, muskrat and beaver can both enhance aquatic and wetlands habitats by creating openings and ponding water. Many species in this forested region favor beaver ponds and wetlands (e.g., great blue heron, wood frogs, and wood ducks). Beaver are a keystone species for cycling small wetlands systems from pond to meadow to scrub-shrub to forest, and back to pond. The refuge recognizes the dynamic value beaver and muskrat play within wetland ecosystems of the Connecticut River watershed. The removal of excess furbearers from those areas would maintain furbearer populations at levels compatible with the habitat and with refuge objectives, minimize furbearer damage to facilities and wildlife habitat, minimize competition with, or interaction among, wildlife populations and species that conflict with refuge objectives, and minimize threats of disease to wildlife and humans.

During five winter trapping seasons (2004/5 and 2007/8 to 2010/11), a total of 66 beaver and 46 muskrats were taken in the Moorehen Marsh vicinity of the Pondicherry CFA/Division by permitted trappers, thus averaging about 13 beaver and 9 muskrat in any one trapping season. This was a cooperative effort with the New Hampshire Bureau of Trails which manages the recreational rail-trail bordering Moorhen Marsh. Beavers and muskrats were plugging outlets under the rail-trail resulting in trail flooding which created sheet ice in winter, a safety hazard on this popular snowmobile trail. It is also likely that some of these recorded animals were actually taken off-refuge in the rail-trail ROW where the same trappers operated. At the Nulhegan Basin Division, furbearer management

activity conducted from 2001-2012 resulted in a harvest of 65 beaver, 77 muskrat, 41 mink, and 13 river otter, averaging about 16 beaver, 8 muskrat, less than 4 mink, and 1 otter annually. Average annual trap-days spent by individuals in the wetland environment was 64. The potential adverse impact of a furbearer management program is considered by the refuge to be negligible to minor, and in the long term of negligible adverse impact due to the fecundity of both beaver and muskrat. The impact of managing the populations of these species is also considered beneficial due to beaver providing and maintaining dynamic forested wetlands. The compatibility determination for furbearer management in appendix D "Appropriateness and Compatibility Determinations," provides additional references on furbearer management.

All alternatives predict some increase in annual visitor numbers over time (Table 5.5); however, the increase varies due to each alternative's respective refuge boundary configuration or expansion level, and impacts are expected to be negligibly adverse in the short and long term. Public use trails are placed and managed to avoid or minimize adverse impacts to the refuge's diverse mammal assemblage. For example, at Pondicherry's Mud Pond Trail boardwalk, the refuge elevated sections a couple of feet to allow passage of small animals while also having one section lowered to about 4 inches above the wetland to allow large animals to cross. At present, most use occurs at the Nulhegan Basin and Pondicherry CFAs/Divisions. Alternative A predicts the lowest annual increase in visitor use (Table 5.5), since no expansion of hiking trails and visitor use is proposed, while alternative C predicts the highest increase due to its large refuge expansion proposal with trails potentially modifying and disturbing up to 22 miles and 44 acres of habitat (2 acres disturbed/mile); similarly, alternative D proposes modification and disruption of up to 22 acres (1 acres disturbed/mile). All of these trails, however, would be appropriately situated to avoid or minimize adverse impacts to priority refuge resources of concern mammals and associated mammals.

Bicycling and pet walking can disturb breeding and foraging mammals. Generally, these potentially disturbing activities are not permitted on refuge lands; however, limited use may be authorized in appropriate places. For example, we only allow bicycling on refuge roads (we do not allow bicycles off-road or on refuge trails). Any of these compatible uses would be authorized with appropriate conditions and safeguards to avoid adverse impacts such as on-trail mountain biking or introduction of invasive plant seeds from pet fur. Pets under control are permitted on most existing refuge trails, and they would be allowed on new trails if determined compatible within the specific CFA. The refuge fully recognizes that pets off-leash can disrupt mammals nearby, typically small mammals (eastern chipmunk, red squirrels, cottontail rabbits), thus all pet-walking would be restricted to leash only. Authors of many wildlife disturbance studies concluded that dogs (off-leash with people, dogs on-leash, or loose dogs) provoked the most pronounced disturbance reactions from their study animals. In effect, dogs extend the zone of human influence especially when off-leash and can cause pronounced reactions by ungulates, including energy loss. Dogs are noted predators for various wildlife species in all seasons and can potentially introduce diseases (distemper, parvovirus, and rabies) and transport parasites into wildlife habitats. Adverse impacts can be direct to individual wildlife and to populations over the long term (Sime 1999).

Through the issuance of special use permits, all alternatives would promote monitoring and research of refuge mammals. Plans are in place to monitor Canada lynx to better understand their movements, abundance, and habitat preferences at the Nulhegan Basin CFA/Division, and work continues to document the impact of moose browse on forest regeneration. The refuge recognizes that field monitoring and research may adversely impact mammals being studied largely due to the presence of humans, and sometimes direct contacts (e.g., radio telemetry). The value of an improved knowledge base is

appreciated by the refuge, and there is no indication that previous projects, nor similar ones authorized in the future, would have any more than a negligible adverse impact on mammals.

Impacts to Mammals of Alternative A

Beneficial Impacts. Alternative A would provide beneficial impacts, principally because it would protect up to 97,830 acres (37,000 currently acquired). As noted before, however, this alternative encompasses 65 widely separated, often small, and logistically difficult to manage SFAs. The primary objective of land acquisition under alternative A is to protect habitat for species listed in the refuge's statutory purposes (re: chapter 1), including federally and state-listed threatened and endangered species and other native species of plants, fish, and wildlife. While habitat diversity is represented within this SFA structure, the amount and distributions is limited in overall habitat representation, resiliency, redundancy, connectivity, and protection of ecosystem processes. Mammals associated with the habitats of priority refuge resources of concern species (table 5.15) that will benefit from lands and habitats protected in alternative A cannot be clearly distinguished due to the lack of appropriate GIS files distinguishing habitat types. However, 46 of the SFAs are now included within the newly proposed, more consolidated CFAs, thus recognizing their habitat values to mammals and other wildlife. Most of the species noted in Table 5.15 would also benefit under alternative A, yet management capability would be somewhat impeded under this alternative A due to the scattered nature of the SFAs. Management of the woodcock habitat demonstration units on the Nulhegan Basin Division under alternative A will result in the maintenance of approximately 300 acres of early-successional forests. While these treatments are designed specifically to benefit woodcock, a priority refuge resources of concern species, the refuge recognizes some mammals use early-successional forests.

Adverse Impacts. Nineteen of the 65 SFAs would not be included within the CFA structure, representing 36,915 acres of potential habitat that would not be available for inclusion into the refuge. The refuge recognizes that these SFAs continue to hold valuable habitat for mammals such as the Southern bog lemming known to occur in the Victory Basin (SFA 42). Seven of the SFAs are contained within proposed CFAs having priority refuge resources of concern associated mammals (Table 5.15). As noted in "Impacts that Do Not Vary by Alternative" above, alternative A would permit hunting of game mammals but such potential adverse impact would be deemed negligible. Alternative A would include very few habitat and ground disturbing activities known to adversely impact priority refuge resources of concern associated mammals, and none would be of any permanent adverse impact. Adverse impacts to mammals under alternative A are considered negligible in the short term and long term given the small acreage of forest the refuge maintains in an early-successional condition. Small mammals are adversely impacted by mowing (Yeager and Brittingham 2008), as is done at the Fort River and Nulhegan Basin Divisions/CFAs. When done, mowing height is set to avoid contact with small mammals to ensure negligible short- and long-term term impacts.

White-tailed deer fawn

USFWS

Under alternative A, active management would include annually mowing and haying up to 200 acres of grassland on three refuge divisions: Fort River, Nulhegan Basin, and Pondicherry, 255 acres of forest management (Table 5.4), hazardous fuel treatments on less than 100 acres, controlled mechanical and herbicide use on approximately 60 acres, maintenance of six buildings, road maintenance with some tree cutting and mowing (40 miles public, 2 miles administrative), and visitor use impacts (e.g., 20 miles of trails); some of these activities potentially can adversely impact mammals, particularly small mammals (e.g., mowing and fuel treatment) but they are considered to be of negligible adverse

impact in the short and long term due to their small scale application over such a potentially large refuge landscape. Both watershed-wide and refuge-specific, these activities are of negligible adverse impact. As noted prior, best management practices are implemented in all forest management activities.

Visitation under alternative A would not appreciably change over current levels and is expected to be lower than any of the other alternatives (Table 5.5), although similar to alternative D. As such, alternative A visitor activities that might impact mammals, as described would pose the lowest concern.

As noted previously, we do not plan to increase capacity for snowmobiling regardless of alternative (and alternative D would eliminate snowmobiling); rather, we plan only to maintain existing use levels. Snowmobile trails on new lands potentially to be acquired under proposed alternatives C and D may be maintained, especially if they are connector trails. In rare situations closed trails may be opened to promote wildlife-dependent public uses. Snowmobiling can introduce petroleum hydrocarbons to wild lands, but potential adverse impacts are expected to be negligible. Some studies that indicate that snowmobile traffic can harass mammals, causing increased metabolic rates and stress responses, and increase susceptibility to disease and predation, especially during hard winters (Oliff et al. 1999, Picton 1999). The accumulations of snowmobile exposures over the course of a winter or several seasons can result in significant long-term wildlife displacement and expanded home ranges. Collescott and Gillingham (per Hammitt and Cole, eds. 1998) found that moose that bedded down within 1,000 feet of an active snowmobile trail, or fed within 500 feet of snowmobile traffic, were likely to change their behavior in response to snowmobile disturbance. These types of potential adverse behavioral and metabolic impacts are discussed in considerably more detail within the compatibility determinations for snowmobiling in appendix D "Appropriateness and Compatibility Determinations," (appendix D) which concludes, however, that much of the disturbances to wildlife noted in literature are from snowmobiles that are not on designated trails and are traveling across open range habitats in unpredictable ways. Restricting snowmobile traffic to designated road corridors helps to increase predictability and wildlife habituation. The existing snowmobile trails, and many of the existing trails that may be incorporated into the refuge with new land acquisition, have been in place for decades and predate the establishment of the refuge. The snowmobile use at the Nulhegan Basin Division is currently at manageable levels based on monitoring studies, which supports our assessment that adverse impacts associated with this activity are expected to remain low.

An indirect impact to mammals from cross country skiing and snowmobiling stems from snow compaction. Snow cover is important to the winter survival of many species because of the protection that the subnivian environment provides from the stresses of direct exposure to severe winter weather and predation (Formozov 1946, Pruitt 1957, Fuller 1969). Jarvinen and Schmid (1971) found that snowmobile-compacted snowfields increased the winter mortality of small mammals, indicating that compaction inhibited mammal movements beneath the snow and subjected subnivian organisms (animals that travel below snow) to greater temperature stress. We have not, however, recorded any notable adverse impacts due to cross country skiing or snowmobiling and believe such impacts that may occur will be of negligible to minor adverse impact in the short term and over the long term.

Impacts to Mammals of Alternative B

Beneficial Impacts. Alternative B would provide very similar beneficial impacts when compared to alternative A, principally because it would protect almost the same amount of habitat, of which 37,000 acres are currently acquired. However, in contrast to the 65 widely separated, often small, and logistically difficult to manage SFAs, alternative B consolidates most of alternative A's current

97,830 acre acquisition boundary into 19 CFAs, thus promoting a larger, more diverse, and connected habitat system within the larger watershed landscape. This consolidation is designed to allow the refuge to acquire large contiguous forest tracts that are connected (and thus able to serve as corridors) to other tracts, offer a diverse and complex forest structure and composition, provide for structural integrity of forested wetlands, and more readily accommodate the ability of refuge mammals to adapt to a warming climate.

Alternative B offers acquisition of lands that would provide habitat for New England Cottontail, a priority refuge resource of concern. Three CFAs provide much of this potential habitat: the Farmington River CFA (which does not include former SFAs), and the Salmon River and Whalebone Cove CFAs, which include eight of the original SFAs. (Table 5.16). The protection of additional acres of habitat is likely to have negligible to minor beneficial impacts on the cottontail, with the degree of impact relative to the quantity of habitat protected and managed for this species.

Table 5.16. Estimated Potential New England Cottontail Habitat Acres Proposed by Alternative.

LCC Habitat Type	Alternative B	Alternative C	Alternative D
Pasture/Hay/Grassland	5,059	,634	11,234
Hardwood forest	61,190	150,836	195,518
Shrub swamp and floodplain forest	1,635	2,797	3,479
Old fields and shrubland	37	50	100
Total	**67,921**	**163,317**	**210,331**
Total without hardwood forest	**6,731**	**12,482**	**14,813**
Alternative A includes approximately 6000 acres of habitat.			

Alternative B offers acquisition of a large expanse, and protection and management potential, of spruce-fir/conifer swamp and hardwood forests (76,561 acres), habitats that accommodate all priority refuge resources of concern associated mammals including wetland dependent water shrew that also uses non-forested wetlands.

Alternative B proposes the establishment and management of 775 acres of shrubland habitat principally for New England cottontail (Table 5.4). The full extent of these acres will be established over an estimated ten year period. The expected benefits of such habitat management is to restore adequate habitat areas for this species so that viable self-sustaining meta-populations can become established in and near currently recognized habitat areas for this mammal. In doing such management, the refuge will contribute directly to the goals of the Strategic Plan for New England Cottontail (Fuller and Tur 2012).

Adverse Impacts. As presented and discussed in alternative A above, 19 of the 65 SFAs would not be included within the proposed CFA structure, representing 36,915 acres of potential mammal habitat that would not be available for inclusion into the refuge. Over the 15 year CCP horizon, alternative B encompasses management of a minimum of 9,312 acres of habitat compared to 455 acres under alternative A: 7,660 acres forest, 422 acres grassland, and 775 acres shrubland, all designed to improve habitat for priority wildlife, fish, and plant species (table

5.4), and over time additional acres could become subject to active management if determined necessary through development of future HMPs.

A prominent difference between alternative B and alternative between A would be the establishment and active management of 775 acres of shrubland habitat under alternative B to benefit New England cottontail (table 5.4). As noted in alternative A, negligible adverse impacts to small mammals may occur due to active management activities but are not expected to have any short- and long-term impacts. We recognize that there are tradeoffs with all habitat management decisions. If we manage a particular areas for species that require grasslands, that area will not have the greatest benefit for species that require late successional forests. However, we hope by protecting and managing a diversity of habitat types (e.g., different forest types, grasslands, and shrublands) we will benefit a wide range of mammals. Prescribed burning would be used under this alternative to maintain fire regime communities (e.g., pitch pine) and to facilitate treatment of less than 100 acres of hazardous fuels annually. Best management practices are implemented in all habitat management activities, as noted prior.

Visitation under alternative B would potentially increase by 22 percent over alternative A levels (Table 5.5), due in large part to an expanded 19-mile trail system. As such, visitor activities that might impact mammal habitats, such as occasional hiking off designated trails, illegal running of unleashed pets, and snowmobiling would pose negligible to minor impacts over the long-term management. Due to the expansive nature of largely forest habitats to be potentially acquired under alternative B (tables 5.6 and 5.7), the refuge considers these active management priorities of negligible adverse impacts to mammals. Alternative B would permit hunting of game mammals but such potential adverse impact would be deemed negligibly adverse at worse and more likely beneficial in impact to the hunted mammal population.

Alternative B also proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis.

Impacts to Mammals of Alternative C

Beneficial Impacts. Alternative C would provide the second most beneficial impacts to priority refuge resources of concern mammals primarily because it would protect up to 197,337 acres of habitat. Other native mammals sensitive to development would be afforded this additional habitat protection as well. This level of protection represents a 48 percent increase in acres over alternative B. As noted in alternative B's discussion above, alternative C yields beneficial impacts due to employing a CFA structure. However, in contrast to alternative B, alternative C would establish 22 CFAs and their sizes would be larger. This even larger CFA consolidation will greatly promote principals outlined in the CCP Objective for Forested Uplands and Wetland (re: chapter 4, Obj.1.1), as discussed above in alternative B.

Similarly to alternative B above, alternative C proposes acquisition of lands that would provide habitat for New England Cottontail, a priority refuge resource of concern. Three CFAs provide much of this potential habitat: the Farmington River CFA (which does not include former SFAs), and the Salmon River and Whalebone Cove CFAs, which include eight of the original SFAs (Table 5.16). The protection of additional acres of habitat is likely to have negligible to minor beneficial impacts on the cottontail, with the degree of impact relative to the quantity of habitat protected and managed for this species. The same amount of acres (775) are planned to be managed between alternatives B and C (Table 5.4), with the same negligible to minor beneficial impacts on the cottontail for each. These beneficial impacts would not occur in alternative A.

Also similar to alternative B, alternative C offers a high level of protection and management potential of spruce-fir/conifer swamp and hardwood forests (162,427 acres), and it advances a marked increase in protection of hardwood forests. It also represents a commitment to protect sizeable increases of hardwood swamps, shrub swamp/floodplain forests, freshwater marshes, cliff and talus, pasture/hay/grassland, and rocky outcrop. Such habitat protections accommodate all priority refuge resources of concern and associated mammals (Table 5.15). Alternative C proposes 6,558 additional acres over alternative B for the three CFAs that contain habitat for the New England cottontail (Table 5.16).

Adverse Impacts. The adverse impacts discussed in alternative B above largely apply to alternative C. Over the 15 year CCP horizon, alternative C encompasses management of a minimum of 12,873 acres of habitat compared to 455 acres under alternative A: 11,550 acres. forest, 548 acres grassland, and 775 acres shrubland, all designed to improve habitat for priority wildlife, fish, and plant species including mammals (table 5.4). Over time additional acres could become subject to active management if determined necessary through development of future HMPs. As noted and discussed prior, 19 SFAs would not be included within alternative C's proposed CFA structure, including SFA 42 (Victory Basin) known to be inhabited by southern bog lemming. Potential adverse impacts would be considered negligible over the short and long term and would be similar to those discussed under alternative B.

Visitation under alternative C would likely increase over current alternative A levels (Table 5.5) and would potentially offer the highest level of visitor use opportunities of all alternatives. Nevertheless, with such visitation activities being established across a potentially much larger refuge landscape, the refuge concludes that there would be negligible to minor adverse impacts over the short term and long term.

Impacts to Mammals of Alternative D

Beneficial Impacts. Alternative D may provide the most beneficial impacts to priority refuge resources of concern mammals and associated mammals over the long term because it would protect up 231,307 acres of habitat, of which 37,000 acres are currently acquired. This represents a 59 percent increase over alternative A's 97,830 acres, 58 percent increase over alternative B's 97,772 acres and 16 percent increase over alternative C's 197,337 acres. As noted in alternative B's discussion above, alternative D yields benefits due to employing a CFA structure, and, like alternative C, would establish 22 CFAs. This even larger CFA consolidation will advance the best opportunity to promote principals outlined in the CCP Objective for Forested Uplands and Wetland (re: Chapter 4, Obj.1.1), as discussed above in alternative B.

In contrast to all other alternatives, alternative D would employ a very low impact or passive management approach. This approach would essentially allow all natural ecological functions and processes to operate without influence from active management as proposed in the other alternatives. Although we will not be actively managing habitats under alternative D, we expect that natural events and disturbances (e.g., floods, fire, disease, hurricanes, microbursts, drought) will create some habitat complexity over the very long term (i.e., decades to centuries).This habitat complexity will serve some of the needs of priority refuge resources of concern species over the long term. However, some habitats, such as those utilized by the New England cottontail, are relatively less likely to occur on the refuge without active human management. Alternative D provides for the largest amount of potential cottontail habitat (Table 5.16), but without active management there is more uncertainty about the beneficial impacts to cottontail from its acquisition. They are likely negligible to minor, depending on the quality and persistence of habitat over time.

It is also recognized that such an approach tends to eliminate the ability of the refuge to seek selective habitat improvements for the New England cottontail, and potentially for the Canada lynx once more certainty is gained about how the refuge can best contribute to its needs. Management results (or wildlife response to management activities), when monitored, can reveal valuable lessons in using effective and wildlife-responsive techniques.

Similar to alternatives B and C, alternative D offers a very high level of protection and management potential of spruce-fir/conifer swamp and hardwood forests (194,756 acres), and it advances a notable increase in protection of hardwood swamps (+1,475 acres). Alternative D proposes 15,653 additional acres over alternative C for the three CFAs that contain habitat for the New England cottontail (Table 5.16). With alternative D's proposing considerable acquisition of spruce-fir/conifer swamp and hardwood forests, species likely to benefit include those noted in Table 5.15. As noted and discussed in alternative B above, 19 SFAs would not be included within alternative D's proposed CFA structure.

Adverse Impacts. As noted in "Impacts that Do Not Vary by Alternative" above, alternative D would permit hunting of game mammals but such potential adverse impact would be deemed negligible, and it would include the slight modifications described in alternative C. Due to its large size, and a passive management approach by the refuge (i.e., minor accessibility improvements), the land base proposed by alternative D (231,307 acres) may result in fewer hunting opportunities for some of the proposed CFAs.

The adverse habitat impacts discussed in the other alternatives apply much less to alternative D since the 'passive' management approach would not employ the habitat alteration activities described for the other alternatives. Under alternative D there would be no active forest management designed for target priority refuge resources of concern wildlife. Thus, there will be no regularly prescribed sivicultural operations or use of heavy equipment. Management steps would be taken to mitigate unexpected events that may pose safety hazards (e.g., flooding due to collapsed culvert, clear trail blockages due to storm damage, eliminate hazardous fuel loads) or that impede natural succession or restoration (e.g., control serious outbreaks of invasive plants, hands-on restoration of highly impaired habitats through planting or other habitat management that may require the use of heavy equipment). Activities such as required road and parking lot maintenance would continue (e.g., roadside mowing, tree trimming). Effectively, this means that under passive management natural processes would be allowed unimpeded to alter the landscape, thus impacting a host of species in positive and negative ways. For example, allowing existing grasslands and old fields to revert to forest would eliminate habitat for New England cottontail unless natural processes opened new shrubland areas. The passive approach would compromise the refuge's ability to apply an adaptive management approach designed to clarify and strengthen assumptions about expected results from applied management techniques. Visitation under alternative D is projected to be lower than alternative C, but higher than under alternatives A or B. Its scope is different because snowmobile use will be eliminated. Thus, adverse impacts would be considerably less than those noted in alternatives B and C and other alternatives, but nevertheless would be viewed as negligible.

Linda Cullivan

New England cottontail

Summary

In summary, our management activities across alternatives would not *significantly* adversely or beneficially impact mammals in the Connecticut River

watershed. As previously noted, all alternatives would facilitate the acquisition and protection of additional acres of refuge land beyond the current refuge acreage of 37,000 acres, ranging from about 60,000 acres (alternative A) to nearly 200,000 acres (alternative D). With those potential additions of habitat to the refuge, in concert with currently protected lands (37,000 acres), we expect benefits to watershed mammals. The continued maintenance of existing refuge uplands and the potential to acquire and permanently protect more will be of direct and long-term beneficial impacts to promoting mammals over the short and long term. We will take appropriate management action to help maintain and improve mammals known to be in decline (e.g., New England cottontail). Maintaining and protecting the defined LCC subhabitats (notably grassland and shrubland habitat for New England cottontail) will help to guarantee their beneficial habitat functions for watershed mammals. Because it is unlikely that acquisition of the full proposed level of refuge ownership will be reached within the 15-year lifetime of the CCP, we acknowledge that there are limits to both the adverse and beneficial impacts predicted in this analysis, and that over the short-term there is some reduction in variation among alternatives. Proposed management activities–forest management, mowing, prescribed burning, trail construction, and snowmobile use–may be allowed in one or more of the alternatives presented, but in all situations described above, we would expect all to be of negligible adverse impact to promoting mammal conservation.

Impacts to Reptiles, Amphibians, Fish, and Other Aquatic Species

The diverse aquatic habitats, and adjacent upland areas, within the expansive Connecticut River watershed provide breeding, migratory, wintering, and foraging areas for a diversity of reptiles and amphibians, hundreds of species of migratory and resident fish, and other aquatic species (e.g., freshwater mussels). Table 5.17 lists the priority refuge resources of concern reptile, amphibian, fish, and other aquatic species that may be impacted by the four alternatives. Some of these species are described in more detail under the discussion on federally threatened and endangered species. Although most of these species are aquatic, some occur seasonally in terrestrial areas (mole salamanders), or have terrestrial life-cycle phases (e.g. red-spotted newt). Some of the reptiles discussed are obligate terrestrial species (e.g., eastern box turtle, eastern hog nose snake).

Table 5.17. Priority Refuge Resources of Concern Reptiles, Amphibians, Fish, and Other Aquatic Species for Conte Refuge

	PRRC Reptiles, Amphibians, Fish, and Other Aquatic Species	
CFA	PRRC Fish & Mussels	PRRC Associated Aquatic Species
Maromas CT	American Shad, shortnose sturgeon, American eel, Atlantic salmon, alewife, blueback herring	spotted turtle, smallmouth bass, striped bass, pumpkinseed, sea lamprey, longnose dace, yellow perch, rainbow smelt, banded sunfish
Pyquag CT*	American Shad, shortnose sturgeon, American eel, Atlantic salmon, alewife, blueback herring	smallmouth bass, striped bass, burbot, pumpkinseed, sea lamprey, longnose dace, yellow perch, rainbow smelt, banded sunfish
Muddy Brook CT†	Eastern brook trout, American eel	sea lamprey, longnose dace
Salmon River CT*	American eel, Atlantic salmon, alewife, blue-backed herring, brook floater	Eastern box turtle, Eastern hognose snake
Scantic River CT*	American shad, shortnose sturgeon, American eel, Atlantic salmon, alewife, blueback herring	spotted turtle, smallmouth bass, burbot, striped bass, pumpkinseed, sea lamprey, longnose dace, yellow perch, rainbow smelt, banded sunfish
Whalebone Cove CT*	American eel, Atlantic salmon, alewife, blueback herring, Eastern brook trout	Eastern box turtle, sotted turtle, sea lamprey, bridle shiner, pumpkinseed, striped bass, longnose dace, yellow perch, rainbow smelt, banded sunfish, white perch

	PRRC Reptiles, Amphibians, Fish, and Other Aquatic Species	
CFA	**PRRC Fish & Mussels**	**PRRC Associated Aquatic Species**
Farmington River CT/MA	Eastern brook trout, American eel	Eastern box turtle, Jefferson salamander, Eastern ribbon snake, spotted turtle, black racer, bridle shiner, burbot, Eastern silvery minnow, longnose dace, longnose sucker, creek chubsucker
Dead Branch MA*	Eastern brook trout, Atlantic salmon	black racer, Jefferson salamander, Eastern ribbon snake, spotted turtle, wood turtle, Spring salamander, bridle shiner, longnose sucker, slimy sculpin, creek chubsucker, longnose dace, lake chub
Fort River MA*	Eastern brook trout, American eel	wood turtle, Spring salamander, sea lamprey, fallfish, longnose dace
Mill River MA*	American shad, shortnose sturgeon, American eel, Atlantic salmon, blueback herring, dwarf wedge mussel	Spring salamander, sea lamprey, Eastern silvery minnow, burbot, black dace, longnose sucker, slimy sucker, creek chubsucker, longnose dace
Westfield River MA*	Eastern brook trout, American eel, Atlantic salmon	Spring salamander, Eastern box turtle, four-toed salamander, black racer, spotted turtle, Northern leopard frog, Eastern ribbon snake, longnose sucker, black dace, slimy sculpin, creek chubsucker, longnose dace, lake chub
Sprague Brook NH/MA†	Eastern brook trout, Atlantic salmon	Jefferson salamander, marbled salamander, black racer, Eastern ribbon snake, Northern leopard frog, Northern red-bellied dace, slimy sculpin, burbot, creek chubsucker, longnose dace
Ashuelot NH	Eastern brook trout, American eel, dwarf wedge mussel	wood turtle, black racer, slimy sculpin, tessellated darter
Blueberry Swamp NH*	Eastern brook trout	Northern leopard frog, wood turtle, slimy sculpin; Northern red-bellied dace and finescale dace [both suspected but unconfirmed]
Mascoma River NH	Eastern brook trout	black racer, wood turtle, spotted turtle, slimy sculpin
Pondicherry NH*	Eastern brook trout	smooth green snake, Northern leopard frog, mink frog, Northern red-bellied dace, slimy sculpin, tessellated darter
Nulhegan Basin VT*	Eastern brook trout, Atlantic salmon	smooth green snake, black racer, wood turtle, mink frog
Ompompanoosuc VT	Eastern brook trout, Atlantic salmon	Jeffereson salamander, black racer, Eastern ribbon snake
Ottauquechee River VT†	Eastern brook trout, Atlantic salmon	blackstone shiner
West River VT	Eastern brook trout, Atlantic salmon, American shad, American eel, brook floater	Eastern ribbon snake, wood turtle, Eastern pearlshell
White River VT†	Eastern brook trout, Atlantic salmon	blacknose shiner
Quonatuck CFA*	8,000 acres of tidal (salt, brackish, and fresh) wetlands, floodplain forest, and riparian areas within the Quonatuck CFA , running through the mainstem river, will be protected but specific LCC habitats cannot be determined at this time but will be selected using detailed criteria (see also Appendix C: Land Protection Plan).	

** CFA contains a SFA, part of alternative A*

† CFA not proposed under alternative B, only proposed under alternatives C and D

Note: See appendix B for a full description of how we identified priority refuge resources of concern species based on information from a variety of conservation plans. See appendix A on additional information on priority refuge resources of concern species and proposed management for each CFA.

We evaluated the benefits to these species from actions proposed under the four alternatives, including:

- The extent to which refuge land acquisition and habitat conservation under the alternatives would limit the growth of nearby land development activities and their impact to reptile, amphibian, fish, and other aquatic species.
- Managing and restoring habitat to improve habitat structure and integrity for reptile, amphibian, fish, and other aquatic species.
- Repairing and upgrading road culverts.
- Removing surplus buildings and roads.
- Supporting partnerships.
- Conducting effective visitor interpretation.

We evaluated the potential for negative impacts to these species from actions proposed under the four alternatives, including:

- Forest management activities, including use of logging roads and skid trails.
- Mowing and haying grasslands, and managing for early-successional shrublands.
- Invasive plant control.
- Prescribed burning in appropriate fire-regime habitats, or for hazardous fuel reduction.
- Visitor use impacts on refuge lands, trails and roads (e.g., hiking, snowmobiles, and introduction of invasive species).
- Construction of trails, access roads, and parking facilities.
- Construction and/or demolition of buildings.
- Road maintenance (grading, ditch maintenance, spreading gravel, removing boulders, roadside mowing/debrushing).

Impacts to Reptiles, Amphibians, Fish, and Other Aquatic Species That Would Not Vary by Alternative

None of the refuge activities proposed under the four alternatives would significantly benefit or adversely impact reptiles, amphibians, fish, and aquatic species in the Connecticut River watershed. We expect refuge land conservation and management under all alternatives will help maintain and even improve habitat for these species.

Under all alternatives, we anticipate that proposed additional refuge land acquisition will permanently protect habitat for and benefit reptiles, amphibians, fish, and other aquatic species. Over the long term, we expect alternatives C and D to have the greatest benefit because they propose the largest refuge expansions. However, in the short term (within 15 years), we would likely acquire

similar amounts of land under all the alternatives, thus beneficial impacts would be similar across all alternatives in the short term.

Across all alternatives, none of our proposed management actions would permanently degrade habitat for these species, except when constructing minor infrastructure appropriate to outdoor environmental education and interpretation, such as new trails, parking lots, raised boardwalks, and observation platforms (e.g., incidental trampling of terrestrial "eft" phase of the aquatic adult red-spotted newt, temporary disruption of slimy sculpin stream habitat during culvert replacement). Impacts from these activities would be negligibly adverse in both the short and long term. There are no plans for major facilities or new road construction on refuge lands. Regardless of which alternative is selected, we would continue to use best management practices in all management activities that might impact refuge wetlands, streams, and rivers (e.g., approved herbicide use for invasive plant control, not mowing within 100' of wetland areas, appropriate buffering of streams and vernal pools during forest management activities).

Across all alternatives, we would restore and protect key spawning reaches for priority fish species, where feasible, and would participate with our partners in the Eastern Brook Trout Joint Venture and other partnerships to do so. We recognize, however, the imperative to work with others since refuge lands would not compose an adequate habitat base to independently influence a significant fish population response. There are no management activities that would pose any adverse impacts to either the dwarf wedgemussel or brook floater, yet protection of riverine habitats in select CFAs would have a beneficial impact on these PRCC species (i.e., Fort River, West River, Ashuelot River, and Salmon River). We would also pursue protection and restoration activities on rare and exemplary habitats (e.g., vernal pools), and would reduce or eliminate invasive plant areas through partnerships with Cooperative Invasive Plant Management Areas (CISMA) on and off refuge lands using mechanical and approved herbicidal treatment. As noted previously, regardless of the alternatives selected, use of pesticides, most often herbicides, will be conducted under an Integrated Pest Management plan that addresses environmentally safe application procedures and requirements. Pesticides will only be used if it is the most effective management technique (e.g., dense expansive stands of Japanese knotweed), and will be combined with other management tools. Pesticides must be approved by the Regional Contaminants Specialist, who is responsible for upholding Federal standards for water quality and soil protection. Additionally, treatments would not occur during spring salamander migrations (March 15th to May 1st) in areas containing vernal pools, and most often conducted in mid to late summer dry periods.

Conserving habitat for these species would include improvements to the aquatic area's immediate watershed by removing dwellings and other small infrastructure on property acquired by the refuge, and carefully manage roads near sensitive habitat areas. As noted by Jochimsen et al. (2004), although relatively few studies address the population-level consequences of roads, population declines in several reptile and amphibian species have been shown to be associated with roads. Species with restricted distributions and/or small population sizes appear to be more vulnerable to extinction because of their sensitivity to random events and changes. Direct effects are considered to involve injury or mortality due to physical contact from vehicles or occurring during road construction. Indirect effects include habitat loss, fragmentation, and alteration of ecosystem processes at both fine and broad scales (physical, chemical, and biological). Research indicates that the combined ecological effects may extend outward from the road edge beyond 100 meters, delineating a "road-effect zone." Altered roadside habitats have been shown to modify amphibian and reptile

behavior and movement patterns. Increased mortality and barriers to movement may influence species demography and gene flow, consequently having an impact on overall population stability and persistence (Jochimsen et al. 2004). There are no plans for major facilities or new road or snowmobile trail construction on refuge lands. As needed, roads will remain open to provide motorized and non-motorized access to visitors, and to benefit management access. Where appropriate, roads may be closed to visitor access. Roads no longer required for management activities may be closed permanently to improve local soil and hydrology. Roads may be upgraded, re-opened, or maintained to improve access for habitat management. Roads created during management actions will follow applicable BMPs to avoid wetlands, vernal pools, and sensitive habitat areas to avoid reptile and amphibian migration barriers (although we recognize artificial depressions may seasonally function as vernal pools). Logging may be performed over snow pack during winter to minimize such adverse impacts.

Off road vehicle use, can directly kill migrating reptiles and amphibians and indirectly impact populations by creating migration barriers, destroying habitats, increasing sedimentation, and introducing chemical contamination (Cooper et al. 2005, Hels and Buchwald 2001, Haxton 2000, and Trombulak and Frissell 2000). The refuge, however, prohibits ATV use and, where permitted (e.g., Nulhegan Basin Division), bicycling is restricted to refuge roads (trail use prohibited).

Forest management operations can adversely impact reptiles and amphibians (Martin and McComb 2003, Ash 1996) but may also create a beneficial diversity of habitat and species response (Loehle et al. 2005). Within the regional and refuge specific landscape, forest management activities across alternatives are negligibly adverse in the short term and beneficial in the long term. As noted previously, all forest silvicultural activities would follow established best management practices, including measures such as established buffers when necessary or conducting operations in winter.

The Service regulates human uses of the refuge to appropriate and compatible uses (usually wildlife-dependent uses) and thus curtails anthropogenic impacts that may impair aquatic and associated terrestrial habitats. All alternatives predict some increase in annual visitor numbers over time (Table 5.5); however, the increase varies due to each alternative's respective refuge expansion level and impacts are expected to be negligibly adverse. Public use trails are carefully placed and managed to avoid or minimize adverse impacts to the refuge's reptiles, amphibians, and fish in nearby streams. Alternative A predicts the lowest annual increase, since no expansion of hiking trails and visitor use is proposed, while alternative C predicts the highest increase due to its large refuge expansion proposal with 22 miles of ADA-compliant trails potentially modifying and disturbing up to 44 acres of habitat (2 acres displaced/mile); similarly, alternative D proposes modification and disruption of up to 22 acres (1 acre/mile). All of these trails, however, would be appropriately situated to avoid or minimize impacts to terrestrial phase amphibians and terrestrial reptiles without reducing visitor observation and appreciation for rare and unique 'wildlife-rich' habitat areas.

The refuge is not currently officially open to recreational fishing, but it may occur on refuge lands. Under all alternatives, we propose to complete the administrative steps necessary to open refuge lands, where compatible, to recreational fishing. Recreational fishing by the public can have negative impacts on fish populations if it occurs at high levels or is not managed properly. Potential impacts from fishing include direct mortality from harvest and catch and release; injury to fish caught and released, changes in age and size class distribution, changes in reproductive capacity and success, loss of genetic diversity, altered behavior, and changes in ecosystems and food webs (Lewin et al. 2006, Cline et al. 2007). Since fishing occurs along the shores of or in streams, rivers, and

lakes, it has the greatest potential to impact wildlife associated with riparian, wetland, and aquatic habitats. In particular, fishing has the potential to disturb nesting and brooding birds. Anglers can also affect the number, behavior, and temporal distribution of some species of birds, including bald eagles, common ravens, and American crows (Knight et al. 1991). Discarded fishing tackle may harm waterfowl, eagles, and other birds externally by catching and tearing skin. Fishing line may also become wrapped around body parts and hinder movement (legs, wings), impair feeding (bill), or cause constriction with subsequent reduction of blood flow and tissue damage. Pollutants from motorboats, human waste, and litter have the potential to have negative impacts on water quality, and bank and trail erosion from human activity (e.g. canoe/ kayak landings, foot traffic) may increase aquatic sediment loads of streams and rivers, and alter riparian or streamside habitat/ vegetation in ways harmful to fish or other wildlife. Accidental introduction of invasive plants, pathogens, or exotic invertebrates, attached to fishing boats may also impact native vegetation, wildlife, and habitats. None of the potential impacts noted above are known to cause anything more than negligible to minor adverse impacts to fish populations or aquatic habitats, nor to nearby wildlife in adjacent habitats. Our fishing program would adhere to state regulations for annual take levels and seasons by species. These regulations are set within each state based on what harvest levels can be sustained for a species without adversely affecting its overall population. Thus, fishing can result in individual losses, but the projected cumulative harvest would not jeopardize the viability of any harvested species populations. The compatibility determinations on fishing are contained in appendix D 'Appropriateness and Compatibility Determinations,' and provide additional discussion and references on fishing impacts.

Bicycling can directly and indirectly impact reptiles and amphibians (trampling, habitat disturbance). However, we would only allow bicycling seasonally on refuge roads that are open to other motor vehicles. Generally, these trampling type activities are not permitted on refuge lands; however, limited use may be authorized when determined that the use is appropriate and compatible. Leashed pets are permitted on most refuge trails, yet they can have direct adverse impacts on snakes and turtles especially when off-leash. Their waste can cause negative adverse impacts to refuge habitats and natural water quality critical to fish and reptiles and amphibians. There are no known pet waste problems on any refuge division or unit, and future acquisitions will be carefully managed to authorize any pet walking so that their wastes are removed from refuge lands. These potential adverse impacts are considered negligible, both in the short term and long term.

Through the issuance of special use permits, all alternatives would promote monitoring and research on fish and reptiles and amphibians. The refuge recognizes that field monitoring and research may adversely impact fish and reptiles and amphibians often due to both indirect methods (e.g., visually checking salamander egg masses in vernal pools) and direct methods (e.g., netting, electro-fishing during fish surveys, or collecting and measuring salamanders). Similarly, research on fish and reptiles and amphibians can include capture and marking or tagging, or even use of radio transmitter implants. The value of an improved knowledge base upon which management depends is appreciated by the refuge, and there is no indication that previous projects, nor similar ones authorized in the future, would have any more than a negligible adverse impact on aquatic fauna.

Impacts to Reptiles, Amphibians, Fish, and Other Aquatic Species common to Alternatives B, C, and D

Alternative A calls for habitat protection in several SFAs that would contribute to fish and reptiles and amphibians conservation. Some SFAs valuable to fish and reptiles and amphibians would not be included in the CFA structure proposed

by the action alternatives. The refuge recognizes that these SFAs continue to hold valuable habitat for fish and reptiles and amphibians. Further details on fish and reptiles and amphibians benefits in the SFAs are provided by Appendix 3-10 of the 1995 FEIS (USFWS 1995). The CFAs proposed under the other three alternatives contain valuable wetland and riverine habitats, which extend across a greater potential spatial extent than that proposed under alternative A. Due to the benefits conferred through consolidating into fewer, larger CFAs, the overall beneficial impacts to reptiles, amphibian, fish, and other aquatic species are predicted to be larger under the action alternatives than under alternative A.

Impacts to Reptiles, Amphibians, Fish, and Other Aquatic Species under Alternative A

Beneficial Impacts. Alternative A would provide some beneficial impacts to fish and reptiles and amphibians because it would protect up to 97,830 acres (37,000 currently acquired) across 65 widely separated, often small SFAs. As noted in chapter 3 and table 5.17, many species discussed therein will benefit from habitat protection afforded by this alternative: fish (43 species), reptiles and amphibians (30 species), and mussels/clams (14 species). Many of the SFAs were established because of the presence of valuable spawning habitat for migratory fish, notably Atlantic salmon, alewife, and blueback herring. Beneficial protection of aquatic habitats has occurred under this framework, including, for example:

- Nulhegan Basin Division: North, Yellow, and Black Branches of the Nulhegan River.
- Blueberry Swamp Division: East Branch of Simms Stream.
- Pondicherry Division: Slide Brook, Johns River, and Ayling Brook.
- Salmon River Division: Pine Brook.
- Fort River Division: portions of the Fort River
- Dead Branch Division: portions of the Dead Branch.

Adverse Impacts. Alternative A would include very few ground disturbing activities that might adversely impact fish and reptiles and amphibians. These generally include forest management of the woodcock management demonstration units at the Nulhegan Basin Division, annually mowing and haying up to 200 acres at three refuge divisions: Fort River Division, Nulhegan Basin, and Pondicherry. The refuge would employ use of controlled mechanical and herbicide use on approximately 60 acres, maintenance of six buildings, road maintenance with some tree cutting and mowing (40 miles public, 2 miles administrative), and visitor use impacts (e.g., 20 miles of trails). Both regionally and refuge-specific, these activities are of negligible adverse impact. Best management practices are implemented in all ground disturbing activities (re: section on Impacts to Soils, Impacts to Freshwater Wetlands, and Impacts to Upland Habitats).

Visitation under alternative A would not appreciably change over current levels and is expected to be the lowest of the alternatives. As such, visitor activities that might adversely impact fish and reptiles and amphibians would pose negligible impacts.

Snowmobile use is the principal off-road vehicle, a use restricted to winter and many of the snowmobile trails are in the same locations as refuge roads. We do not plan to increase capacity for snowmobiling under alternative A. As noted under the water quality section, snowmobiling can introduce petroleum hydrocarbons to wild lands; however, it is unlikely that the potential adverse

impacts would be more than minor, and in most locales negligible due to the low number of trails and users.

Impacts to Reptiles, Amphibians, Fish, and Other Aquatic Species under Alternative B

Beneficial Impacts. Alternative B would provide minor beneficial impacts to reptile, amphibian, fish, and other aquatic species because it proposes to acquire up to 97,830 acres (37,000 currently acquired) across 19 consolidated CFAs. Compared to scattered SFAs under alternative A, the CFAs proposed under alternative B promote protection of a generally more intact and connected landscape. Although alternatives B and A protect similar amounts of acres of habitat, we predict that alternative B will provide better protection for river and stream habitats because it would protect larger blocks of habitat compared to alternative A. However, alternative B would protect less habitat than alternatives C and D. We anticipate that alternative D will protect the greatest amount of river and stream miles over the long term, followed by alternative C.

Alternative B would recognize priority habitat areas as those identified within the Eastern Brook Trout Joint Venture (e.g., Farmington River, Dead Branch, Westfield River, Mascoma, Ashuelot, Nulhegan Basin, West River, and Ompompanoosuc. Under alternative B, we would better protect vernal pools by mapping their presence on refuge lands. This alternative would also facilitate reclamation of Lewis Pond, working in concert with the state of Vermont, and generally to promote fish passage and aquatic habitat assessments.

Adverse Impacts. Similar to alternative A, alternative B would include relatively few ground disturbing activities that might adversely affect refuge fish and reptiles and amphibians. The essential difference would be the potential for increased mowing and haying on newly acquired lands, an expectation to substantially increase management of shrubland acres (775 acres over 10 years), and annual forest management of approximately 7,660 acres (~250-300 acres annually). Prescribed burning would be used under this alternative to maintain fire regime communities (e.g., pitch pine) and to facilitate treatment of approximately 100 acres annually. All other activities would be the same as alternative A.

We would follow best management practices when conducting ground disturbing activities to minimize impacts to wetlands and streams. None of the management activities are expected to have more than a negligible impact over the short term and long term.

Visitation under alternative B would be expected to be the second lowest of all alternatives (Table 5.5) since public use is proposed to be expanded within this alternative, largely through an expanded, ADA-compliant 19-mile trail system (displacing 38 acres of habitat). As such, visitor activities that might trample or disturb reptiles and amphibians and their habitat, such as hiking off designated trails, and, similarly, snowmobiling would pose a potential indirect adverse impact to fish and reptiles and amphibians through possible water pollution from hydrocarbon emissions. Under alternatives B and C,

Adult male atlantic salmon

E. Peter Steenstra

we do not propose to greatly increase snowmobiling on the refuge over current levels. As we acquire new lands with existing state-recognized snowmobile trails, we will evaluate whether or not to continue to allow snowmobiling in these locations. We believe the adverse impacts from visitation would be negligible to minor over both the short and long term.

Alternative B proposes an outdoor classroom at the Fort River Division, which may involve some sort of structure and would require subsequent NEPA analysis.

Impacts to Reptiles, Amphibians, Fish, and Other Aquatic Species under Alternative C

Beneficial Impacts. Alternative C would provide the second highest level of beneficial impacts to fish and reptiles and amphibians because it would protect up to 197,337 acres across 22 CFAs. Table 5.17 lists the species that would benefit from alternative C. These consolidated and larger CFAs enable the protection of more intact, connected, and hierarchical ordered riverine system. We anticipate that alternative C would protect greater amounts of potential spawning habitat than alternative B. Alternative C, would recognize priority habitat areas as those identified within the Eastern Brook Trout Joint Venture (e.g., Farmington River, Dead Branch, Westfield River, Mascoma, Ashuelot, Nulhegan Basin, West River, and Ompompanoosuc, but would also include the Ottauquechee, Muddy Brook, and Sprague Brook. As described under alternative B, alternative C would also map the location of vernal pools to better protect them. This alternative would facilitate reclamation of Lewis Pond, working in concert with the state of Vermont, and generally to promote fish passage and aquatic habitat assessments.

Adverse Impacts. Alternative C would be nearly identical to alternative B regarding ground disturbing activities although they would be implemented across a larger landscape. The essential difference would be the potential for increased mowing and haying on newly acquired lands (548 acres), an expectation to substantially increase management of shrubland acres (775 acres), and annual forest management of approximately 11,550 over the 15 year CCP period (~350-500 acres annually). We would follow best management practices when conducting ground disturbing activities to minimize impacts to wetlands and streams. None of the management activities are expected to have more than a negligible impact over the short term and long term.

Visitation under alternative C would be expected to be the highest of all alternatives (Table 5.5) since public use is proposed to be expanded within this alternative, largely through an expanded, ADA-compliant 22-mile trail system (displacing 44 acres of habitat). Adverse impacts would be nearly the same as those discussed in alternative B. Nevertheless, we believe the adverse impacts would be considered of short- and long-term negligible to minor adverse impact.

Impacts to Reptiles, Amphibians, Fish, and Other Aquatic Species under Alternative D

Beneficial Impacts. Alternative D would provide the highest level of beneficial impacts to fish and reptiles and amphibians compared to all other alternatives because it would protect up to 231,307 acres across 22 CFAs. Table 5.17 illustrates the species that would benefit from alternative D. These consolidated and larger CFAs enable the protection of more intact, connected, and hierarchical ordered riverine system. We predict that alternative D will protect the greatest amount of stream and river habitat, which is important to fish, amphibians, and reptiles.

In contrast to all other alternatives, alternative D would employ a very low impact or passive management approach. This passive approach is thought to be more feasible on a large landscape, and may allow all natural ecological functions and processes to operate without influence from active management as

proposed in the other alternatives. As noted previously, although we will not be actively managing habitats under alternative D, we expect that natural events and disturbances (e.g., floods, fire, disease, hurricanes, microbursts, drought) will create some habitat complexity over the very long term (i.e., decades to centuries). This habitat complexity will likely serve some of the needs of priority refuge resources of concern species over the long term. However, a passive approach may limit the amount of active habitat improvements for spawning fish and migrating reptiles and amphibians (e.g., potential removal of small dams on newly acquired lands, or occasional prescribed burns in pitch-pine habitat used by Box turtle and Eastern hog-nosed snake). The passive approach could serve as a baseline for comparing impacts from applied management techniques on other lands. Management results (or wildlife response to management activities), when monitored, can reveal valuable lessons in using effective and wildlife-responsive techniques. The passive management approach is expected to have minor beneficial impacts over the short term and modest impacts over the long term.

Adverse Impacts. Alternative D will result in fewer adverse impacts from ground-disturbing activities than the other three alternatives. Under alternative D there would be no active forest management designed for target priority refuge resources of concern wildlife. Thus, there will be no regularly prescribed sivicultural operations or use of heavy equipment. Management steps would be taken to mitigate unexpected events that may pose safety hazards (e.g., flooding due to collapsed culvert, clear trail blockages due to storm damage, eliminate hazardous fuel loads) or that impede natural succession or restoration (e.g., control serious outbreaks of invasive plants, hands-on restoration of highly impaired habitats through planting or other habitat management that may require the use of heavy equipment). There would be no mowing or haying on any refuge land. Activities such as required road and parking lot maintenance would continue (e.g., roadside mowing, tree trimming).

Visitation under alternative D's potentially larger refuge landscape would be expected to the second-highest among the alternatives, after alternative C,. Up to 22 miles of trails would be constructed under this alternative but would not be ADA accessible. The trail construction impact may approach 22 acres (1 acres disturbance for each mile of trail in each CFA). As such, visitor activities that might trample or disturb reptiles and amphibians, such as hiking off designated trails, would pose low adverse impacts to fish and reptiles and amphibians habitat as noted in alternative C, and would be considered of negligible to minor impact. Under alternative D, we would eliminate snowmobiling, which should lessen potential impacts to these wildlife species.

Summary

In summary, our management activities across alternatives would not significantly adversely or beneficially impact reptiles, amphibians, fish, other aquatic species, or their habitats in the Connecticut River watershed. As previously noted, all alternatives would facilitate the acquisition and protection of additional acres of refuge land beyond the current refuge acreage of 37,000 acres, ranging from about 60,000 additional acres (alternative A) to nearly 200,000 additional acres (alternative D). The additional proposed refuge acquisitions contain extensive stream and wetland habitats. We anticipate these additional refuge lands will increase the amount of permanently conserved habitat for reptile, amphibian, fish, and other aquatic species. The continued maintenance of existing refuge riverine and wetland habitats, and the potential to acquire and permanently protect more, will be of direct and long-term beneficial impacts to promoting fish and reptiles and amphibians over the short and long term. We will

take appropriate management action to help maintain and improve fish, reptiles, and amphibians (table 5.17).

Maintaining and protecting suitable riverine and wetland habitats (notable along the Connecticut River mainstem and major tributaries) will help to benefit reptiles, amphibians, fish, and other aquatic species. It will also help fulfill goals set by the Eastern Brook Trout Joint Venture. Because it is unlikely that acquisition of the full proposed level of refuge ownership will be reached within the 15-year lifetime of the CCP, we acknowledge that there are limits to both the adverse and beneficial impacts predicted in this analysis, and that over the short-term there is some reduction in variation among alternatives. Proposed management activities—forest management, prescribed burning, trail construction, snowmobile use, and fishing—may be allowed in one or more of the alternatives presented, but in all situations described above, we would expect all to be of negligible adverse impact to promoting fish, reptile and amphibian conservation.

Impacts to Other Native Plants and Invertebrates

Beyond the species already described above, a number of other native plant and invertebrate species occur on the proposed CFAs. Table 5.18 highlights some of these species, such as dragonflies, tiger beetles, and wetland plants, for each CFA. As noted in chapter 3, there is a serious concern about human influences that impact pollinators, especially wild pollinators such as the now very rare rusty-patched bumble bee.

Table 5.18. Native Plants and Invertebrate Species Associated with Proposed CFAs

CFA	LCC Habitat Type	Other Native Plants and Invertebrate Species Associated with Priority Refuge Resources of Concern
Maromas CT		
Pyquag CT*	Freshwater marsh	Davis' sedge, waputo arrowhead
Muddy Brook CT†	Open water/riverine	Riverine clubtail, skillet clubtail, cobra clubtail
Salmon River CT*		
Scantic River CT*	Freshwater Marsh	Davis' sedge, waputo arrowhead
Whalebone Cove CT*		
Farmington River CT/MA	Open water/riverine	Harpoon clubtail, riverine clubtail, rapids clubtail
Dead Branch MA*	Open water/riverine	Riffle snaketail
Fort River MA*	Open water/riverine	Harpoon clubtail, arrow clubtail, rapids clubtail
Mill River MA*	Open water/riverine	Puritan tiger beetle, brook snaketail, arrow clubtail
Westfield River MA*	Open water/riverine	Arrow clubtail, riffle snaketail
Sprague Brook NH/MA†	Open water/riverine	Arrow clubtail, rapids clubtail
Ashuelot NH		
Blueberry Swamp NH*		
Mascoma River NH		
Pondicherry NH*		
Nulhegan Basin VT*	Open water/riverine	Riffle snaketail, brook snaketail, Maine snaketail, zebra clubtail

CFA	LCC Habitat Type	Other Native Plants and Invertebrate Species Associated with Priority Refuge Resources of Concern
Ompompanoosuc VT	Open water/riverine	Riffle snaketail, brook snaketail, Maine snaketail, zebra clubtail
Ottauquechee River VT†	Open water/riverine	Riffle snaketail, brook snaketail, zebra clubtail
West River VT	Freshwater marsh	Greene's rush, clustered sedge, grass rush, arrowleaf tapering rush
	Open water/riverine	Cobblestone tiger beetle (priority refuge resources of concern), boulder-beach tiger beetle, riffle snaketail, brook snaketail, zebra clubtail
White River VT†	Open water/riverine	Riffle snaketail, brook snaketail, zebra clubtail
Quonatuck*	8,000 acres of tidal (salt, brackish, and fresh) wetlands, floodplain forest, and riparian areas within the Quonatuck CFA , running through the mainstem River, will be protected but specific LCC habitats cannot be determined at this time but will be selected using detailed criteria (Appendix C: Land Protection Plan).	

** CFA contains a SFA, part of alternative A*
† CFA not proposed under alternative B, only proposed under alternatives C and D

Note: See appendix B for a full description of how we identified priority refuge resources of concern species based on information from a variety of conservation plans. See appendix A on additional information on priority refuge resources of concern species and proposed management for each CFA.

We compared the benefits of the alternatives from actions that would enhance native fauna and flora including:

- Extent to which refuge land acquisition and habitat conservation under the alternatives would limit the growth of nearby land development activities and their impact to native fauna and flora.
- Habitat management and restoration activities designed to improve habitat structure and integrity for native fauna and flora (e.g., floodplain forests).
- Invasive plant control.
- Effective visitor interpretation.

The potential adverse impacts of refuge management actions within the alternatives that were evaluated included impacts from:

- Invasive plant control.
- Visitor use impacts on refuge lands, trails and roads (e.g., hiking, snowmobiles, introduction of invasive species, camping).

Impacts to Other Native Plants and Invertebrates That Would Not Vary by Alternative

None of the refuge activities proposed under the four alternatives would significantly benefit or adversely impact native plants and invertebrates in the Connecticut River watershed. We expect refuge land conservation and management under all alternatives will help maintain and even improve habitat for these species.

Under all alternatives, we anticipate that proposed additional refuge land acquisition will permanently protect habitat for and benefit these species. Over the long term, we expect alternatives C and D to have the greatest benefit because they propose the largest refuge expansions. However, in the short term (within 15 years), we would likely acquire similar amounts of land under all the

alternatives, thus beneficial impacts would be similar across all alternatives in the short term.

Many of the rare native plants and invertebrates rely heavily on two habitat types: freshwater marshes and open water/riverine habitats. Table 5.19 lists the amount of these habitat types proposed across the CFAs under alternatives B, C, and D. However, in the short term (within 15 years), we would likely acquire similar amounts of land under all the alternatives, thus beneficial impacts would be similar across all alternatives in the short term. Greater beneficial impacts to native plants and invertebrates would be expected to occur under alternatives C and D over the long term because they propose the greatest refuge expansion.

Table 5.19. Proposed Freshwater Marsh and Open Water Habitat Protection Under Alternatives B, C, and D

LCC Habitat	Alternative B	Alternative C	Alternative D
Freshwater Marsh	962 acres	2,054 acres	2,401 acres
Open Water/Riverine	2,155 acres	2,972 acres	3,783 acres

Across all alternatives, our management actions would not contribute to the permanent impairment of native rare plants and invertebrates. Regardless of which alternative is selected, we would continue to use best management practices in all management activities that might impact refuge wetlands, stream, and rivers. Few management activities would be conducted in or near these habitats. Open water/riverine habitat is used by tiger beetles and often invasive plants encroach upon their shoreline habitats. Invasive plant control would be taken across all alternatives to protect and enhance this habitat type.

As noted previously, we would reduce or eliminate invasive plant areas through partnerships at Cooperative Invasive Plant Management Areas (CISMAs) on and off refuge lands using mechanical and approved herbicidal treatment. Regardless of the alternatives selected, pesticides, most often herbicides, would be used under conditions of an Integrated Pest Management plan. Pesticides will only be used if it is the most effective management technique (e.g., extensive dense stands of Japanese knotweed), and will be combined with other management tools. Pesticides must be approved by the Regional Contaminants Specialist, who is responsible for upholding Federal standards for water quality and soil protection. Dragonflies also rely upon openwater/riverine habitat and can be adversely impacted by poor water quality (e.g., siltation, road salts run-off), shoreline habitat destruction, and even boat wakes (MassWildlife 2015).

Promoting native rare plants and invertebrates would include improvements to aquatic and immediately adjacent areas by removing dwellings and other small infrastructure on property acquired by the refuge in developed areas, and careful and appropriate management of roads near sensitive habitat areas. Forest management operations on the refuge are unlikely to adversely impact native rare plants and invertebrates because we would use best management practices during any forestry operations (e.g., buffers around wetlands and vernal pools).

Adverse impacts in freshwater marshes may occur if there were ever plans to construct stilted boardwalks or observation platforms is freshwater marshes for outdoor environmental education and interpretation. Currently there are no immediate plans for such types of construction. Any future proposals would need additional NEPA analysis. We would try to avoid placing trails in sensitive areas and would use best management practices to design the least impactful trails.

The Service regulates human uses of the refuge to appropriate and compatible uses (usually wildlife-dependent uses) and thus curtails anthropogenic impacts

that may impair aquatic and associated terrestrial habitats. All alternatives predict some increase in annual visitation over time (Table 5.5); however, the increase varies due to each alternative's respective refuge expansion level and impacts are expected to be negligibly adverse. Public use trails are placed and managed to avoid or minimize adverse impacts to the refuge's native fauna and flora. Construction of trails has been discussed previously (re: Impacts to Soils section) but none of this activity across all alternatives is expected to impact native rare plants and invertebrates except to a very negligible adverse level. Leashed pets are permitted on most refuge trails, yet they can have indirect adverse impacts on native plants and invertebrates due to their waste, which can cause negative adverse impacts to refuge water quality, and from trampling. are no known pet waste problems on any refuge division or unit, and future acquisitions will be carefully managed to authorize any pet walking so that their wastes are prevented from being introduced to refuge lands. Overall, these potential adverse impacts are considered negligible, both in the short term and long term, because we require owners to remove solid pet waste and pets must be leashed at all times on refuge lands.

Through the issuance of special use permits, all alternatives would promote monitoring and research on rare plants and invertebrates. The refuge recognizes that field monitoring and research may adversely impact these resources largely due to potential collections. The value of an improved knowledge base upon which management depends is appreciated by the refuge, and there is no indication that previous projects, nor similar ones authorized in the future, would have any more than a negligible adverse impact on these resources.

Impacts to Native Rare Plants and Invertebrates common to Alternatives B, C, and D

Nineteen of 65 SFAs would not be included within the CFAs. The refuge recognizes that these SFAs continue to hold valuable habitat, and in some cases, important habitat for native rare plants and vegetation. The adverse impact from not acquiring these acres should be offset by the greater amount of habitat to be acquired under the action alternatives.

Impacts to Native Rare Plants and Invertebrates under Alternative A

Beneficial Impacts. Alternative A would provide beneficial impacts to native rare plants and invertebrates because it would protect up to 97,830 acres across 65 widely separated SFAs. Table 5.18 provides a partial list of the rare plants and invertebrates that would benefit from land conservation under the proposed CFAs, many of which overlap with the SFAs proposed in the 1995 FEIS. Of the 65 SFAS, 46 occur within CFAs. Within these 46 SFAs, 22 contain rare plants, and some have a high diversity of rare plants: Colebrook Hill Farms (10 species) which is part of the Blueberry Swamp CFA and Mount Tom (30 species), which is part of the Mill River CFA. Most of the dragonfly species noted in Table 5.18 would also benefit under alternative A due to the number of riverine habitats included within the SFAs.

Adverse Impacts. Alternative A would include essentially no ground disturbing activities that might adversely impact rare plants and invertebrates species that rely upon open water/riverine and freshwater marsh habitat as these habitats generally need no land management manipulation. Control of invasive plants is one refuge activity that may adversely impact these habitat types if not properly implemented. As noted above, all precautions are taken to provide for minimal adverse impacts. Visitation under alternative A is not expected to impact native fauna and flora since their recreational activities (e.g., hiking, pet walking) do not enter freshwater marshes or open water/riverine habitats. Alternative A visitation levels would not appreciably change over current levels and are

expected to be lower than any of the other alternatives. Thus, visitor activities that might impact native fauna and flora would pose negligible adverse impacts over the short and long term.

Impacts to Other Native Plants and Invertebrates under Alternative B
Beneficial Impacts. Same as alternative A, because alternative B proposes to protect similar amounts of habitat.

Adverse Impacts. Similar to alternative A, except a slightly greater potential for adverse impacts from expanded habitat management activities (table 5.4) and from building additional hiking trails. However, as mentioned above, we would generally avoid these types of activities or use best management practices near wetland and open water habitats.

Impacts to Other Native Plants and Invertebrates under Alternative C
Beneficial Impacts. Similar to alternatives B and C, but we anticipate a slightly greater benefit to rare plants and invertebrates from protecting additional acres of habitats (table 5.18).

Adverse Impacts. Similar to alternative B, except a slightly greater potential for adverse impacts from expanded habitat management activities (table 5.4) and from building additional hiking trails. However, as mentioned above, we would generally avoid these types of activities or use best management practices near wetland and open water habitats.

Impacts to Other Native Plants and Invertebrates under Alternative D
Beneficial Impacts. Compared to the other alternatives, we predict the greatest benefits from native rare plants and invertebrates under alternative D because it proposes to protect the greatest amount of habitat (table 5.19).

Adverse Impacts. Compared to the other alternatives, we expect the fewest adverse impacts to rare plants and invertebrates under alternative D because we propose almost no active habitat management (except where necessary for threatened and endangered species).

Summary
In summary, our management activities across alternatives would not significantly adversely or beneficially impact the native rare plants and vegetation in the Connecticut River watershed. As previously noted, all alternatives would facilitate the acquisition and protection of additional acres of refuge land beyond the current refuge acreage of 37,000 acres, ranging from about 60,000 acres (alternative A) to nearly 200,000 acres (alternative D). With those potential additions of habitat to the refuge, in concert with currently protected lands (37,000 acres), we except benefits to fauna and flora. Maintaining and protecting these habitats will help to guarantee their beneficial habitat functions for these native species. Because it is unlikely that acquisition of the full proposed level of refuge ownership will be reached within the 15-year lifetime of the CCP, we acknowledge that there are limits to both the adverse and beneficial impacts predicted in this analysis, and that over the short-term there is some reduction in variation among alternatives. Proposed management activities–forest management, prescribed burning, trail construction, snowmobile use–may be allowed in one or more of the alternatives presented, but in all situations described above, we would expect all to be of negligible adverse impact on native plant or invertebrate conservation.

Archaeological, Historical, and Cultural Resources Impacts

Chapter 3–Affected Environment presents a description of historic and cultural resources in the surrounding refuge regional landscape and Connecticut River watershed. We evaluated and compared management actions that each

alternative proposes for their impacts, beneficial or adverse, on archaeological, historical, and cultural resources.

The following management activities are most likely to beneficially impact historic and cultural resources:

- Continued protection of valuable habitats, and potential for expanded acquisition of habitats, that prevents developments activities from exposing and damaging archaeological, historical, and cultural resources.
- Careful adherence to existing laws and policies designed to protect archaeological, historical, and cultural resources.

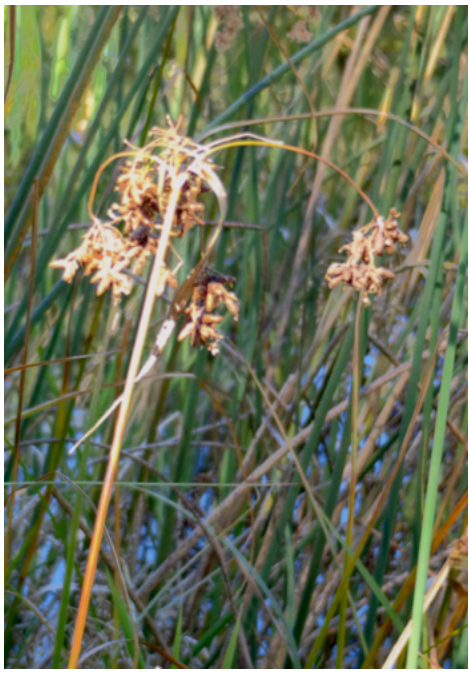
The following management activities are most likely to adversely impact historic and cultural resources:

- Habitat restoration activities involving excavation.
- Mechanized forest management activities.
- Improvements to existing buildings and trails.
- Demolition of existing/acquired structures.
- Building new infrastructure, to include: buildings, trails, trailhead parking lots, and signage installation.
- General public use.

Archaeological, Historical, and Other Cultural Resources Impacts that Would not Vary by Alternative

The refuge, through its Visitor Services efforts, ensures that significant cultural and historic resources are protected, experienced by visitors, and interpreted in accordance with authorizing legislation and policies. Activities outlined in each alternative, however, have some potential to adversely impact cultural resources, either by direct disturbance during a variety of habitat projects (e.g., logging), minor construction (e.g., interpretative sign installation), public use activities (e.g., hiking), and administration and operations activities (e.g., building and road construction and demolition). These actions may directly or indirectly expose cultural and historic artifacts. The presence of cultural resources including historic properties would not prevent a Federal undertaking or project, but any undertaking would be subject to Section 106 of the National Historic Preservation Act and other Federal laws protecting cultural resources. Potential adverse impacts to cultural resources would be identified, and options for minimizing adverse impacts would be discussed before any implementation of a refuge action.

Refuge staff would provide the Regional Office archaeologist a formal description and location of all projects, activities, routine maintenance, and operations that could disturb the ground or structures, details on requests for appropriate and compatible uses, and the options being considered. The archaeologist would analyze these undertakings for their potential to affect historic properties and enter into consultation with the State Historic Preservation Officer and other parties as appropriate. As necessary, the refuge would notify the public and local government officials. The Service would protect all known gravesites. Any collection of materials for tribal ceremonial purposes would be conducted under a special use permit.



USFWS

Northeastern bulrush

Under all alternatives, we would continue to identify areas with a high or moderate likelihood of having cultural resources, and actions could be taken to avoid or minimize adverse impacts on cultural resources. Visitors who are interested in the refuge's historical past would benefit from an increased emphasis on interpretation of the refuge's archaeological, historical, and cultural resources and the efforts to preserve its rich past.

Archaeological, Historical, and Other Cultural Resources Impacts of Alternatives A, B and C Compared to Alternative D

As discussed in prior sections, alternatives A, B, and C propose activities that would disturb land (e.g., forest management , kiosk construction, and trail construction). These activities would be employed over a wide landscape and are expected to have a negligible adverse impact to archaeological, historical, and cultural resources, especially given the required consultation review that is performed prior to work (as noted above). In contrast to the other three alternatives, alternative D proposes a passive management approach that would undertake very few land disturbance activities, other than minor work during establishment of trails, minor habitat management, and occasional maintenance. Because of this, we expect alternative D to have the least impact to cultural resources over the short and long term.

Summary

The Service would continue to follow all cultural resources laws for any project work on the refuge. Under alternatives B, C, and D, the Service would increase protection efforts largely through better planning, habitat assessments and related field survey work. These efforts would result in negligible to minor benefits to cultural resources.

Impacts to Public Use and Access

Each visitor's experiences on the refuge can be positively or adversely affected by the types of opportunities available, the refuge's setting, and other user groups (Manfredo 2008). The National Wildlife Improvement Act and Service policy emphasizes the need to provide for quality opportunities when providing for wildlife-dependent recreational activities. Wildlife-dependent recreation programs are evaluated based on the goal of providing for quality programs with the following elements: (1) safety and compliance with applicable laws; (2) minimized conflicts with wildlife and habitat goals and public uses; (3) accessibility for all; (4) resource stewardship, and (5) reliable and reasonable opportunities to experience wildlife (605 FW 1, *http://www.fws.gov/policy/605fw1.html;* accessed August 2016). This section addresses the priority public uses and the activities and facilities that support those uses and how visitors would be affected by the actions in chapter 3.

The following management activities are most likely to beneficially impact public use:

- Continued protection of valuable habitats, and potential for expanded acquisition of habitats, that will offer new and expanded wildlife-dependent recreational opportunities.
- Continuing to allow or expanding the existing range of public uses on properties acquired.
- Building new trails, trail heads, and parking lots.
- Improvements and/or new construction to visitor infrastructure.
- Increased distribution of refuge information.

- Increased partnerships with local, regional, and state recreational interests.
- Increased outreach and Service visibility to promote fish and wildlife stewardship.

The following management activities are most likely to adversely impact public use:

- Refuge acquisition may result in the elimination of non-wildlife dependent, non-priority activities that are presently allowed by the current owner (e.g., off-road vehicles).
- Increased conflict between user groups as visitation increases.
- Confusion over ownership boundaries and which rules apply.
- Short-term trail closures from forest management operations and other refuge management activities.

Many of the existing refuge divisions are currently open to the six priority wildlife-dependent public uses for the Refuge System: hunting, fishing, wildlife observation and photography, environmental education and interpretation. Divisions open to all six of these uses are: Nulhegan Basin, Pondicherry, Fort River, Mill River, Salmon River, Blueberry Swamp, and Dead Branch Divisions. In addition, wildlife observation and photography, environmental education and interpretation can be enjoyed at Third Island (Aug 1 thru Dec 31), Mt Toby, and Honey Pot Wetlands, all located in Massachusetts although these sites also have no improvements. Certain Units are closed for specific purposes: Wissatinnewag (presence of archaeological resources), Deadman's Swamp (presence of Puritan tiger beetle — federally threatened), and Mt Tom (presence near refuge land of unsafe buildings owned by Holyoke Boys and Girls Club needing repair). Two Units — Westfield River and Peterson — have no existing wildlife-dependent recreational public uses that have been determined to be compatible; consequently, no public uses are as yet authorized but may be in the future. Other popular activities allowed on the refuge include hiking, snowmobiling on designated trails, and cross-country skiing. Some regionally popular activities are currently not allowed on the refuge. These include: sled dog mushing, geocaching, ski-joring, biking in certain designated areas, and ATV or other motorized ORV use.

Table 5.2 provides a summary of projected annual visitation by the major activities allowed for each alternative. We evaluated the beneficial and adverse impacts of the following management actions with the potential to affect the level of opportunity or visitor experience.

Public Use Impacts That Would Not Vary by Alternative.
Under all alternatives, we would continue to offer the existing hunt programs at the following refuge divisions and units Nulhegan Basin, Blueberry Swamp, Pondicherry, Dead Branch, Westfield River, Fort River, Mill River, and Salmon River Divisions and the Putney Mountain, Third Island, Mount Toby, and Honeypot Wetlands Units. These hunts are generally consistent with state regulations, however some refuge-specific regulations do apply to protect sensitive resources and to ensure public safety. Under all alternatives, we would evaluate opening new refuge lands to hunting where compatible and a huntable area exists.

By continuing to allow hunting, we would continue to provide an opportunity for people to engage in a wildlife-dependent recreational use on refuges. Public

hunting is a popular activity in portions of the watershed and allowing this use will benefit individuals interested in engaging in public hunting on refuge lands.

However, hunting can also lead to adverse conflicts among user groups. For example, the noise from shotguns may disturb some non-hunters experience on the refuge. Other individuals do not support hunting for a variety of reasons, such as concerns over public safety, animal welfare, and impacts on nontarget wildlife. For these individuals, continuing to offer refuge hunting programs may negatively impact their experience of the refuge. Although, there are some safety concerns with any hunting program, state, Federal, and refuge-specific regulations help ensure public safety, such as no-hunting buffers around occupied buildings and in several other high-traffic locations on the refuge. Also, at the Pondicherry Division (NH) and all areas of Massachusetts and Connecticut, hunters are required to wear blaze orange safety hunting apparel. Conversely, hunters in stands anticipating game species might be adversely impacted by trail users (and vice versa). Overall, under all alternatives, we expect impacts among users to be negligible to minor due to the current and anticipated low levels of hunting.

The refuge will evaluate ADA needs to accommodate hunters with disabilities regardless of alternative. Special use permits will continue to be made available, as appropriate, for a number of potential activities such as those authorizing commercial hunt outfitters at the Nulhegan Basin Division. The Nulhegan Basin Division is located in an area of Vermont that is particularly noteworthy for large white-tailed deer, high moose densities, 45 percent of the State black bear harvest, and some of the best ruffed grouse and American woodcock hunting. Snowshoe hare and coyote also support abundant hunting opportunities in this remote setting. With an abundance of game, and fewer roads and development than other areas, the 'Northeast Kingdom' of Vermont, where the Nulhegan Basin Division is located, offers some of the best hunting opportunities in Vermont.

The refuge will maintain its 20 miles of trails located at the Nulhegan Basin, Pondicherry, Blueberry Swamp, and Fort River Divisions, and also maintain its current 40 miles of public roads. Trails and roads are the principal means by which the refuge promotes wildlife observation and photography, and interpretation and environmental education. Currently there are 6 miles of hiking trails that also serve to facilitate bird-watching, photography, and winter cross-country skiing. Other continued uses will include berry picking, camping, pet-walking, and non-motorized boating.

Dogwalking would continue to be allowed under all alternatives. Visitors walking dogs on the refuge may have adverse impacts of other users (e.g., photographers), sometimes through aggressive pet behavior or simple distraction from the wildlife experience. To minimize these impacts, we require all pets to be leashed.

Environmental education field walks are common and will be encouraged at most Divisions and Units unless there are strict closures in place (e.g., Deadman's Swamp, Mt. Tom). Large "in-field" educational interpretive walks with young children may adversely impact individuals seeking quiet and solitude, or a chance to take that special photograph.

There may also be times when public use is adversely impacted by standard refuge management activities such as habitat management, commercial haying, and restricted research areas. We do not expect these impacts to be greater than negligible because these activities only occur on a very small percentage of refuge lands and occur seasonally or for short periods of time.

Public Use Impacts of Alternative A
Beneficial Impacts. The public use benefits are the same as those described under "Public Use Impacts That Would Not Vary by Alternative," except under alternative A we would continue to allow snowmobiling on designated trails on the Nulhegan Basin, Pondicherry, and Dead Branch Divisions. Continuing to allow snowmobiling at these divisions would benefit visitors that participate in this activity on refuge lands, including those engaged in priority wildlife-dependent recreational uses.

Adverse Impacts. The adverse public use impacts are the same as those described under "Public Use Impacts That Would Not Vary by Alternative," except under alternative A there would be the potential for conflicts between snowmobilers and other users (e.g., snowshoers and cross-country skiiers). Under alternative A, we would contine to not allow other uses on snowmobile trails. This could negeatively impact visitors who snowshoe or cross-country ski by preventing them from accessing these trails and by creating noise which could impact their experience on the refuge. However, we expect these impacts to be minor as there are other trails available for these users. Separating snowmobiles and other users may lessen the likelihood for direct conflicts among different user groups (e.g., visitor safety concerns).

Public Use Impacts of Alternative B
Beneficial Impacts. The benefits of alternative B are similar to those discussed for alternative A, except for the following.

Although some fishing likely occurs on existing refuge lands, we propose to officially open existing refuge lands to public fishing, consistent with state regulations, under alternatives B, C, D. This will require developing a fishing plan and compatibility determinations, as well as completing other administrative requirements. We would only open fishing in places where it is found feasible and compatible. Under all alternatives, we would evaluate opening new refuge lands to fishing where compatible and a fishable area exists. By allowing hunting, we would continue to provide an opportunity for people to engage in a wildlife-dependent recreational use on refuges. Public hunting is a popular activity in portions of the watershed and allowing this use will benefit individuals interested in engaging in public hunting on refuge lands.

Under alternative B, we also propose to establish new hiking trails at the 19 proposed CFAs, where feasible, compatible, and it would create desirable wildlife-dependent recreational opportunities. Whenever feasible, we would try to develop these trails to be ADA-compliant. The trails would be designed to provide high-quality opportunities for wildlife observation, photography, environmental education, and interpretation. The proposed trails would range from a half-mile to one mile in length and will displace up to 38 acres of habitat (2 acres per mile). These trails would provide opportunities for individuals with disabilities and other user groups that require or prefer developed, gradually graded trails, such as families with children in strollers, other limited mobility. This type of recreational experience is still rare in the watershed and these trails could fill an important gap in serving these groups.

We would also seek to enhance our existing environmental education and interpretive programs by working with partners throughout the watershed. We anticipate a minor increase in the quality and quantity of environmental education and interpretive materials and programs on the refuge.

Adverse Impacts. In addition to the impacts described under alternative A, there is slight increase in the likelihood of conflicts between user groups under

alternative B. For example, constructing 19 miles of new trails may increase the amount of trail use and therefore, conflicts between trail users. These potential adverse conflicts may be more prevalent in more urban CFAs only because we would expect higher visitation and an overall greater density of visitors on relatively smaller units. However, overall we expect conflicts would be negligible to minor because of the proposed level of use and stipulations on use (e.g., pets must be leashed). There is also the potential for greater conflicts between snowmobilers and other users at the Nulhegan Basin Division under alternative B because we would propose to open the existing designated snowmobile trails to multiple uses, such as cross-country skiers and snowshoers. As we open these trails up to these uses, we will monitor and address any conflicts or other issues that arise.

Public Use Impacts of Alternative C
Beneficial Impacts. The same as alternative B, except we propose to construct up to 22 new trails under alternative B. We expect a slightly greater benefit from providing approximately 3 additional trail opportunities.

Adverse Impacts. The same as alternative B, except we propose to construct up to 22 new trails on the proposed CFAs. We expect a slightly greater chance of user conflicts compared to alternative, but still expect this impact to be negligible.

Public Use Impacts of Alternative D
Beneficial Impacts. Similar to alternatives B and C, except that the 22 new trails proposed under alternative D would be less developed (e.g., narrower, native surface) and benefit user groups that prefer a more "back-country" experience. Also, we expect overall less visitation under alternative D and therefore expect fewer conflicts between user groups.

Adverse Impacts. Alternative D proposes to eliminate snowmobiling on the refuge, which would negatively impact a larger user group, particularly at the Nulhegan Basin Division. However, prohibiting snowmobiling may benefit other user groups by reducing conflicts between snowmobiles and snowshoers and skiiers and other user groups that are disturbed by snowmobiles.

Cumulative Impacts

As noted early in this chapter, according to the CEQ regulations on implementing NEPA (40 CFR 1508.7), "cumulative impacts" result from adding the incremental impacts of the proposed action to the impacts of other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. This cumulative impacts assessment includes other agencies' or organizations' actions if they are inter-related and influence the same environment. Thus, this analysis considers the interaction of activities at the refuge with other actions occurring over a larger spatial and temporal frame of reference.

Air Quality: Although any form of anthropogenic pollutant emission contributes to overall cumulative impacts to some extent, we believe none of the alternatives are expected to have significant incremental contributions to cumulative adverse impacts on air quality locally or watershed-wide, and almost certainly be of negligible adverse impact. None of the proposed refuge actions would have a significant cumulative impact on the three Class I Airsheds located within the Connecticut River watershed: Great Gulf Wilderness (5,552 acres) and Presidential Range-Dry River Wilderness (20,000 acres) designated within the White Mountain National Forest (New Hampshire) and the Lye Brook Wilderness (12,430 acres) designated within the Green Mountain National Forest (Vermont).

Some short-term, local, and immediate deterioration in air quality would be expected from air emissions of motor vehicles, heavy equipment, prescribed burning, and snowmobiles. These incremental sources of emissions potentially do contribute to a degradation of air quality of the local and regional environment, but such contributions are extremely minor and of very short duration. Visitors would access the refuge primarily by automobile and snowmobile, but there is no expectation for marked visitor increases over the short term or long term (table 5.2). Additionally, visitor use due to 'on-refuge' visits (e.g., hiking, hunting, bird watching) are considerably less than visits that are indirectly associated with the refuge and its land base (table 5.2). Much of visitor-associated air emissions would result from private vehicles destined to visit the "off-refuge" environmental education centers and events: Great Falls Discovery Center, MA; Montshire Museum of Science, Vermont, Wildlife on Wheels (mobile unit throughout the watershed), and the Conte Corners at Cabela's in Connecticut and at the Springfield Science Museum in Massachusetts. A fair amount of this vehicular use is in conjunction with other destination activities or purposes that the visitors have. Thus, the refuge associated visits to these centers and exhibits tend to be coupled, or sometimes secondary purpose, to trips. The refuge land generally is not expected to be a New England recreation destination where visitors are drawn from distant places. Most visitors would already be in the area or would be passing through the area on vacation and would seek out the refuge for a day trip. The "off-refuge" visits, however, may draw individuals from regionally distant areas such as Cabela's in Hartford, Connecticut. All snowmobile trails on the refuge would essentially be through trails only; we would not provide parking, warming huts, or other infrastructure on refuge lands. Therefore, the presence of the refuge alone would only account for a small percentage of vehicle emissions generated in the watershed.

Projected land/habitat acquisitions, and limited restoration, of native upland forest, shrublands, and wetland vegetation should generate beneficial impacts to air quality locally. All alternatives would facilitate continued and increased land protection ability, with alternative C and D facilitation more than twice the current ability of the refuge to protect valuable habitats. These beneficial habitat impacts will derive from the refuge's capacity to continue to filter out many air pollutants harmful to humans, wildlife, and the environment. We will also strive to reduce energy consumption with green infrastructure and products associated with refuge activities.

In addition, with the new Service goal of achieving carbon neutrality by 2020, the refuge will be undertaking aggressive efforts to reduce the energy use and carbon footprint of our buildings, facilities, vehicle fleet, and workforce to the maximum extent possible. We will also be exploring ways to offset our residual carbon footprint by increasing carbon sequestration through our habitat management activities, including some limited riparian, floodplain, and old field afforestation projects. Integrating carbon sequestration awareness into conservation actions for wildlife and other habitat management activities will also have cumulative beneficial impacts for the air quality and humans within the local environment.

With our partners, we would continue to contribute to improving air quality through cooperative land conservation and management of natural vegetation and wetlands. Protecting valuable fish and wildlife habitat from development and maintaining it in natural upland vegetation or wetlands, assures these areas would continue to filter out many air pollutants that, incrementally, may be harmful to humans and the environment.

Hydrology and Water Quality: There would be no significant adverse cumulative impacts to hydrology or water quality under any of the alternatives. BMPs and erosion and sediment control measures would be used on building, road, trail, and other recreation infrastructure construction sites to ensure impacts are minimized. Strict adherence to PUPs would also minimize impacts from use of those chemicals. These projects are few in number and located widely dispersed throughout the refuge so their local effects would not be additive. There would be cumulative benefits to hydrology and water quality from restoration of unnecessary buildings and structures (e.g. removing impermeable surfaces), other disturbed sites, and unused roads and trails on acquired lands. There would also be cumulative benefits from more intensive efforts to restore natural hydrology through such measures as culvert removal, upgrading, or resizing, which will be facilitated by all alternatives.

All alternatives will facilitate meaningful levels of land/habitat acquisition, potentially increasing the size of the refuge from the current 37,000 acres to 231,307 over time. All alternatives call for some active management (e.g., habitat management, invasive plant control), although alternative D is largely designed for passive management (re: chapter 4). In each instance, the attention to habitat protection, active management of approximately 60 to 500 acres annually, and (in alternative D) passive ecosystem development, may result in improved water quality, water chemistry, , reduced sediment inputs, and possible mitigation of contaminated run-off. Over time, it is thought those actions would improve the ability of refuge upland and wetland systems to process nutrients and store carbon and contribute to other state watershed regulation standards and initiatives that are designed to maintain and improve water quality in the Connecticut River watershed.

Refuge management will introduce herbicides into wetlands and streams, albeit in limited quantities and only when treating invasive plant populations. It is assumed that these limited management efforts will not contribute to larger local or regional discharges. Based on the relatively short half-life and the limited acreage treated (currently about 60 acres annually it is not expected that any discernible effects would occur to these water resources as a result of herbicide treatments.

Management actions will be adaptive, in an effort to respond to a changing climate. Protecting, managing, and restoring the defined LCC upland and wetland habitats in our defined CFAs will improve the health of refuge watercourses and aquatic resources. In slightly varying degrees, all the alternatives emphasize maintaining the biological integrity, diversity, and environmental health of lands within the refuge boundaries, which strengthens the ecological integrity of the watershed. It is our hope that actions taken to ensure the long-term health of freshwater wetlands and forested habitats, preserve and enhance rare native plant and animal communities, and conserve state and federally listed species, will serve as a model for conservation planning.

When the conservation actions on the refuge are combined with actions by state wildlife managers, non-profit organizations, private landowners, local communities, and the new Connecticut River National Blueway coalition, considerable progress in mitigating the urbanization and development changes that directly impact water quality and habitat productivity within the Connecticut River watershed will be realized.

Soils: There is the potential for cumulative beneficial impacts to soils under all alternatives due to the permanent protection of existing and future refuge lands. With the cessation of development or, in select situations, till agriculture,

watershed soils managed by the refuge should improve in natural fertility and productivity. We anticipate greater long-term cumulative impacts to soils with alternatives C and D since we propose expanded land/habitat protection under these two alternatives. All alternatives would employ best management practices to minimize impacts to soils.

Adverse cumulative impacts to refuge soils potentially are from timber management, hiking, road repair, and minor construction activities (e.g., conventional ADA trail construction and parking lots), activities described in previous sections. We would improve watershed soil conditions and minimize site-level soil impacts through acquisition and protection of new habitat areas in SFAs (alternative A) or proposed CFAs (alternatives B, C, D) that may currently be degraded but retain land and soil structural features indicative of having excellent potential for restoration. Restoration typically would involve soil stabilization through appropriate re-vegetation plantings often in combination with site grading.

We will minimize any potential for adverse cumulative impacts by continuing to use best management practices when improving forest stands, maintaining or setting back succession in native grassland and shrubland habitats, mowing, brush-hogging, or prescribed burning to ensure cumulative beneficial impacts for soils. Under all alternatives, we expect to reclaim problem areas dominated by invasive species and restore them to native plant communities, which should improve nutrient recycling, restore native soil biota and soil fertility, and return soils to natural productivity regimes.

We expect beneficial cumulative effects from increasing carbon sequestration by managing and protecting native vegetation and soils. Biological CO_2 sequestration can be enhanced in managing natural habitats that increase the natural absorption of atmospheric carbon in soils. The carbon storage potential of soils that support differing vegetation communities has been estimated by the Congressional Budget Office (2007). The long-term storage potential of soil and vegetation is limited by characteristics such as location, climate, soil type, and plant species. On land used for crops in the continental United States, the equilibrium level of carbon in an acre of soil varies from the equivalent of 56 metric tons of CO_2 to 120 metric tons, averaging about 80 metric tons (CBO, 2007). Pasture, rangeland, and agricultural land that is reserved for conservation purposes store carbon at higher equilibrium levels: those levels range from 73 to 159 metric tons per acre and average 113 metric tons. Mature, never-harvested forests have even higher equilibrium levels per acre, varying from 286 to 1,179 metric tons of $CO_2$and averaging 465 metric tons (Birdsey 1992). In contrast, the average stand of timber harvested on a 30-year rotation holds the equivalent of 203 metric tons of CO_2 per acre at the beginning of the rotation (that is, at the start of its regrowth) and 256 metric tons at the end of the rotation (Lubowski et al. 2006). The long-term cumulative potential is limited to how the land is used and managed, and the refuge would maintain and, where possible, enhance the ability of refuge habitats to sequester carbon.

As with many areas nationwide, the greatest cumulative impacts on soils and those of the Connecticut River valley are from land development. Non-Federal forest land is the dominant land type being developed. Combined, forest land and cultivated cropland have made up more than 60 percent of the total acreage developed since 1982, yet since then and through 1997, erosion on cropland and USDA Conservation Reserve Program land has been reduced by 38 percent. Among all farm production regions, combined water and wind erosion in 2007 was lowest in the Northeast (USDA 2007). Potential land and habitat protections afforded by all alternatives are expected to beneficially impacts overall soil conservation in the Connecticut River watershed.

Climate Change: Department of the Interior Secretarial Order 3226 states that "there is a consensus in the international community that global climate change is occurring and that it should be addressed in governmental decision making. This order ensures that climate change impacts are taken into account in connection with Departmental planning and decision making." Additionally, it calls for the incorporation of climate change considerations into long-term planning documents, such as a CCP.

The Wildlife Society published an informative technical review report in 2004 titled Global Climate Change and Wildlife in North America (Inkley et al. 2004). It interprets results and details from publications such as the Intergovernmental Panel on Climate Change reports (1996 to 2002) and describes the potential impacts and implications on wildlife and habitats. It mentions that projecting the impacts of climate change is complex because it is important to predict changing precipitation and temperature patterns, their rate of change, and the exacerbated effects of other stressors on the ecosystems. Those stressors include loss of wildlife habitat to urban sprawl and other developed land uses, pollution, ozone depletion, exotic species, disease, and other factors. Projections over the next 100 years indicate major impacts such as extensive warming in most areas, changing patterns of precipitation, and significant acceleration of sea level rise. According to the Wildlife Society report, "…other likely components of ongoing climate change include changes in season lengths, decreasing range of nighttime versus daytime temperatures, declining snowpack, and increasing frequency and intensity of severe weather events" (Inkley et al. 2004). The Wildlife Society report details known and possible influences on habitat and wildlife, including changes in primary productivity, changes in plant chemical and nutrient composition, changes in seasonality, sea level rise, snow, permafrost, and sea ice decline, increased invasive species, pests and pathogens, and impacts on major vertebrate groups.

The effects of climate change on populations and range distributions of wildlife are expected to be species specific and highly variable, with negative and positive effects. Generally, the prediction in North America is that the ranges of habitats and wildlife will generally move upwards in elevation and northward as temperatures rise. Species with small or isolated populations and low genetic variability will be least likely to withstand impacts of climate change. Species with broader habitat ranges, wider niches, and greater genetic diversity should fare better or may even benefit. This will vary depending on specific local conditions, changing precipitation patterns, and the particular response of individual species to the different components of climate change (Inkley et al. 2004). The report notes that developing precise predictions for local areas is not possible due to the scale and accuracy of current climate models, which is further confounded by the lack of information concerning species-level responses to ecosystem changes, their interactions with other species, and the impacts from other stressors in the environment. In other words, only imprecise generalizations can be made about the implications of our refuge management on regional climate change.

Our evaluation of the proposed action concludes that the activities that may contribute negligibly, but incrementally, to stressors regionally affecting climate change: our prescribed burning program, our use of vehicles and equipment to administer the refuge, and visitor use of motorized vehicles. We discuss the direct and indirect impacts of those activities elsewhere in this chapter. We also discuss measures to minimize the impacts of both. For example, with regard to prescribed burning, we follow detailed burn plans operating only under conditions that minimize air quality concerns. In addition, many climate change experts advocate prescribed burning to manage the risk of catastrophic fires (Inkley et al. 2004). Federal mandates require all Federal agencies to reduce petroleum fuel use by two percent annually based upon 2005 fuel use, having a

goal of reducing petroleum fuel use by 30 percent. More than any other factor, this mandate will drive fleet management practices through 2020, and the refuge will attempt to replace older, inefficient vehicles, with more fuel efficient models. With regard to our equipment and facilities, we are trying to reduce our carbon footprint wherever possible by using alternative energy sources and energy-saving appliances, and using recycled or recyclable materials, along with reduced travel and other conservation measures.

In our professional judgment, the majority of management actions we propose would not exacerbate climate change in the region or project area, and some might incrementally prevent or slow local impacts. We discuss our actions relative to the 18 recommendations in The Wildlife Society (TWS) report to assist land and resource managers in meeting the challenges of climate change when working to conserve wildlife resources (Inkley et al. 2004). We make specific reference below to where the TWS recommendations are addressed by the goals of the Service's *Rising to the Urgent Challenge*.

- ***Recommendation #1—*** Recognize global climate change as a factor in wildlife conservation: This recommendation relates to land managers and planners becoming better informed about the consequences of climate change and the variability in the resources they work with. The Service and Refuge System are addressing this factor in three complimentary plans:

- Rising to the Urgent Challenge

- National Fish, Wildlife and Plants Climate Adaptation Strategy

- Planning for Climate Change on the National Wildlife Refuge System (draft).

The Service is taking a major role among Federal agencies in distributing and interpreting information on climate change. *Rising to the Urgent Challenge* is the FWS strategic plan for responding to climate change, and much of what is recommended by The Wildlife Society (TWS) in its technical report (Inkley et al. 2004) noted above is covered by the Service's *Rising to the Urgent Challenge*. The key principles of this plan are setting priorities in the context of climate change, vigorous partnership and interdependence with others, use of the best available science, landscape-level conservation, using state-of-the-art technology, and taking a global approach in addressing climate change (USFWS 2010). These principles are woven through three strategic themes: adaptation, mitigation, and engagement, and eight goals are allocated among these themes as follows:

Adaptation
Goal 1: We will work with partners to develop and implement a National Fish and Wildlife Climate Adaptation Strategy.

Goal 2: We will develop long-term capacity for biological planning and conservation design and apply it to drive conservation at broad, landscape scales.

Goal 3: We will deliver landscape conservation actions that support climate change adaptations by fish and wildlife of ecological and societal significance.

Goal 4: We will develop monitoring and research partnerships that make available complete and objective information to plan, deliver, evaluate, and improve actions that facilitate fish and wildlife adaptation to accelerating climate change.

Mitigation
Goal 5: We will change our business practices to achieve carbon neutrality by the Year 2020.

Goal 6: To conserve and restore fish and wildlife habitats at landscape scales while simultaneously sequestering atmospheric greenhouse gases, we will build our capacity to understand, apply, and share biological carbon sequestration science; and we will work with partners to implement carbon sequestration projects in strategic locations.

Engagement
Goal 7: We will engage FWS employees; our local, state, Tribal, national, and international partners in the public and private sectors; our key constituencies and stakeholders; and everyday citizens in a new era of collaborative conservation in which, together, we seek solutions to the impacts of climate change and other 21st century stressors of fish and wildlife.

In 2009, Congress directed the Secretary of the Interior "to develop a national strategy to assist fish, wildlife, plants, and associated ecological processes in becoming more resilient, adapting to, and surviving the impacts of climate change" (U.S. House of Representatives 2010:77). Working closely with the Council on Environmental Quality, FWS (representing DOI) assembled Federal, state, and Tribal partners, and with input from numerous scholars the *National Fish, Wildlife and Plants Climate Adaptation Strategy* was developed. The collection of participants was called the "NFWPCAS Partnership." The national strategy was reviewed by the public and published (NFWPCAS Partnership 2012). The seven goals of the NFWPCAS, very similar to the Service's *Rising to the Urgent Challenge* goals, are to "to inspire and enable natural resource professionals and other decision makers to take action to conserve the nation's fish, wildlife, plants, and ecosystem functions, as well as the human uses and values these natural systems provide, in a changing climate" (NFWPCAS Partnership 2012:16). And last, the Service's Northeast Region co-hosted a workshop in June 2008 titled Climate Change in the Northeast: Preparing for the Future. The goal of the workshop was "to develop a common understanding of natural and cultural resource issues and to explore management approaches related to climate change in the Northeast." Its primary target audience was land managers. Experts in climate change gave presentations and facilitated discussion. The stated outcomes were to have participants more fully understand the present and anticipated impacts from climate change on forested, ocean and coastal ecosystems, and to be able to identify effective management approaches that include collaboration with other local, state and Federal agencies. All of the Northeast Region refuge supervisors and planners attended, as did more than 20 refuge field staff. In addition, in response to Executive Order 134*22*, Strengthening Federal Environmental, Energy, and Transportation Management, and the Service goal of becoming a carbon neutral agency, the Service and refuge will assess its energy use and opportunities for investments to boost energy efficiency and implement renewable energy sources, on-refuge and in most of the Service's locations. Energy audits will help us identify needed actions and performance measurements such as return on investment, reduced O&M costs, and reduced energy intensity.

USFWS

YCC crew at work at North Branch Trail, Nulhegan Basin Division

Conserving the Future is a broad vision document of the Refuge System. *Planning for Climate Change on the National Wildlife Refuge System* is a *Conserving the Future* deliverable, and is designed to help refuge planners and managers to incorporate the themes of the various mandates in a philosophically coherent manner while providing practical guidance for incorporating climate change into planning documents. At the same time, Refuge System planning documents must function within the already existing cycle of strategic habitat conservation (SHC) (FWS 2008). The basic SHC components are planning, implementation, and evaluation, which is discussed in Chapter 1—Purpose and Need for Action.

- ***Recommendation #2***—Manage for diverse conditions (re: FWS Goal 3): This recommendation relates to developing sound wildlife management strategies under current conditions, anticipating unusual and variable weather conditions, such as warming, droughts, and flooding. Our proposed habitat management actions described in chapter 3 promote healthy, functioning forested uplands and wetlands, non-forested uplands and wetlands, inland aquatic habitats, coastal non-forested uplands, and coastal wetlands and aquatic habitats. Protecting the integrity of wetlands and managing for fully functioning riparian areas is also a priority. We have identified monitoring elements, which will be fully developed in the inventory and monitoring step-down plan, to evaluate whether we are meeting our objectives and to assess changing conditions. We will implement an adaptive management approach as new information becomes available.

- ***Recommendation #3***—Do not rely solely on historical weather and species data for future projections without taking into account climate change (re: FWS Goals 4 and 6). This recommendation relates to the point that historical climate, habitat and wildlife conditions are less reliable predictors of climate changes. For example, there may be a need to adjust breeding bird survey dates if migratory birds are returning earlier to breed than occurred historically. A 3-week difference in timing has already been documented by some bird researchers. We are aware of these implications and plan to build these considerations into our inventory and monitoring plan, habitat management plans, and annual habitat work plans so that we can make adjustments accordingly. Our results and reports, and those of other researchers on the refuge, will be shared within the conservation community.

- ***Recommendation #4***—Expect surprises, including extreme events (re: FWS Goals 2, 4, and 6). This recommendation relates to remaining flexible in management capability and administrative processes to deal with ecological surprises such as floods or pest outbreaks. Refuge managers have flexibility within their operations funds to deal with emergencies. Other regional operations funds would also be redirected as needed to deal with an emergency.

- ***Recommendation #5***—Reduce non-climate stressors on the ecosystem (re: FWS Goal 3). This recommendation relates to reducing human influences that adversely affect resilience of habitats and species (e.g., invasive species, contaminants, diseases). The objectives of our habitat management program are to maintain and enhance the biological integrity, diversity, and health of refuge lands. Objectives to enhance upland, wetland, and riverine habitats (interior and coastal) for watershed protection, to establish 25,000 acre habitat blocks with partners, and to establish healthy, diverse native forests in large tracts (greater than 500 acres) will help offset the local impacts of climate change.

- ***Recommendation #6—*** Maintain healthy, connected, genetically diverse populations (re: FWS Goal 3). This recommendation relates to the fact that small isolated populations are more prone to extirpations than larger, healthy, more widespread populations. Large tracts of protected land facilitate more robust populations and can offer better habitat quality in core areas. We will continue to work with our many conservation partners at the state and regional levels to support and complement restoration and protection efforts.

- ***Recommendation #7:—*** Translocate individuals (re: FWS Goal 4). This recommendation suggests that it may sometimes be necessary to physically move wildlife from one area to another to maintain species viability, or even transplant captive-raised individuals. However, it is recognized that this is an extreme conservation strategy, one currently not needed within this CCP's 15 year horizon. Our action alternatives (alternatives B, C, and D) are designed to protect and manage habitats in a manner that facilitates species adaptation to climate change. An example has been the limited or short-term success in translocating Puritan tiger beetles, achieved using larval beetles in both New England and the Chesapeake Bay area. To date, the attempted translocations of Puritan tiger beetles have not led to a secure beetle populations, likely a result several factors. Successful propagation of Puritan tiger beetles has been developed through research at the University of Massachusetts and Randolph Macon College. Translocation of propagated Puritan tiger beetle larvae has been attempted at cliffs along the Chesapeake Bay, but was not successful. Nonetheless, the Service believes that additional efforts, using existing and new techniques, should be pursued in appropriate habitats to support the recovery of these species, and the refuge will participate in this effort if called upon (*http://www.fws.gov/chesapeakebay/EndSppWeb/BEETLE/TigerBeetle.html*; accessed August 2016).

- ***Recommendation #8—*** Protect coastal wetlands and accommodate sea level rise (re: FWS Goal 3): This recommendation relates to actions that could ameliorate wetland loss and sea level rise, such as purchasing wetlands easements, establishing riparian and coastal buffers, restoring natural hydrology, and refraining from developments or impacts in sensitive wetlands and coastal areas. Our habitat goal and associated objectives proposes the acquisition and protection of diverse coastal habitat in Connecticut including salt marsh (e.g., Whalebone Cove CFA), which would be managed under a future Habitat Management Plan that incorporates the influence of climate change stressors.

- ***Recommendation #9—*** Reduce the risk of catastrophic fire (re: FWS Goal 3). This recommendation acknowledges that fire can be a natural part of the ecosystem, but that climate change could lead to more frequent fires or greater likelihood of a catastrophic fire. There are no alternatives with management actions calling for annual prescribed burning to maintain large areas of forest habitat, although selective use likely will occur under HMPs for pitch-pine dominated forest and similar fire-regime systems; controlled burning to reduce fuel loads may be conducted under emergency fire threat situations. Fuel load management will be done through prescribed burning and mechanically within the context of a Forest Management Plan.

- ***Recommendation #10—*** Reduce likelihood of catastrophic events affecting populations (re: FWS Goal 3). This recommendation states that increased intensity of severe weather can put wildlife at risk. While the severe weather cannot be controlled, the refuge's preferred alternative calls for an expanded acquisition boundary that will, over the long term horizon of this CCP enable

the protection and management of greater habitat areas, thus offering a form of safe harbor to a number of species during severe weather events.

- ***Recommendation #11—*** Prevent and control invasive species (re: Goals 3). This recommendation emphasizes the increased opportunities for invasive species to spread because of their adaptability to disturbance. Invasive species control will be essential, including extensive monitoring and control to preclude larger impacts. Invasive species control is a major initiative within the Service. The refuge and Northeast Region, in particular, has taken a very active stand. In chapter 3, we provide descriptions of our current and future plans on the refuge to control existing invasive plant infestations. We also describe monitoring and inventorying strategies to protect against any new infestations.

- ***Recommendation #12—*** Adjust yield and harvest models (re: FWS Goal 3 and 4). This recommendation suggests that managers may have to adapt yield and harvest regulations for game species in response to climate variability and change to reduce the impact on species and habitats. Hunting is permitted under state law at several refuge divisions and units (i.e., Nulhegan Basin, Blueberry Swamp, Putney Mountain Unit, Pondicherry, Fort River, and Salmon River). Species hunted include deer, moose, black bear, ruffed grouse, woodcock, wild turkey, coyote, and snowshoe hare. There is no indication of harvest stress on any of these species, yet we will ensure harvest compatibility within our developing hunt plans. The refuge does not have authority to set harvest regulations but can restrict time and location. For resident wildlife, regulations are established at the state level. For Federal migratory game birds, the harvest framework is established by the Service at the national level while being further refined at the state level.

- ***Recommendation #13—*** Account for known climatic conditions (re: FWS Goal 2 and 4). This recommendation states we should monitor key resources through predictable short-term periodic weather phenomena, such as El Nino, to aid us in future management efforts. We will develop an Inventory and Monitoring Plan that will help us set and evaluate our hypotheses, assumptions, and management actions in achieving objectives, as well as enable us to refine and adjust future management decisions.

- ***Recommendation #14—*** Conduct medium- and long-range planning (re: FWS Goal 2). This recommendation states that plans longer than 10 years should take into account potential climate change and variability as part of the planning process. This intent and statutory purpose of this 15-year CCP is to achieve the purposes, goals, and vision of the refuge, to contribute to the mission of the Refuge System, and to advance the policies and directives of the Service and Department of the Interior. Notably, this CCP addresses the Department's Secretarial Order 3226 (January 19, 2001) calling for long-term planning on climate change. The refuge's CCP addresses climate change with an emphasis on protecting and managing spatially diverse, contiguous, structurally sound native habitat areas. It advances the mitigation of non-climate human stressors on refuge lands, while also promoting education and interpretation about climate change. Our monitoring program and adaptive management strategies will also facilitate our ability to respond to climate change.

- ***Recommendation #15—*** Select and manage conservation areas appropriately (re: FWS Goal 3). This recommendation states that establishment of refuges, parks, and reserves is a conservation strategy needed to minimize the decline of wildlife and habitats in North America. Decisions on locating future conservation areas should take into account potential climate change and variability. This CCP specifically meets this recommendation by its preferred

'alternative C' proposal (and similarly with alternative D) to expand the acquisition boundary of the refuge across a wide range of essential habitat types throughout the north-south alignment of the 7.2 million acre watershed. Having been established as a unique watershed-oriented refuge, there is an acute recognition of the refuge's role in promoting an integrally connected landscape that facilitates movement and adaptation of fish and wildlife in an ever warming climate environment. Our watershed-level partnerships with state agencies, numerous conservation organizations, private and other public landowners, coupled with our refuge expansion proposals, would result in more stable, resilient habitats across the landscape, and help reduce other non-climate stressors. Conserving and connecting protected lands provides wildlife migration corridors, maintains a refugium for species on the edge of their range, removes dispersal barriers and establishes dispersal bridges, protects hydrology, and increases the ecological, genetic, and geographic variation in species. Our plans to control invasive plants, maintain the integrity and function of forest floodplains and wetlands, and promote forest health and diversity, could also minimize climate change impacts.

- ***Recommendation #16***— Ensure ecosystem processes (re: FWS Goals 2, 3, and 4). This recommendation suggests that managers may need to enhance or replace diminished or lost ecosystem processes. Manually dispersing seed, reintroducing pollinators, and treating invasive plants and pests, are examples. We plan to take an aggressive approach to treating invasive plants, and our acquisition boundary expansion will greatly enable the refuge to enhance ecosystem processes. None of our proposed management actions will diminish existing natural ecosystems processes. We will rely upon our forthcoming Inventory and Monitoring Plan implementation to guide adjustments to management actions aimed at a more active role in enhancing ecosystem processes.

- ***Recommendation #17***— Look for new opportunities (re: FWS Goals 2, 4, and 7): This recommendation states that managers must be continually alert to anticipate and take advantage of new opportunities that arise. Creating wildlife conservation areas from abandoned or unusable agricultural land, and participating with industry investment in carbon sequestration or restoration programs are two examples. This CCP specifically meets this recommendation by its preferred 'alternative C' proposal (and similarly with alternative D) to expand the acquisition boundary of the refuge across a wide range of essential habitat types. Additionally, refuge staff members have many conservation partners in the watershed who, in turn, are networked throughout the larger region. Our land protection expansion proposal was largely borne from this extensive partnership. Our 13-state Northeast Region has field offices and a regional office that integrates the other Service program areas, including those that work with private entities. We also coordinate across Service regions on essential climate related issues such as sea level rise and invasive species, and frequently benefit from national guidance and technical information transfer. We have developed outreach materials and make ourselves available to interested organizations and groups to provide more detailed information on the Service and Refuge System missions, refuge goals and objectives, and partnership opportunities.

- ***Recommendation #18***— Employ monitoring and adaptive management (re: FWS Goals 2, 3, and4). This recommendation states that we should monitor climate and its effects on wildlife and their habitats and use this information to adjust management techniques and strategies. Given the uncertainty with climate change and its impacts on the environment, relying on traditional methods of management may become less effective. We agree that an effective

and well-planned monitoring program, coupled with an adaptive management approach, will be essential to dealing with the future uncertainty of climate change. We have built both aspects into our CCP. We will develop a detailed step-down Inventory and Monitoring Plan designed to test our assumptions and management effectiveness in light of on-going changes. With that information in hand, we will either adapt our management techniques or reevaluate or refine our objectives and techniques as appropriate. This plan will address broad aspects of refuge habitat change and species that are known to be sensitive to climate change such as Piping plover (sea level rise), Canada lynx (snowpack), brook trout and juvenile Atlantic salmon (stream flow), and Bicknell's thrush (breeding habitat displacement and increased egg predation by red squirrels).

Biological Resources — Conserved Habitats, Fish, and Wildlife: All of the alternatives would maintain or improve native biological resources on the refuge, in the Connecticut River watershed, and New England in general. The combination of our management actions with those of other conservation partners, organizations, and landowners would result in beneficial cumulative impacts on the biological environment by:

- Improving the protection and management of refuge Priority Refuge Resources of Concern (e.g., Federal trust species, state-listed species, and migratory birds), and associated species.
- Protecting and improving major wetland and upland habitat types defined in this final CCP and their associated LCC subhabitat types, though habitat acquisition and protection proposed in each of the alternatives.
- Actively managing select habitats to promote habitat structure and diversity needed for priority refuge resources of concern species (e.g., wood thrush, blackburnian warbler, New England cottontail, Eastern brook trout).
- Controlling invasive plants and insects.
- Restoring and conserving native flora, pollinators, and other wildlife.
- Enhancing and restoring biological integrity, diversity, and environmental health of refuge lands and new lands to be acquired.

There would be no significant cumulative adverse effects to biological resources under any of the alternatives because the changes in habitat components that we would manage for directly or expect to realize through natural succession would on balance be beneficial. Biological resources that we would manage to prevent their introduction, limit, or eliminate, such as invasive plants, are not natural components of the Connecticut River watershed and refuge ecosystems.

In general, native habitat protection and varying levels of management (including both active and passive management) as described in the alternatives will have cumulative beneficial impacts on the biological environment. We expect to increase select species populations in targeted situations (e.g., Eastern brook trout, wood thrush) through habitat protection and active management (e.g., stream restoration, silviculture operations). Native habitat protection and management cumulatively benefits the biological environment by increasing and enhancing healthy soil biota, restoring and enhancing native plant resources, potentially increasing resident wildlife populations of mammals, fish, reptiles, and amphibians, and enhancing invertebrate populations such as dragonflies and pollinators. Cumulative beneficial impacts on the refuge's biological environment will also accrue from reducing habitat fragmentation across the watershed landscape through refuge land protection activities.

A 2006 survey of New England's aging forest owners revealed that 41,000 owners of 1.72 million acres claimed they planned to sell some or all of their land in the 5 five years, and a group of 28,000 owners managing another 560,000 acres planned to subdivide their land over the same period (Butler et al. 2008). Cumulatively, the habitat protection efforts of the refuge will tie well with activities of other land protection organizations, public and private, thus will offer beneficial cumulative impacts. For example, the Trust for Public Lands has protected over 170,000 acres in the watershed and The Nature Conservancy has protected nearly a quarter million acres (*www.tpl.org/what-we-do/where-we-work/massachusetts/connecticut-river.html*; accessed October 2013) and *www.nature.org/ourinitiatives/regions/northamerica/unitedstates/connecticut/connecticutriver/index.htm*; accessed October 2013). Under the USDA Forest Legacy Program, a grant program to protect forestlands from conversion to non-forest uses, well over 321,000 forestland acres have been protected in the four watershed states while retaining such land in private ownership, although it is unknown how many acres fall within the watershed. A number of priority areas in the watershed are identified for potential future Forest Legacy protections: Connecticut—Roaring Brook ; Massachusetts—Quabbin to Wachusett ; New Hampshire— Mahoosuc Gateway/Success, Oliverian Valley; and Vermont—Northern Green Mountains, Windham Working Forest.

A number of other forest and forest related conservation programs and initiatives are actively underway in New England and the Connecticut River watershed and, along with the refuge's efforts, will serve to promote cumulative beneficial impacts to the region's forestlands: Community Forest and Open Space Conservation Program (USDA) , Urban and Community Forestry (USDA), Land and Water Conservation Fund (LWCF), Wildlife Habitat Incentives Program (USDA), Wetlands Reserve Program (USDA), Conservation Stewardship Program (USDA), Environmental Quality Incentives Program (USDA), Farm and Ranch Lands Protection Program (USDA), Healthy Forest Reserve Program (USDA), the Cooperative Conservation Partnership Initiative (USDA), and Conservation Innovation Grants (USDA). Notably, New England has pioneered the movement to conserve and restore large interstate landscapes such as the Northern Forest and the Connecticut River watershed. Both of these landscapes were named as priorities in the President's FY 2012 Budget and the America's Great Outdoors report (New England Forest Partners 2013). Additionally, watershed states also have forest protection programs (e.g., Massachusetts Chapter 61 Laws, Vermont Forest Stewardship Program).

Proposed habitat enhancement and restoration activities (e.g., increase forest structural diversity, floodplain restoration) under alternatives A, B, and C will limit any potential adverse cumulative impacts effects on the biological environment by careful employment of best management practices, as noted earlier. Refuge timber harvests will be driven by habitat considerations, not economic concerns, and will enhance the diversity of the forest landscape for target priority refuge resources of concern wildlife. Within much of the watershed, forests are younger and support more simplified species and age mixtures than their pre-European cohorts (Foster and Aber 2004, Irland 1999, Elliot 1999). Changing economic pressures to maximize short-term profits have led to shorter rotations and more aggressive harvesting practices (Lansky 1992), and erosion from improperly constructed roads can contribute tons of sediment to streams each year. Rising pressures for wood-based bioenergy to meet alternative fuel targets of New England states may intensify adverse harvesting practices (Evans and Perschel 2009, Damery et al. 2009, Benjamin et al. 2009, Cronan et al. 2010). Timber harvests occur on lands surrounding the Nulhegan Basin Division: Plum Creek Timber Company (3,604 acres treated in 2013; 84,000 acres ownership) and West Mountain Wildlife Management Area (50 acres treated annually; 22,000 acres ownership by state of Vermont).

Forest management proposed by the refuge, ranges from no cutting (alternative D), to approximate annual harvest of 500 acres. Refuge forests subject to will contribute to the overall health of the watershed's forest ecosystem. In select situations, where forest regeneration is inhibited by invasive species, over browsing by ungulates, or human disturbances, native tree species will be planted to speed forest establishment.

Similar to habitat management to improve certain forest habitat areas for target wildlife, maintenance of grassland and shrubland areas as described earlier will help to provide for these otherwise declining habitats well recognized for their value to target wildlife (e.g., upland sandpiper, bobolink). Westover Air Reserve Base in Chicopee, Massachusetts hosts the most important populations of grasshopper sparrows and upland sandpipers in the watershed, an area previously designated as an SFA but currently protected and managed through an agreement between the U.S. Air Force and Mass Wildlife. The Connecticut River valley in Massachusetts provides the greatest potential for grassland habitat restoration in the watershed, indicating the importance of the refuge's proposed CFAs such as the Fort River, and Mill River. As New England becomes increasingly forested and urbanized these grassland species will be increasingly limited by available habitat. Refuge management of these lands (164 acres) will cumulatively have very negligible impacts to the forest environment that typically would successionally replace the grasslands, due to the expansive forests in the watershed. Additionally, the refuge will use all available best management practices when mowing and brush-hogging these habitat areas to minimize immediate and potential adverse impacts, recognizing that the long-term impacts are expected to be cumulatively beneficial.

Certain biological resources that we would work to control, principally invasive plants, are not natural components of our managed wildland areas or the Connecticut River watershed. We do not consider the loss of these biotic elements to be an adverse impact, and in fact, our control efforts along with those of others (e.g., USDA-NRCS) cumulatively should help maintain a broader, more resilient array of native habitats. In contrast, not controlling invasive species would contribute to adverse cumulative impacts to the biological environment. All alternatives facilitate control of invasive species. Controlling invasive plants will involve the use of chemical herbicides and mechanical treatments. The selective use of herbicides will be based upon an integrated pest management strategy that incorporates pest ecology, the size and distribution of the population, site-specific conditions, and known efficacy under similar site conditions. Best management practices will reduce potential effects to non-target species, sensitive habitats, and quality of surface and groundwater. Herbicide applications will be targeted to control discreet plant, and potentially insect, populations in localized areas. A 'minimal' approach is generally used (e.g., 'cut and drip' herbicide application on individual plants) contrasted, when appropriate, with broadcast applications in larger invasive plant areas. Herbicides applied on the refuge would be short-lived, resulting from environmental and microbial breakdown to less or non-hazardous degradation products.

Beaver and muskrats are native aquatic rodents that are a natural component of the refuge ecosystem. However, on occasion individual animals or small colonies will damage valuable refuge infrastructure, burrow into dikes or cause flooding conditions on neighboring private land. Beaver damming and flooding of refuge managed habitats may impact the refuge's ability to achieve an optimal management regime for Federal trust resources. Cumulatively, managing these furbearers over the long term and in concert with those harvested through regulatory programs of the state Fish and Wildlife agencies in the watershed should pose negligible adverse impact and, beneficial impacts over time as their population levels will be expected to be more in balance with the wetland environment. Similarly, refuge management of other more terrestrial furbearers (e.g., coyote, bobcat) is conducted through special use permits in a manner that

is consistent with population objectives of the respective watershed states, while also playing a role to minimize undue predator pressure on other species such as ground nesting birds and interspecific competition between bobcat and Canada lynx. The cumulative adverse impacts of these trapping activities are expected to be of adverse and immediate negligible impact (on individual animals), and over the long term to be of beneficial cumulative impact to the furbearer population.

Relationship Between Short-term Uses of the Human Environment and Enhancement of Long-term Productivity

In this section, we examine the relationship between local, short-term uses of the human environment and maintaining the long-term productivity of the environment. By long-term, we mean that the impact would extend beyond the 15-year period of this CCP. Under all alternatives, our primary aim is to maintain or enhance the long-term productivity and sustainability of natural resources on the refuge, including migratory birds, inter-jurisdictional fish, and other far-ranging wildlife species. Habitat protection and restoration actions across all alternatives may entail short-term negative impacts to ensure the long-term productivity of the refuge. Many of the cyclic management actions in the alternatives, namely, actively managing forests, shrublands, and grasslands, controlling invasive plants and animals, and grasslands, and restoring native plant communities can have dramatic short-term impacts. These include direct mortality of some plants and animals, displacement of species, and temporary displacement or cessation of certain types of public use. However, the long-term benefits of those actions generally offset their short-term impacts. Habitat management practices that mimic ecological and sustainable processes optimize the maintenance and enhancement of the biological diversity, integrity, and environmental health of those habitats for the long term. Long-term productivity is especially enhanced when the ecological and sustainable management actions that are proposed in the preferred alternative would best support and improve links between nutrient cycling, ecological processes, and ecosystem function.

Diverse and wide-ranging wildlife recreational opportunities for public use should provide the best long-term positive economic impacts to local communities. That mirrors the widely accepted premise that maintaining biological diversity in natural ecosystems helps ensure their long-term resiliency. We would design our proposed public use programs to heavily rely on outreach and environmental education to explain all of our management actions to visitors and the public that would encourage everyone to be better stewards of our natural environment.

In summary, we predict that the alternatives would contribute positively to maintaining and enhancing the long-term productivity of the refuge's natural resources, with sustainable beneficial cumulative and long-term benefits to the environment surrounding the refuge, while necessitating only minimal inconvenience or loss of opportunity for the American public.

Unavoidable Adverse Impacts

Unavoidable adverse effects are the effects of those actions that could cause harm to the human environment and cannot be avoided, even with mitigation measures. All the alternatives would result in some minor, localized, unavoidable adverse impacts. For example, any minor construction, burning or prescribed fires, control of invasive plant species, or upgrading a trailhead parking lot to be ADA compliant would produce minor short-term, localized adverse impacts. Some habitat types on the refuge will be adversely impacted as previously noted (e.g., Impacts to Mammals) following direct habitat management applications (e.g., logging or haying). There will be adverse but negligible impacts to species whose preferred habitat has been altered; however, the altered habitat will be of beneficial impact to the priority refuge resources of concern species being managed. Furthermore, all of those impacts would be mitigated with best management practices, so none of the alternatives would cause significant, unavoidable cumulative impacts. There would be property tax losses to towns and increased visitation that could have unavoidable effects. These impacts are minimally offset by refuge revenue sharing payments. All the alternatives, in

varying degrees, will have adverse impacts to a certain segment of the public that does not desire any change in current habitat management or public use programs. Some may be concerned about increased visitation to the refuge, or others may not like us to open new tracts for public use adjacent to their residences. Some of these impacts on certain individuals or neighbors are unavoidable. Our responsibility is to provide equal opportunities to the American public. We believe we have sought a fair balance in minimizing and mitigating adverse impacts while optimizing wildlife conservation and providing excellent recreational opportunities to the public. Nevertheless, none of these unavoidable impacts rises to the level of significance under any of the alternatives. All these unavoidable adverse effects on the physical and biological environment will be relatively local and more than offset by the long-term benefits of cleaner air, cleaner water, and making rare wildlife species more common across the landscape, while providing quality wildlife-dependent recreation.

Potential Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those commitments that cannot be reversed, except perhaps in the extreme long-term or under unpredictable circumstances. One extreme example is an action that contributes to a species' extinction. Once extinct, it can never be replaced. By comparison, irretrievable commitments of resources are those that can be reversed, given sufficient time and resources, but represent a loss in production or use for a time. An example of an irretrievable commitment for the refuge is maintaining early-successional shrubland, old fields, and young forest for breeding American woodcock, a management action common to all alternatives. If for justifiable reason, American woodcock breeding habitat at the Nulhegan Basin Division was no longer considered by the refuge and conservation partners as necessary, those managed acres would revert gradually to mature forest and would be valuable to another suite of birds. Another example would be a management action that calls for building a large permanent visitor education center. We have not proposed any management action that poses a Potential Irreversible and Irretrievable Commitments of Resources, and we do not consider small visitor facilities, such as photo blinds and information kiosks, or new trails, to be irretrievable commitments of resources. We can dismantle those facilities and restore the sites if resource damage is occurring or priorities have shifted.

A prominent irreversible commitment proposed in this final CCP impacting local communities is Service land acquisition. All alternatives enable the Service to acquire new lands, and alternatives C and D expand current land acquisition authorization, as previously described herein and Chapter 4 — Alternatives. Once these lands become part of the refuge, they would not revert back to private ownership. There are provisions for exchanges of land parcels when such exchanges are determined to be in the best interest of the refuge; however, an exchange is not a reversion. The commitment of resources to maintain newly acquired lands is small compared to the benefits derived from the increased habitat areas for fish and wildlife, biodiversity, and the potential benefit to refuge visitors by providing a variety of wildlife-oriented recreational opportunities.

Environmental Justice Impacts

President Clinton signed Executive Order no. 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations on February 11, 1994, to focus Federal attention on the environmental and human health conditions of minority and low-income populations, with the goal of achieving environmental protection for all communities.

The order directs Federal agencies to develop environmental justice strategies to aid in identifying and addressing disproportionately high adverse human

health or environmental effects of their programs, policies, and activities on minority and low-income populations. The order is also intended to promote nondiscrimination in Federal programs substantially affecting human health and the environment, and to provide minority and low-income communities access to public information and participation in matters relating to human health or the environment.

The United States EPA Office of Environmental Justice defines it as follows:

> *"Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental law, regulations, and policies. EPA has this goal for all communities and persons across this Nation. It will be achieved when everyone enjoys the same degree of protection from environmental and health hazards and equal access to the decision-making process to have a healthy environment in which to live, learn, and work."*

Overall, we expect none of the alternatives to place disproportionately high, adverse environmental, economic, social, or health effects on minority or low income persons. All of the alternatives maintain or establish refuge CFAs (later to be refuge Divisions) throughout the watershed, in both rural and urban settings. Opportunities will be created to have all people visit and enjoy the refuge. Before we make any decisions to change habitat management or the environment we inform the public. Our programs and lands are equally open to all users who follow refuge rules and regulations. We do not discriminate in our responses for technical or practical information on conservation issues or when providing technical assistance in managing private lands.

It's estimated that both urban and rural communities within the Connecticut River watershed may benefit economically under all management alternatives if increased visitor expenditures offset property tax losses on acquired lands. This benefit would vary widely from urban to rural communities, and is dependent on respective communities' reliance on property tax revenues and tourism. We estimate that no community will be adversely affected over the long term by loss of access to game or fish for those who use them to supplement their annual diet, because both hunting and fishing are likely to remain a compatible use of the refuge. Many refuge areas may promote outdoor recreational activities (e.g., hiking, birding, hunting, and fishing) that may stimulate local jobs and revenue sources. Certain areas may restrict particular recreation activities known to be an important source of income for local communities (e.g. snowmobiling), but efforts will be made to provide sufficient access to support this revenue base.

Summary of the Impacts of the Alternatives

The following table summarizes and compares the benefits and adverse impacts we described above in chapter 5 for each of the four alternatives. For our discussion on cumulative impacts, the relationship between short-term uses of the human environment and enhancement of long-term productivity, unavoidable adverse impacts, potential irreversible and irretrievable commitments of resources, and environmental justice, please refer to the chapter 5 narratives above.

Table 5.20. Summary of the impacts of the alternatives.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO REGIONAL AND LOCAL SOCIOECONOMICS			
Socioeconomic impacts that do not vary between the alternatives: Under all alternatives, we would continue to pay refuge revenue sharing payments to municipalities where refuge lands are located. Regardless of the alternative selected, refuge jobs, refuge expenditures, and visitor spending would negligibly contribute to the local economy.			
Refuge purchase of goods and services and Refuge personnel salary spending			
As additional refuge lands are acquired, non-salary expenditures will shift from occurring most frequently in the north to greater spending in the south of the watershed. We would continue to maintain our current level of staffing and, therefore, we would expect personnel salary spending to continue at similar levels.	Similar to alternative A.	Compared to alternatives A and B, we predict an increase in spending of about $175,000, particularly in the Tri-State Border and White River Junction subregions. Over the long term, we would add up to 16 new staff positions (dependent upon funding), particularly in the Northern and Tri-State Border subregions.	Similar to alternative C
Refuge visitor spending in the local economy			
In general, as with the other alternatives, visitation (and therefore visitor spending) would continue at current levels at existing divisions and units. Over the long term, as we acquire additional lands in other areas in the southern watershed, we expect visitation and visitor spending to increase in these areas.	As with the other alternatives, we expect current levels of visitation (and therefore visitor spending) to continue at existing divisions and units. As new lands are acquired and additional ADA-accessible trails are built, we expect visitation to increase (estimate about 22 percent above current visitation levels).	As with the other alternatives, we expect current levels of visitation (and therefore visitor spending) to continue at existing divisions and units. As new lands are acquired and additional ADA-accessible trails are built, we expect visitation to increase (estimate about 54 percent above current visitation levels).	As with the other alternatives, we expect current levels of visitation (and therefore visitor spending) to continue at existing divisions and units. As new lands are acquired and "backcountry" trails are built, we expect visitation to increase (estimate about 25 percent above current visitation levels). This increase will occur despite a large decrease in visitation due to the elimination of snowmobiling. Impact on local economies due to eliminating snowmobiling is likely minor as many other snowmobile trails exist in area.
Economic contributions from habitat management			
We may acquire additional acres of commercial forest lands across the watershed, particularly in the Northern, White River Junction, and Tri-State Border Subregions. We would continue to manage approximately 225 acres of forest in the Northern Subregion and up to 200 acres of grassland each year across the Northern and Greater Amherst Subregions for migratory birds and other wildlife, generating negligible amounts of timber products and hay.	Short-term impacts similar to alternative A. Over the long term, as we acquire new refuge lands, we would actively manage approximately 7,660 acres of forest. We would also manage approximately 422 acres of grassland and 775 acres of shrubland on the refuge. Similar to A, as part of this management, we may generate some negligible to minor amounts of timber products and hay.	Short-term impacts similar to alternative A. Over the long term, as we acquire new refuge lands, we would actively manage up to 11,500 acres. We would also manage approximately 548 acres of grassland and 775 acres of shrubland on the refuge. Similar to A and B, As part of this management, we may generate some negligible to minor amounts of timber products and hay.	Alternative D would generate the smallest economic contribution from habitat management. Under alternative D, we would passively manage all refuge habitats, except in rare circumstances (e.g., major disturbance such as fire, hurricane, or ice storm, to restore degraded habitats, for threatened and endangered species).

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO REGIONAL AIR QUALITY			
Air quality impacts that do not vary between the al**ternatives**: None of the alternatives would significantly benefit or adversely affect local or regional air quality. None of the alternatives would violate EPA standards for air pollutants and all would comply with the Clean Air Act. There are no major stationary or mobile sources of air pollution present on Service-owned lands nor would any be created under any of the alternatives. No Class I air quality areas would be affected. All of the alternatives would have short- and long-term negligible adverse impacts (e.g., emissions from vehicles, equipment, and buildings) and negligible to minor long-term beneficial impacts (e.g., preventing further development, sequestrating carbon, and filtering air from permanently protecting native habitats) on regional air quality. To reduce the amount of refuge emissions, we would replace or upgrade, as necessary, refuge equipment, vehicles, and facilities with more efficient models and look for alternative energy sources. Over the short-term, we expect similar minor beneficial impacts to air quality as habitat conservation and management actions lead to lower levels of emissions in areas near the refuge, and the air pollutant filtering function of vegetation on refuge-protected lands continues.			
Within the next 15 years: Negligible, short-term adverse impacts from: • Maintaining and using existing refuge administrative and public use facilities (e.g., trails, roads, buildings). Lowest among the alternatives. • Emissions from refuge staff and visitor vehicles. • Emissions from snowmobiles. • Emissions from equipment for continuing existing habitat management projects (up to 445 acres). *Beyond the next 15 years:* Minor long-term beneficial impacts to regional air quality from protecting up to 97,830 acres of habitat from further development (e.g., continued carbon sequestration, decreased likelihood of emissions from development). Lowest among the alternatives.	*Within the next 15 years*: Similar to other alternatives—negligible, short-term adverse impacts. *Up to and beyond the next 15 years:* Negligible long-term beneficial impacts to regional air quality from protecting up to 97,772 acres of habitat. Potential for adverse, short-term impacts from: • Emissions from managing greater amounts of habitat (approximately 9,312 acres). • Emissions and fugitive dust from constructing new trails (up to 19 1-mile long ADA-accessible trails). • An increase in refuge visitation, and related increase in vehicle emissions. • Emissions from snowmobiles.	*Within the next 15 years*: Similar to other alternatives—negligible, short-term adverse impacts. *Up to and beyond the next 15 years:* Negligible long-term beneficial impacts to regional air quality from protecting up to 197,337 acres of habitat. Potential for adverse, short-term impacts from: • Emissions from managing the greatest amounts of habitat (approximately 12,873 acres). Highest among the alternatives. • Emissions and fugitive dust from constructing new trails (up to 22, 1-mile long ADA-accessible trails). Highest among the alternatives. • Large projected increase in refuge visitation and related increase in vehicle emissions. Highest among the alternatives. • Emissions from snowmobiles. Highest among the alternatives.	*Within the next 15 years*: Similar to other alternatives—negligible, short-term adverse impacts. *Up to and beyond the next 15 years:* Negligible long-term beneficial impacts to regional air quality from protecting up to 231,307 acres of habitat, and from eliminating snowmobiling on refuge lands. Potential for adverse, short-term impacts from: • Emissions from managing habitat intermittently. Lowest among the alternatives. • An increase in refuge visitation, and related increase in vehicle emissions. • Emissions and fugitive dust from constructing new trails (up to 22 1-mile long native-material trails). Lowest among the alternatives.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO REGIONAL HYDROLOGY AND WATER QUALITY			
Hydrology and water quality impacts that do not vary between the alternatives: None of our proposed management activities would significantly benefit or adversely affect local or regional hydrology and water quality. None of our proposed management activities would violate Federal or state standards for contributing pollutants to water sources; all four would comply with the Clean Water Act. Under all alternatives, we would use best management practices to prevent spills and protect hydrology and water quality during management (e.g., only using approved herbicides to remove invasive plants, leaving a forested buffer along riparian areas) and construction (e.g., using elevated boardwalks and installing appropriately sized culverts) activities. We would also encourage refuge visitors to stay on trails and in other designated areas to limit potential to disrupt hydrology or adversely affect water quality (e.g., trail erosion into streams). We also require that pet owners remove solid pet wastes to reduce the potential to affect water quality.			
Within the next 15 years: Negligible adverse short-term, localized impacts from refuge visitation (e.g., snowmobile emissions), road and trail maintenance, and invasive plant control (e.g., herbicide application). *Up to and beyond the next 15 years:* Negligible, long-term beneficial impacts to regional water quality and hydrology from protecting up to 97,830 acres of habitat from further development.	*Within the next 15 years*: Similar to alternative A—negligible, short-term, localized adverse impacts. *Up to and beyond the next 15 years:* Negligible long-term beneficial impacts to regional water quality and hydrology are similar to alternative A (protect up to 97,772 acres of native habitat). However, we would protect larger blocks of habitat under alternative B than alternative A, and therefore expect slightly greater benefits. Also, slightly greater potential for adverse, short-term impacts from: • Actively managing greater amounts of habitat (approximately 9,312 acres). • Constructing new trails (up to 19, 1-mile long ADA-accessible trails). • An increase in refuge visitation (i.e., increased vehicles emissions).	*Within the next 15 years*: Similar to other alternatives—negligible, short-term adverse impacts. *Up to and beyond the next 15 years:* Compared to other alternatives, second greatest potential for long-term benefits to regional air quality from protecting up to 197,337 acres of native habitat. We expect these impacts to be minor to modest. However, compared to other alternatives, the greatest potential for adverse, short-term impacts from: • Equipment and vehicle emissions from actively managing the greatest amount of habitat (approximately 12,873 acres). • Constructing new trails (up to 22, 1-mile long ADA-accessible trails). • The greatest projected increase in refuge visitation (i.e., increased vehicle emissions).	*Within the next 15 years*: Negligible adverse short-term, localized impacts from refuge visitation, road, and trail maintenance, new construction (e.g., trails and trail heads) and invasive plant control (e.g., herbicide application). Compared to other alternatives, least potential for adverse short-term impacts because of emphasis on a "back-country" visitor experience, eliminating snowmobiling, and least amount of active habitat management. *Up to and beyond the the next 15 years:* Minor to modest long-term beneficial impacts to regional hydrology and water quality. Compared to other alternatives, greatest potential for benefits to regional hydrology and water quality by protecting the greatest amount of habitat (up to 231,307 acres) and allowing natural hydrological processes to occur across the refuge, with limited to no active management. We expect these impacts to be minor to modest.

Table 5.24. Summary of Environmental Consequences by Alternatives.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
CLIMATE CHANGE IMPACTS			
Climate change impacts that do not vary between the alternatives: Under all alternatives, changes in temperature, precipitation, sea level rise, storm intensity, and other physical changes are having a significant biological impact across a broad range of natural systems. This includes increased uncertainty related to the outcomes of management actions. To reduce the adverse impacts of climate change stressors, the refuge intends to protect the structural and functional dynamics of defined refuge habitats, diversity of species, promote landscape connectivity and corridors to facilitate migration, strengthen partnership support to address climate change, and promote effective environmental education and interpretation.			
Given climate change impacts, under this management strategy the refuge could see negligible adverse impacts from managing 97,830 acres of habitat across dispersed SFAs that are smaller, less contiguous, and less connected than SFAs, and have a higher likelihood of becoming ecological sinks. Negligible to minor long-term adverse impacts to forest resilience are possible, given that active management can only occur on a small portion of the refuge.	Given climate change impacts, under this management strategy the refuge could see minor beneficial impacts from protecting larger and more connected ecosystems across up to 97,772. Less benefit than alternatives B and C. Negligible to minor long-term adverse impacts to forest resilience are possible, given that active management can only occur on a small portion of the refuge. This alternative better positions the refuge to adapt to climate change than alternatives A or D, but offers fewer opportunities than under alternative B.	Given climate change impacts, under this management strategy the refuge could see minor beneficial impacts from protecting larger and more connected ecosystems across up to 197,337. These benefits would be greater than alternatives A and B, and lesser than under alternative D. Negligible to minor long-term adverse impacts to forest resilience are possible, given that active management can only occur on a small portion of the refuge. This alternative better positions the refuge to adapt to climate change than alternatives A, B or D.	Given climate change impacts, under this management strategy the refuge could see minor to moderate beneficial impacts from protecting larger and more connected ecosystems across up to 231,307. These benefits would be greater than alternatives A, B and C. Negligible to moderate long-term adverse impacts to forest resilience are possible, given that active management can only occur in rare circumstances. Under this alternative, the refuge is likely to be the most impacted by climate change, since resilience-enhancing active forest management may not occur.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO SOILS			
Soil impacts that do not vary between the alternatives: None of our proposed management activities would significantly benefit or adversely affect local or regional soils. Under all alternatives, we would use best management practices to conserve soils during management (e.g., forest management to improve habitat), maintenance, and construction (e.g., new trail construction) activities. We would also encourage refuge visitors to stay on trails and in other designated areas to limit potential for soil erosion and compaction.			
Within the next 15 years: Negligible adverse short-term, localized impacts from: • Visitor use impacts (e.g., soil compaction and erosion alongside trails). • Road and trail maintenance. • Invasive plant control (e.g., herbicide application). • Continuing to manage up to 455 acres of habitat. *Up to and beyond the next 15 years:* Negligible minor long-term beneficial impacts to soils from permanently protecting up to 97,830 acres of habitat.	*Within the next 15 years*: Similar to alternative A. *Up to and beyond the next 15 years:* Similar to alternative A, minor beneficial impacts to soils from permanently protecting up to 97,772 acres of habitat. We expect slightly greater benefits from protecting larger blocks of habitat under alternative B. However, we also expect a slightly greater potential for adverse impacts to soils from managing additional acres of habitat (approximately 9,312 acres). Also, from constructing up to 19 1-mile-long, ADA-accessible hiking trails and increased visitation.	*Within the next 15 years*: Similar to alternatives A and B. *Up to and beyond the next 15 years:* Compared to other alternatives, the second greatest potential to benefit soils from permanently protecting up to 197,337 acres of habitat. However, compared to other alternatives, the greatest potential for adverse impacts to soils from actively managing additional acres of habitat (approximately 12,873 acres) and from constructing up to 22 1-mile-long, ADA-accessible trails. We also expect the highest visitation under alternative C.	*Within the next 15 years*: Similar to other alternatives, except slightly less impacts to soils because of very little to no active habitat management. *Up to and beyond the next 15 years:* Alternative D would have the greatest potential to benefit soils from protecting the greatest amount of habitat and allowing soil processes to occur, with no to limited active management. Also, we would construct the least amount of new infrastructure (e.g., backcountry trails, kiosks, trailheads, boardwalks) under alternative D and eliminate snowmobiling trails. However some potential for adverse impacts to soils from occasional habitat management and from constructing up to 22 1-mile-long, native-surface trails. We also expect the second-highest visitation under alternative D.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO FRESHWATER WETLANDS			
Freshwater wetland impacts that do not vary between the alternatives: None of alternatives would have a significant adverse effect on any freshwater wetland habitats on the refuge. Under all alternatives, we predict negligible to minor long-term benefits from protecting and/or restoring wetland habitats on the refuge. We would also use best management practices to minimize adverse impacts to wetlands from new construction (e.g., building outside of wetland areas), trail and road maintenance, invasive species control (e.g. only using approved herbicides and/or using other non-chemical controls), and habitat management (e.g., buffering wetlands). The majority of habitat management will occur in upland areas, away from freshwater wetlands. We would also encourage visits to stay on trails to minimize the potential for impacts to wetland vegetation and wildlife.			
Within the next 15 years: Negligible adverse short-term, localized impacts from: • Visitor use (e.g., sedimentation from small amounts of off trail use). • Road and trail maintenance. • Invasive plant control (e.g., herbicide application). • Continuing to manage upland habitats following best management practices (up to 455 acres). *Up to and beyond the next 15 years:* Negligible to minor long-term beneficial impacts to wetlands from permanently protecting up to 97,830 acres of habitat.	*Within the next 15 years*: Similar to alternative A. *Up to and beyond the next 15 years:* Negligible to minor long-term beneficial impacts to wetlands from permanently protecting up to 97,772 acres of habitat. Potential negligible to minor adverse impacts to freshwater wetlands from managing additional acres of habitat (approximately 9,312 acres). Negligible to minor adverse impacts from constructing up to 19 1-mile-long, ADA-accessible hiking trails. Most of the management and trail construction will occur in uplands, but we will follow best management practice to reduce impacts where activities occur near wetlands.	*Within the next 15 years*: Similar to alternatives A and B. *Up to and beyond the next 15 years:* Compared to other alternatives, the second greatest potential to benefit wetlands by permanently protecting up to 197,337 acres of habitat. However, we also expect the greatest potential for adverse impacts to freshwater wetlands from managing additional acres of habitat (approximately 12,873 acres). Negligible to minor adverse impacts from constructing up to 22 1-mile-long, ADA-accessible hiking trails. Most of the management and trail construction will occur in uplands, but we will follow best management practice to reduce impacts where activities occur near wetlands.	*Within the next 15 years*: Similar to other alternatives, except slightly less impacts to wetlands because of very little to no active habitat management. *Up to and beyond the next 15 years:* Alternative D would have the greatest potential to benefit wetlands by from protecting the greatest amount of habitat with no to limited active management. Also, we would construct the least amount of new infrastructure (e.g., backcountry trails, kiosks, trailheads, boardwalks) under alternative D and eliminate snowmobiling trails. Negligible to minor adverse impacts from constructing up to 22 1-mile-long, native-material hiking trails. Most of the management and trail construction will occur in uplands, but we will follow best management practice to reduce impacts where activities occur near wetlands.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO UPLAND HABITATS AND VEGETATION			
Upland habitat and vegetation impacts that do not vary between the alternatives: None of alternatives would have a significant adverse effect on any upland habitats on the refuge. Under all alternatives, we predict negligible to minor long-term benefits from protecting, managing, and/or restoring upland habitats on the refuge. Under all alternatives, there is the potential for short-term adverse impacts to habitats from habitat management (e.g., herbicide application), new construction (e.g., trails, boardwalks, etc.), and refuge visitation; however, we would minimize these impacts by using best management practices and encouraging visitors to stay on trails.			
Within the next 15 years: Negligible adverse, short-term impacts from: • Visitor use (e.g., trampling of vegetation from small amount of off-trail use). • Continuing active habitat management on up to 255 acres of forest and 200 acres of grasslands (e.g., compaction and trampling from heavy equipment, use of herbicides and prescribed burning). *Up to and beyond the next 15 years:* Negligible to minor long-term beneficial impacts to wetlands from permanently protecting up to 97,830 acres of habitat.	*Within the next 15 years*: Similar to alternative A. *Up to and beyond the next 15 years:* Negligible to minor long-term beneficial impacts to uplands habitats and vegetation from permanently protecting up to 97,772 acres of habitat. Negligible to minor beneficial impacts to vegetation from managing additional acres of habitat (approximately 7,660 acres of forest, 422 acres of grassland, and 755 acres of shrubland). Negligible to minor adverse impacts from constructing up to 19 1-mile-long, ADA-accessible hiking trails and increased visitation.	*Within the next 15 years*: Similar to alternatives A and B. *Up to and beyond the next 15 years:* Compared to other alternatives, the second greatest potential to benefit upland habitats and vegetation by permanently protecting up to 197,337 acres of habitat. Negligible to minor beneficial impacts to vegetation from managing additional acres of habitat (approximately 11,550 acres of forest, 548 acres of grassland, and 755 acres of shrubland). Negligible to minor adverse impacts from constructing up to 22 1-mile-long, ADA-accessible hiking trails and increased visitation.	*Within the next 15 years*: Similar to other alternatives, except slightly less impacts to vegetation because of very little to no active habitat management. *Up to and beyond the next 15 years:* Alternative D would have the greatest potential to benefit uplands and vegetation by protecting the greatest amount of habitat. No beneficial impacts from active habitat management. Negligible to minor adverse impacts from constructing up to 22 1-mile-long, native-material hiking trails. Least potential for adverse imapacts among alternatives. Also, we would construct the least amount of new infrastructure (e.g., backcountry trails, kiosks, trailheads, boardwalks) under alternative D and eliminate snowmobiling trails.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO BIOLOGICAL INTEGRITY, DIVERSITY AND ENVIRONMENTAL HEALTH			
Biological integrity, diversity, and environmental health impacts that do not vary between the al**ternatives**: None of the alternatives would have significant adverse effects on biological integrity, diversity, or environmental health (BIDEH), either regionally or on the refuge. Under all alternatives, we predict negligible to minor long-term benefits to BIDEH from protecting, managing, and restoring native habitats, conserving native wildlife, and controlling invasive plants and animals. There is the potential for short-term, adverse impacts on some native wildlife and habitats from habitat management (e.g., herbicide application, timber harvesting), trail construction and facilities maintenance; however, we would minimize these impacts by using best management practices. Under all alternatives, there is also the potential for refuge visitors to adversely impact wildlife and habitats, but we would reduce these impacts by only allowing appropriate and compatible uses, encouraging visitors to stay on trails, and closing sensitive areas to public use, if necessary. Under all alternatives, we would actively manage habitats to mitigate threats to environmental health.			
Within the next 15 years: Negligible adverse, short-term impacts to BIDEH from: • Visitor use (e.g., trampling of vegetation from small amount of off-trail use). • Continuing active habitat management on up to 255 acres of forest and 200 acres of grasslands (e.g., compaction and trampling from heavy equipment, use of herbicides and prescribed burning). Beyond next 15 years: Negligible to minor long-term beneficial impacts to biological integrity from permanently protecting up to 97,830 acres of habitat. Negligible benefits to biological diversity from actively managing habitats to provide a diversity of age/size classes, successional stages, and structural diversity.	*Within the next 15 years*: Similar to alternative A. *Up to and beyond the next 15 years:* Minor to modest long-term beneficial impacts to biological integrity from permanently protecting up to 97,772 acres of habitat. The second greatest potential to benefit biological diversity by actively managing habitats (approximately 7,660 acres of forest, 422 acres of grassland, and 755 acres of shrubland) to provide a diversity of age/size classes, successional stages, and structural diversity. However, we also expect the greatest potential for adverse impacts to biological integrity from actively managing habitats and constructing up to 19 1-mile-long ADA-accessible hiking trails (e.g., trampling/removal of native vegetation and soil compaction). Our habitat management is designed to promote BIDEH by enhancing the diversity of refuge habitats and mimicking or restoring natural processes.	*Within the next 15 years*: Similar to alternatives A and B. *Up to and beyond the next 15 years:* Compared to other alternatives, the second greatest potential for beneficial impacts to biological integrity from permanently protecting up to 197,337 acres of habitat. The greatest potential to benefit biological diversity by actively managing the most acres of habitat (approximately 11,550 acres of forest, 548 acres of grassland, and 755 acres of shrubland) to provide a diversity of age/size classes, successional stages, and structural diversity. However, we also expect the greatest potential for adverse impacts to biological integrity from actively managing habitats and constructing up to 22 1-mile-long ADA-accessible hiking trails. Our habitat management is designed to promote BIDEH by enhancing the diversity of refuge habitats and mimicking or restoring natural processes.	*Within the next 15 years*: Similar to other alternatives. *Up to and beyond the next 15 years:* Compared to the other alternatives the greatest potential for benefits to biological integrity from permanently protecting and allowing natural processes on up to 231,307 acres of habitat. Also, from discontinuing snowmobiling and creating less developed trails and public use facilities. Slightly less potential for positive benefits to biological diversity because we will not actively manage refuge habitats (e.g., less structural diversity in forests, more homogenous age/size classes, fewer grasslands and shrublands). Benefits to ecological health would be similar to alternatives A, B, and C as we would use active management in the case of significant outbreaks of forest pests and other ecological disturbances.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES			
Listed species impacts that do not vary between the alte**rnatives**: None of the activities proposed in any of the alternatives should adversely affect any federally listed or Federal candidate species and we will continue to consult on proposed actions with Service Endangered Species staff under Section 7 of the Endangered Species Act. Under all alternatives, we will continue to work with partners to help conserve federally listed and Federal candidate species in the Connecticut River watershed. In particular, we will work with the Connecticut River Coordinator's office to conserve federally listed aquatic species that occur in the Connecticut River main stem and its tributaries. Under all alternatives, we will continue to protect federally listed species that occur on existing refuge lands. We will continue to manage habitat and prohibit public access to protect listed or proposed plant and beetle species. We will monitor known populations of listed or proposed species and work with the Service's New England Field Office to determine if any active habitat management on the refuge is warranted. We expect only negligible impacts to listed or proposed species from refuge visitors and from active habitat management. Visitors are encouraged to stay on trails and we will close sensitive areas to the public (e.g., Deadman's Swamp). Habitat management in areas where listed species occur is designed to improve these areas for those species and will result in long-term benefits for listed or proposed species. Under all alternatives, we may acquire additional lands that support or protect water quality for federally listed threatened and endangered and candidate species, including northern long-eared bat, dwarf wedgemussel, and shortnose sturgeon.			
Up to and beyond the next 15 years: Negligible to minor long-term beneficial impacts to listed and proposed species from permanently protecting up to 97,830 acres of habitat. Negligible to minor beneficial impacts from active forest, shrubland, and grassland management. Negligible adverse impacts from visitation.	*Up to and beyond the next 15 years:* Minor to modest long-term beneficial impacts to listed and proposed species from permanently protecting up to 97,772 acres of habitat. Negligible to minor beneficial impacts from active forest, shrubland, and grassland management. Negligible adverse impacts from trail construction or water quality. Negligible impacts from visitation.	*Up to and beyond the next 15 years:* Compared to other alternatives, the second greatest potential for beneficial impacts to listed and proposed species from permanently protecting up to 197,337 acres of habitat. Negligible to minor beneficial impacts from active forest, shrubland, and grassland management. Greatest potential for negligible adverse impacts from trail construction or water quality. Greatest potential for negligible adverse impacts from visitation.	*Up to and beyond the next 15 years:* Compared to the other alternatives the greatest potential for benefits to listed and proposed species from permanently protecting and allowing natural processes on up to 231,307 acres of habitat. Negligible to minor beneficial impacts from active forest, shrubland, and grassland management. Negligible adverse impacts from trail construction or water quality. Negligible adverse impacts from visitation.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
Impacts to Native Wildlife and Plants ** Covers the following sections: Impacts to Birds; Impacts to Mammals; Impacts to Fish, Aquatic Fauna, Reptiles, and Amphibians; Impacts to Rare Plants and Invertebrates **			
Native wildlife and plant impacts that do not vary between the alternatives: None of the activities proposed in any of the alternatives would significantly benefit or adversely affect terrestrial wildlife species at the watershed scale. All alternatives would permanently protect habitat for a wide-range of bird species across the watershed. Under all alternatives, there is the potential for negligible, short-term impacts to wildlife and rare plants species from habitat management, public use, and facilities maintenance and construction. However, we will minimize these impacts by using best management practices (e.g., delaying grassland mowing until after breeding) and encouraging visitors to stay on trails and closing sensitive areas to public use. Any active habitat management would be designed to enhance refuge habitats, and therefore, is expected to have long-term benefits to certain species. None of the activities proposed in any of the alternatives would significantly benefit or adversely impact aquatic species at the watershed scale. We would continue to work with partners (e.g., Connecticut River Coordinator's Office, Eastern Brook Trout Joint Venture, etc.) to conserve, restore and enhance aquatic species and habitat in the Connecticut River main stem and its tributaries (e.g., land conservation, removing barriers to aquatic organism passage, improving water quality). Under all alternatives, there is the potential for negligible, short-term impacts to aquatic species from habitat management (e.g., mowing, forest management, and invasive plant control), public use, and facilities maintenance and construction. However, we will minimize these impacts by using best management practices (e.g., approved herbicide use for invasive plant control, not mowing within 100 feet of wetland areas, appropriate buffering of streams and vernal pools during forest management activities) and encouraging visitors to stay on trails and closing sensitive areas to public use.			
Within the next 15 years: Negligible adverse, short-term impacts from: • Visitor use (e.g., disturbance along trails, trampling of plants and small animals, road kill from vehicles, disturbance from snowmobiles, siltation into streams from trail use, impacts from hunting and fishing following state regulations). • Continuing active habitat management on up to 255 acres of forest and 200 acres of grasslands (e.g., short-term displacement or disturbance, compaction and trampling from heavy equipment, use of herbicides and prescribed burning). Beyond next 15 years: Negligible to minor long-term beneficial impacts from permanently protecting up to 97,830 acres of habitat. Negligible to minor benefits to species requiring actively management habitats. We would continue to manage approximately 255 acres of early successional forest and 200 acres of grasslands.	*Within the next 15 years*: Similar to alternative A. Beyond next 15 years: Similar to alternative A, over the long term alternative B will protect up to 97,772 acres of habitat. Compared to alternative A, alternative B will protect larger, more contiguous tracts of habitat. The second greatest benefit to species that require actively managed habitats, such as grasslands, shrublands, or young forests (approximately 7,660 acres of forest, 422 acres of grassland, and 755 acres of shrubland). Compared to alternative A, slightly greater potential for adverse, short-term impacts from: • Actively managing greater amounts of habitat (approximately 9,312 acres). • Constructing new trails (up to 19, 1-mile long ADA-accessible trails). • An increase in refuge visitation (e.g., disturbance along trails).	*Within the next 15 years*: Similar to alternatives A and B. Beyond next 15 years: Over the long term, alternative C will protect the second greatest amount of habitat (up to 197,337 acres). The second greatest benefit to species that require large, contiguous, relatively undisturbed blocks of mature forest. The greatest benefit to species that require actively managed habitats, such as grasslands, shrublands, or young forests (approximately 11,550 acres of forest, 548 acres of grassland, and 755 acres of shrubland). However, compared to other alternatives, the greatest potential for adverse, short-term impacts from: • Disturbance from actively managing the greatest amount of habitat (approximately 12,873 acres). • Constructing new trails (up to 22, 1-mile long ADA-accessible trails). • The greatest projected increase in refuge visitation.	*Within the next 15 years*: Similar to other alternatives, except that snowmobiling would be eliminated and no active habitat management, except in rare circumstances (e.g., major disturbance such as fire, hurricane, or ice storm, to restore degraded habitats, for threatened and endangered species). Beyond next 15 years: Over the long term, alternative D will protect the greatest amount of habitat (up to 231,307 acres). The greatest benefit to species that require large, contiguous, relatively undisturbed blocks of mature forest. The greatest adverse impact to species that require actively managed habitats, such as grasslands, shrublands, or young forests. Fewest impacts from public use because we would eliminate snowmobiling and create less developed trails and public use facilities.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
Impacts to Archaeological, Historical, and Cultural Resources			
Archaeological, historical, and cultural resource impacts that do not vary between the alternatives: We expect negligible to minor benefits to cultural resources under all alternatives because we would continue to consult with Service archaeologists and state and Tribal historic preservation officers prior to ground-disturbing activities to limit disturbance to refuge's archaeological, historical, and cultural resources. Also, we would protect any known sites or resources on the refuge and incorporate information on these resources into refuge interpretive and educational programs. There is a small risk that our management activities would disturb unknown sites, as well as the risk that some visitors may inadvertently or intentionally damage known of undiscovered sites.			
Same as impacts that do not vary by alternative		Compared to alternative A, alternatives B and C would have a greater potential to benefit archaeological, historical, and cultural resources because they propose to increase protection efforts for these resources through better planning and more extensive survey work.	Similar to alternatives B and C, except alternative D has the least potential to disturb archaeological, historical, and cultural resources because it proposes the least amount of ground-disturbing activities.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO PUBLIC USE AND ACCESS			
Public use and access impacts that do not vary between the alte**rnatives**: Under all alternatives, we would continue to provide opportunities for six compatible, priority, wildlife-dependent public uses (wildlife observation and photography, environmental education, interpretation, fishing, and hunting). Under all alternatives, there is a small possibility of conflicts between users groups (e.g., between hunters and other users, pet walkers and bird watchers). Also, some sensitive areas of the refuge are closed to public use, but this mitigated by other public use opportunities on other parts of the refuge or other ownerships nearby.			
Negligible beneficial impacts from permanently protected public access on refuge lands. Continue to offer current level of public use and access on existing refuge divisions and units, including the six priority public uses. We would also allow these uses on newly acquired lands, if found compatible. Continue to allow snowmobiling on designated trails at the Pondicherry, Nulhegan Basin, and Deadbranch Division. Based on current low levels of visitation, we anticipate negligible short-term, adverse impacts from conflicts between user groups.	Negligible beneficial impacts from permanently protected public access on refuge lands. Continue to offer current levels of public use and access, including the six priority uses. We would also allow these uses on newly acquired lands, if found compatible. Continue to allow snowmobiling on designated trails at the Pondicherry, Nulhegan Basin, and Deadbranch Division. Compared to alternative A, we expect slightly greater benefits to visitors, especially those with limited mobility, from the construction of up to 19 miles of ADA-accessible trails. Compared to alternative A, slightly greater potential for conflicts between user groups as visitation increases (we anticipate a 22 percent increase in on refuge visits over current levels).	Similar to alternative B; however, expect greater beneficial impacts from permanently securing public access on additional acres. Continue to allow snowmobiling on designated trails at the Pondicherry, Nulhegan Basin, and Deadbranch Division Compared to alternative B, we would construct up to 22 miles of ADA-accessible trails. Compared to alternatives A and B, slightly greater potential for conflicts between user groups as visitation increases (we anticipate a 54 percent increase in on refuge visits over current levels).	Continue to offer opportunities for the six priority public uses, focusing on providing a more backcountry experience (e.g., narrower, native surface trails; less motorized uses; less developed facilities; etc.). Adverse impacts to snowmobilers from closing all refuge snowmobile trails; however, we expect these impacts to be minor as extensive snowmobile trails are available on other ownerships nearby. Compared to alternative A, slightly greater potential for conflicts between user groups as visitation increases (we anticipate a 24 percent increase in on refuge visits over current levels). Reduced potential for some conflicts as snowmobiling is eliminated.

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IMPACTS TO REGIONAL AND LOCAL SOCIOECONOMICS			
Socioeconomic impacts that do not vary between the alternatives: Under all alternatives, we would continue to pay refuge revenue sharing payments to municipalities where refuge lands are located. Regardless of the alternative selected, refuge jobs, refuge expenditures, and visitor spending would negligibly contribute to the local economy.			
Refuge purchase of goods and services and Refuge personnel salary spending			
As additional refuge lands are acquired, non-salary expenditures will shift from occurring most frequently in the north to greater spending in the south of the watershed. We would continue to maintain our current level of staffing and, therefore, we would expect personnel salary spending to continue at similar levels.	Similar to alternative A	Compared to alternatives A and B, we predict an increase in spending of about $175,000, particularly in the Tri-State Border and White River Junction subregions. Over the long term, we would add up to 16 new staff positions (dependent upon funding), particularly in the Northern and Tri-State Border subregions.	Similar to alternative C
Refuge visitor spending in the local economy			
In general, visitation (and therefore visitor spending) would continue at current levels at existing divisions and units. Once the ADA-accessible trail at the Fort River Division is complete, we expect annual visitation there to increase. Over the long term, as we acquire additional lands in other areas in the southern watershed, we expect visitation and visitor spending to increase in these areas.	Similar to alternative A, we expect current levels of visitation (and therefore visitor spending) to continue at existing divisions and units. As new lands are acquired and additional ADA-accessible trails are built, we expect visitation to increase (estimate about 10 percent above current visitation levels).	Similar to alternative B, except we expect a slightly greater increase in visitation (estimate about 13 percent above current visitation levels).	Large decrease in visitation in the Northern subregion from eliminating snowmobiling. However impact on local economy likely minor as many other snowmobile trails exist in area. Over the long term, as new lands are acquired we anticipate that non-snowmobile visits will increase. However, we expect a smaller increase in visitation under alternative D than under alternatives B and C because we propose less developed trails.
Economic contributions from habitat management			
We may acquire additional acres of commercial forest lands across the watershed, particularly in the Northern, White River Junction, and Tri-State Border Subregions. We would continue to manage approximately 225 acres of forest in the Northern Subregion and up to 200 acres of grassland each year across the Northern and Greater Amherst Subregions for migratory birds and other wildlife, generating negligible amounts of timber products and hay.	Short-term impacts similar to alternative A. Over the long term, as we acquire new refuge lands, we would actively manage approximately 7,660 acres of forest. We would also manage approximately 422 acres of grassland and 775 acres of shrubland on the refuge. Similar to A, as part of this management, we may generate some negligible to minor amounts of timber products and hay.	Short-term impacts similar to alternative A. Over the long term, as we acquire new refuge lands, we would actively manage up to 11,500 acres. We would also manage approximately 548 acres of grassland and 775 acres of shrubland on the refuge. Similar to A and B, As part of this management, we may generate some negligible to minor amounts of timber products and hay.	Alternative D would generate the smallest economic contribution from habitat management. Under alternative D, we would passively manage all refuge habitats, except in rare circumstances (e.g., major disturbance such as fire, hurricane, or ice storm, to restore degraded habitats, for threatened and endangered species).

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO REGIONAL AIR QUALITY			
Air quality impacts that do not vary between the alternatives: None of the alternatives would significantly benefit or adversely affect local or regional air quality. None of the alternatives would violate EPA standards for air pollutants and all would comply with the Clean Air Act. There are no major stationary or mobile sources of air pollution present on Service-owned lands nor would any be created under any of the alternatives. No Class I air quality areas would be affected. All of the alternatives would have short- and long-term negligible adverse impacts (e.g., emissions from vehicles, equipment, and buildings) and negligible to minor long-term beneficial impacts (e.g., preventing further development, sequestrating carbon, and filtering air from permanently protecting native habitats) on regional air quality. To reduce the amount of refuge emissions, we would replace or upgrade, as necessary, refuge equipment, vehicles, and facilities with more efficient models and look for alternative energy sources.			
Within the next 15 years: Negligible, short-term adverse impacts from: • Maintaining existing refuge administrative and public use facilities (e.g., trails, roads, buildings). • Emissions from refuge facilities (e.g., heating/cooling buildings) and from refuge staff and visitor vehicles, including snowmobiles. • Emissions from equipment for continuing existing habitat management projects (up to 445 acres). *Beyond the next 15 years:* Negligible long-term beneficial impacts to regional air quality from protecting up to 97,830 acres of habitat from further development (e.g., continued carbon sequestration, decreased likelihood of emissions from development).	*Within the next 15 years*: Similar to other alternatives—negligible, short-term adverse impacts. *Beyond the next 15 years:* Similar to alternative A, negligible long-term beneficial impacts to regional air quality from protecting up to 97,772 acres of habitat. However, slightly greater potential for adverse, short-term impacts from: • Emissions from managing greater amounts of habitat (approximately 9,312 acres). • Emissions and fugitive dust from constructing new trails (up to 19 1-mile long ADA-accessible trails). • An increase in refuge visitation, and related increase in vehicle emissions.	*Within the next 15 years*: Similar to other alternatives—negligible, short-term adverse impacts. *Beyond the next 15 years:* Negligible long-term beneficial impacts to regional air quality. Compared to other alternatives, second greatest potential to benefit regional air quality from protecting up to 197,337 acres of habitat. However, compared to other alternatives, the greatest potential for adverse, short-term impacts from: • Emissions from managing the greatest amounts of habitat (approximately 12,873 acres). • Emissions and fugitive dust from constructing new trails (up to 22, 1-mile long ADA-accessible trails). • The greatest projected increase in refuge visitation and related increase in vehicle emissions.	*Within the next 15 years*: Similar to other alternatives—negligible, short-term adverse impacts. *Beyond the next 15 years:* Negligible long-term beneficial impacts to regional air quality. Compared to other alternatives, greatest potential to benefit regional air quality from: • Protecting the greatest amount of habitat and discontinuing active management (e.g., by permanently protecting 231,307 acres from development). • Allowing the least amount of motorized use (e.g., eliminating snowmobiling). • Proposing the fewest new construction projects (e.g., new hiking trails and other public use infrastructure).

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO REGIONAL HYDROLOGY AND WATER QUALITY			
Hydrology and water quality impacts that do not vary between the alternatives: None of our proposed management activities would *significantly* benefit or adversely affect local or regional hydrology and water quality. None of our proposed management activities would violate Federal or state standards for contributing pollutants to water sources; all four would comply with the Clean Water Act. Under all alternatives, we would use best management practices to prevent spills and protect hydrology and water quality during management (e.g., only using approved herbicides to remove invasive plants, leaving a forested buffer along riparian areas) and construction (e.g., using elevated boardwalks and installing appropriately sized culverts) activities. We would also encourage refuge visitors to stay on trails and in other designated areas to limit potential to disrupt hydrology or adversely affect water quality (e.g., trail erosion into streams). We also require that pet owners remove solid pet wastes to reduce the potential to affect water quality.			
Within the next 15 years: Negligible adverse short-term, localized impacts from refuge visitation (e.g., snowmobile emissions), road and trail maintenance, and invasive plant control (e.g., herbicide application). Beyond next 15 years: Negligible, long-term beneficial impacts to regional water quality and hydrology from protecting up to 97,830 acres of habitat from further development.	*Within the next 15 years*: Similar to other alternatives—negligible, short-term adverse impacts. Beyond next 15 years: Compared to other alternatives, second greatest potential for long-term benefits to regional air quality from protecting up to 197,296 acres of native habitat. We expect these impacts to be minor to modest. However, compared to other alternatives, the greatest potential for adverse, short-term impacts from: • Equipment and vehicle emissions from actively managing the greatest amount of habitat (approximately 12,873 acres). • Constructing new trails (up to 22, 1-mile long ADA-accessible trails). • The greatest projected increase in refuge visitation (i.e., increased vehicle emissions).	*Within the next 15 years*: Negligible adverse short-term, localized impacts from refuge visitation, road, and trail maintenance, new construction (e.g., trails and trail heads) and invasive plant control (e.g., herbicide application). Compared to other alternatives, least potential for adverse short-term impacts because of emphasis on a "back-country" visitor experience, eliminating snowmobiling, and least amount of active habitat management. *Beyond the next 15 years:* Minor to modest long-term beneficial impacts to regional hydrology and water quality. Compared to other alternatives, greatest potential for benefits to regional hydrology and water quality by protecting the greatest amount of habitat (up to 231,307 acres) and allowing natural hydrological processes to occur across the refuge, with limited to no active management.	*Within the next 15 years*: Negligible adverse short-term, localized impacts from refuge visitation, road, and trail maintenance, new construction (e.g., trails and trail heads) and invasive plant control (e.g., herbicide application). Compared to other alternatives, least potential for adverse short-term impacts because of emphasis on a "back-country" visitor experience, eliminating snowmobiling, and least amount of active habitat management. *Beyond the next 15 years:* Minor to modest long-term beneficial impacts to regional hydrology and water quality. Compared to other alternatives, greatest potential for benefits to regional hydrology and water quality by protecting the greatest amount of habitat (up to 231,307 acres) and allowing natural hydrological processes to occur across the refuge, with limited to no active management.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO CLIMATE CHANGE			
Climate change impacts that do not vary between the alternatives: Under all alternatives, refuge operations and emissions from refuge and visitor vehicles would continue to contribute negligibly to climate change. However, under all alternatives we would continue to seek ways to limit the refuge's carbon emissions by adopting energy efficient practices.			
Negligible adverse impacts from: • Emissions from staff and visitor vehicles (including snowmobiles). • Refuge equipment and machinery used to maintain existing administrative and public use facilities and to actively manage habitats (up to 455 acres). Negligible to minor long-term benefits from permanently protecting up to 97,830 acres of habitat (e.g., carbon sequestration).	Negligible adverse impacts from emissions from staff and visitor vehicles (including snowmobiles). Compared to alternative A, we expect slightly higher visitation from completing up to 19, 1-mile ADA-accessible trails. Compared to alternative A, slightly greater potential for adverse impacts from actively managing greater amounts of habitat (approximately 9,312 acres). Negligible to minor long-term benefits from permanently protecting up to 97,772 acres of habitat.	Negligible adverse impacts from emissions from staff and visitor vehicles (including snowmobiles). Compared to alternatives A and B, we expect higher visitation from completing up to 22 1-mile ADA-accessible trails. Compared to alternatives A and B, slightly greater potential for adverse impacts from actively managing greater amounts of habitat (approximately 12,873 acres). Compared to other alternatives, second greatest potential for benefits from permanently protecting up to 197,337 acres of habitat.	Negligible adverse impacts from emissions from staff and visitor vehicles. Compared to other alternatives, the least potential for adverse impacts because we would eliminate snowmobiling. Compared to other alternatives, least potential for adverse impacts from active habitat management because we would passively manage all refuge habitats, except in rare circumstances (e.g., major disturbance such as fire, hurricane, or ice storm, to restore degraded habitats, for threatened and endangered species). Compared to other alternatives, greatest potential for benefits from permanently protecting up to 231,307 acres of habitat.
IMPACTS TO SOILS			
Soil impacts that do not vary between the alternatives: None of our proposed management activities would significantly benefit or adversely affect local or regional soils. Under all alternatives, we would use best management practices to conserve soils during management (e.g., forest management to improve habitat), maintenance, and construction (e.g., new trail construction) activities. We would also encourage refuge visitors to stay on trails and in other designated areas to limit potential for soil erosion and compaction.			
Within the next 15 years: Negligible adverse short-term, localized impacts from: • Visitor use impacts (e.g., soil compaction and erosion alongside trails). • Road and trail maintenance. • Invasive plant control (e.g., herbicide application). • Continuing to manage up to 455 acres of habitat. Beyond next 15 years: Negligible minor long-term beneficial impacts to soils from permanently protecting up to 97,830 acres of habitat.	*Within the next 15 years*: Similar to alternative A. Beyond next 15 years: Similar to alternative A, minor beneficial impacts to soils from permanently protecting up to 97,772 acres of habitat. We expect slightly greater benefits from protecting larger blocks of habitat under alternative B. However, we also expect a slightly greater potential for adverse impacts to soils from managing additional acres of habitat (approximately 9,312 acres). Also, from constructing up to 19 1-mile-long, ADA-accessible hiking trails and increased visitation.	*Within the next 15 years*: Similar to alternatives A and B. Beyond next 15 years: Compared to other alternatives, the second greatest potential to benefit soils from permanently protecting up to 197,337 acres of habitat. However, compared to other alternatives, the greatest potential for adverse impacts to soils from actively managing additional acres of habitat (approximately 12,873 acres) and from constructing up to 22 1-mile-long, ADA-accessible trails. We also expect the highest visitation under alternative C.	*Within the next 15 years*: Similar to other alternatives, except slightly less impacts to soils because of very little to no active habitat management. Beyond next 15 years: Alternative D would have the greatest potential to benefit soils from protecting the greatest amount of habitat and allowing soil processes to occur, with no to limited active management. Also, we would construct the least amount of new infrastructure (e.g., backcountry trails, kiosks, trailheads, boardwalks) under alternative D and eliminate snowmobiling trails.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO FRESHWATER WETLANDS			
Freshwater wetland impacts that do not vary between the alternatives: None of alternatives would have a *significant* adverse effect on any freshwater wetland habitats on the refuge. Under all alternatives, we predict negligible to minor long-term benefits from protecting and/or restoring wetland habitats on the refuge. We would also use best management practices to minimize adverse impacts to wetlands from new construction (e.g., building outside of wetland areas), trail and road maintenance, invasive species control (e.g. only using approved herbicides and/or using other non-chemical controls), and habitat management (e.g., buffering wetlands). The majority of habitat management will occur in upland areas, away from freshwater wetlands. We would also encourage visits to stay on trails to minimize the potential for impacts to wetland vegetation and wildlife.			
Within the next 15 years: Negligible adverse short-term, localized impacts from: • Visitor use (e.g., sedimentation from small amounts of off trail use). • Road and trail maintenance. • Invasive plant control (e.g., herbicide application). • Continuing to manage upland habitats following best management practices (up to 455 acres). Beyond next 15 years: Negligible to minor long-term beneficial impacts to wetlands from permanently protecting up to 97,830 acres of habitat.	*Within the next 15 years*: Similar to alternative A. Beyond next 15 years: Negligible to minor long-term beneficial impacts to wetlands from permanently protecting up to 97,772 acres of habitat. However, we also expect a slightly greater potential for adverse impacts to soils from managing additional acres of habitat (approximately 9,312 acres). Also, from constructing up to 19 1-mile-long, ADA-accessible hiking trails. Most of the management and trail construction will occur in uplands, but we will follow best management practice to reduce impacts where activities occur near wetlands.	*Within the next 15 years*: Similar to alternatives A and B. Beyond next 15 years: Compared to other alternatives, the second greatest potential to benefit wetlands by permanently protecting up to 197,337 acres of habitat. However, we also expect the greatest potential for adverse impacts to soils from managing additional acres of habitat (approximately 12,873 acres). Also, from constructing up to 22 1-mile-long, ADA-accessible hiking trails. Most of the management and trail construction will occur in uplands, but we will follow best management practice to reduce impacts where activities occur near wetlands.	*Within the next 15 years*: Similar to other alternatives, except slightly less impacts to wetlands because of very little to no active habitat management. Beyond next 15 years: Alternative D would have the greatest potential to benefit wetlands by from protecting the greatest amount of habitat with no to limited active management. Also, we would construct the least amount of new infrastructure (e.g., backcountry trails, kiosks, trailheads, boardwalks) under alternative D and eliminate snowmobiling trails.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO UPLAND HABITATS AND VEGETATION			
Upland habitat and vegetation impacts that do not vary between the alternatives: None of alternatives would have a *significant* adverse effect on any upland habitats on the refuge. Under all alternatives, we predict negligible to minor long-term benefits from protecting, managing, and/or restoring upland habitats on the refuge. Under all alternatives, there is the potential for short-term adverse impacts to habitats from habitat management (e.g., herbicide application), new construction (e.g., trails, boardwalks, etc.), and refuge visitation; however, we would minimize these impacts by using best management practices and encouraging visitors to stay on trails.			
Within the next 15 years: Negligible adverse, short-term impacts from: • Visitor use (e.g., trampling of vegetation from small amount of off-trail use). • Continuing active habitat management on up to 255 acres of forest and 200 acres of grasslands (e.g., compaction and trampling from heavy equipment, use of herbicides and prescribed burning). Beyond next 15 years: Negligible to minor long-term beneficial impacts to wetlands from permanently protecting up to 97,830 acres of habitat.	*Within the next 15 years*: Similar to alternative A. Beyond next 15 years: Negligible to minor long-term beneficial impacts to uplands habitats and vegetation from permanently protecting up to 97,772 acres of habitat. However, we also expect a slightly greater potential for adverse impacts to vegetation from managing additional acres of habitat (approximately 7,660 acres of forest, 422 acres of grassland, and 755 acres of shrubland) and from constructing up to 19 1-mile-long, ADA-accessible hiking trails and increased visitation.	*Within the next 15 years*: Similar to alternatives A and B. Beyond next 15 years: Compared to other alternatives, the second greatest potential to benefit upland habitats and vegetation by permanently protecting up to 197,337 acres of habitat. However, we also expect the greatest potential for adverse impacts to vegetation from managing additional acres of habitat (approximately 11,550 acres of forest, 548 acres of grassland, and 755 acres of shrubland). Also, from constructing up to 22 1-mile-long, ADA-accessible hiking trails and increased visitation.	*Within the next 15 years*: Similar to other alternatives, except slightly less impacts to vegetation because of very little to no active habitat management. Beyond next 15 years: Alternative D would have the greatest potential to benefit uplands and vegetation by protecting the greatest amount of habitat with no to limited active management. Also, we would construct the least amount of new infrastructure (e.g., backcountry trails, kiosks, trailheads, boardwalks) under alternative D and eliminate snowmobiling trails.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO BIOLOGICAL INTEGRITY, DIVERSITY AND ENVIRONMENTAL HEALTH			
Biological integrity, diversity, and environmental health impacts that do not vary between the alternatives: None of the alternatives would have *significant* adverse effects on biological integrity, diversity, or environmental health (BIDEH), either regionally or on the refuge. Under all alternatives, we predict negligible to minor long-term benefits to BIDEH from protecting, managing, and restoring native habitats, conserving native wildlife, and controlling invasive plants and animals. There is the potential for short-term, adverse impacts on some native wildlife and habitats from habitat management (e.g., herbicide application, timber harvesting), trail construction and facilities maintenance; however, we would minimize these impacts by using best management practices. Under all alternatives, there is also the potential for refuge visitors to adversely impact wildlife and habitats, but we would reduce these impacts by only allowing appropriate and compatible uses, encouraging visitors to stay on trails, and closing sensitive areas to public use, if necessary.			
Within the next 15 years: Negligible adverse, short-term impacts to BIDEH from: • Visitor use (e.g., trampling of vegetation from small amount of off-trail use). • Continuing active habitat management on up to 255 acres of forest and 200 acres of grasslands (e.g., compaction and trampling from heavy equipment, use of herbicides and prescribed burning). Beyond next 15 years: Negligible to minor long-term beneficial impacts to biological integrity from permanently protecting up to 97,830 acres of habitat. Negligible benefits to biological diversity from actively managing habitats to provide a diversity of age/size classes, successional stages, and structural diversity. Similar to other alternatives, we would actively manage habitats in the case of threats to environmental health.	*Within the next 15 years*: Similar to alternative A. Beyond next 15 years: Minor to modest long-term beneficial impacts to biological integrity from permanently protecting up to 97,772 acres of habitat. The second greatest potential to benefit biological diversity by actively managing habitats (approximately 7,660 acres of forest, 422 acres of grassland, and 755 acres of shrubland) to provide a diversity of age/size classes, successional stages, and structural diversity. Similar to other alternatives, we would actively manage habitats in the case of threats to environmental health. However, we also expect the greatest potential for adverse impacts to biological integrity from actively managing habitats and constructing up to 19 1-mile-long ADA-accessible hiking trails (e.g., trampling/removal of native vegetation and soil compaction). However, our habitat management is designed to promote BIDEH by enhancing the diversity of refuge habitats and mimicking or restoring natural processes.	*Within the next 15 years*: Similar to alternatives A and B. Beyond next 15 years: Compared to other alternatives, the second greatest potential for beneficial impacts to biological integrity from permanently protecting up to 197,337 acres of habitat. The greatest potential to benefit biological diversity by actively managing the most acres of habitat (approximately 11,550 acres of forest, 548 acres of grassland, and 755 acres of shrubland) to provide a diversity of age/size classes, successional stages, and structural diversity. Similar to other alternatives, we would actively manage habitats in the case of threats to environmental health. However, we also expect the greatest potential for adverse impacts to biological integrity from actively managing habitats and constructing up to 22 1-mile-long ADA-accessible hiking trails. However, our habitat management is designed to promote BIDEH by enhancing the diversity of refuge habitats and mimicking or restoring natural processes.	*Within the next 15 years*: Similar to other alternatives. Beyond next 15 years: Compared to the other alternatives the greatest potential for benefits to biological integrity from permanently protecting and allowing natural processes on up to 231,307 acres of habitat. Also, from discontinuing snowmobiling and creating less developed trails and public use facilities. Slightly less potential for positive benefits to biological diversity because we will not actively manage refuge habitats (e.g., less structural diversity in forests, more homogenous age/size classes, fewer grasslands and shrublands). Benefits to ecological health would be similar to alternatives A, B, and C as we would use active management in the case of significant outbreaks of forest pests and other ecological disturbances.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES			
Listed species impacts that do not vary between the alternatives: None of the activities proposed in any of the alternatives should adversely affect any federally listed or Federal candidate species and we will continue to consult on proposed actions with Service Endangered Species staff under Section 7 of the Endangered Species Act. Under all alternatives, we will continue to work with partners to help conserve federally listed and Federal candidate species in the Connecticut River watershed. In particular, we will work with the Connecticut River Coordinator's office to conserve federally listed aquatic species that occur in the Connecticut River main stem and its tributaries. Under all alternatives, we will continue to protect federally listed species that occur on existing refuge lands. At the Deadman's Swamp Unit, we will continue to manage habitat (e.g., invasive plant control) and prohibit public access to protect the federally threatened Puritan tiger beetle. At the Putney Mountain Unit, we will continue to protect populations of the federally endangered northeastern bulrush and monitor the impacts to this plant from unauthorized public uses. At the Nulhegan Basin Division, we will continue to monitor federally threatened Canada lynx use of the refuge and work with the Service's New England Field Office to determine if any active habitat management on the refuge is warranted. We expect only negligible impacts to listed species from refuge visitors and from active habitat management. Visitors are encouraged to stay on trails and we will close sensitive areas to the public (e.g., Deadman's Swamp). Habitat management in areas where listed species occur is designed to improve these areas for those species and will result in long-term benefits for listed-species. Under all alternatives, we may acquire additional lands that support or protect water quality for federally listed threatened and endangered and candidate species, including northern long-eared bat, dwarf wedgemussel, and shortnose sturgeon.			
Same as those described under impacts that do not vary among the alternatives.	*Within the next 15 years*: Same as those described under impacts that do not vary among the alternatives.	*Within the next 15 years*: Same as those described under impacts that do not vary among the alternatives.	*Within the next 15 years*: Same as those described under impacts that do not vary among the alternatives.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
Impacts to Native Wildlife and Plants ** Covers the following sections: Impacts to Birds; Impacts to Mammals; Impacts to Fish, Aquatic Fauna, Reptiles, and Amphibians; Impacts to Rare Plants and Invertebrates **			
Native wildlife and plant impacts that do not vary between the alternatives: None of the activities proposed in any of the alternatives would significantly benefit or adversely affect terrestrial wildlife species at the watershed scale. All alternatives would permanently protect habitat for a wide-range of bird species across the watershed. Under all alternatives, there is the potential for negligible, short-term impacts to wildlife and rare plants species from habitat management, public use, and facilities maintenance and construction. However, we will minimize these impacts by using best management practices (e.g., delaying grassland mowing until after breeding) and encouraging visitors to stay on trails and closing sensitive areas to public use. Any active habitat management would be designed to enhance refuge habitats, and therefore, is expected to have long-term benefits to certain species. None of the activities proposed in any of the alternatives would *significantly* benefit or adversely impact aquatic species at the watershed scale. We would continue to work with partners (e.g., Connecticut River Coordinator's Office, Eastern Brook Trout Joint Venture, etc.) to conserve, restore and enhance aquatic species and habitat in the Connecticut River main stem and its tributaries (e.g., land conservation, removing barriers to aquatic organism passage, improving water quality). Under all alternatives, there is the potential for negligible, short-term impacts to aquatic species from habitat management (e.g., mowing, forest management, and invasive plant control), public use, and facilities maintenance and construction. However, we will minimize these impacts by using best management practices (e.g., approved herbicide use for invasive plant control, not mowing within 100 feet of wetland areas, appropriate buffering of streams and vernal pools during forest management activities) and encouraging visitors to stay on trails and closing sensitive areas to public use.			
Within the next 15 years: Negligible adverse, short-term impacts from: • Visitor use (e.g., disturbance along trails, trampling of plants and small animals, road kill from vehicles, disturbance from snowmobiles, siltation into streams from trail use, impacts from hunting and fishing following state regulations). • Continuing active habitat management on up to 255 acres of forest and 200 acres of grasslands (e.g., short-term displacement or disturbance, compaction and trampling from heavy equipment, use of herbicides and prescribed burning). Beyond next 15 years: Negligible to minor long-term beneficial impacts from permanently protecting up to 97,830 acres of habitat. Negligible to minor benefits to species requiring actively management habitats. We would continue to manage approximately 255 acres of early successional forest and 200 acres of grasslands.	*Within the next 15 years*: Similar to alternative A. Beyond next 15 years: Similar to alternative A, over the long term alternative B will protect up to 97,772 acres of habitat. Compared to alternative A, alternative B will protect larger, more contiguous tracts of habitat. The second greatest benefit to species that require actively managed habitats, such as grasslands, shrublands, or young forests (approximately 7,660 acres of forest, 422 acres of grassland, and 755 acres of shrubland). Compared to alternative A, slightly greater potential for adverse, short-term impacts from: • Actively managing greater amounts of habitat (approximately 9,312 acres). • Constructing new trails (up to 19, 1-mile long ADA-accessible trails). • An increase in refuge visitation (e.g., disturbance along trails).	*Within the next 15 years*: Similar to alternatives A and B. Beyond next 15 years: Over the long term, alternative C will protect the second greatest amount of habitat (up to 197,337 acres). The second greatest benefit to species that require large, contiguous, relatively undisturbed blocks of mature forest. The greatest benefit to species that require actively managed habitats, such as grasslands, shrublands, or young forests (approximately 11,550 acres of forest, 548 acres of grassland, and 755 acres of shrubland). However, compared to other alternatives, the greatest potential for adverse, short-term impacts from: • Disturbance from actively managing the greatest amount of habitat (approximately 12,873 acres). • Constructing new trails (up to 22, 1-mile long ADA-accessible trails). • The greatest projected increase in refuge visitation.	*Within the next 15 years*: Similar to other alternatives, except that snowmobiling would be eliminated and no active habitat management, except in rare circumstances (e.g., major disturbance such as fire, hurricane, or ice storm, to restore degraded habitats, for threatened and endangered species). Beyond next 15 years: Over the long term, alternative D will protect the greatest amount of habitat (up to 231,307 acres). The greatest benefit to species that require large, contiguous, relatively undisturbed blocks of mature forest. The greatest adverse impact to species that require actively managed habitats, such as grasslands, shrublands, or young forests. Fewest impacts from public use because we would eliminate snowmobiling and create less developed trails and public use facilities.

Alternative A Current Management	Alternative B Consolidated Stewardship	Alternative C (Service-preferred) Enhanced Conservation Connections and Partnerships	Alternative D Reduced Management with Emphasis on Backcountry Recreation
IMPACTS TO ARCHAEOLOGICAL, HISTORICAL, AND CULTURAL RESOURCES			
Archaeological, historical, and cultural resource impacts that do not vary between the alternatives: We expect negligible to minor benefits to cultural resources under all alternatives because we would continue to consult with Service archaeologists and state and Tribal historic preservation officers prior to ground-disturbing activities to limit disturbance to refuge's archaeological, historical, and cultural resources. Also, we would protect any known sites or resources on the refuge and incorporate information on these resources into refuge interpretive and educational programs. There is a small risk that our management activities would disturb unknown sites, as well as the risk that some visitors may inadvertently or intentionally damage known of undiscovered sites.			
Same as impacts that do not vary by alternative	Compared to alternative A, alternatives B and C would have a greater potential to benefit archaeological, historical, and cultural resources because they propose to increase protection efforts for these resources through better planning and more extensive survey work.		Similar to alternatives B and C, except alternative D has the least potential to disturb archaeological, historical, and cultural resources because it proposes the least amount of ground-disturbing activities.
IMPACTS TO PUBLIC USE AND ACCESS			
Public use and access impacts that do not vary between the alternatives: Under all alternatives, we would continue to provide opportunities for six compatible, priority, wildlife-dependent public uses (wildlife observation and photography, environmental education, interpretation, fishing, and hunting). Under all alternatives, there is a small possibility of conflicts between users groups (e.g., between hunters and other users, pet walkers and bird watchers). Also, some sensitive areas of the refuge are closed to public use, but this mitigated by other public use opportunities on other parts of the refuge or other ownerships nearby.			
Negligible beneficial impacts from permanently protected public access on refuge lands. Continue to offer current level of public use and access on existing refuge divisions and units, including the six priority public uses. We would also allow these uses on newly acquired lands, if found compatible. Continue to allow snowmobiling on designated trails at the Pondicherry, Nulhegan Basin, and Deadbranch Division. Based on current low levels of visitation, we anticipate negligible short-term, adverse impacts from conflicts between user groups.	Negligible beneficial impacts from permanently protected public access on refuge lands. Continue to offer current levels of public use and access, including the six priority uses. We would also allow these uses on newly acquired lands, if found compatible. Continue to allow snowmobiling on designated trails at the Pondicherry, Nulhegan Basin, and Deadbranch Division. Compared to alternative A, we expect slightly greater benefits to visitors, especially those with limited mobility, from the construction of up to 19 miles of ADA-accessible trails. Compared to alternative A, slightly greater potential for conflicts between user groups as visitation increases (we anticipate a 10 percent increase in on refuge visits over current levels).	Similar to alternative B; however, expect greater beneficial impacts from permanently securing public access on additional acres. Continue to allow snowmobiling on designated trails at the Pondicherry, Nulhegan Basin, and Deadbranch Division Compared to alternative B, we would construct up to 22 miles of ADA-accessible trails. Compared to alternatives A and B, slightly greater potential for conflicts between user groups as visitation increases (we anticipate a 13 percent increase in on refuge visits over current levels).	Continue to offer opportunities for the six priority public uses, focusing on providing a more backcountry experience (e.g., narrower, native surface trails; less motorized uses; less developed facilities; etc.). Adverse impacts to snowmobilers from closing all refuge snowmobile trails; however, we expect these impacts to be minor as extensive snowmobile trails are available on other ownerships nearby. Compared to other alternatives, slightly less potential for conflicts between user groups as snowmobiling is eliminated.