Chapter 4

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Seal

Environmental Consequences

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Introduction

This chapter describes the foreseeable environmental consequences we predict if the refuge management alternatives presented in chapter 3 are implemented. Specifically, we predict the beneficial and adverse effects of implementing the management actions and strategies for each of the alternatives:

- Alternative A–Current Management (which serves as a baseline for comparing against the other two alternatives)
- Alternative B–Enhanced Management of Habitat and Public Uses (Service-preferred)
- Alternative C–Natural Processes Management

In this chapter, we describe the direct, indirect, short-term, and cumulative effects likely to occur over the 15-year life span of this CCP. Longer-term cumulative impacts are also included, but beyond certain timeframes (5 to 10 years), we are less certain about the impact of our actions and therefore provide more approximate descriptions of environmental consequences. Where detailed information is available, we present a scientific and analytic comparison of the alternatives and their anticipated impacts and effects on the environment. In the event that detailed information is unavailable, we base those comparisons on our best professional judgment and experience. At the end of this chapter, table 4.8 summarizes the effects predicted for each alternative and provides a side-by-side comparison. Our discussion also relates the predicted impacts of the alternatives to the refuge goals and to the key issues identified in chapter 1.

The Council for Environmental Quality (CEQ) and Service regulations on implementing NEPA require that we assess the significance of the effects of all alternatives based on their context, duration, and intensity. The context of our impact analysis ranges from site-specific to regional and landscape-scale, depending on how widely the effect of an action can be observed. Certain actions (such as removal of invasive plant species) may have effects only in a local context, while others (such as participation in regional partnerships) may have a much broader impact. However, it is important to note that even local actions may have cumulative effects that reach beyond their local context, when combined with other actions. For example, invasive plant control on a local scale, when combined with other control efforts across that landscape, could result in combined, significant reductions in the overall abundance and distribution of invasive species. Although the refuge makes up only a small percentage of the larger ecoregion, we developed the three management alternatives to contribute toward regional conservation goals. Our proposed conservation objectives and strategies for species and habitats are consistent with regional, State, and Service landscape-level plans identified in chapter 1, including the North Atlantic Landscape Conservation Cooperative (NALCC), Massachusetts Comprehensive Wildlife Conservation Strategy (MA CWCS), and the many other plans relevant to this area.

We based our evaluation of the intensity of the effects from implementing the alternatives on these factors:

- The expected degree or percent of change in the resource from current conditions.
- The frequency and duration of the effect.
- The sensitivity of the resource to such an effect, or its natural resiliency to recover from such an effect.

- The potential for implementing effective preventive or mitigating measures to lessen the effect.

Effects range in duration from short-term (a matter of days or weeks, as with noise produced by construction) to effectively permanent (e.g., new infrastructure).

Certain types of proposed projects are not fully evaluated in this chapter. These include aspects of management that are common to all alternatives and do not individually or cumulatively have a significant effect on the quality of the human environment. The following would qualify under the Service's list of categorical exclusions (categorical exclusions are classes of actions that do not individually or cumulatively have a significant effect on the human environment, and are specifically detailed in 516 DM 8.5(B) and 43 C.F.R. sections 46.210 and 46.215), if individually proposed:

- Environmental education and interpretive programs (unless major construction is involved or significant increase in visitation is expected).
- Non-invasive research, monitoring, and inventory of biological resources.
- 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., kiosk, interpretive signs, boardwalks).
- Native vegetation planting and invasive plant control.
- 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 describe in chapter 3, in Additional NEPA Analysis, those future management decisions that may require more detailed analysis before a choice is made. We analyze the impacts of available choices in this document to the extent possible, but more detailed analysis would inform the final decision in each case.

None of the alternatives recommend further detailed study for wilderness for any of the non-wilderness portions of Monomoy NWR during the 15-year plan period. In all alternatives, we will continue managing the existing Monomoy wilderness, and the Inward Point and Powder Hole (currently non-wilderness) exclusions as well as the Nauset/South Beach area that is now part of South Monomoy Island. We will manage these areas to maintain their size, naturalness, and outstanding opportunities for solitude or primitive and unconfined recreation, to the extent it will not prevent us from fulfilling and carrying out refuge establishing purposes and the Refuge System mission, in accord with Service wilderness stewardship policy (610 FW).

Effects on Air Quality

Chapter 2, Affected Environment, presents the status of air quality in Massachusetts. Poor air quality has adverse impacts on the refuge and other natural areas. Overall air quality in the refuge landscape is currently good. There are no current criteria pollutant exceedances, with the exception of moderate levels of ozone that exceeded safe health levels in the recent past. Air quality

monitoring records for the station in Fairhaven, MA, (MA DEP 2012) indicate that it exceeded the 8-hour ozone standard of 0.075 ppm on 4 days in 2011.

We evaluated the management actions proposed in each alternative for their potential to help improve air quality locally, in the region, and globally. The benefits we considered included:

- Maintaining natural vegetative cover on the refuge's 7,604 acres.
- Requiring that all new facilities and upgrades to existing facilities be energy-efficient.
- Limiting public uses to those that are appropriate, compatible, and wildlife-oriented activities.
- Adopting energy efficient practices to reduce the refuge's contribution to emissions and meet the Service's carbon-neutral goal by 2020.

Collectively, these management actions would help reduce the potential for additional sources of emissions in the surrounding landscape. The potential adverse effects of the management alternatives that were evaluated include increases in:

- Vehicle and equipment emissions associated with visitor use.
- Particulates from using prescribed fire as a management tool.

Morris Island

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Air pollutants contributed by vehicle emissions are a significant concern in Massachusetts. The State is addressing this problem through programs to reduce automobile emissions. While our visitors' vehicles directly contribute air pollutants, they are not the principle cause of reduced air quality. Based on findings from the USGS National Wildlife Refuge Visitor Survey Results: 2010/2011 (Sexton et al. 2011), the majority of refuge visitors (75 percent) were nonlocal and for most local visitors, Monomoy NWR was the primary purpose or sole destination of their trip (65 percent). Local visitors traveled an average of 17 miles to get to the refuge, while nonlocal visitors traveled an average of 330 miles (Sexton et al. 2011). However, their contribution to poor air quality is negligible compared to that of urban and industrial centers within a 200-mile radius.

The refuge positively impacts air quality primarily through the protection of natural lands. Natural vegetated areas such as salt marshes help to offset pollution levels by acting as filters. Unfortunately, the benefit of this natural filtration has never been quantified for refuge lands.

Impacts on Air Quality Common to All Alternatives

Benefits

Regional air quality should not be adversely affected by refuge management activities regardless of which alternative is selected. None of the alternatives would violate EPA standards and all three would comply with the Clean Air Act. Since most of the impacts to regional air quality originate from sources off the refuge, management actions on the refuges would have negligible effect on regional air quality. No major stationary or mobile sources of air pollution are present on the refuge, nor would any be created under any of the alternatives. Refuge land management would help reduce any future direct and cumulative impacts by maintaining natural vegetative cover on refuge lands, requiring

that all upgrades to existing facilities or all new facilities be energy efficient, and limiting public uses to those that are appropriate, compatible, and wildlife-oriented activities. Collectively, these management actions reduce the potential for additional anthropogenic sources of emissions in the surrounding landscape.

The refuge will pursue opportunities to purchase hybrid or alternative fueled vehicles to reduce air emissions from its operations. Morris Island is the only place on the refuge that vehicles can access; it offers limited space for parking and driving. We would attempt to keep the use of vehicles on the refuge to a minimum by restricting travel on the refuge (with the exception of Morris Island) to foot traffic to preserve wilderness character. We would also evaluate opportunities to implement recommendations from a Volpe National Transportation Systems Center study to reduce the number of vehicles coming to the refuge on a daily basis, such as alternative fuel shuttles from a satellite parking area. Establishing a satellite parking location and shuttle bus service would likely decrease the amount of vehicle traffic to the refuge and may result in a negligible reduction in emissions in the immediate vicinity of the refuge. At this time, the refuge has not actively monitored the number of motorboats within the Declaration of Taking. We would expect to see less motorboat use in the Southway as it becomes shallower, but this could be offset by increased use in the shallows on the west side. It is also possible that there may be less motorboat use if the waterway between Morris Island and North Monomoy Island continues to silt in, becoming shallower over time. Alternatively, if the Morris Island channel is maintained and the breach on Nauset/South Beach remains open, there could be an increase in the amount of motorboat use on and around the northern end of the refuge.

Adverse Impacts
In all the alternatives, we would use the herbicides approved by the Service such as, but not limited to, glyphosate to control invasive plants. Glyphosate is a non-volatile compound we would apply only with ground equipment, backpack sprayers, or to individual plants, thereby virtually eliminating the likelihood of any measurable airborne particulates. We will take all precautions with respect to wind conditions, time of day, and proper equipment to ensure that only target plants are exposed to the chemical.

The primary management action common to all alternatives that may affect air quality is prescribed fires. When a prescribed burn is used for refuge vegetation management, some localized and temporary impacts on air quality may result. Although this action is proposed under all alternatives, its use varies among the three and, therefore, air quality impacts would vary and differ by alternative.

Under each alternative, the refuge would continue to use motorized equipment to support maintenance operations and general habitat and wildlife management activities. Equipment would include cars and trucks, motorboats, weed eaters, lawn mowers, etc., that use gasoline. Emissions associated with these sources are expected to have minimal impacts on regional air quality. Table 4.1 provides a summary of criteria pollutants (PM2.5, PM10, CO, CO_2, NO_X, SO_2, and VOC) from the refuge's boat and vehicle use in 2012 and Barnstable County's stationary point source emissions from year 2005. The refuge contributes approximately 19,845.7 lbs/year in boat emissions and 15,387.74 lbs/year in vehicle emissions (based on 2012 boat hours and vehicle mileage). Based on 2005 data, mobile sources in Barnstable County contributed approximately 43,029.76 tons per year (94,864,382.3 lbs/year) in emissions. Monomoy refuge mobile operations contribute about 0.037 percent compared with the regional output of criteria pollutants in Barnstable County.

Table 4.1. Monomoy NWR and Barnstable County Emissions.

Source	Emission per Year (lbs/year)
Monomoy NWR Boat Fleet (2012 hours)	19,845.7
Monomoy NWR Vehicle Fleet (2012 mileage)	15,387.74
Total Monomoy NWR Emissions	35,233.4
Barnstable County (2005)	94,864,382.3
Percentage	0.037 percent

Source: MassDEP Clean Air Act Emissions Inventories, http://www.mass.gov/dep/air/priorities/aqdata.htm; accessed April 2013.

Figure 4.1 shows the relative distance and direction of the six nearest (Clean Air Act) Class I air sheds to Monomoy NWR. Based on their distances from Monomoy NWR, we do expect no visibility impairment of the Class I air sheds from the limited and infrequent prescribed fire and herbicide use on Monomoy.

Figure 4.1. Class 1 Airsheds of the Northeastern U.S.

The potential air quality impacts from prescribed fire on human health and public welfare range from occupational exposure of smoke on firefighters to public health, soiling of materials (economic losses), public nuisance, and highway safety impacts from reduced visibility. Sandberg et al. (2002) provide a comprehensive overview of current knowledge about the effects of fires in wildland fuels, including prescribed fires on air quality.

The major pollutant of concern in smoke from fire is fine particulate matter, both PM10 and PM2.5 (Sandberg et al. 2002). Studies indicate that 90 percent of all smoke particles emitted during wildland burning are PM10[1], and 90 percent of PM10 is PM2.5 (Ward and Hardy 1991). Particulates can reduce visibility or cause negative effects to the health of people with respiratory or cardiovascular illnesses (Hardy et al. 2001). Several population subgroups are more sensitive to fine particulates than is the general population. Asthmatics are especially susceptible to PM exposure. Children are more likely to have decreased

[1] The PM10 and PM2.5 standard includes particles with a diameter of 10 micrometers or less and 2.5 micrometers or less, respectively.

pulmonary function, while increased mortality has been reported in the elderly and in individuals with cardiopulmonary disease.

Globally, biomass fires (especially in tropical forests) are a significant contributor of carbon dioxide and other greenhouse gases in the atmosphere. Fires are also an important mechanism in the redistribution of ecosystems in response to climate stress, which, in turn, affects the atmosphere-biosphere carbon balance (Sandberg et al. 2002).

Although the long-term health effects from occupational smoke exposure remain unknown, evidence to date suggests that brief, intense smoke exposures can exceed short-term exposure limits in peak exposure situations, such as for firefighters holding firelines downwind of an active prescribed burn. Work shift-average exposure only occasionally exceeds recommended instantaneous exposure limits set by the American Conference of Governmental Industrial Hygienists (ACGIH), and rarely exceeds Occupational Safety and Health Administration (OSHA) time weighted average (TWA) limits (Reinhardt and Ottmar 2000; Reinhardt et al. 2000). Overexposure increases to 10 percent of the time if the exposure limits are adjusted for hard breathing, extended hours, and high elevations, factors common to wildland firefighting that intensify the effects of many of the health hazards of smoke (Betchley and others 1995; Materna et al. 1992; Reinhardt and Ottmar 2000; Reinhardt et al. 2000).

Smoke exposure is a hazard only a small portion of the time, but is predictable and therefore manageable. Fireline practices such as crew rotation, awareness training, and carbon monoxide monitoring can mitigate the hazard, allowing firefighters to focus on fire management by lessening the distraction, discomfort, and health impacts of smoke exposure (Reinhardt and Ottmar 2000). The long-term health effects of occupational smoke exposure to wildland firefighters are unknown in spite of anecdotal evidence that suggests a greater incidence of cardiopulmonary disease and death compared to the general population (Sandberg et al. 2002).

The deposition of smoke particles on the surface of buildings, automobiles, clothing, and other objects reduces aesthetic appeal and damages a variety of objects and building structures (Baedecker and others 1991). Smoke may also discolor artificial surfaces such as building bricks or stucco, requiring cleaning or repainting. Increasing the frequency of cleaning, washing, or repainting soiled surfaces becomes an economic burden and can reduce the useful life of soiled material (Maler and Wyzga 1976). Soiling from smoke also changes reflectance of opaque materials and reduces light transmission through windows and other transparent materials (Beloin and Haynie 1975). When fine smoke particles (less than 2.5μm) infiltrate indoor environments, soiling of fabrics, painted interior walls, and works of art may occur.

Nuisance smoke is the amount of smoke in the ambient air that interferes with a right or privilege common to members of the public, including the use or enjoyment of public or private resources (EPA 1990). Nuisance smoke complaints are linked to loss of visibility, odors, and ash fallout that soils buildings, cars, laundry, and other objects. Acrolein (and possibly formaldehyde) in smoke at distances of 1 mile from the fireline can cause eye and nose irritation, exacerbating public nuisance conditions (Sandberg and Dost 1990). Population centers, homes, and businesses on the mainland are well over a mile distant from prescribed burn units proposed for Monomoy and therefore unlikely to be exposed to irritating effects of acrolein or formaldehyde even with unexpected wind direction shifts. A small number of individuals in boats or walking within

1 mile or less of prescribed burn operations on Monomoy NWR could, however, experience the irritating effects of such exposure.

Perhaps the most significant nuisance effect of prescribed fire smoke is local visibility reduction in areas impacted by the plume. People go to places they deem as special and picturesque such as Monomoy NWR, Cape Cod National Seashore, and Chatham village to enjoy colorful scenic vistas of natural landscapes that depend upon clear, clean air. Visitor enjoyment and satisfaction is adversely impacted by reduced visibility (Sandberg et al. 2002). Smoke can impede driver ability to see the roadway and result in loss of life and property damage at concentrations far below National Ambient Air Quality Standards (NAAQS). During the daytime, smoke becomes a problem when it drifts into areas of human habitation. At night, smoke can become entrapped near the ground and, in combination with fog, create visibility reductions that cause roadway accidents. The potential exists for limited smoke intrusions into boat channels and possibly onto the public roads from prescribed fires conducted on the refuge.

Fires are known to emit the pollutants that are precursors for ozone (O_3) formation, such as volatile organic compounds and a minor amount of NO_X. Ground-level O_3 is a criteria (NAAQS) pollutant with a history of non-attainment of the NAAQS standard during warm months (e.g., days above 90˚F) and, therefore, important in eastern Massachusetts. Emissions from fires in wildland fuels (especially NO_X) subjected to sunlight and warm temperatures, either in the original plume or as a result of the plume mixing with the regional atmosphere, combined with nitrate and, indirectly, sulfate aerosol formation, contribute to ozone formation, visibility impairment, and increased PM2.5 concentrations (Sandberg et al. 2002). Stith et al. (1981) mapped ozone mixing ratios in an isolated, fresh, biomass-burning plume. At the source, or near the bottom, of the horizontally drifting plume, they measured low or negative changes in ozone values, which they attributed to titration by NO and low ultraviolet (UV) intensity. Near the top of the plume, 10 km downwind, and in smoke less than 1 hour old, they measured change in ozone values as high as 44 parts per billion by volume (ppbv). Greater changes in ozone were positively correlated with high UV. Much uncertainty still surrounds the magnitude of O_3 formation in the smoke plume, the degree of mixing with pre-existing urban O_3 sources and other precursors, and transport of O_3 downward to ground level (Sandberg et al. 2002), such as during atmospheric subsidence events.

Refuge prescribed burning is conducted in late fall or early spring under all alternatives, not the summer ozone season and therefore is unlikely to contribute significantly to O_3 exceedance episodes in Barnstable County or urban (metropolitan Boston) areas under any alternative.

Low intensity prescribed burning would release inconsequential amounts of other gases (Sandberg et al. 2002). Appropriate smoke management can minimize or nearly eliminate those negative effects. The consideration of the wind speed, direction, and mixing heights is all-important in managing smoke. In planning our prescribed burns, we consider all those factors, and other environmental and geographical factors. Based on our experience, we expect prescribed burning to produce no major, long-term negative impacts.

Prescribed fire emissions, including those from Monomoy NWR, are subject to regulation nationwide under the Clean Air Act by the U.S. Environmental Protection Agency and by the Massachusetts Department of Environmental Protection in the interest of protecting human health and welfare. Massachusetts has an approved State Implementation Plan for Ozone Attainment (2008a).

Prior to igniting any prescribed burn, the refuge must obtain an air quality permit from the Massachusetts DEP and a burn authorization from the Chatham Fire Department, and conduct burning operations in accordance with those authorizations. These permitting processes consider the expected quantity of emissions released over time (source strength) as well as smoke plume rise, trajectory, and down-range concentration (dispersion). The goals of smoke management on the refuges within the Eastern Massachusetts Complex incorporate goals enumerated by the National Wildfire Coordinating Group (1985): reduce fire emissions by maximizing combustion efficiency; enhance the dispersal of smoke plumes; steer smoke plumes away from smoke-sensitive areas; and coordinate the ignitions of prescribed burns (USFWS 2003c).

For purposes of comparing potential worst case air quality impacts from the differing levels of prescribed burning under the plan alternatives, we made an estimate of the maximum fuel biomass (tons) consumed during prescribed burning over a 10-year period was made. Once consumption was estimated, emission factors (pounds emitted/tons consumed) for each air pollutant of interest was applied to derive the maximum emissions estimate for the plan period for each prescribed burn pollutant of interest. Tables 4.2 and 4.3 illustrate a very simplified form of the worst case alternative consumption and emissions estimates. Actual emissions for each pollutant are expected to be considerably less than the worst case maximums listed in table 4.3 below. Air quality regulators and refuge managers use a number of more complex tools that permit more precise estimates for total emissions and their down-range trajectory and dispersion including, but not limited to, fuels characteristics classification system (FCCS), digital photo series, Consume, first order fire effects model (FOFEM), fire emissions production simulator (FEPS), VSmoke, HYSPLIT, CalPuff, and Bluesky. These tools use more site and time-specific fuel and weather variables, but all the tools available regardless of complexity involve estimating fuel consumption and the emissions produced during that consumption.

The alternatives vary in terms of the number and size of burn treatment units established across the Monomoy NWR landscape, and the frequency of prescribed burns during a 10-year period (table 4.2). Currently (alternative A), a single 35-acre burn unit encompassing the South Monomoy tern colony is burned on average every 3 years (3.3 times/decade). Alternative B retains the same 3-year burn interval as alternative A, but expands the area treated during each burning operation to 3 burn units of 25 to 35 acres each (median 30 acres/unit). Alternative C reduces the size of the current burn unit to 10 acres or less, and increases the burn interval to 5 years (2 times/decade).

The beach grass community growing in dry, nutrient-poor sands subjected to prescribed burn treatments under all alternatives is expected to have lower above ground biomass loadings than typical tall grass communities. Above-ground fuel loadings typical of tall grass dominated communities average 2 to 4 tons/acre (FBMS Model #3 after Anderson 1982, GR06 and GR07 after Scott and Burgan 2005). Alternative C with the longer (5-year) interval between burns allows slightly more vegetative biomass accumulation between burns and therefore was assigned a 4 ton/acre average loading. Alternatives A and B with a 3-year interval between burns were assigned a 3 ton/acre average loading for purposes of the worst case emissions estimate. It was then assumed that all this biomass loading was in the fine (1-hour time lag, 0 to ¼ diameter) and dead (0 percent live fuel moisture) categories and consumed during prescribed burning for the worst case scenario. Invariably, prescribed burning leaves unburned and many partially burned areas within a burn unit perimeter under moister conditions with greater live fuel components than the complete combustion assumed in this worst case estimate.

Table 4.2. Maximum Biomass Consumption Estimates From Prescribed Burning for a 10-Year Period, by Alternative.*

Plan Alternative	Maximum Acres per Burn	# X per decade unit is burned (Return Interval)	Maximum Acreage Burned over 10-year Period	Total Biomass (Fuel) Load**	Maximum Biomass Consumed in 10-year Period
Alternative A	1×35-acre unit = **35 acres/burn**	3.3 burns/ decade (3 years)	115.5 acres	3 tons/acre	**347 tons**
Alternative B	3×30-acre units = **90 acres/burn**	3.3 burns/ decade (3 years)	297 acres	3 tons/acre	**891 tons**
Alternative C	1×10-acre unit = **10 acres/burn**	2 burns/ decade (5 years)	20 acres	4 tons/acre	**80 tons**

** Estimate is based on maximum acreage that would be burned under each alternative.*

*** FBPS 3 (Anderson) and GR06 GR07 after Scott and Burgan (2005).*

For simplicity of estimation, it was assumed that because all fuels consumed are fine, dead fuels with little or no duff layer or coarse woody fuels, all prescribed burn emissions are released during flaming combustion. The primary combustion products emitted during flaming combustion of biomass fuels, essentially a reversal of photosynthesis, are the greenhouse gas CO_2 water vapor H_2O, and thermal (heat) energy (Hardy et al. 2001). While some biomass consumption and emissions release does take place through smoldering or glowing phase combustion following flaming front passage, these latter phases are very brief in grassland fuelbeds without a duff layer, helping keep the estimation error small. In table 4.3, flaming combustion emission factors derived from the FOFEM 6.0 emissions model were applied to the biomass consumption estimates to derive the total 10-year period prescribed burn emission estimates.

Under ideal laboratory combustion conditions, 1 ton of biomass fuel combines with 3.84 tons of air and yields 1.84 tons of CO_2 and 0.54 tons of water vapor (Prescribed Fire Effects Working Team 1985). Actual field wildland conditions are never ideal, leading to combustion inefficiencies that produce different emission yields and compounds such as particulates, carbon monoxide, methane, hydrocarbons, and nitrogen oxides (Hardy et al. 2001). The air emissions of greatest interest from prescribed burning include fine particulates (PM10 and PM2.5), carbon monoxide (CO), methane (CH_4), nitrous oxides (NO_X), sulfur dioxide (SO_2), and other greenhouse gases, including carbon dioxide that forms when elemental carbon combines with oxygen already in the atmosphere.

While CO overexposure causes serious health problems and can prove fatal, CO is diluted and disperses rapidly as it mixes with ambient air downrange from the combustion source. So, CO emissions are primarily an occupational health concern for prescribed burn personnel, not for the general public.

Prescribed fire can produce trace amounts of many different hydrocarbon compounds, a few of which are known to be harmful or toxic at higher concentrations. Wildland fuels typically contain less than 1 percent nitrogen, of which approximately 20 percent is converted to NO_x during combustion. Both hydrocarbons and NO_x are believed to be precursors for ozone formation

once exposed to sunlight and warm temperatures in the atmosphere (Hardy et al. 2001).

Table 4.3. Maximum Emissions From Prescribed Burning for a 10-Year Period for Air Pollutants of Interest by Alternative.

Alternative Air Pollutant of Interest	Biomass Consumed Over 10-year Period	Emission Factor Flaming Phase*	Total Emissions Tons Per Decade
Alternative A	347 tons		
PM2.5		5 lbs/ton	0.87 tons
PM10		6 lbs/ton	1.04 tons
CO		13 lbs/ton	2.26 tons
CH_4		2 lbs/ton	0.35 tons
CO_2		3,556 lbs/ton	616.97 tons
NO_x		6 lbs/ton	1.04 tons
SO_2		2 lbs/ton	0.35 tons
			622.88 tons
Alternative B	891 tons		
PM2.5		5 lbs/ton	2.23 tons
PM10		6 lbs/ton	2.67 tons
CO		13 lbs/ton	5.79 tons
CH_4		2 lbs/ton	0.89 tons
CO_2		3,556 lbs/ton	1,584.20 tons
NO_x		6 lbs/ton	2.67 tons
SO_2		2 lbs/ton	0.89 tons
			1599.34 tons
Alternative C	80 tons		
PM2.5		5 lbs/ton	0.20 tons
PM10		6 lbs/ton	0.24 tons
CO		13 lbs/ton	.52 tons
CH_4		2 lbs/ton	0.08 tons
CO_2		3,556 lbs/ton	142.24 tons
NO_x		6 lbs/ton	0.24 tons
SO_2		2 lbs/ton	0.08 tons
			143.6 tons

* *Derived from FOFEM 6.0 model using SRM 601 Bluestem Prairie typical and heavy fuel loadings and moderate moisture conditions.*

The estimated worst case emissions from prescribed burning over a 10-year period as presented above are not expected to adversely affect the region's air quality index (combined PM2.5 and 8-hour ground level ozone) given anticipated dispersion, mixing, and the seasonal timing of prescribed burning even under alternative B.

Air Quality Impacts of Alternative A (Current Management)

Current refuge management activities would neither substantially benefit nor adversely affect local and regional air quality. There is a small amount of hydrocarbon emissions caused by refuge activities, including emissions from transportation to and from the refuge. The vehicle fleet at the refuge headquarters is becoming more efficient and cleaner as older vehicles are replaced by low-emission hybrid cars and trucks.

There would be minor air quality benefits from the air pollutant filtering effects of shrubland, grassland, and aquatic vegetation. The sequestering effects of existing grassland and woody terrestrial vegetation and submerged aquatic vegetation would produce a negligible reduction in atmospheric carbon.

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American oystercatcher

The treatment of invasive plant species to maintain quality habitat conditions would occasionally incorporate chemical or biological control as needed under alternative A. Chemical application through both aerial and backpack sprayers have the greatest potential to impact a wider area than is targeted through spray drift (the movement of herbicides to non-target sites). Backpack sprayers are used most often on the refuge, and have optimal target specificity due to the close range of application. Aerial application of herbicides has not been used on Monomoy NWR in recent decades, and no conditions exist or are anticipated where backpack spraying is not feasible or cost-effective.

The installation of solar panels at the Monomoy Point Light Station to generate electricity would more than offset some of the pollution (ozone precursors, PM2.5, and GHGs) associated with electrical power production from fossil fuel combustion. Short-term, localized effects from construction vehicles and equipment exhausts would occur.

Air Quality Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))

Proposed management activities would neither substantially benefit nor adversely affect local and regional air quality. Under this alternative, invasive plant treatment would be more intensive compared to current management to ensure that there is less than 10 percent coverage refugewide for species that are highly invasive or replace stands of native vegetation. This would be accomplished through increased chemical application (compared to alternative A) or mechanical control as necessary and feasible; associated short-term impacts and long-term benefits would be slightly increased in alternative B.

Under this alternative, we propose several methods based on recommendations from the Volpe National Transportation Systems Center study to reduce traffic congestion at the refuge and better serve the needs of our visitors. The proposed visitor contact station located in downtown Chatham or Harwich would potentially reduce vehicle emissions on the refuge by offering a shuttle service from satellite parking. Although we anticipate an increase in visitors to the refuge, we believe that establishing an offsite location for parking and implementing a shuttle service would contribute to reduced vehicle emissions on the refuge, reduce traffic congestion at the headquarters site and along the causeway, and encourage the use of bicycles and kayaks. We expect to see an increase in emissions with the addition of regular ferry services to the offshore portions of the refuge via the concessionaire; however, we do not foresee the frequency of trips increasing significantly from current use.

Renovation of the headquarters/visitor contact station, dormitory, and maintenance facilities would cause some temporary, local impacts on air quality during the construction phase. The proposed visitor contact station in downtown Chatham or Harwich would preferably be located in an existing structure and not require construction of a new facility. Operations of these facilities would result in emissions from heating and cooling systems; visitor and employee travel would

add sources of air pollution. These would be partially offset by the installation of energy-efficient heating and cooling systems and replacement of our fleet with more energy efficient models.

Alternative B biomass emissions from prescribed burning activities are an estimated 156 percent increase over current levels (alternative A) for a 10-year period.

Air Quality Impacts of Alternative C (Natural Processes)

Air quality would benefit the most under this alternative, as we would no longer allow the use of motorized boat transportation to the refuge, and instead provide arrangements for non-motorized access via a concessionaire or special use permit. Impacts from the application of herbicide would be similar to alternative A. Prescription burns, if approved, would be carried out as described above in alternative B, but there would likely be fewer burns as a result of allowing natural succession, so the benefits and impacts would be less than described in alternative B. Alternative C prescribed burning emissions over a 10-year period are estimated at 23 percent of current (alternative A) levels and 9 percent of alternative B levels due to the smaller acreage treated and lower frequency of prescribed burn treatments expected. Wilderness policy may determine how these activities are prioritized. Less use of mechanized equipment in the wilderness area would result in reduced emissions and a lower carbon footprint.

A satellite parking location and shuttle transportation would benefit air quality by reducing the number of visitors commuting to the refuge in personal vehicles similar to alternative B. The possible relocation of all refuge facilities offsite would have the greatest reduction in emissions on the refuge compared to alternatives A and B.

Effects on Climate Change

Climate change has been identified by the Service as a serious management concern, as detailed in chapter 2. With climate change, we face great challenges (Scott et al. 2008, Griffith et al. 2009). 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 the intensity of tropical storms. Furthermore, these and other physical changes associated with climate change are having a significant biological impact across a broad range of natural systems. For managers at Monomoy NWR 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. Climate change vulnerability assessment is a key tool for bringing climate data and related ecological understanding to bear in conservation planning and management efforts (Glick et al. 2011).

The Northeast is already facing significant changes (Frumhoff et al. 2006, 2007; Hayhoe et al. 2006), including:

- Higher average air temperatures, particularly in winter months.
- More frequent heat waves.
- An increase in the number and intensity of heavy rainfall events.
- Reduced snowpack and earlier peak snowmelt and spring peak flows.
- A lengthening of the frost-free season and earlier date of last-spring freeze.
- Accelerating rate of sea level rise and increased ocean acidity.

- Higher sea surface temperatures.
- An increase in the intensity, duration, and destructiveness of hurricanes and winter storm events such as nor'easters.

Added to the 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. Much of Massachusetts' intertidal habitat has already been lost over the past two centuries due to human activities, including construction of roads and rail lines; urban, commercial, and agricultural development; and ditching and draining for mosquito control. These activities have restricted tidal flows, caused increased freshwater runoff and water pollution, and contributed to the expansion of harmful invasive species such as common reed (*Phragmites*) and purple loosestrife. Remaining habitats such as those found at Monomoy refuge (i.e., coastal dunes, beaches, small islands) are just fragments of what once existed, making them all the more important for the migratory birds, fish, wildlife, and human communities they support (The Manomet Center for Conservation Sciences [Manomet] and Massachusetts Division of Fisheries and Wildlife [MDFW] 2010).

Climate Change Impacts Common to All Alternatives

Benefits

Over the life of the plan, the refuge would implement departmental and Service policies regarding climate change, including biological planning, landscape conservation, and monitoring and research, to become more carbon neutral in day-to-day operations, partner with others on climate change, and educate the public and others.

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. The refuge would seek to implement the findings of the Volpe Center Alternative Transportation Study and transport more people to the refuge for compatible wildlife-dependent recreation while promoting and demonstrating climate-ready and carbon-neutral practices. We would propose to implement several methods based on recommendations from the Volpe National Transportation Systems Center study to reduce traffic congestion at the refuge and along the causeway in order to better serve the needs of our visitors. We would decrease the amount of vehicle emissions directly on the refuge by providing a shuttle service from an offsite location to the refuge. This would result in fewer visitors travelling to the visitor contact station and the Morris Island trails in their personal vehicles, and would offset the overall increase in visitation we expect over the next 15 years.

The proposal to implement a shuttle service would reduce fossil fuel consumption and associated atmospheric carbon release and other pollutants, including ozone precursors (NO_x and VOCs). An estimated savings of 56,934 vehicle miles of travel (VMT)/season for automobiles, offset by a 24,360 VMT/season increase for the shuttle buses yields a net savings of 32,574 VMT/season (MassDOT). Applying standard automobile emission factors to the 32,574 VMT/season net savings yields estimated (air) emission reductions as seen in table 4.4.

Table 4.4. Estimated Air Emission Reductions.

Air Pollutant	Emission Factor (gm/VMT)	VMT/season Reduction	(Kg) Emission Reduction/season
VOCs (volatile organics)	0.695	-32,574	22.64
NO_X (Ozone precursor)	0.601	-32,574	19.58
CO (greenhouse gas)	12.15	-32,574	395.77

The primary ways in which the refuge would likely lessen its contribution to climate change under all three alternatives is through the ability of natural communities to sequester carbon and by limiting the emissions of greenhouse gases associated with energy use. Compared with urban areas, lands covered with natural vegetation offer greater opportunities for carbon sequestration, both in the form of vegetation (Heath and Smith 2004) and in the soil (Swift 2001). The habitat types on the refuge, however, do not have much capacity for carbon sequestration. The salt marsh habitat on the refuge offers the greatest capacity for carbon sequestration. Tidal salt marshes can produce up to 8,000 metric tons of plant material per year, a process by which plants continually remove carbon dioxide from the atmosphere and convert it to plant material (Mitch and Gosselink 2000). Above- and below-ground plant biomass represents a standing pool of carbon captured by plants, which remains the same each year unless more acreage of marsh becomes vegetated. The plants themselves do not contribute to continual carbon storage because marsh plants do not build up woody material from year to year, as trees do (Trulio et al. 2007). Therefore, estimates of carbon sequestration in estuarine ecosystems do not include contributions from the living plants (Brigham et al. 2006). Instead, carbon content in soils, especially in deeper layers, is the best measure of long term, continuing carbon storage (Brigham et al. 2006). Choi et al. (2001) found that as sea levels rise, the marsh plains continue to build up (accrete) and, as they do, continually store carbon in the process. As a result, tidal marshes help protect uplands from storm events while continuing to take carbon from the atmosphere, as long as there is sufficient input of mineral sediments to build marsh soil and keep pace with sea level rise. Choi et al. (2004) conclude that, "because of higher rates of carbon sequestration and lower methane emissions, coastal wetlands could be more valuable carbon sinks per unit area than other ecosystem in a warmer world." Carbon can be stored for some time in the tissue of plants (wood) and in soils. Only a small portion of the refuge consists of vegetation dominated by woody species, such as maritime shrubland, which has limited carbon sequestration abilities.

Recent studies have demonstrated that conserving and restoring sea grass meadows may also reduce greenhouse gas emissions and increase carbon stores (Fourqurean et al. 2012). Sea grass meadows are highly productive ecosystems that play a key role in supporting biodiversity, as well as acting as an enormous carbon sink. Some of this carbon gets transported to the deep sea, where it provides a supply of organic matter in environments that can often be limited in food sources (Orth et al. 2006). Most of the organic carbon produced by sea grasses is stored within the sediments, making these areas hot spots for carbon sequestration (Orth et al. 2006). Sea grass sediments are organic-rich, with an average organic concentration of 4.1 percent, and can be characterized by their capacity to sequester and store large amounts of carbon in their sediments (known as blue carbon) (Fourqurean et al. 2012). Sea grasses remove carbon dioxide from the atmosphere and incorporate it into organic matter; they contribute to approximately 10 percent of the yearly global carbon sequestration in marine sediments even though they occupy less than 0.2 percent of the ocean surface (Fourqurean et al. 2012).

In recent years, Monomoy NWR has made considerable advancements in building energy conservation and efficiency improvements as well as making large investments in equipment upgrades. In response to Federal mandates, various energy efficiencies have been incorporated into refuge facilities such as additional insulation in the attics and roofing, on-demand controls for heating/cooling offices, motion sensors for lights in common areas and bathrooms, Energy Star-compliant equipment, and timers for turning off equipment during non-work days and at night. A solar-thermal domestic hot water system was installed in the refuge dormitory building. In addition, the refuge vehicle fleet is being

converted to hybrid vehicles, which have lower emissions. In compliance with section 141 of the 2007 Energy Independence and Security Act, which requires Federal agencies to acquire low greenhouse gas emitting vehicles, the refuge would continue to replace older vehicles with hybrid or other low emission models, where feasible. Additionally, the refuge would continue to implement the Service's 2010 Fleet Action Plan (USFWS 2010d), with concomitant benefits to air quality.

Another way to reduce emissions is through outreach and education programs—by encouraging climate-friendly behavior through our interpretive materials and actions, such as implementing a shuttle bus to the refuge. Under all alternatives, the refuge would continue to explore recommendations made in the Volpe Center Alternative Transportation Study and improve bicycle and non-motorized modes of transportation on the refuge.

Several of the inventory and monitoring projects initiated by the refuge would benefit our understanding of climate change impacts as we establish baseline trend information. Some of these include bird phenology monitoring, shoreline change surveys, sediment elevation tables, salt marsh integrity study, and wilderness character report. The refuge would also continue to benefit from the use of periodic aerial photos to track the migration of the refuge lands and the rate of accretion and erosion. This information would 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.

Adverse Impacts
Monomoy NWR contributes to greenhouse gas emissions such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). These greenhouse gases result from our daily activities, including combustion of fuels, use of refrigerants to operate buildings, and visitor vehicle travel both to and from and within the refuge.

Increasing temperatures, coastal climate change impacts, and changing precipitation patterns may alter Monomoy NWR's ecosystems, changing vegetation communities, habitats available for species, and the experience of refuge visitors. Whatever management alternative is chosen, no actions would be taken to cause additional impacts other than what are already occurring under current management.

Numerous studies suggest that climate change would have a significant impact on coastal habitats at Monomoy NWR and surrounding areas. For example, more frequent and severe coastal storms would cause beach erosion and overwash of barrier islands, threatening wildlife habitats and placing human infrastructure at risk (Drut and Buchanan 2000). Substantial changes in bird life are expected across the Northeast due to rising temperatures, shifting distribution of suitable habitat, or declining habitat quality (Frumhoff et al. 2007). Bird species that migrate to the Northeast from neotropical and temperate climate zones make up the majority of birds breeding in the region. These species are likely to suffer losses in the amount and quality of habitat, and associated declines in abundance. The manner in which humans respond to climate change would also have serious implications for refuges; for example, rising sea levels and more intense coastal storms may prompt coastal property owners to armor their shorelines, which would limit the adaptive capacity of coastal habitats (USFWS 2011). The main risks to Monomoy's wilderness are the chances of its being overrun with nonnative species or having its existing habitats shift or decline as

a result of climate change; uncharacteristic alterations in sea level, temperature, precipitation, soil moisture, and frequency and magnitude of storms may cause a distorted landscape. Erosion of the coastal bluff on Morris Island due to more intense wind and wave action could result in the need to relocate the first part of the Morris Island trail and might eventually be the impetus to relocate the headquarters/visitor contact station and other facilities on Morris Island.

According to Giese et al. (2010), "A marked increase in Nantucket Sound water depths could increase tidal range and currents in the eastern sound, increasing the scour of Pollock Rip Channel—an erosional trough (Uchupi et al. 1996)—thereby adding to the bulk of Handkerchief Shoal. This, in turn, coupled with an increased supply of sediment from the north, could enhance the southwestern growth of Monomoy Point. A large and rapid relative sea level rise would be accompanied by a similar rise in the South Monomoy water table, flooding low-lying areas and enlarging existing ponds and wetlands. Prevailing southwesterly wind waves coupled with higher sea levels could markedly increase erosion of sound-side Monomoy, narrowing the peninsula. At the same time, higher sea levels and reduced sediment supply could be expected to deepen Monomoy Flats." Based on this analysis, it can be assumed that the patterns of coastal change at Monomoy NWR in the next century would follow the general trends of those experienced in the recent past, but at an accelerated rate.

Bill Thompson/USFWS

Northern pintail

Sea level rise and coastal storm activity pose significant threats to Atlantic coast piping plovers (USFWS 2009). Current impacts on habitat availability and breeding success are expected to increase within the next 10 to 20 years. Furthermore, ongoing and near-term human coastal stabilization activities may strongly influence the mid- and long-term effects of climate change on piping plovers and their habitat. It is urgent, therefore, that we improve our understanding of threats from sea level rise and increased coastal storm activity and develop scientifically sound strategies to address them.

As described in chapter 3, prescribed burning would continue to be a valuable habitat management tool under all alternatives. The primary gases released during prescribed fire include carbon dioxide, carbon monoxide, and water vapor, with other gases present in trace amounts (EPA 40 CFR Part 5). The primary combustion products emitted during flaming combustion of biomass fuels, essentially a reversal of photosynthesis, are the greenhouse gas CO_2, water vapor H_2O, and thermal (heat) energy (Hardy et al. 2001). Under ideal laboratory combustion conditions, 1 ton of cellulose fuel combines with 3.84 tons of air and yields 1.84 tons of CO_2 and 0.54 tons of water vapor (Prescribed Fire Effects Working Team 1985). Based on our experience, and as described in Appendix F, Fire Management Guidance, we expect prescribed burning to produce no major, long-term negative impacts in terms of climate change.

In addition, climate change can influence how infectious diseases spread, particularly through vectors like mosquitos. If a serious threat were posed to impact the wildlife and habitats at the refuge, we would likely implement precautions that include pesticide use.

Climate Change Impacts of Alternative A (Current Management)

Under alternative A, personal motor vehicles or boats would continue to be the primary means to access the refuge and visitation would likely remain near current levels of 25,000. These localized and concentrated emissions, including dust and hydrocarbons, would continue to occur during periods of high use, typically during the summer months.

Monomoy NWR would continue to implement energy-efficient practices such as installing a photovoltaic system at the Monomoy Point Light Station. Solar energy is considered environmentally friendly because the sun is a natural energy source that does not require the burning of fossil fuels and the associated air emissions. In addition, it is considered renewable since the energy produced from the sun does not deplete any natural resources.

The Wilderness Character report (Sudol 2012) established a baseline assessment of the Monomoy wilderness and provides attributes that can be measured in subsequent years to actively monitor wilderness character, including the following indicators of climate change: plant and species composition; and physical resources, such as visibility, ozone levels, and total nitrogen and sulfur deposition; biophysical processes, such as mean sea level rise, wind speed, and wave height. In the future, refuge staff can correlate this data with species inventories and be more informed in the decision-making process.

Monomoy NWR benefits from the removal of invasive species and the promotion of natural vegetation communities. Large monotypic stands of *Phragmites* are the greatest invasive threat present at the refuge. The continued removal and monitoring of this invasive plant species reduces this additional stress on native plant communities and helps maintain a resilient landscape in the presence of climate change.

Climate Change Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))

Alternative B takes a more proactive approach in addressing the threats of climate change, including using dredge material in areas outside of the Monomoy wilderness to combat rising sea levels. The renourishment of Morris Island would help restore the eroded beach area that is vital to supporting public use activities on the refuge.

At some coastal sites, depositing sands adjacent to barrier beaches could temporarily minimize erosion from wave energy. However, based on the findings in Giese et al. (2010), "the suggestion of using Stage Harbor dredge spoil to create an islet, similar to Minimoy, which would provide a suitable environment for beach nesting birds raises several concerns. First, although a northerly location on Monomoy Flats would be preferred for economic reasons, it could have negative impacts on nearby navigation channels. Second, there is the question of the lifespan of such an islet. Unlike Minimoy, which developed slowly as a flood tidal shoal over an extended period under natural conditions, a single, quickly-deposited islet would soon be reworked by waves and tides, and lacking an extended source of additional sediment, could be transformed to an inter-tidal shoal sooner than expected. A possible alternative plan could locate a Stage Harbor dredge spoil deposition site immediately adjacent to the western shore of North Monomoy. While not providing the advantages of a separate islet, such a deposit would increase the bird nesting area and could be designed to be compatible in form with the existing wave-dominated shoreline." This could be a short-term benefit in the face of climate change by providing quality nesting habitat.

As in alternative A, the refuge would pursue the installation of a photovoltaic system at the Monomoy Point Light Station. Along with upgrades to improve energy efficiency, implementing a shuttle service, improving facilities for bicyclists, and installing an electric car charging station would reduce fossil fuel consumption and associated carbon emissions by refuge visitors and educate the public about our efforts to become carbon neutral. Alternative B would also pursue installing a wind turbine at the Morris Island headquarters complex to utilize the available renewable wind energy to generate electrical power and hot water for the headquarters complex and reduce power consumption from the

utility grid. This would also serve the dual purpose of demonstrating to refuge visitors and public officials energy-producing alternatives that reduce dependence on nonrenewable energy. Should the refuge receive funding for this project, a stand-alone NEPA analysis would be completed.

Under alternative B, the refuge would take a more aggressive role in controlling nonnative invasive plant species by maintaining less than 10 percent cover refugewide. The resiliency of the natural plant communities would increase and the restored habitats would be able to respond more effectively to climate change. Reducing non-climate stressors, including habitat destruction, invasive species, and pollution, would help improve the ability of natural systems to better withstand or adapt to impacts associated with climate change.

In order to better predict future scenarios regarding climate change, the refuge would benefit from a geomorphological study of Morris Island to determine the rate of coastal erosion and a cost-benefit analysis to determine which mitigation strategies would be most efficient.

Climate Change Impacts of Alternative C (Natural Processes)

Alternative C offers the greatest benefit to addressing the impacts of climate change. Under this alternative, a concessionaire and guided hunts would facilitate non-motorized boat use within the refuge boundary and Declaration of Taking, but this would likely necessitate motorized boat support outside of the wilderness area. The discontinuation of public motorized boat use within the wilderness area (with the exception of emergency use) would decrease emissions that can contribute to climate change; however, it is unlikely this would make a significant difference considering the frequency of visitors to the Cape Cod region.

Benefits from the removal of invasive species would be the same as discussed under alternative B. Similar to alternative B, alternative C would benefit from a geomorphological analysis of Morris Island and the use of dredge material to renourish Morris Island, in addition to the installation of a wind turbine at the headquarters. We expect that the erosion on Morris Island would continue without renourishment and we would benefit from further geomorphological analysis that would look more carefully at sediment transport and erosion to determine the best course of action.

Effects on Water Quality

Water Quality Impacts Common to All Alternatives

The waters immediately surrounding the refuge, in particular the Outer Cape Cod region, are the latest designation in the Commonwealth of Massachusetts to be approved as a No Discharge Area (NDA) (MA CZM 2012). Boats may not discharge any sewage, treated or otherwise, in these waters immediately adjacent to the Monomoy islands to protect this ecologically and recreationally important area. Influxes of sewage from boats, even when treated, can discharge nutrients, chemicals, and pathogens into the water, increasing public health concerns as well as overall concern for water quality. Increased levels of nitrogen, a component of sewage, can have wide-ranging effects on water bodies, including encouraging algal blooms, decreasing dissolved oxygen content, and increasing turbidity, which can impact species reliant upon these coastal waters. Nantucket Sound has experienced a yearly trend of increasing nitrogen input. Gaining compliance with EPA's total maximum daily loads (TMDLs) for nitrogen is and will remain the focus of wastewater planning initiatives across Cape Cod throughout the plan period, and is not unique to the waters surrounding Monomoy NWR. Under all three alternatives, none of the proposed management activities would contribute to this problem.

None of our proposed management activities would violate Federal or State standards for contributing pollutants to water sources; all three would comply with the Clean Water Act.

In managing the refuge, we would closely monitor and mitigate all our routine activities that may result in chemical contamination of water directly through leakage or spills or indirectly through soil runoff. These include control of weeds and insects around structures, use of chemicals for deicing walkways and roads, and use of soaps and detergents for cleaning vehicles and equipment. Our personnel take precautions to minimize the potential for chemicals and petroleum products from becoming a water quality problem. As part of regular maintenance activities, some grease and cleaning chemicals could be washed off vehicles and equipment. This is not expected to impact water quality because we would be using best management practices to minimize potential impacts.

Regardless of the alternative selected, we would continue to identify and control invasive plant species before they cause large changes on the landscape. An early detection and rapid response approach can succeed in preventing much larger problems later on. We would use integrated pest management, which employs a variety of mechanical, biological, and chemical means of controlling invasive plants, but our experience to date suggests that the use of herbicides would continue to be part of our invasive species control program.

Please refer to the Effects on Soils section to review the herbicides we use on the refuge. The level of review that Service policy requires before we can apply any chemical on a refuge ensures that the environmental risk is minimized, and that all facets of the proposed use have been examined and justified. We follow all of the precautions listed on the labels to minimize impacts on ground and surface waters. When used appropriately, these products do not have direct or indirect negative impacts on water quality. In addition, only herbicides specifically approved for aquatic application are used on or near refuge waters.

Some potential exists for the concentration of herbicides to build up over time in sediments and wetland habitats. The potential depends on the balance of herbicide input and removal from an aquatic system. Herbicide inputs may occur either through direct application, water inflow, or through re-suspension and diffusion from the sediment layer. Herbicide removal from the system may occur through outflow, degradation, volatilization, and settling or diffusion into the underlying sediment (Neitsch et al. 2001).

Impacts to freshwater ponds and wetlands (primarily located at the southern end of South Monomoy) are expected to be minimal because current and future visitation (for fishing) is very low. Additionally, many of the smaller freshwater ponds and wetlands are closed to human access to prevent disturbance to migratory birds and habitats. The refuge's population of seals does not have a significant impact on water quality. Based on analysis reported in chapter 2, the seal haulout site is not currently impacting water quality within the refuge and should continue to not adversely impact water resources. Analysis completed by the Woods Hole Institute between 2003 and 2012 of fecal indicator bacteria (FIB) found that beaches near the haulout sites showed a decreasing trend in yearly FIB exceedance events over the last decade (Woods Hole Oceanographic Institute 2012). Concern about the potential impact on water quality at seal haulout sites has been recognized by the Northwest Atlantic Seal Research Consortium and is likely to be studied more specifically in coming years.

Chapter 2 discussed the historical use of the refuge as a formerly used defense site (FUDS). The findings of the USACE (2010) report state that, "No munitions or explosives of concern are expected to be present on this munitions response site." During the military use of the FUDS, the center of the bombing target was located on land, but due to dynamic coastal processes, it is now located offshore in the Atlantic Ocean. It is therefore assumed that "no known or suspected hazards" are present on the land portion of the bombing range or air-to-ground gunnery

range. Regardless of which alternative is selected, these potential impacts have already occurred.

Water Quality Impacts of Alternative A (Current Management)

Refuge-related activities that could impact water quality are oil or gas leaks from motorized boats, refuge vehicles, or offshore boats; however, the impacts to water quality are likely to be negligible from these activities. Impacts to water quality of saltwater habitats (salt marshes and nearshore marine waters) may result from pollution from motor boats navigating in these waters in alternative A, but these are expected to be minimal.

Some risks could occur to water quality from use of herbicides by the refuge to control invasive plant species, but these risks are low (Shepard et al. 2004). We would use integrated pest management (IPM) to prevent or minimize any impacts from use of herbicides and would only use herbicides that are safe for aquatic habitats when working near water bodies on the refuge, as well as follow permitting regulations. Adverse impacts to water quality would include the continued use of pesticides to control mosquitoes. The use of pesticides to control mosquitos is permitted in cases where a human health risk has been established. Effects are expected to be relatively short-lived and of minimal consequence (Massachusetts Department of Agriculture 1998). A more detailed discussion on the impacts of mosquito control is addressed under the salt marsh section in Terrestrial Invertebrates and Insects.

Under alternative A, in the short term the Monomoy Point Light Station facilities would remain without electric power aside from small-capacity, temporary, and portable photovoltaic panels for small electronic devices. Over the long term, we also propose to install permanent panels. During the recent restoration, a new sewage disposal system and composting toilet replaced the non-compliant system. Leave-no-trace policies are in place throughout the refuge for refuge staff and permittees, including overnight camps. The refuge is closed to overnight camping by visitors. The field camp introduces some minimal impacts to water quality from runoff during activities like dishwashing. Biodegradable soaps are used and all human waste is packed out. Therefore, little to no potential for significant water quality impacts from overnight use by refuge staff or visitors exists under alternative A.

Water Quality Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))

Under alternative B, refuge-related activities that could impact water quality are the same as those discussed under alternative A. Impacts to saltwater habitats would be similar to alternative A. Under this alternative, invasive plant treatment would be more intensive compared to current management to ensure that there is less than 10 percent coverage of nonnative species, such as *Phragmites*, in the freshwater ponds. As in alternative A, the use of herbicides by the refuge to control invasive plant species could incur some risk to water quality, but these risks are low (Shepard et al. 2004). We would use IPM to prevent or minimize any impacts from use of herbicides, and would only use herbicides that are safe for aquatic habitats when working near water bodies on the refuge, in addition to following all permit regulations.

There are higher risks of short-term adverse effects on water quality associated with renovation of existing facilities directly on the refuge and new construction of facilities offsite. In all cases, appropriate permits would be obtained, and best management practices would be followed to minimize any potential adverse effects. Additional NEPA analysis would likely be conducted for major projects; that is beyond the scope of this CCP. Compared to alternative A, alternative B would provide additional opportunities for public use, resulting from increased outreach efforts and expanded public use opportunities. This could result in higher levels of vegetation trampling, soil disturbance, and erosion, potentially affecting water quality. However, we expect these impacts to be localized and of

minimal consequence. Closures to human access in sensitive habitats and during biologically important times of the year would continue to minimize impacts. During times of the year when access is not restricted, public use is generally very low, again resulting in very low impacts overall. Impacts from use of the light station and field camp would be the same as under alternative A. There are no anticipated long-term adverse impacts specific to this alternative.

Under all alternatives, the refuge would evaluate the use of dredge material from other ongoing projects to address erosion issues at Morris Island. Under alternative B, the refuge would also evaluate the use of dredge material to increase elevation of important bird nesting habitat outside of the Monomoy wilderness and most at risk from inundation due to sea level rise and increased storm surges and erosion. The primary environmental effects associated with dredging are suspended sediments and increased water turbidity. The short-term increases in the level of suspended sediment can give rise to changes in water quality that can affect marine flora and fauna, both beneficially and adversely. Examples are increased turbidity and the possible release of organic matter, nutrients, or contaminants, depending on the nature of the material in the dredging area (Brehmer 1965). The remobilization of contaminants trapped in the sediments can render them more available to the biota. The exposure of living organisms to contaminants could result in mortality or, more often, disturbances affecting biodiversity and species representation in target populations. Settlement of the suspended sediments can result in the smothering or blanketing of subtidal communities or adjacent intertidal communities, although this can also be used beneficially to raise the level of selected areas to offset sea level rise or erosion (Bray, Bates, and Land 1997). The refuge would follow MassDEP's Guide to Best Management Practices for Beach Nourishment (MA DEP 2007), as well as the Service's Tern Management Handbook (Kress and Hall 2004). Geise et al. (2010) reported that past dredging operations in the vicinity of the refuge (e.g., the entrance channel to Stage Harbor, which lies north and west of Morris Island, is regularly dredged) have not adversely impacted water quality with turbidity, nutrients, or toxins. The use of dredge materials would require additional NEPA analysis.

Should the refuge decide to no longer allow dredging to occur within the channel, there is the risk this channel could close due to natural accretion and restricted tidal flows. This might, however, reduce the need for additional sediments to be placed on the Morris Island beach itself.

Water Quality Impacts of Alternative C (Natural Processes)

Under alternative C, water quality impacts would be considerably lower than in the previous alternatives. Only non-motorized personal watercraft, such as kayaks, would be allowed as a means for water access within the wilderness area. This would reduce the overall discharge from motorized boats, as access would only be allowed in non-wilderness waters within the Declaration of Taking. This also lessens the chances of a catastrophic spill, which could greatly impact water quality within and near the refuge.

Alternative C also potentially limits the number of visitors at one time to enhance the wilderness experience. These measures would reduce the amount of petroleum discharges from motorized boat use into the waters surrounding Monomoy NWR.

Invasive species control would only be conducted if there were a direct threat to wetland integrity or a risk of the invasive species replacing stands of native vegetation. In that case, invasive species management techniques would be similar to those described in alternatives A and B.

The impacts from dredging and channel closure would be the same as those discussed under alternative B.

Effects on Soils

Soils are the structural matrix and nutrient source for plant productivity at the refuge and must be protected to sustain the barrier island habitats that meet our habitat and species management goals. Overall, the soils on the refuge are productive and in good condition, with no substantive erosion, compaction, or contamination problems. 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 soils of dunes, maritime shrubland, and beach areas.

We compared the benefits of the three alternatives based on actions that would, or would not, protect soils from erosion, compaction, or contamination, or that would restore eroded, compacted, or contaminated soils, including the:

- Protection of refuge lands from development.
- Habitat restoration projects.

The potentially adverse effects of the management alternatives included impacts from:

- Constructing buildings, parking facilities, access roads, and interpretive trails.
- Conducting habitat management activities, including prescribed burning and herbicides.
- Providing refuge visitor activities and programs.

Soil Impacts Common to All Alternatives

The refuge is exposed to the natural coastal processes of accretion and erosion, or the deposition and removal, of sand along shorelines. Sand that is eroded, or removed, from one beach will be transported downdrift and will accrete, or be added, on another. These processes are influenced by many factors, some of which include currents, tides, winds, sea floor bathymetry, and human modifications. The dynamic nature of these systems means that the same beach can both accrete and erode seasonally within a given year, and can fluctuate between accretion and erosion over long periods of time. These movements of sand provide ever-changing coastlines and habitats for many species of wildlife. The soil layer underlying our coastal refuge habitats is one of the most active sites of energy exchange; it plays a critical role in ecosystem processes such as the carbon, nitrogen, and oxygen cycles. Healthy soils are critical to nutrient cycling and plant productivity and must be protected to sustain the variety of tidal, wetland, and upland habitats on the refuge.

Benefits

Overall, Monomoy refuge's soils are productive and in relatively good condition. However, there is some concern about contaminated sediments associated with boat use, as well as the potential for erosion caused by large groups of users, such as birding groups and education field trips. Most pedestrian traffic is confined to designated trails, and the refuge would continue to be proactive in minimizing impacts to the soil environment. The Morris Island trail, boat launch sites, wildlife observation areas, parking areas, and other high-use areas will continue to be well maintained to keep their impact on refuge soils to a minimum. An established, maintained trail on Morris Island reduces vegetation trampling and soil erosion from pedestrian traffic. On North Monomoy Island and South Monomoy, some dune erosion is expected to occur as a result of pedestrian traffic and trampling, but through public education we would discourage pedestrians from walking across dunes and explain the impacts this has on fragile resources. Pedestrian-induced dune erosion is expected to be minimal in most areas because of the relatively low intensity use on the dunes. However, this has been an issue in past years on the east side of North Monomoy Island where there is a relatively narrow width of beach available to visitors at higher tides. Visitors are more likely to establish a presence on the slopes of the dunes (instead of at the toe of

the dunes) at higher tides, and this contributes to dune erosion in some years. We would note any erosion problems during routine monitoring and correct them as soon as possible.

Under alternative B, a we will consider a wilderness access pass, which would potentially limit the number of visitors at one time in the Monomoy wilderness, thereby reducing the likelihood of adverse impacts like soil compaction.

The prohibition of motorized vehicles on the refuge under all three alternatives significantly reduces, but does not eliminate, the risk of vegetation trampling and soil erosion from human recreational activity. Regardless of which alternative is selected, we would continue to use best management practices in all management activities to minimize erosion.

Adverse Impacts
Under all three alternatives, some soil disturbance occurs from prescribed burning and removing nonnative or otherwise invasive plant species. Herbicides would be used to control nonnative vegetation. The mobility of an herbicide is a function of how strongly it is adsorbed to soil particles and organic matter. Herbicides that strongly adsorb to soil particles are relatively insoluble in water and not environmentally persistent. These would be less likely to move across the soil surface into surface waters or leach through the soil profile and contaminate groundwater. We would choose the most effective herbicide available with the least potential risk to soils for use on the refuge. Removing plants has the potential to cause localized soil disturbance and erosion until new plant species establish. There could be more soil disturbance associated with higher levels of invasive species control, but any soil disturbed by the physical removal of plants would be tamped down and compacted. This is a standard aspect of any removal operation. The advantage of chemical controls is that they are often the most effective, particularly when treating large areas or sites where the invasive plants are well-established. The disadvantages are that the chemicals may affect non-target species at the site and may contaminate soils and surface or groundwater. We would take all appropriate steps when applying herbicide, including applying the minimum effective dose, using application methods that minimize non-target effects, applying during the optimal growth stage, and adhering to licensing requirements and other regulations. Again, we would only use herbicides

Prescribed burning

USFWS

approved by the regional contaminants coordinator and only in accordance with approved rate and timing of application.

Prescribed fires help reduce fuel loads and thereby prevent excessively hot future fires that could damage soils. Prescribed fires provide benefits by releasing stored nutrients back into the soil, offsetting any short-term adverse impacts following a burn. Soil damage from fires, or from erosion on fire-damaged sites, is unlikely to occur on the refuge because of the rarity of wild fires and the relatively flat topography of the area. We will implement small-scale prescribed fires on confined areas, in short durations and low-to-moderate intensities. Such fires consume only part of the upper layer, and rarely transfer major amounts of heat into the soils. We will use prescribed fires to remove litter and light fuels, and seek to avoid adverse effects of severe, hot wildfires on soil resources.

Neary et al. (2008) provide a comprehensive overview of current knowledge about fire impacts on soil. The rate at which heat energy from a fire burning through aboveground surface fuels is transmitted downward through the soil is limited by the soil's thermal properties. Most energy released by flaming combustion of aboveground fuels is not transmitted downward (Packham and Pompe 1971, Frandsen and Ryan 1986). The limited heat pulse and residence time of flaming fronts downward into Monomoy refuge's dry, sandy substrates that are low in organics and nutrients limit the prescribed fire severity and impacts to soil properties.

The greatest increase in temperature from the downward heat transfer during a surface fire occurs at or near the soil surface. However, the temperature increases quickly diminish within 2.0 to 3.9 inches (5 to 10 cm) of the soil surface, largely confining soil property impacts from the fire to this shallow surface zone. Dry soils are poor conductors of heat and do not heat substantially below about 2 inches (5 cm) unless heavy long-burning fuels are combusted. The low-severity, infrequent, prescribed burns proposed under any alternative are not expected to significantly change soil texture, bulk density, porosity, infiltration rates, water holding capacity, water repellency (hydrophobicity), or erodibility, or the sediment yields of underlying soils.

In non-fire environments, nutrient availability is regulated biologically by decomposition processes of widely variable rates depending on moisture, temperature, and type of organic matter. Through decomposition, this material breaks down, releases nutrients, and moves into the soil as organic matter. Fire dramatically accelerates biological decomposition rates to that of nearly instantaneous thermal decomposition during the combustion of organic fuels (St. John and Rundel 1976). The magnitude of these fire-related changes depends largely on fire severity (DeBano et al. 1998). Nitrogen (N), organic matter, and duff decrease as fire severity increases. Available NH_4-N and cations increase. The pH of the soil generally increases because of the loss of organic matter and its associated organic acids, which are replaced with an abundance of basic cations in the ash.

In grasslands, savannas, and tundra-covered areas, much greater quantities of organic carbon (C) are found in the underground plant parts than aboveground (less than 10 percent of the total C in these herbaceous vegetation ecosystems is found aboveground). In general, soils with larger proportions of organic matter in the aboveground biomass and on their forest floors are more prone to disturbances, including fire, in their nutrient and C regimes than those in which most of the C in the ecosystem is located below ground (Neary et al. 2008), such as the Monomoy refuge grasslands. Prescribed burning that consumes a large proportion of the organic fraction of the soil can at least temporarily deplete soil C and N availability as well as cation exchange capacity. If such high severity burning is frequent, then long-term site productivity can decrease due to depleted soil C and N reserves and cation exchange.

Nitrogen is likely the most limiting nutrient in natural systems (Maars et al. 1983), followed by phosphorus (P) and sulfur (S). Cations released by burning may affect soil pH and result in the immobilization of P. The role of micronutrients in ecosystem productivity and their relationship to soil heating during fire is, for the most part, unclear (Neary et al. 2008).

Nitrogen is particularly vulnerable to fire effects in N-deficient ecosystems (Maars et al. 1983) such as Monomoy refuge's dunelands. Nitrogen is the only soil nutrient not supplied to the soil by chemical weathering of parent material. Almost all N found in the vegetation, water, and soil of wildland systems is added to the system from the atmosphere. The amount of N lost is generally proportional to the amount of organic matter combusted during the fire. Volatilization is the chemically driven process most responsible for N losses during fire. As a general rule, the amount of total N that is volatilized during combustion is directly proportional to the amount of organic matter destroyed (Raison et al. 1985). It has been estimated that almost 99 percent of the volatilized N is converted to N_2 gas (DeBell and Ralston 1970). The N that is not completely volatilized either remains as part of the unburned fuels or is converted to highly available NH_4-N that remains in the soil (DeBano et al. 1979, Covington and Sackett 1986, Kutiel and Naveh 1987, DeBano 1991). Even small total N losses can adversely affect the long-term productivity of N-deficient ecosystems, and losses tend to be proportionally greater on dry soils over moist soils. In contrast, available N is usually increased as a result of fire, particularly NH_4-N (Christensen 1973, DeBano et al. 1979, Carballas et al. 1993). This increased N availability enhances post-fire plant growth. This apparent increase in fertility is short-lived. A temporary increase in available N following fire is quickly utilized by plants within a few years after burning.

The atmosphere supplies N to soil in natural ecosystems mainly through organisms that fix inert N_2 into forms that can be used by plants. Nitrogen additions to the soil by N-fixing organisms, both free-living and symbiotic, counterbalance the volatilized N lost during combustion and subsequent leaching of soluble N compounds into and through the soil following fire (DeBano and others 1998). Symbiotic N-fixation is carried out by symbiotic microorganisms associated with the roots of higher plants, obtaining energy required for N-fixation from the host plant. The most common symbiotic relationships found in wildland ecosystems are those formed by rhizobia or actinomycetes associated with plant roots. *Rhizobium* bacteria are found associated with the roots of leguminous plants that make up about 700 genera in the Leguminosae family (Haynes 1986). Beach pea is a common and prominent legume within duneland habitats subjected to prescribed burning on Monomoy.

Changes in microbial population size and activity are common following wildfire and prescribed fire. Heat penetration into the soil during a fire affects biological organisms located below the soil surface, depending on the heat transfer mechanism, soil moisture content, and duration of combustion. Because many living organisms and the organic matter in soils are located on or near the soil surface, they are exposed to heat radiated by flaming surface fuels and smoldering forest floor fuels. Resilience is a trademark of the microbial community. Population sizes often match or surpass pre-burn levels within a growing season (Ahlgren and Ahlgren 1965, Renbuss et al. 1973). Intense wildfire can have severe and sometimes long-lasting effects on microbial population size, diversity, and function. Low-severity underburning generally has an inconsequential effect on microorganisms, although microbial activity often shows a positive response to this type of fire, particularly with respect to N-fixation (Jorgensen and Wells 1971) and N availability (Schoch and Binkley 1986, White 1986, Knoepp and Swank 1993a, 1993b).

The combustion of organic matter leaves a relatively large amount of highly available P in the surface ash on the soil surface immediately following fire. This highly available P, however, can be quickly immobilized and become unavailable for plant growth if calcareous substances are present in the ash.

Soil cations such as calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), and ammonium (NH_4) released from surface organics during fires are however often redeposited in relatively soluble mineral forms in the ash left behind the flaming front. Combustion of organic matter during a fire and subsequent release of soluble cations tend to increase pH slightly as basic cations are released during combustion and deposited on the soil surface. The increase in soil pH, however, is usually temporary, depending upon the original soil pH, amount of ash released, chemical composition of the ash, and wetness of the climate (Wells et al. 1979). The pH of the soil is an important factor affecting the availability of plant nutrients such as phosphorus (P), iron (Fe), and copper (Cu), which are most likely to be affected by a fire. Phosphorus is a macronutrient that is frequently limiting in wildland ecosystems and can also become insoluble at high or low pHs.

The low-severity and infrequent refuge grassland and shrubland prescribed burns (3- to 5-year intervals) can improve soil properties in two ways: stimulating and maintaining native vegetation vigor, and periodically returning back into soils a quick pulse of nutrients in a form more readily used by plants across the refuge landscape on a rotational basis.

Soil Impacts of Alternative A (Current Management)

Any of the low-severity prescribed fires conducted by the Service on Monomoy refuge should benefit soils in the short term by releasing nutrients bound up in plant biomass back into the soil (Dudley and Lajtha 1993); the degree depends on fire intensity (USFWS 2003c). The mechanical removal of invasive plant species has the potential to cause localized soil disturbance and erosion until new plant species establish. Maintaining native shrubland habitat and reducing invasive plant species would likely improve soil condition. Native vegetation supports the natural functioning and production of ecological services that improve soil fertility and sustain soil health.

Some soil compaction occurs from walking on the unmaintained trail network during refuge management and monitoring visits, as well as from public use. In some areas, particularly in and around the field camp and tern nesting areas on South Monomoy, trails used by refuge staff are well worn and devoid of vegetation for much of the growing season. The field camp location and some of the management trails stay the same from year to year, and in these areas, very little vegetation regrows because of the extensive use. Staff intentionally use a small number of trails to concentrate impacts and prevent disturbance through the larger areas. Past observations have shown that when these trails and camp locations are no longer needed and use is abandoned, they are generally revegetated naturally within one to two growing seasons. However, revegetation may result in different species composition than was previously there, particularly at abandoned field camp sites. Soils on the refuge are well-drained, sandy soils that help filter waste and byproducts; however, all human waste is packed out and biodegradable cleaning products are used at the field camp for activities like dishwashing.

Under current management, the refuge has a minimum requirements analysis that permits motorized vehicles for the purpose of restoring the historic light station. These activities are occasional and short-term, and as a result soil compaction is minimal overall.

Alternative A proposes installing solar panels at the Monomoy Point Light Station. During the construction of these structures, some upper layers of soils would be disturbed and compacted. Most, if not all, small project construction would be located where high levels of soil disturbance from visitors or previous

construction and maintenance activities already exist. This would increase soil compaction and erosion only in these already disturbed areas. As with other activities on the refuge that have the potential to disturb soils, the refuge would implement best management practices, including soil protection plans as necessary to minimize any negative effects on soils, including erosion and compaction. If the Monomoy Point Light Station is used to accommodate staff and visitors, there may be the potential for long-term impacts from trampling and other activities. Installation of solar panels on South Monomoy would result in short-term, temporary impacts, such as wearing away or removal of protective vegetative cover, which exposes the soil to wind, sun, and precipitation, and can destabilize the dunes. Disturbed soil areas would be reshaped to original contours and, where vegetation is worn away in the course of construction, bare soil areas would be revegetated using native dune plants. For both new construction and maintenance of facilities, we would employ best management practices during construction of any facilities in proximity of sensitive vegetation to avoid runoff of sediments.

Soil Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))

Impacts from habitat and wildlife management activities would be similar to alternative A. Under alternative B, the use of prescribed fire would increase by 55 additional acres compared with alternative A. Impacts would be the same as those discussed under Soil Impacts Common to All Alternatives. We would also incorporate invasive plant treatment as necessary to maintain quality habitat and promote biological integrity. This would be enacted through manual, chemical, or biological control. Though similar to alternative A, impacts would possibly be more short-term as we control more invasive plants and increase the presence of refuge staff. Impacts from use of the field camp would be the same as alternative A, although with a slightly greater potential for short-term impacts.

Alternative B would provide more onsite Service presence to manage visitor services and offer greater enforcement of unauthorized uses. This would help restore and protect dunes by designating authorized trails and directing foot and vehicular access away from sensitive areas to more stable beach sandy areas. Under alternative B, increased visitor services staff and expanded environmental education and interpretation, including additional signs, would raise awareness among visitors about the sensitivity of the refuge habitats and potential effects of unauthorized uses. Alternative B proposes additional facilities on Morris Island, including small trail expansions, observation area, kiosk, Americans with Disabilities Act-compliant ramp, and possible renovation of the existing headquarters facility. We anticipate some short-term, localized adverse impacts to the soil environment during these minor construction projects. Best management practices would be employed to maintain the integrity and productivity of refuge soils and minimize erosion, compaction, and other impacts. Overall, these impacts are considered minimal, as the total affected area is a small fraction of the total refuge.

Impacts from the proposed installation of solar panels at the Monomoy Point Light Station would be the same as those discussed under alternative A.

Under alternative B, the proposed downtown visitor contact station, if it were to be built, would cause localized compaction and loss of soil productivity where soils are removed or surfaced for the building and associated parking area; the same is true for immediately adjacent areas where vehicles and heavy equipment would be used for site access and preparation work. Otherwise, an existing structure would be purchased, and any impacts to the soils would already have occurred. The proposed relocation of refuge headquarters and visitor contact station, if realized, would be located off-refuge and would not impact the existing refuge resources. The impacts from additional proposed construction activities would be assessed under a separate stand-alone NEPA.

Alternative B would continue to rely on symbolic fencing, although with greater use of adaptive management and onsite presence of Service staff to determine location and duration to protect habitat and dune processes.

As a part of alternative B, a cultural resource overview is proposed, which may result in additional short-term soil disturbance activities. Any soil disturbance would be temporary, and would be replaced or tamped down when the project was completed.

This alternative would evaluate the use of dredge material obtained from projects outside the refuge to increase elevation of important refuge bird nesting habitat outside of the Monomoy wilderness, and most at risk from inundation due to sea level rise and increased storm surge. Placement of the dredge material would be determined on a case-by-case basis, but it would likely be placed as high possible, above the intertidal zone, for maximum benefits to beach- nesting birds. In most areas of New England, sediment is predominantly composed of quartz particles, so the borrow material would likely have adequate strength and high resistance to abrasion (MA DEP 2007). The refuge would follow MassDEP's best management practices for beach nourishment (MA DEP 2007).

Soil Impacts of Alternative C (Natural Processes)

Alternative C would provide the greatest protection of refuge soils through more focused public use and emphasis on natural processes. We would not pursue the installation of solar panels at the light station and would therefore maintain the integrity of the soils at that location. In addition, impacts from staff would be decreased since we would no longer maintain a field camp on South Monomoy and only make periodic trips to the refuge.

Impacts from the proposed visitor contact station in downtown Chatham or Harwich would be the same as described under alternative B.

Impacts from prescribed burns would be the same as previously discussed; however, acreage under alternative C would be 23 percent of the current acreage and 9 percent of the acreage proposed under alternative B. Therefore, we would expect any adverse impacts associated with this management activity to be considerably less than in the other alternatives.

Prescribed burn protocols would be evaluated through a minimum requirements analysis to identify the minimum impact methods and tools to accomplish necessary activities safely and with minimal impairment of wilderness character. In addition, refuge staff visits would be reduced from alternative B, so any compaction as a result of staff activities would be minimal and possibly even less than alternative A.

Effects on Federal Threatened and Endangered Species

Preservation, enhancement, restoration, and management of federally endangered and threatened species and their habitats are among our highest priorities on the refuge. This includes researching and monitoring their populations. Working toward recovery of roseate tern (endangered), piping plover (threatened), northeastern beach tiger beetle (threatened), red knot (candidate species), leatherback turtle (endangered), the northwest Atlantic distinct population segment of loggerhead turtle (threatened), Kemp's ridley (endangered), green (threatened) and hawksbill (endangered) sea turtles is fundamental to achieving our refuge goals. We will complete an intra-Service evaluation with our New England Field Office for Ecological Services in Concord, New Hampshire, to ensure the selected alternative complies with the Endangered Species Act. Management for federally listed species would also benefit several other species of conservation concern, including American oystercatchers, common and least terns, and gray and harbor seals.

We evaluated the proposed habitat management actions and strategies of all alternatives for their potential to affect, beneficially or adversely, the habitats

required for sustaining healthy and viable populations of these species. Our proposed conservation actions targeting Federal and State endangered species include managing beach and inland habitats to reduce predation and disturbance, and restoring native vegetation.

The benefits we considered included:

- Protecting and enhancing migratory bird species and their habitat components at currently inhabited sites on the refuge.
- Creating new habitats.

The potential adverse effects of the Monomoy refuge management alternatives that we evaluated included impacts from:

- Vegetation management methods that may affect the potential for successful recovery of threatened and endangered species or their habitats.
- Inventory and monitoring activities by refuge staff.
- Predator management activities.
- Public and economic use activities on the refuge that might damage habitat or disturb the species.

Roseate Tern

Roseate terns nest on the ground, making them vulnerable to human disturbance and predators. After habitat loss, these factors are among the greatest threats to the recovery of this species (USFWS 1998). We would continue to close all nesting sites to public use from May through August. Symbolic fencing used in all alternatives would minimize human disturbance and help achieve the productivity levels for this species. Regular law enforcement patrols would help enforce the posted closures. Predator management, both nonlethal and lethal, would continue to be a major management strategy to aid our efforts to maintain desired productivity levels. Careful removal of individual predators that pose the greatest threat to roseate tern colonies would result in higher fledgling success, benefitting this endangered species. In addition, establishing a human presence during the nesting season would help deter some predators, further benefitting the tern colony. Minimizing human disturbance at nest sites reduces the energy reserves terns need to defend their nest sites, reduces the susceptibility of nests to predation from other seabirds such as gulls, and reduces the time adult terns are kept away from their nests. Closing areas and managing predators during the breeding season should improve the nesting success of the endangered roseate tern and benefit other tern colonies.

Kirk Rogers/USFWS

Roseate tern

We would also continue to use artificial nesting structures in all alternatives, as these have been shown to lure terns to nesting sites and reduce predation by gulls on common tern chicks (Burness and Morris 1992); these would also help reduce predation on roseate tern chicks by avian predators.

Habitat management would also remain an important component of roseate tern management. Through the use of fire, herbicides, or manual means, we would maintain an optimal vegetative structure (a mosaic of open areas for common terns in close proximity to more densely vegetated areas preferred by roseate terns) in potential nesting areas, increasing the opportunity for common and roseate tern colonies to become established. Dormant-only seasonal burning common to all alternatives eliminates the potential risk of mortality to nesting adults, nests, unhatched eggs, and unfledged nestlings. Waiting until spring to conduct prescribed burning foregoes the head-start effects, or even sets back seasonal vegetative recovery. It also risks terns avoiding the site and potentially

losing some or all of the burned acres from the nesting habitat base for the entire first post-burn nesting season.

Under alternative A, roseate terns would continue to benefit from maintaining 30 acres of nesting habitat in addition to 2 acres of prime habitat specifically for this species. The installation of artificial nesting structures and use of decoys and sound systems would help increase the likelihood that roseate terns would select an area on the refuge to establish a nesting colony; this has been shown to be effective at other locations (Kress 1983) and is an established management tool (Kress and Hall 2004).

Management actions under alternative B take a more proactive approach in the recovery efforts of this species and would likely provide the greatest benefit to this species compared with alternatives A and C. As in alternative A, alternative B would employ the use of decoys and sound systems to attract nesting roseate terns. We would expand the acreage of nesting habitat for common and roseate terns by 45 acres compared with alternative A, with an additional 8 acres of prime nesting habitat for roseate terns. Roseate terns and other migratory nesting species would benefit from efforts to control nonnative plant species in the dune grasslands. The benefits of maintaining no more than 10 percent coverage of invasive plant species refugewide is discussed in more detail under Effects on Vegetation.

Under alternative B, roseate terns would benefit from efforts to establish new tern habitat in areas not currently used on the refuge, in addition to the possibility of creating new habitat outside of the Monomoy wilderness through the use of dredge material. The dynamic coastal processes of accretion and erosion have made Monomoy refuge susceptible to losing valuable habitat. Using dredge material would protect habitats that benefit roseate terns from the effects of erosion and sea level rise, and further support recovery efforts to reach a productivity of 1.0 chicks per nesting pair. Increased partnerships and participation in research relevant to the roseate tern and its habitat would better inform future management and conservation efforts.

Under alternative C, the roseate tern would continue to benefit from recovery efforts; however, we would only focus on protecting 10 acres of tern colony nesting habitat and, as with alternative A, only 2 acres of prime nesting habitat for roseate terns. The benefit of a 24-hour human presence found in alternatives A and B would decrease in alternative C to 3 times per week. This may adversely impact the productivity of roseate terns by reducing protection efforts and increasing opportunities for predators.

Piping Plover

Piping plovers would greatly benefit from proposed activities under all alternatives. In addition to intensive beach management and monitoring on the refuge, staff monitor all nesting activity on the refuge. Under all the alternatives, Monomoy refuge would continue to make an important contribution toward recovery of the Atlantic coast population of piping plovers.

Seasonal closures using temporary symbolic fencing and law enforcement patrols would continue to protect nesting areas from human disturbance. Along the Atlantic coast, piping plover parents and young seem to lose considerable foraging time because of human presence. Active predator management would additionally improve nest success and help us achieve the target productivity levels (number of young that successfully fledge per nest) necessary for population growth. Predator exclosures would continue to protect nests from a variety of mammalian and avian species that prey on plovers, contributing to the targeted productivity levels. Symbolic fencing has been shown to help minimize the impacts of human disturbance by keeping a safe distance between

prospecting and nesting plovers and the public (Patterson et al. 1990, Doherty 2007). The refuge would continue to restrict certain activities that are not compatible wildlife uses. For example, beach fires can disturb nesting birds as well as attract predators, thereby increasing predation of bird species.

For the most part, refuge management activities do not significantly impact the number of piping plovers that nest on Monomoy's beaches from year to year. The main factors influencing the numbers of nesting pairs are quantity and quality of nesting habitat and shape of beach. The Northeast and Atlantic regional population has been growing since piping plover monitoring began. The shape of the beach is mainly affected by natural maritime forces. Large nor'easters can either reduce habitat by creating steep foredunes or create habitat by overwashing backdunes and setting back succession. Since plovers are adapted to this rapidly shifting habitat mosaic, allowing natural processes to occur would benefit the piping plover over the long term. South Monomoy has shown an increase in available habitat as a result of accretion and we do not anticipate any significant loss of habitat that would adversely impact this species over the next 15 years.

Because plovers tend to return to sites where they successfully raise young, increasing productivity tends to increase local populations, and vice versa. We aim to increase productivity by minimizing disturbance (closing areas of the refuge, symbolically fencing off nesting areas), outreach and education, and reducing predator pressure (nest exclosures, electric fencing, staff presence, selected predator removal). By protecting critical feeding and resting areas, we would be contributing to improved physical condition of piping plover during their migration, and ultimately contributing to the recovery of the species.

Under alternative A, the refuge's piping plover population would continue to benefit from refuge actions, with increases in productivity. Without active refuge involvement (funding for supplies, staffing for monitoring and management, expertise, and predator management), the number of nesting pairs and productivity are likely to be much reduced.

Under alternative B, we include the use of solar-powered electric fencing to further increase piping plover productivity, but this use of electric fencing would be minimal because of the time necessary to install and maintain fencing and the relatively few areas on the refuge where habitat conditions are optimal for electric fencing. In alternative B, we would increase management to protect nesting piping plovers in a manner consistent with preserving wilderness character by closing to the public all available high-quality habitat by mid-April.

The rationale for objective B1.2 discusses the likelihood of rising sea levels and coastal erosion. Piping plovers are at risk of losing valuable habitat due to storm surges that may amplify rates of habitat change along coastal beaches. Piping plovers would benefit from the use of dredge material to create additional nesting locations should we determine that their habitat is at risk. These additional strategies might help us achieve higher productivity and nesting pairs compared to alternatives A and C.

Alternatives A and B propose the installation of solar panels at the Monomoy Point Light Station. Construction activity on South Monomoy would not commence until at least August, after piping plover and roseate and least tern nesting is complete for the year and near the end of the normal chick fledging period. Setback distances and Service presence would be required any time there is project-related activity on the beach-dune interface within the sight distance of any foraging piping plovers with unfledged chicks (possible during August). No unsupervised project-related activity would be undertaken from the beginning of April to the end of August unless all plover chicks have fledged, minimizing the potential for any project-related adverse effects on piping plover under any

alternatives. The greatest impact would be loss of potential habitat where solar panels are installed; however, these structures would be placed in previously disturbed areas where nesting does not occur.

In alternative C, piping plovers would not benefit from the use of dredge material or other habitat alterations to accommodate sea level rise, and electric fencing would not be used.

Northeastern Beach Tiger Beetle
In addition to habitat loss, mortality and degradation of suitable breeding areas caused by off-road vehicles and other activities have been shown to be among the major threats to northeastern beach tiger beetles. Continued vehicle closures on North Monomoy Island and South Monomoy would protect beach habitat from degradation and minimize direct mortality of beetles. As a result of the protection afforded on the refuge, the population is currently estimated at more than 500 individuals, which was the target for a sustainable level in all three alternatives. The refuge's support and participation in relevant research projects not only helped protect the beetles' habitat, thus helping beetle populations, but also informed the public about the need to protect the species and its habitat. The mark-and-recapture studies require refuge staff to handle beetles and could result in the accidental death of individuals during periods of handling and keeping in captivity.

Alternative B would provide the greatest protection efforts for the northeastern beach tiger beetle by increasing partnerships with the New England Ecological Services Field Office staff to find additional sites for translocation, and utilizing the existing population at Monomoy refuge as a donor population. These actions would further contribute to the recovery and protection of this endangered species. Projects with partners may involve the direct take of individuals; however, we believe the benefits from increasing our knowledge on the recovery of this species outweigh the adverse impact of a loss of a very small portion of the population.

In addition to the protection afforded to tiger beetles under alternative A and addressing research needs identified in the most recent 5-year review, management for this species under alternative B would include working with partners to locate new introduction sites, and hopefully increase the population and geographic extent rangewide. One of the best ways to ensure the future survival of isolated, rare species is to protect and maintain as many populations across as broad an area as possible.

Red Knot
Piping plover and shorebird management strategies proposed under all alternatives would benefit the red knot. Red knots would continue to benefit from our collaborative efforts to monitor and document the importance of Monomoy NWR to this species' recovery. We would continue to monitor red knot usage and implement additional strategies as we learn more about the species and its life history.


Bill Thompson/USFWS
Red knot

The ban on horseshoe crab harvesting would remain in effect for all three alternatives. If the refuge did not have this measure in place, we would expect high harvest pressure on the refuge, especially in consideration of closures elsewhere in the Cape Cod region, and would likely see a decline in the local horseshoe crab population. Chapter 3 details the importance of horseshoe crab eggs to migrating shorebirds, including red knots. Since the ban on horseshoe crab harvest on Monomoy NWR was implemented, we have seen an increase and even a repopulation in Stage Harbor—an area that was fished out years ago. The benefit of enforcing this management action is a viable and continuous food source for migrating red knots and other shorebirds. Law enforcement patrols would help ensure that the public stays out of posted areas and adheres to the

refuge policies and regulations. In all three alternatives, we would continue working with partners to document the importance of Monomoy refuge to migrating red knots and contribute to research that would inform and contribute to the species' recovery.

Alternative B would provide the greatest benefit to the red knot by implementing strategies that protect foraging habitat and reduce the impact of human disturbance. Increased public awareness through an outreach campaign would contribute to recovery efforts by educating the public about the importance of minimizing disturbance. The prohibition of mussel harvesting would further benefit the red knot by preserving a valuable food source.

Sea Turtles

Fishery interactions, vessel interactions, and channel dredging operations are the principal activities affecting sea turtles using the nearshore marine (neritic) environment, and were among the principal threats that led to their original listing under the Endangered Species Act (NMFS-NER 2012). Leatherback sea turtles are by far the most commonly encountered of the five sea turtle species known to use nearshore open water areas around Monomoy NWR. Leatherbacks are followed in prevalence by loggerhead, Kemp's ridley, and green sea turtles. Although rare, hawksbill sea turtles have also been documented in Nantucket Sound waters. The spatial range of leatherbacks in Massachusetts waters largely depends upon the seasonality (May to October, with July to August peak months) and location of their primary food supply, gelatinous zooplankton (Burke and Sharp 2010). Pelagic and benthic juvenile loggerheads are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd 1988, NMFS and USFWS 2008). Sub-adult and adult loggerheads are primarily coastal-dwelling and typically prey on benthic invertebrates, such as mollusks and decapod crustaceans, in hard-bottom habitats (NMFS and USFWS 2008).

Loggerhead or leatherback sea turtles caught or wrapped in the buoy lines of trap gear can die as a result of forced submergence, or incur injuries such as severe constriction of a flipper, leading to death. A review of leatherback mortality documented by the Sea Turtle Sighting and Stranding Network in Massachusetts suggests that vessel strikes and entanglement in fixed gear (primarily lobster pots and whelk pots) were the principal sources of leatherback mortality (Dwyer et al. 2002). A 1990 National Research Council report concluded that, for loggerhead juveniles, sub-adults, and breeders in coastal waters, the most common cause of human-related mortality in U.S. Atlantic waters was fishery interaction. The Loggerhead Biological Review Team determined that the greatest threats to the loggerhead northwest Atlantic distinct population segment result from cumulative fishery bycatch in neritic and oceanic habitats (Conant et al. 2009).

Leatherbacks may also be more susceptible to marine debris ingestion than other sea turtle species due to the tendency of floating debris to concentrate in convergence zones that juveniles and adults use for feeding (Shoop and Kenney 1992, Lutcavage et al. 1997). Leatherbacks might not be able to distinguish between prey items such as jellyfish and plastic debris (Mrosovsky 1981) that may resemble food items as it drifts about, inducing a feeding response in leatherbacks (Balazs 1985). NMFS Northeast Region established the Northeast Sea Turtle Disentanglement Network (STDN) in 2002 in response to the high number of leatherback sea turtles found entangled in pot gear along the U.S. northeast Atlantic coast. The STDN is considered a component of the larger Sea Turtle Stranding and Salvage Network (STSSN) program and operates in all states in the region.

Leatherbacks are susceptible to entanglement in lines associated with trap/pot gear used in several fisheries. From 1990 to 2000, 92 entangled leatherbacks

were reported from New York through Maine (Dwyer et al. 2002). Additional leatherbacks stranded were wrapped in line of unknown origin or with evidence of a past entanglement (Dwyer et al. 2002). More recently, from 2002 to 2010, NMFS received 137 reports of sea turtles entangled in vertical lines from Maine to Virginia, with 128 confirmed events (verified by photo documentation or response by a trained responder; NMFS 2008a). Of the 128 confirmed events, 117 involved leatherbacks. NMFS identified the gear type and fishery for 72 of the 117 confirmed events, which included lobster (42), whelk/conch (15), black sea bass (10), crab (2), and research pot gear (1).

There were 97 confirmed or probable vertical line entanglement reports of leatherbacks from Maine to New York during 2002 to 2010. During the period 1980 to 2000, there were 119 reported leatherback sea turtles entangled in lobster trap gear from Maine to New York. Documented leatherback entanglements from Maine to New York averaged 10.77 annually from 2002 to 2010. Forty-three leatherback events involved lobster gear, 22 events involved fishery gear from a different source, and for 32 events the gear could not be assigned to a specific fishery. From the total of 65 events involving a verified gear, 66 percent came from the lobster fishery. All 43 leatherback lobster gear entanglements involved vertical line of the gear and occurred in Maine, Massachusetts, Rhode Island, with one in Connecticut waters, and occurred in the warmer months as illustrated in figure 4.2.

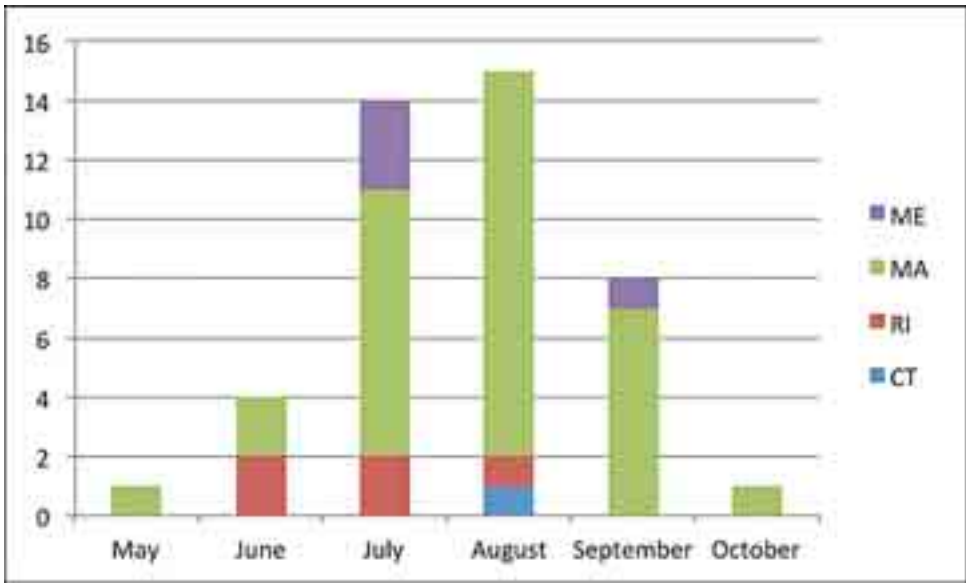

Figure 4.2. Leatherback Sea Turtle Lobster Gear Entanglements by New England State for 2002 to 2010.

Of the 43 confirmed or probable sets of gear, one was verified as Massachusetts recreational lobster pot gear (August 2006), and two sets of gear have been identified to a fisherman with both Massachusetts State and Federal permits for lobster pot gear. Four entanglements involved gear from fishermen with State permits, and possibly Federal permits, but this could not be confirmed. In seven entanglements, it was unknown if the gear came from a state, Federal, or recreational fishery. All other lobster gear has been confirmed to be state commercial (Maine, Massachusetts, Connecticut, or Rhode Island) coastal lobster pot gear.

Recorded loggerhead interactions with American lobster fishery gear are few. There have been three loggerheads reported entangled in lobster gear.

For 1980 to 2000 there was one loggerhead (alive) entangled in lobster gear in Massachusetts (SEFSC STSSN database: *www.sefsc.noaa.gov/species/turtles/strandings.htm*) and none during the recording period 2002 to 2010, according to the STDN database. During the same time period, 10 loggerhead sea turtle entanglements in other vertical line trap/pot gear (i.e., crab, whelk, and unknown) were documented. Five of the other gear entanglements were in whelk pot gear, and two entanglements were confirmed to be from a crab fishery. Whelk pots, unlike lobster traps are not fully enclosed, and have been suggested as a potential source of entrapment for loggerhead sea turtles enticed by the bait or whelks in the trap (Mansfield et al. 2001). Gear from three of the loggerhead entanglements was never identified. The factors influencing loggerhead sea turtle entanglements in pot/trap fishing gear are unclear. Actions taken to reduce anthropogenic impacts to loggerhead sea turtles from various sources, for example, turtle excluder devices on trawl gear and chain mat regulations on sea scallop dredge gear, represent a significant improvement in the baseline gear effects on loggerheads in the northwest Atlantic.

For the 3 years beginning June 1, 2007 and ending May 31, 2010, the Massachusetts Sea Turtle Disentanglement Network (MASTDN) undertook 36 on-water responses to 41 confirmed entangled sea turtle reports throughout Massachusetts coastal waters and shorelines (Burke and Sharp 2010). These entanglements consisted of 40 leatherback and 1 loggerhead, of which 24 were successfully disentangled and released alive by MASTDN response teams. Where it could be identified, the gear type involved in the entanglements is shown in table 4.5.

Table 4.5. Sea Turtle Entanglements by Fishery or Gear Type During 2007 to 2010.

	Number of Documented Entanglements	
Fishery/Gear Type	Count	Percent
Lobster	10	43
Whelk/Fish Pot	9	39
Weir	2	9
Unknown buoy line	2	9

Lobster pots and whelk/fish pots entangled approximately equal numbers of leatherback turtles during the period. Most of the whelk and fish pot gear in Massachusetts waters exists in Nantucket Sound, including within the Monomoy NWR Declaration of Taking boundary. The majority of lobster gear occurs north and east of Cape Cod, but lobster gear is placed annually within the Monomoy NWR Declaration of Taking boundary. A fish weir is operated some years within the refuge Declaration of Taking boundary, and has been responsible for at least two known sea turtle entanglements.

Northeastern Nantucket Sound and the waters lying west of the Monomoy land mass are emerging as a potential hot spot for southern New England entangled sea turtle discoveries as evident in Figure 4.3. The actual entanglement sites for many of the turtles discovered in northeastern Nantucket Sound near Monomoy NWR may be long distances from these discovery locations. Prevailing winds during warmer months when sea turtles are present in Nantucket Sound are from the southwest. Sea turtles entangled elsewhere may drift and swim long distances with wind driven currents before they are detected as they reach the shallow waters and busy boat channels lying just west of the Monomoy land mass. The STDN receives the majority of reports from private boaters and recreational fishermen who encounter entangled turtles in the water. Since the majority of entanglements are reported by recreational boaters, these data may be skewed toward coastal waters that are easily accessible and highly utilized by boaters.

Reports may also be skewed toward entanglements in buoy lines because those entanglements are visible at the surface. Despite these limitations, this STDN dataset is the most complete and best available consolidation of sea turtle entanglement data in the Northeast region, and will be used by NMFS-NER to estimate sea turtle interactions in the American lobster fishery.

Figure 4.3. Southern Massachusetts Confirmed Sea Turtle Entanglements June 2007 to May 2010; adapted from Burke and Sharp 2010.

The Massachusetts Division of Marine Fisheries and Provincetown Center for Coastal Studies continue to work to better understand these spatial relationships between sea turtles and fishing gear and methods for reducing the incidence and severity of entanglements. Some of the entanglement mitigation strategies currently being explored by the Massachusetts Disentanglement Network include buoy line density and other gear modifications targeted at turtle entanglement aggregation hot spots.

The National Marine Fisheries Service (NMFS), Northeast Region, recently completed a biological opinion on continued implementation of management measures for the American lobster fishery in Federal waters (NMFS-NER 2012) for the next 10 years. American lobsters are managed under a dual State and Federal regulatory combination of authorities. The Atlantic States Marine Fisheries Commission (ASMFC) manages the lobster fishery in state waters 0 to 3 nautical miles from shore, and NMFS manages the lobster fishery in Federal waters from 3 to 200 miles from shore (the Exclusive Economic Zone), both under the authority of the Atlantic Coastal Fisheries Cooperative Management Act. The predominant area of harvest in the United States is the Gulf of Maine in depths up to 40 meters (ASMFC 1999). The southern New England (SNE) lobster stock unit is primarily fished by Connecticut, Massachusetts, New York, and Rhode Island fishermen, with smaller contributions from New Jersey, Delaware, and Maryland accounting for 19 percent of the U.S. landings between 1981 and 2007. From 2000 to 2007, landings from the SNE accounted for only 9 percent of the U.S. landings, reaching a time-series low of 6 percent in 2004.

The 2012 NMFS-NER biological opinion concluded that continuing current lobster fishery management measures will not affect Kemp's ridley, green, or hawksbill sea turtles. There are no documented interactions of Kemp's ridley sea turtles with gear from the lobster trap/pot fishery. Because there are no proposed changes to the lobster fishery that would increase the likelihood of interactions between Kemp's ridleys and lobster trap/pot gear, no future interactions are anticipated. Similarly, there are no documented interactions of green sea turtles with gear from the lobster trap/pot fishery, and because there are no proposed changes to the lobster fishery that would increase the likelihood of interactions between greens and lobster trap/pot gear, no future interactions are anticipated.

An October 29, 2010, biological opinion concluded that operation of the federally regulated portion of the lobster trap fishery may adversely affect loggerhead and leatherback sea turtles as a result of entanglement in the ground lines or buoy lines associated with this type of gear. An incidental take statement was issued with the 2010 biological opinion, exempting the annual incidental take (lethal or nonlethal) of one loggerhead sea turtle and five leatherback sea turtles (NMFS 2010a). The trap reduction measures associated with an interstate plan for rebuilding the depleted southern New England lobster stocks will benefit sea turtles by reducing the amount of gear (specifically buoy lines) in the water where sea turtles also occur. Additionally, NMFS must implement reasonable and prudent measures (RPM) in its management of the American lobster fishery over the next 10 years as detailed in the 2012 biological opinion.

The lethal removal of five leatherback sea turtles annually from the Atlantic Ocean as a result of the continued operation of the American lobster fishery over the next 10 years will not appreciably reduce the likelihood of survival or recovery of leatherbacks in the Atlantic. The 2012 biological opinion concluded that trap gear fixed on benthic habitat as a result of the fishing activities will have an insignificant effect on loggerhead sea turtle prey or habitat and is unlikely to appreciably reduce the likelihood survival and recovery of the northwest Atlantic distinct population segment of loggerhead turtles.

The only fishery that NMFS determined would reduce the reproduction, numbers, or distribution of ESA-listed sea turtles, and reduce appreciably their likelihood of survival and recovery, is the pelagic longline component of the Atlantic highly migratory species fishery (Atlantic bluefish, Atlantic mackerel/squid/butterfish, Atlantic sea scallop, highly migratory species, monkfish, Northeast multispecies, red crab, skate, spiny dogfish, and summer flounder and scup fisheries). Pelagic, long-line fishing does not occur in the nearshore open waters around Monomoy; it is practiced well offshore along the edge of the

continental shelf. On June 1, 2004, NMFS released a biological opinion on the Atlantic pelagic longline fishery that stated the fishery was likely to jeopardize the continued existence of leatherback sea turtles and developed a reasonable and prudent alternative (RPA) aimed at removing the jeopardy. This requires that NMFS reduce post-release mortality, improve monitoring the effects of the fishery, confirm the effectiveness of the hook and bait combinations required as part of the proposed action, and take management action to avoid long-term elevations in leatherback takes or mortality. The biological opinion specified an RPA that allows the continuation of the Atlantic highly migratory species fishery without jeopardizing ESA-listed species.

In general, the significantly reduced fishing effort in the Northeast multi-species fishery under recent amendments to this fishery management plan results in substantially less time that gear is in the water and therefore less opportunity for sea turtles to be captured or entangled in multi-species fishing gear.

NMFS completed section 7 consultation on the Skate Fishery Management Plan (FMP) on October 29, 2010, and concluded that operation of the skate fishery may adversely affect ESA-listed sea turtles as a result of interactions with gillnet and trawl gear. The incidental take statement issued with the 2010 biological opinion exempted the annual incidental take of up to 24 loggerheads over a 5-year average in trawl gear, of which up to 11 per year may be lethal. The annual take is up to 15 loggerheads over a 5-year average in gillnet gear, of which up to 6 per year may be lethal. The incidental take statement also exempted four leatherbacks, four Kemp's ridleys, and five green sea turtles in skate gear (NMFS 2010b). New information estimating loggerhead bycatch in bottom trawl gear has recently been published in Warden (2011). Using Northeast Fisheries Observer Program (NEFOP) data from 1996 to 2008 applied to vessel trip reporting (VTR) days fished, the average annual bycatch of loggerhead sea turtles in bottom otter trawl gear used in the skate fishery between 2005 and 2008 was estimated to be seven loggerhead sea turtles per year (Warden 2011).

Section 7 consultation on the Spiny Dogfish FMP completed October 29, 2010, concluded that operation of the fishery may adversely affect ESA-listed sea turtles as a result of interactions with and capture in gillnet and trawl gear. The incidental take statement issued with the 2010 biological opinion exempted the annual incidental take of up to one loggerhead over a five-year average in trawl gear, which may be lethal or nonlethal, and the annual take of up to one loggerhead over a five-year average in gillnet gear, which may be lethal or nonlethal. The incidental take statement also exempted four leatherbacks, four Kemp's ridleys, and five green sea turtles in spiny dogfish gear (NMFS 2010c).

Various crab fisheries, such as horseshoe crab and blue crab, also occur in Federal and state waters. The crab fisheries may have detrimental impacts on sea turtles beyond entanglement in the fishing gear itself. Loggerheads are known to prey on crab species, including horseshoe and blue crabs. The decline in loggerhead abundance in Virginia waters (Mansfield 2006), and possibly Long Island waters (Morreale et al. 2005), commensurate with noted declines in the abundance of horseshoe crab and other crab species, raises concerns that crab fisheries may be impacting the forage base for loggerheads in some areas of their range.

The refuge would remain open to fin fishing (except using methods that disturb the bottom) and whelk, lobster, and crab fishing with pots under State

regulations. These uses pose minimal entanglement risk for leatherback and loggerhead sea turtles under all alternatives. Refuge staff will review sea turtle stranding and entanglement reports throughout the plan period under all alternatives to ensure the actual incidence remains as low as expected.

Under alternative A, refuge waters remain open to operation of all vessel types, including motorized boats. Therefore the risk and incidence of sea turtle vessel strike injuries or mortality (incidental take) within the refuge boundary (Marine Protected Area) will persist through the plan period.

Under alternative B, refuge waters also remain open to operation of all vessel types, including motorized boats, but increased emphasis on refuge visitation may increase motorized boat traffic in refuge waters over current levels. Therefore, the risk and incidence of sea turtle vessel strike injuries or mortality (incidental take) within the refuge boundary (Marine Protected Area) may increase somewhat over the plan period. Refuge staff will review sea turtle stranding and entanglement reports throughout the plan period under all alternatives to ensure the actual vessel strike incidence remains as low as expected.

Under alternative C, greater emphasis on non-motorized (paddling) watercraft for accessing the Monomoy wilderness should reduce the risk and incidence of sea turtle vessel strike injuries or mortality within the refuge boundary. Impacts to sea turtles from gear will be the same as under alternative B.

Effects on Vegetation and Habitats

The refuge includes an amazing diversity of habitats, some of which are unique to the Refuge System. Our limited habitat management on the refuge is focused on maintaining beach and dune grasslands to provide breeding areas for various seabirds. In addition, some areas of the refuge are treated to remove nonnative invasive plants. The effects of our management actions on refuge habitats, including dune grasslands, maritime shrubland, intertidal, salt marsh, freshwater wetlands, and nearshore marine open water are described below for each of the proposed alternatives. Effects on native and invasive plant communities are also discussed.

Effects on Dune Grasslands, Dune Edges, and Beach Shoreline

This section considers impacts from strategies related to objectives A1.1, B1.1, C1.1, A1.2, B1.2, C1.2, A1.3, B1.3, A1.4, B1.4, A1.5, B1.5, and C1.3. Coastal beach (above mean high tide) and dune habitat are some of the most threatened habitats in the U.S. (Brown et al. 2001). These habitats are part of a naturally unstable, dynamic ecosystem that is subject to erosion and accretion processes from wind and wave action. Development, beach stabilization projects, and heavy recreational use affect the quality of this habitat for wildlife species of conservation concern. The refuge has approximately 1,970 acres of dune and beach habitat that provide habitat for nesting terns and shorebirds, including piping plover, roseate tern, and American oystercatcher. All three alternatives employ varying degrees of active management in order to protect and maintain dune habitat, but the level of protection and management of the barrier beach ecosystem varies by alternative. Each alternative offers differing levels of wildlife and plant inventories and monitoring, as well as adaptive management strategies to guide the management of dune and beach habitat and associated species. Due to the dynamic nature of coastal habitats, there is continuous fluctuation in the geographic distribution of resources. Therefore, it is necessary to view coastal habitat protection and management in a regional ecosystem context. All alternatives would incorporate actions, where possible and as funding allows, that monitor for any impacts to the refuge due to sea level rise.

All alternatives would implement periodic prescribed burns in the tern colony to set back succession and improve habitat. The primary intent of prescribed burning in the tern colony is to periodically remove accumulated dead grass litter, increase the amount of exposed bare sand for nesting terns, and maintain native perennial grassland dominance, with woody encroachment kept to less than 10 percent cover. The low-severity ignition patterns and burns common to all alternatives effectively remove only dead vegetative materials, with little to no injury to the largely below-ground, dormant but living portions of the plants. Fall and winter burning is preferred over early spring burning, as the blackened ground surface absorbs more solar heat, raising the surface soil temperatures and stimulating an earlier green-up of the burned area than the surrounding unburned areas. This earlier green-up of the burned areas prior to the return of nesting migratory birds to the colony site the following spring gives the post-burn vegetative recovery enough of a head start that the burn unit remains attractive as nesting habitat. Waiting until spring to conduct prescribed burning foregoes the head start effects on vegetative recovery.

The spread of invasive plant species invasive plants are left untreated would potentially degrade the quality of the vegetated dune habitat for focal species. Invasive plants may adversely impact native dune plants through direct resource competition, and can contribute to the decline of threatened or rare native plant species (Thomson 2005). The short-term impacts of habitat management activities, such as herbicide use or mechanical removal, contribute to maintaining suitable, quality habitat in the long term.

Visitors engaging in wildlife-dependent recreational activities, whether independently or as part of an organized tour, are expected to stay on maintained trails and obey seasonal and permanent closures in sensitive beach and dune habitats to minimize disturbance and other negative impacts. Onsite activities, particularly group activities, may result in short-term impacts by trampling vegetation. All alternatives would maintain vehicle closures to protect this habitat.

Under all alternatives, we are committed to managing the area to maintain and enhance wilderness character. Some refuge management actions (dune vegetation and maintenance measures, control of invasive species, predator management for gulls, and artificial nesting structures for tern species) may be modified or reprioritized to comply with wilderness policy guidelines. Proposed actions and protocols would be evaluated through a minimum requirements analysis to identify the minimum impact methods and tools, if necessary, to accomplish essential management activities with a minimal amount of impairment to wilderness character.

Dune Grasslands, Dune Edges, and Beach Shoreline Impacts of Alternative A (Current Management)

Under current management, we would continue to protect and manage approximately 30 acres of dune and beach habitat to benefit priority bird species and enhance 2 acres of prime nesting habitat for roseate terns. We would continue to modify the habitat using mechanical methods, herbicide, and rotational prescribed burning to promote a mosaic of dense and sparse vegetation, which would benefit tern colonies on the refuge.

Under alternative A, we would continue to provide public access to South Monomoy and North Monomoy Island via boat landings and ferries operating under a special use permit. Soil compaction and vegetation trampling would likely occur along the dunes, although under current public use levels, neither is considered a major threat to refuge resources. Visitors would continue to utilize the existing unauthorized land-bridge and unmaintained footpaths created by extensive use near the lighthouse.

The presence of a seasonal field camp used by refuge staff also poses some minor impacts to the surrounding vegetation due to trampling and high use. However, given the small percentage of acreage the camp occupies in relation to the refuge, we believe this is a temporary and negligible impact.

Impacts associated with the installation of solar panels at the Monomoy Point Light Station would be the same as those described under Soil Impacts in Alternative B.

Dune Grasslands, Dune Edges, and Beach Shoreline Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))
Alternative B proposes a significant increase in habitat management and intervention. Under this alternative, we would actively manage up to 75 acres of vegetated dune habitat for nesting common terns, and provide 10 acres of prime nesting habitat for roseate terns. This would include a more concerted effort to control invasive plant species to provide greater benefit to dune focal species. Invasive species management would be more aggressive under alternative B, aiming for a target of less than 10 percent coverage refugewide of nonnative invasive plant species throughout the dune grasslands. This would benefit native plant species within this habitat type. To maintain the herbaceous dune habitat and prevent succession to woody growth, we would remove woody vegetation as needed with prescribed fire, herbicide, or mechanical means. The proposed maximum acreage for prescribed burns under alternative B is almost three times the area in alternative A. The quality of this habitat would improve as a result of a more regular burning regime and removal of woody and invasive plant species.

This alternative would also consider the use of dredge material outside of the Monomoy wilderness. Benefits of beach re-nourishment projects are discussed in chapter 3, objective B1.1. The impacts of dredge material are discussed under Effects on Water Quality and Effects on Soils. Adaptive management would be used to guide seasonal closures depending on time of year and species presence (see chapter 3). The time and location of seasonal closures will vary year to year based on wildlife use and habitat conditions. New research and inventory and monitoring would also allow greater use of adaptive management to better protect habitat and better respond to shifting coastal habitat dynamics.

We would provide greater protection of coastal dune and shoreline habitats in balance with priority public uses. More onsite refuge seasonal staff would provide greater protection to habitat through increased public awareness, enforcement of closures, and additional signs. Providing more habitat may allow for more nesting common terns, but more importantly, would allow common terns to increase nearest neighbor distances while still maintaining the benefit of being a colony member. A larger habitat base would also allow terns to move around between microhabitats within the larger area as we apply a rotational-based habitat management scheme. Under this alternative, we would replace our current signs with fiberrod posts and string. This method would be less visible and more appropriate within the Monomoy wilderness.

Through implementation of the North Atlantic LCC, the Service would be able to set aside additional coastal lands for conservation, share resources and scientific information with partners, and collaborate on management activities to protect a greater amount of beach and dune habitat under this alternative. More proactive land protection efforts with partners would provide opportunities to permanently protect more coastal dune and shoreline habitats, and create a larger area of continuous protection for species like the roseate and common tern, piping plover, least tern, American oystercatcher, and northeastern beach tiger beetle.

Under alternative B, there would be potentially more vegetation trampling as sites like the Monomoy Point Light Station become open to the public. We would

also expect to see a minor increase in vegetation trampling with an increased staff presence and field camp. Impacts associated with the installation of solar panels at the Monomoy Point Light Station would be the same as those described under Soil Impacts of Alternative B.

Dune Grasslands, Dune Edges, and Beach Shoreline Impacts of Alternative C (Natural Processes)
Under alternative C, we would only protect 10 acres of the existing 30 acres of nesting habitat for common terns and maintain an additional 2 acres of prime nesting habitat for roseate terns. The reduction in common tern nesting habitat may result in fewer nesting common terns, but the results of our efforts to maintain 2 acres of high quality roseate tern nesting habitat are comparable to the current efforts for roseate terns under alternative A. Ten acres of quality habitat could still support thousands of nesting pairs, and we would therefore still maintain an active predator management program to enhance productivity of both species of terns. In contrast to alternatives A and B, our presence in and around the tern colony would likely be reduced as we would no longer maintain a field camp. This would reduce the impacts of vegetation trampling, but would also likely increase the risk of avian and mammalian predation due to reduced human presence.

Natural, rather than anthropogenic processes, would dominate the remaining 20 acres of existing common tern habitat within these habitat types. We would only conduct vegetation manipulation in this 10-acre area, therefore it is likely that woody species may begin to dominate in some areas and nonnative invasive plants would spread. We would significantly decrease acreage burned compared with alternatives A and B.

Portions of these habitats would continue to be lost on Morris Island through erosion and sea level rise. Without beach renourishment or armoring, this habitat may gradually transition to intertidal habitat. More proactive land protection efforts compared to current levels with partners would provide opportunities to permanently protect more coastal dune and shoreline habitats and emphasize the protection of, and management for, coastal species of concern.

Effects on Maritime Shrubland

This section considers impacts from strategies related to objectives A1.6, B1.6, and C1.5. The refuge's maritime shrubland, while impacted by nonnative plants like rugosa rose, provides habitat for a number of declining species associated with early successional habitats, including black-crowned night-herons and snowy egrets. The approximately 500 acres of this habitat on Monomoy NWR support one of the few remaining nesting sites in Massachusetts for colonial nesting wading birds, and many of these birds are nesting in nonnative rugosa rose. In all three alternatives, we would not control rugosa rose in areas where wading birds are nesting.

Maritime Shrubland Impacts of Alternative A (Current Management)
Under alternative A, nonnative rugosa rose may spread in some areas of the refuge, but this has not been problematic to date. This habitat has been expanding over the last few years, and we do not anticipate any adverse impacts from our passive management. Alternative A would evaluate the importance of maritime shrubland for migrating songbirds.

Maritime Shrubland Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))
Under alternative B, we would evaluate maritime shrubland habitat for its regional importance, looking specifically at habitat conditions, including species composition, nonnative plant presence, and community structure, to better inform us regarding conservation implications and future management. We would utilize

biological, mechanical, chemical, or fire management to reduce nonnative invasive species to no more than 5 percent of habitat composition in utilized habitats. Maritime shrubland quality would improve as invasive species would be removed.

Maritime Shrubland Impacts of Alternative C (Natural Processes)
Under alternative C, this habitat would fall under the umbrella management of BIDEH. We would utilize manual tools, herbicide, or prescribed fire to ensure less than 10 percent coverage refugewide for maritime shrubland in combination with salt marsh and freshwater pond habitats.

Maritime shrubland quality may improve as invasive species would be removed. We would not anticipate any significant impacts from shifting to a biological integrity, diversity, and environmental health (BIDEH) focus because this habitat has never been actively managed and is controlled by the soils and salt spray in its environment.

Effects on Intertidal Habitat

This section considers impacts from strategies related to objectives A1.7, B1.7, C1.4. The intertidal habitat of Monomoy NWR provides important nesting, resting, and foraging habitat for migrating and staging birds, particularly species of conservation concern. All the alternatives would employ seasonal closures to reduce human disturbance from public use activities. The timing and location of these closures would vary year to year based on wildlife use and habitat conditions. Under all the alternatives, we would continue our ban on horseshoe crab harvesting.

Apart from sensitive areas (bird resting/foraging sites) being seasonally closed, the refuge would not conduct any active management in this habitat. Shellfishing for softshell clams and quahogs would continue to be allowed under all alternatives, although the prohibition of motorized boat use within the wilderness area under alternative C might limit the number of people shellfishing. Intertidal habitat is naturally a high-energy zone subjected to various levels of substrate disturbance by wind, tides, and waves. The intensity and scale of the anticipated shellfishing activities, whether reduced or not, would not significantly alter the disturbance regime as a whole.

Horseshoe crab research on the refuge

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Actual shellfish harvest impact stems from the spatial extent and degree that the pre-disturbance and post-disturbance intertidal environments differ (Ray 2005, Beukema 1995). Effects of sediment re-suspension can include reduced light available for photosynthesis, burial or smothering of benthic biota and spawning areas when anoxic conditions result, and negative effects on feeding and metabolic rates of intertidal organisms (Johnson 2002). Re-suspension of sediments also occurs naturally during storms, or from human activities such as operating boats in shallow estuarine areas. Monomoy refuge is characterized by a highly dynamic system of tide and wind-driven shifting sands; therefore, it is likely that at Monomoy refuge natural tide and wind-driven sand movements cause more sediment re-suspension than shellfish harvesting activity. Additional detail on the impacts of shellfishing can be found in the Shellfishing Compatibility Determination in appendix D.

Intertidal Habitat Impacts of Alternative A (Current Management)
Under current management, there is no active habitat management that significantly benefits or impacts this habitat. Under alternative A, the refuge would consider using dredge material from ongoing non-refuge projects in the area. The initial impact of nourishment operations is often the direct loss of benthic species as a result of being covered by dredge sediments or forcing relocation of mobile species. These operations can result in high turbidity in the short term and reduced populations of benthic organisms.

Intertidal Habitat Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))
Under alternative B, we would expand our management within this habitat by protecting up to 2,500 acres. In recent years, public access closures have generally occurred between April 1 and September 30, however we would use an adaptive management process to annually adjust the size and length of closures based on habitat conditions and wildlife use. In addition, we would bring Nauset/South Beach under refuge management consistent with how we are managing those resources elsewhere on the refuge. As in alternative A, no active habitat management would directly benefit or adversely impact this habitat. Alternative B would also consider the use of dredge material; impacts would be the same as discussed under alternative A.

Intertidal Habitat Impacts of Alternative C (Natural Processes)
Under alternative C, passive management would be in place for this habitat type. We do not anticipate any direct benefits or adverse impacts to the intertidal habitat.

Effects on Salt Marsh Habitat

This section considers impacts from strategies related to objectives A1.8, B1.9, and C1.5. Under each of the alternatives, we would continue to protect salt marsh habitat from trampling and disturbance through seasonal closures during the growing season and peak public use periods. On North Monomoy Island, we would continue to provide an east-west pedestrian access corridor in all three alternatives to allow visitor passage across the island. The corridor location is the same every year, and significant changes to salt marsh habitat from trampling have been observed within this corridor as a result. However, while this may be a substantial impact on a very small portion of the salt marsh, it does not detract from the overall salt marsh integrity.

Salt marsh habitat and vegetation may also be altered by pedestrian access. During peak times of public visitation, most of the salt marsh on Monomoy refuge is closed to pedestrian access to protect wildlife and prevent trampling. In particular, on North Monomoy Island, where the largest salt marsh exists on the refuge, a narrow corridor for pedestrian passage stays open and connects the east and west sides of the island. The location of this corridor is the same every year, and soil compaction and trampling impacts are evident but very localized. During non-peak times of public visitation (generally October through April), salt marsh habitats are not closed to pedestrians, but visitation is low and negative impacts to the habitat have not been observed during these times of year.

Under all alternatives, we would continue to allow the Cape Cod Mosquito Control District (CCMCD) to conduct mosquito monitoring on Morris Island. Direct impacts of monitoring include temporary disturbance to habitat and possible direct effects to non-target wildlife. Areas of vegetation may be crushed under foot, with impacts ranging from temporary in nature to loss of habitat over time. Invasive weeds may be introduced or spread by foot. A more detailed discussion on the impacts of nuisance mosquito management and control is under the Insects section in the discussion on Effects on Other Native Wildlife.

Salt Marsh Habitat Impacts of Alternative A (Current Management)
Under alternative A, we would continue to minimally manage about 250 acres of salt marsh with the use of seasonal closures to minimize trampling of vegetation and invertebrates, and benefit nesting saltmarsh sparrows and American oystercatchers.

Salt Marsh Habitat Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))
Under alternative B, we would take a more proactive approach by actively managing at least 150 acres of the 250 acres of coastal salt marsh to ensure that the quality and natural function of the marsh is sustained. Salt marsh habitat provides valuable nesting habitat for saltmarsh sparrow and American oystercatchers, as well as foraging areas for wading birds, roosting areas for shorebirds, and nursery habitat for horseshoe crabs. Invasive species management would be more aggressive under alternative B by aiming for a target of less than 10 percent coverage of nonnative invasive plant species throughout the salt marsh.

This habitat would benefit from information gathered through a regionwide study of salt marsh integrity, in addition to determining the presence and abundance of purple marsh crabs—a species associated with salt marsh degradation. If it is determined that this species is present on the refuge, we would initiate studies to research the impacts and manage accordingly.

Impacts from nuisance mosquito control would be the same as those discussed under alternative A.

Salt Marsh Habitat Impacts of Alternative C (Natural Processes)
Under alternative C, impacts from vegetation and habitat management would be the same as in alternative B. Refuge habitat management actions that increase biological integrity, diversity, and environmental health, and avian diversity have the potential to provide a buffer against future disease outbreaks.

Effects on Freshwater Wetlands

This section considers impacts from strategies related to objectives B1.10 and C1.5. Refuge wetlands include approximately 150 acres of freshwater ponds and associated emergent and shrub wetlands, primarily located on South Monomoy. Refuge wetlands are the least well-known habitat type on the refuge. All alternatives would allow this habitat to continue supporting migratory birds and breeding and wintering waterfowl species. Secretive nesting marshbirds also nest in the freshwater marshes, and pied-billed grebe and American coot use these habitats for migration. The freshwater wetlands also provide a food source for migrating bats.

Freshwater Wetlands Impacts of Alternative A (Current Management)
Under alternative A, there is no active management of this habitat. The freshwater ponds are used for fishing; we anticipate minimal vegetation trampling as a result. This use has been allowed since the refuge was established and has not posed a significant impact on the resource. The nonnative, invasive plant species common reed (*Phragmites)* is found on some of the freshwater ponds on South Monomoy; it has not been treated and would continue to exist. In general, *Phragmites* decreases the value of the pond to wildlife; native vegetation generally provides more food and shelter value than nonnative vegetation. The *Phragmites* population has been relatively stable over the past 10 years, therefore we do not anticipate any significant adverse impacts from its continued presence.

Freshwater Wetlands Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))
Under alternative B, we would work to maintain the ecological integrity of approximately 150 acres of freshwater ponds and associated emergent and

shrub wetlands by removing invasive species to ensure no more than 10 percent coverage. The removal of nonnative invasive plant species, predominantly common reed, would benefit wetland habitats and associated species (Chambers et al. 2003). Removal techniques would include manual tools, herbicides, or prescribed fire. The impacts of these management tools include the potential loss of native vegetation, but we do not anticipate any significant adverse impact to this habitat.

Freshwater Wetlands Impacts of Alternative C (Natural Processes)
Under alternative C, wetland impacts from management actions would be similar to alternative A, but would be evaluated through a BIDEH focus. This alternative would benefit from nonnative invasive species management similar to that in alternative B.

Effects on Nearshore Marine Open and Subtidal Waters

This section considers impacts from strategies related to objectives A1.9, B1.11, and C1.5. All alternatives would enforce a closure on mussel and horseshoe crab harvesting and restrict fishing techniques that disturb the bottom. These activities are not compatible with refuge purposes, and by not allowing these activities within refuge waters we would protect quality habitat for fish nurseries and other aquatic life.

Eelgrass meadows have a complex structure that provides habitat for a diverse community of microorganisms, algae, and marine animals (CT DEP and DA 2007). Eelgrass plants contribute to the overall productivity of the marine ecosystem by using the energy of sunlight to produce organic matter in the form of roots, rhizomes, and plant leaves (CT DEP and DA 2007). Eelgrass meadows support a diverse assemblage of marine invertebrates, including species of marine worms, crustaceans (e.g., barnacles, crabs, shrimp, copepods, amphipods) hydroids, bryozoans and mollusks (e.g., mussels, snails and clams). Eelgrass meadows are widely recognized as important fish habitat. Most fishes using eelgrass extensively are young-of-year, juveniles, or adults of species that are small in size. Eelgrass is an important food source for waterfowl such as Atlantic brant, black duck, canvasback duck, and Canada goose.

Under all alternatives, the refuge would remain open to fishing using techniques that do not disturb the bottom. These techniques include demersal long-line fishing; mid-water trawl fishing; hook and line/rod and reel fishing; lobster, crab, whelk pot fishing; and the hand-harvest of scallops. Since submerged aquatic vegetation grows in nearshore waters, fishermen may fish in and around eelgrass from either boat or shore. Fishing in eelgrass can be difficult because it can foul baited hooks and lures. At the present level of fishing effort, these types of fishing do not have an appreciable effect on eelgrass.

Shellfishing has the potential to damage aquatic vegetation; however, hand tools are generally used in the intertidal zone where eelgrass does not occur. Therefore we do not anticipate any significant adverse impact from this activity.

Nearshore Marine Open and Subtidal Waters Impacts of Alternative A (Current Management)
Fishing for fin fish, lobster, scallops and whelk occurs in nearshore open waters, in accordance with State regulations, along North Monomoy Island, the western shore of South Monomoy, and within the refuge's Declaration of Taking boundary.

Lobster and fish pots can damage aquatic plants during their placement and removal. When pots are hauled off the bottom habitat, they can scrape plants and result in the loss of leaf blades, or uproot entire plants (CT DEP and DA 2007).

The extent of damage by these pots largely depends on the number of pots set, duration, and hauling frequency. The current and expected level of use on the refuge for lobstering and fishing is very minimal, therefore we do not anticipate any significant adverse long-term impacts from these activities.

Moorings can have negative impacts on subtidal vegetation. If a mooring is located within an eelgrass meadow, the chain can damage plants in numerous ways, ranging from leaf shearing to below-ground impacts. In cases where a single mooring is used, the mooring chain is dragged across the bottom repeatedly with each tidal cycle and changes in wind direction. With repeated scouring, the chain can completely denude a circular area defined by the length of the chain and angle of sweep. A boat that swings 360 degrees around the mooring will form a circular mooring ring scar in the eelgrass meadow. Setting and retrieving anchors in eelgrass meadows can dislodge and damage eelgrass leaves and rhizomes (CT DEP and DA 2007).

Nearshore Marine Open and Subtidal Waters Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))
There may be some increase in fishing under alternative B, with the potential for greater adverse impacts.

Of greater concern under alternatives A and B is the potential impact of boats motoring through or anchoring in eelgrass. Due to the relatively small number of fishermen fishing from boats, the cumulative damage to eelgrass from boat propellers, propeller wash and anchors is not significant at this time. In addition, there are numerous people using boats for other recreational purposes that may cause the same type of impacts. Although we expect an increase in visitation under alternative B, we anticipate many of the visitors will be arriving by concessionaire instead of in their own boats.

Nearshore Marine Open and Subtidal Waters Impacts of Alternative C (Natural Processes)
Impacts are the same as in alternatives A and B.

Effects on Birds

The Service has the responsibility for protecting migratory birds under international migratory bird treaties with Mexico and Canada. Providing habitat for declining coastal plain and beach birds is an important contribution of the region. Many species of conservation concern use the outer Cape Cod region, including the refuge, during the breeding season, in migration, or during winter.

We evaluated the proposed management actions and strategies of all alternatives for their potential to affect beneficially or adversely the habitats required for sustaining healthy and viable populations of waterfowl, waterbirds, shorebirds, and seabirds, and for restoring other species of high conservation concern. Our proposed management actions include seasonally closing areas for breeding, feeding, or resting to reduce human disturbance, eliminating or continuing to prohibit particularly disruptive or disturbing public uses, managing and improving habitat, managing predators to reduce predation, and engaging in outreach and education to increase understanding and compliance with regulations.

Waterfowl and Waterbirds

This section addresses impacts regarding objectives A1.6, A1.8, A1.9, B1.6, B1.9, B1.10, B1.11, and C1.5. Migratory waterfowl and waterbirds would continue to benefit from the refuge's salt marsh, freshwater pond, and nearshore marine open water habitats. Across all the alternatives, controlling invasive plant species, particularly *Phragmites*, is an important management activity conducted in refuge wetland habitats. Migrating and wintering waterfowl and waterbirds

would experience direct benefits from the reclamation of *Phragmites* areas that quickly revert to native plant foods (spikerushes, millet, smartweeds, and grasses). Since these native plants are also associated with specific native insect community assemblages that do not exist in *Phragmites* stands, these invertebrates provide additional food sources that supplement waterfowl plant foods. All waterfowl and waterbirds would also indirectly benefit from the refuge's predator management program.

Considering the vast distances that waterfowl travel to complete their annual migratory circuit and the loss of habitats that have occurred over the last 100 years, it has become increasingly essential to recognize the importance of providing high-quality habitats that are available to waterfowl. During migration stopovers, waterfowl must be afforded the time and opportunity to forage in high-quality habitat to attain desired body mass and fat deposits and replace lost energy reserves. To meet these metabolic demands, waterfowl rely on many Federal, State, and private wetlands, including Monomoy NWR, to rest, feed, and reacquire lost fatty deposits. Daily waterfowl maintenance activities such as feeding, flight, metabolic processes, molting, preening, and resting are costly from an energetic standpoint, and require that waterfowl have undisturbed access to quality habitats with diverse food resources. The National Wildlife Refuge System, along with many state and private wetlands, provides the only secure and guaranteed wetland habitats in the United States and has the responsibility of maintaining these resources for the benefit of wildlife.

Unregulated access in the wetland and salt marsh habitats could adversely impact the feeding strategies of waterfowl using the refuge. Birds at migratory stopover sites spend their time resting and foraging as they rebuild protein and energy stores in preparation for their next migratory flight (McWilliams et al. 2004). It is also important to recognize that flight is a very expensive activity from a metabolic perspective, and forcing birds into flight creates the need to replace lost energy reserves that could have been used for other maintenance activities. Although providing protected areas, these alternatives provide no protection to allow waterfowl to completely avoid the energetic costs associated with being forced into unnecessary flight. The molting of feathers requires an increase in nutrient demand, making it necessary for individuals to be afforded the opportunity for undisturbed foraging. Disturbance caused under this alternative may negatively impact the ability of waterfowl to secure nutrients, thus disrupting molting processes and associated reproductive strategies. Maintenance of feathers by preening has been previously correlated to molt activity and is undoubtedly influenced by molt chronology. Adverse impacts to preening activities would be similar to those associated with the molting process.

Providing waterfowl sanctuaries would minimize some of these impacts and allow waterfowl to have undisturbed access to these areas during biologically critical periods of the day. Havera et al. (1992) and Dahlgren (1988), in comprehensive literature reviews of human disturbances to migrating and wintering waterfowl, have noted that the use of sanctuaries (non-hunted areas) was the most common and effective solution to mitigating adverse disturbance impacts.

Nonmotorized boating can affect refuge resources in a number of ways. Studies show that canoes and kayaks disturb wildlife (Bouffard 1982, Kaiser and Fritzell 1984, Knight 1984, Kahl 1991). They may affect waterfowl broods, wintering waterfowl, shorebirds, raptors, and wading birds, but their low speed and their use primarily during the warmer months would mitigate those impacts, especially on wintering waterfowl.

The use of pesticides for the purpose of mosquito management may directly or indirectly affect resident and migratory waterfowl. A detailed discussion on the

impacts associated with mosquito management is addressed under Terrestrial Invertebrates and Insects.

Research activities may disturb fish and wildlife and their habitats. For example, the presence of researchers can cause waterfowl to flush from resting and feeding areas, cause disruption of birds on nests or breeding territories, or increase predation on nests and individual animals as predators follow human scent or trails. Efforts to capture animals can cause disturbance, injury, or death to groups of wildlife or to individuals. To wildlife, the energy cost of disturbance may be appreciable in terms of disruption of feeding, displacement from preferred habitat, and added energy expended to avoid disturbance.

Waterfowl and Waterbird Impacts of Alternative A (Current Management)
Under alternative A, we would continue to minimize disturbance to nesting wading birds using maritime shrubland habitat refugewide. Some nesting areas are in close proximity to high recreational use, and without seasonal closures, these sensitive wading bird species would likely abandon these sites or suffer from increased predator loss and low productivity.

Waterfowl and Waterbird Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))
Under alternative B, we may slightly expand the area and length of seasonal public access closures based on wildlife use and habitat conditions. When wading birds are disturbed and adults flush off nests, eggs and chicks are left vulnerable to nearby nesting gulls and other avian birds that actively prey on these species. Further reducing disturbance may therefore increase productivity of nesting wading birds. This would be very beneficial considering the large number of gulls that will prey on eggs and chicks nesting in close proximity to herons and egrets.

We would continue to conduct our annual wading bird survey, in addition to a complete census of all wading birds refugewide every 5 to 10 years. This would improve our understanding of which species are utilizing this habitat and how to best maintain it.

Alternative B provides a greater benefit to these species with the presence of additional staff to manage predator impacts and provide protection through habitat management. We anticipate an increase in visitor use under alternative B and would expect to see an increase in human disturbance.

Hunting is a priority, wildlife-dependent, consumptive activity with additional direct effects on waterfowl. Waterfowl hunting has been ongoing on refuge lands for decades, including prior to refuge establishment. Under this alternative, the refuge would implement a waterfowl hunt program that follows Federal and State regulations for annual harvest 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 Atlantic coast flyway population. As such, hunting results in individual losses, but the projected cumulative harvest would not jeopardize the viability of any harvested species' population. Some disturbance to non-target wildlife species may occur; however, those impacts should be minimal because hunting pressure is moderate and occurs outside the breeding season.

General adverse impacts of waterfowl hunting are mortality, crippling, and disturbance. Belanger and Bedard (1995) concluded that disturbance caused by waterfowl hunting to waterfowl resources can modify the distribution and use of habitats by waterfowl, affect their activity budget and decrease their foraging

time, and disrupt pair and family bonds and contribute to increased hunting mortality.

Migratory waterfowl hunters may also disturb migratory birds and other wildlife as they travel to and from their hunting sites or when retrieving downed birds. Depending on the location and the number or species of migratory birds in the area, a disturbance can be temporary, with displaced birds moving to nearby backwaters, or major, as in the case of motoring through a large flock of common eider.

Waterfowl and Waterbird Impacts of Alternative C (Natural Processes)
Impacts from habitat and wildlife management activities would be the same as previously described. Impacts from implementing a waterfowl hunt program would be the same as in alternative B. Under alternative C, we expect to see a decrease in visitor use by only allowing nonmotorized watercraft within wilderness waters. However, we may expect to see a minor increase in impacts from canoes and kayaks proportional to the demand for these activities.

Shorebirds (Nesting, Staging, Migrating)

This section addresses impacts regarding objectives A1.3, A1.7, A1.8, B1.3, B1.7, B1.9, C1.4, and C1.5. The primary goal in all our alternatives is providing quality breeding, migrating, and non-breeding habitat for migratory birds that yields considerable indirect beneficial impacts for shorebirds. Specific habitat management actions targeted for shorebirds translate into direct benefits from the provision of high-quality intertidal mudflats and beach habitats for feeding and roosting habitats for both spring and fall migrants and breeding shorebirds. Public education, particularly for beach users, is another important component in the overall management strategy.

Another direct benefit for shorebirds is derived from seasonal beach closures to public use. Minimizing human disturbance would increase nesting and foraging opportunities on overwash habitats to increase shorebird nesting productivity. Indirect benefits for shorebirds are obtained by educating the public about special beach closures with news releases and other outreach mechanisms to engage the public in understanding the needs of nesting shorebirds.

Common tern

Kirk Rodger/USFWS

Pfister et al. (1992) investigated human disturbance as a factor that might limit the capacity of appropriate staging areas to support migrating shorebirds. Long-term census data were used to test the hypothesis that human disturbance at an important coastal migration staging area had adverse impacts on shorebird movement patterns from preferred resting areas and the birds' utilization of food resources. Results indicate that adverse impacts from human disturbance were greater on species

using the front side of beach habitats, with the abundance of impacted species possibly reduced by 50 percent. Such disturbance is implicated as a potential factor in long-term declines in shorebird abundance during migration periods. Birds devote nearly 50 percent of their time watching for or avoiding people. Disturbance can cause shorebirds to spend less time roosting or foraging and more time in alert postures or fleeing from disturbances (Burger 1991, 1994, 2007, Thomas et al. 2003). Shorebirds that are repeatedly flushed in response to disturbance expend energy on costly short flights (Nudds and Bryant 2000).

Disturbance factors causing displacement becomes a very crucial issue during incubation or nesting periods. According to Korschgen and Dahlgren (1992), there are four direct adverse impacts of displacement caused by human disturbance during nesting periods: (1) egg exposure to heat or cold when the adult is displaced; (2) predation of eggs when the nest is vacated by the adult; (3) accidental loss of eggs and chicks, and (4) predation of eggs at a later time due to predators following human trail or other markers to nest sites.

Public education, active protection methods (small fences around nests, signs, wardens), legal measures (beach use regulations, active enforcement patrols), and well-advertised closures of portions of the beach are management actions that often successfully reduce the adverse impacts of human disturbance when shorebirds are most vulnerable. We seasonally close portions of the beach dunes and overwash areas to public use to minimize disturbance to nesting shorebirds such as American oystercatchers. The timing and location of these closures vary year to year based on wildlife use and habitat conditions. All the alternatives predict some increase in annual visitation. However, adverse impacts from an anticipated increase in visitation would vary with the type of habitat management and the kinds of visitor use each alternative proposes. Public use activities are not expected to have any considerable adverse short-term, long-term, or cumulative impacts on shorebirds, as the refuge would maintain beach closures or restrictions in sensitive areas.

At Monomoy refuge, we are particularly concerned about direct and indirect impacts of shellfish harvesting to migratory birds, for which the refuge was originally established. Of particular note is the importance of protecting high-quality stopover sites that shorebirds use while migrating long distances between breeding and non-breeding grounds (Senner and Howe 1984, Myers et al. 1987, Helmers 1992). Human disturbance causing changes in foraging shorebird behavior and distribution of shorebirds at foraging and roosting sites has been well documented. Prolonged or intense human disturbance may also cause shorebirds to expend more energy to avoid disturbances (Helmers 1992) or completely abandon a site (Furness 1973, Burger 1986, Pfister et al. 1992). Shellfish harvesting can alter benthic communities or result in competition for shorebirds that feed on target organisms. Burial or mechanical (vertical) redistribution of invertebrate infauna to deeper depths in the substrate may additionally reduce the availability of invertebrate prey to predators.

Our observations at Monomoy refuge in 2005 and 2006 suggested that some species of shorebirds remained farther from a standing person than from shellfish harvesters. Soft-shell clam harvesters in coastal New England typically use short hand-rakes, spend most of their time bent over at the waist or on hands and knees harvesting patches of shellfish, and traverse the exposed mudflats only to move among patches (Burger 1981, Leavitt and Fraser 2004). Additionally, anecdotal observations of shorebirds congregating in recently shellfished areas at Monomoy refuge led to the hypothesis that sediment turnover associated with softshell clam harvesting may expose additional prey for shorebirds that would normally be at unavailable depths, thereby providing a net benefit to foraging shorebirds (Leavitt and Peters 2005). Some species of shorebirds congregate

near clammers and seem to benefit from the disturbances that result from hand digging for softshell clams. For additional details on the direct and indirect impacts of shellfishing to migratory shorebirds and other species of concern, refer to the Shellfishing Compatibility Determination in appendix D.

Under all three alternatives, we would also continue important work with partners to determine the relative importance of tern staging sites on Cape Cod, identify problematic disturbances, and develop solutions to minimize disturbances. This collaborative effort would, we hope, lead to better protection at the most important sites, which would then result in reduced post-fledgling mortality and higher recruitment into the breeding population.

Shorebird Impacts of Alternative A (Current Management)
It is well documented that gulls are nest predators of tern and other coastal bird species, and also compete with terns and other species for nesting habitat (O'Connell and Beck 2003, Donehower et al. 2007). Under alternative A, management would include maintaining a 125-acre gull-free zone accomplished by habitat management, harassment to prevent nesting, nest removal, egg destruction, or lethal removal. In addition, maintaining a human presence from early May through August would provide further protection from predators.

There are potential impacts during banding activities as a result of handling; however, direct loss is very rare and most studies indicate that banding has no known negative impact on individual birds (*http://www.pwrc.usgs.gov/bbl/MANUAL/consid.cfm*; accessed April 2013). The bands are very lightweight and birds are not harmed during capture and banding. To minimize the effects of banding on birds and the costs of processing banding data, it is necessary to restrict the use of bands and markers to well-designed projects that will enable people to gain a better understanding of birds. Without banding, we could not determine the population and life span of birds, as well as the impact of pesticides, hunting, and development. Refuge staff mitigate for any adverse impacts by following established protocols (e.g., duration of handling, number of birds in a confined space, etc.).

Shorebird Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))
In this alternative, we take a more proactive approach to minimizing disturbance to migrating and staging birds on the intertidal flat. The most significant adverse impacts of human disturbance include displacement of shorebirds from preferred resting areas and abandonment of nests; additional impacts of human disturbance are discussed in previous sections. Developing a rapid-assessment method to identify areas that consistently support foraging or staging shorebirds or terns would reduce the levels of human disturbance and benefit species of conservation concern. Periodic monitoring of human disturbance levels would also provide data to improve how we manage this resource, and can further support efforts like recovery of the red knot and enforcing the prohibition on all horseshoe crab harvesting on the refuge.

Least terns would benefit from the additional management actions under alternative B, which may include increasing predator management, using chick shelters, and using electric or non-electric fencing. American oystercatchers would benefit from greater protection and increased efforts to band under alternative B. Impacts from banding efforts would be the same as those under alternative A. Actions involving deposition of dredge material considered in this alternative for terns would likely benefit American oystercatchers.

Disturbance of refuge wildlife and habitats may be more pronounced with commercially guided activities for wildlife observation. While field trip routes and observation sites are usually located in areas open to the general public, disturbance caused by group tours could be more intense because the number of people, and desire to get close to wildlife, may be greater than normally occurs during general public activities. Restricting the number of guides and managing how guided activities are conducted would reduce adverse habitat effects, conflicts between competing guide services, and conflicts between guided operations and other refuge users. Limiting and monitoring group size and areas accessed by visitors would also minimize impacts on the wilderness character of the refuge.

We plan to eliminate dog walking upon implementing the CCP to further protect wildlife health and to minimize disturbance. Eliminating dog walking would reduce disturbance to nesting and migratory birds and reduce dog feces left on the beach.

Under this alternative, we may slightly expand (in size and/or length) current temporary seasonal closures of intertidal habitat from the edge of the salt marsh based on habitat conditions and wildlife use. This may further reduce the impacts of disturbance to migratory shorebirds from the visiting public. Additional portions of intertidal mudflat may be closed to all human access for several weeks if these areas are consistently highly productive and support large concentrations of foraging shorebirds.

In alternative B, we would only allow non-mechanized harvest of subterranean species (softshell clams, quahogs, and razor clams) and would prohibit harvest of mussels. Hand harvesting of scallops will be allowed according to Town of Chatham and State regulations. Species that grow above sediment, such as mussels, are an important food source for many migratory birds. We would provide additional protection for priority wildlife species such as red knots and other migrating shorebirds by not allowing harvest of their food species.

Shorebird Impacts of Alternative C (Natural Processes)
Alternative C has the least protection for shorebird species; reduced predator control and decreased staff presence may present additional adverse impacts. We would not be participating in banding efforts for American oystercatcher, which would adversely impact our knowledge of this species, but may benefit individual birds as they are not subjected to banding.

Seabirds

This section addresses impacts regarding objectives A1.1, A1.4, A1.7, B1.1, B1.4, B1.7, C1.1, and C1.4. Symbolic fencing would minimize human disturbance and help achieve the target productivity levels for common terns. Regular monitoring would help enforce the posted closures. Predator management is the only practical way to reduce the impact of predation by locally reducing the numbers of mammalian and avian species that prey on common tern eggs and chicks and, sometimes, adults. These actions would limit predation on common terns and other species, especially on more vulnerable eggs and chicks, helping us reach the desired productivity levels. All three alternatives would maintain gull-free zones to benefit these species.

We would continue to use artificial nesting structures, as these have been shown to lure terns to nesting sites and to reduce predation by gulls on common tern chicks (Burness and Morris 1992). These strategies have been effective at other locations (Kress 1983) and are established management tools (Kress and Hall 2004). Least terns indirectly benefit from management activities, including seasonal closures and predator management.

Seasonal closures would benefit seabirds as discussed under Shorebirds. Habitat management activities, such as prescribed fire and invasive plant control, would benefit seabirds by improving quality habitat for nesting. Impacts from banding efforts would be the same as those previously discussed.

Herring and black-backed gulls are considered predator species if they are within the tern colonies. Laughing gulls experience a direct loss from nest destruction if the population exceeds 1,000 pairs on the refuge. The destruction of nests by scattering nesting materials and removing eggs is a direct adverse impact on these birds; however, the benefits afforded to species of conservation concern outweigh the impacts caused by this management action. Gulls benefit from the seasonal closures on South Monomoy by reducing the impacts of human disturbance and protecting their habitat (outside of the gull-free zones). Predator management of mammalian species also provides indirect benefits to these species. Laughing gulls are negatively impacted by our prescribed burns because it removes preferred vegetation; however, the purpose of these burns is to improve habitat for the tern colony and discourage nesting by laughing gulls.

Seabird Impacts of Alternative A (Current Management)
The presence of our 24-hour field camp would continue to benefit terns and other seabirds by reducing the threat of predator species. Impacts from banding activities would be the same as previously discussed.

Seabird Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))
Benefits from the field camp would be the same as in alternative A. There may be increased impacts affiliated with banding activities with an increased staff presence. Seabird species would benefit from potential new habitat through more regular prescribed fires and mechanical thinning of dune grassland and shrubland, as well as possible beach re-nourishment projects. Maintaining a 10 percent cover refugewide of invasive plants species would benefit the quality of habitat available for these birds.

Seabird Impacts of Alternative C (Natural Processes)
Least terns would have the least protection under alternative C, as we focus our management on federally listed species. Adverse impacts would likely result from decreased staff presence and reduced predator management. The removal of structures within the tern colony may provide a minor benefit as we reduce the risk of bird injuries.

Other Colonial Nesting Waterbirds

This section addresses impacts regarding objectives A1.6, B1.6, and C1.5. Other colonial nesting waterbirds, including black-crowned night-heron, egrets, and glossy ibis, benefit from seasonal closures and predator management. These impacts are the same as previously described. Under all alternatives we would continue to lethally remove black-crowned night-herons if they are found within the tern colony on South Monomoy. The benefit to protecting the tern colony outweighs the direct loss of individual birds. Research projects may provide some additional minor benefits to these species as we improve our knowledge and can make more informed management decisions.

Other Colonial Nesting Waterbird Impacts of Alternative A (Current Management)
Impacts would be the same as previously described.

Other Colonial Nesting Waterbird Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))
The expected increase in visitor use may have additional minor adverse impacts as a result of increased levels of human disturbance. These birds would benefit

from a slight expansion in the length and area of seasonal closures and increased staff presence.

Other Colonial Nesting Waterbird Impacts of Alternative C (Natural Processes)
Under alternative C, we expect to see a decrease in visitor use in the wilderness portion of the refuge, which may provide a benefit to these birds with reduced levels of disturbance. However, reduced staff presence and decreased predator management may create additional vulnerability to predators and disturbance.

Other Birds of Conservation of Concern
This section addresses impacts regarding objectives A1.6, A1.8, B1.6, B1.9, B1.10, and C1.5. Land birds, raptors, and songbirds would benefit from seasonal closures and reduced human disturbance. These birds would indirectly benefit from predator management and invasive plant control. Under alternatives A and B, there may be minor impacts from the banding station, as well as minor adverse impacts from mist-net activity and research projects. These species benefit from our increased knowledge improving our management efforts. There may be short-term adverse impacts to breeding songbirds resulting from solar panel installation at the Monomoy Point Light Station.

Effects on Other Native Wildlife

The majority of our biological survey efforts focus on bird species that breed or winter on the refuge; however, the refuge provides habitat for fish, reptiles and amphibians, invertebrates, crustaceans, and small mammals.

Marine Mammals

Marine mammals would continue to benefit under all alternatives from enforcement of the Marine Mammal Protection Act and efforts to partner with the Cape Cod Stranding Network to assist with rescues of stranded and entangled marine mammals and help monitor injured or sick marine mammals. Fishing has the potential to result in conflicts with seals over fish if anglers do not observe the 150-foot buffer distance from seals required by the Marine Mammal Protection Act. Visitor use also has the potential to disturb loafing seals. Gray and harbor seals haul out on the refuge year-round. The buffer around all seals is required by the National Oceanic Atmospheric Administration to ensure compliance with the Marine Mammals Protection Act.

Under alternatives A and B, marine mammals, particularly seals, would continue to be adversely impacted by motorized boats that are used for wildlife tours and transportation to the refuge. The refuge mitigates for impacts to marine mammals by communicating with tour guide operators about the required 150-foot buffer distance and enforcing the Marine Mammal Protection Act; however, we acknowledge there may still be instances when boats come too close and disturb resting seals. Alternative B offers the greatest benefit to marine mammals by supporting efforts to facilitate and participate in research opportunities that would contribute to improving our knowledge about priority species, including gray and harbor seals. Under alternative B, seals would benefit from the possible use of symbolic fencing for haulout and pupping sites to further reduce the impacts from human disturbance.

Alternative C would benefit marine mammals by not allowing motorized boats within the wilderness area. We anticipate fewer visitors under this alternative, decreasing the likelihood of disturbance to resting seals and other marine mammals.

Terrestrial Mammals

The management actions with potential to impact terrestrial mammals are strategies for maintaining and improving native habitats and controlling

invasive or nuisance species and would continue regardless of the alternative we select. These actions indirectly benefit mammalian populations over the long term by ensuring the continuation of quality natural habitats on the refuge for resident mammals and migratory mammalian wildlife such as bats.

USFWS

Deer

Controlling invasive plant species benefits mammals by maintaining the balance of food resources and native vegetative communities with which they evolved or adapted to for cover, nesting, and quality food resources. Those invasive species that pose the biggest threats to mammals are those that quickly colonize an area and form dense, monotypic stands. Herbivorous mammals that depend on a variety of native food resources throughout the year would be adversely impacted by monocultures of invasive plants. For smaller, insectivorous mammals, degradation of native plant diversity and structural integrity by invasion of exotics adversely impacts the biodiversity and availability of invertebrate food resources associated only with native floral assemblages.

Under all alternatives, the most significant impact would be direct mortality of mammal species identified as predators, such as coyotes. Cumulative effects on non-predatory mammals are expected to be minimal. These include species such as voles, moles, mice, shrews, and bats. Except for some species of migratory bats, these species have very limited home ranges and predator management would not affect their populations regionally. Some species of bats are migratory. Cumulative effects to these species at the flyway level should be negligible.

The cumulative effects of disturbance to wildlife under all alternatives are expected to be negligible. Maintenance activities such as prescribed burns naturally present a direct risk to some individuals among small mammals. However, the risk is low, or the impact minor at the population level and always of short duration. Most mammals can scurry out of the way or go underground. Small mammals such as mice, shrews, or voles generally burrow underneath the duff and can escape injury. The direct mortality of some mammals, such as rabbits and raccoons, may occur occasionally during prescribed burns. Another direct effect arises after a prescribed fire has removed their protective cover, exposing small rodents and rabbits to predation and, if it is winter, to cold. The extent to which they are exposed depends on the proximity of available cover and the density of raptors, foxes, and feral cats in the area. We believe the cumulative benefits of fire-improved habitat for the population of small mammals would outweigh the negative effects of exposure.

Direct impacts on wildlife can be expected wherever humans have access to an area. In general, human presence disturbs most wildlife, which typically results in a temporary displacement without long-term effects on individuals or populations. Some species will avoid areas frequented by people, such as developed trails and buildings, while other species seem unaffected or even drawn to a human presence. Vehicles are restricted to Morris Island, and harassment or taking of any wildlife other than legal game species is not permitted. The majority of public use activities at the refuge are in well-traveled corridors where we do not anticipate any significant impact from human disturbances.

Under alternatives A and B, the installation of solar panels at the light station would result in the displacement of some small mammal species. Installation of a solar panel array at the Monomoy Point Light Station would shade out small mammal ground vegetation habitat on approximately less than 1 acre. This disturbance may temporally displace small mammals, but the overall impact is expected to be minimal, especially with the abundance of similar habitat surrounding the construction site. Waste disposal measures for workers would be incorporated into all contracts under all alternatives to minimize the potential attraction for mammalian predators to construction areas and nearby nesting birds.

Under alternative B, we expect to see an increase in visitor numbers to Morris Island and South Monomoy, especially if the Monomoy Point Light Station is opened to the public for tours. Greater risk of human disturbance to mammalian species could result.

Alternative C would present the greatest impact to small mammals as a result of decreased predator management, thereby increasing the local population of predator species.

Amphibians and Reptiles

Expected impacts to sea turtles were previously discussed in the Threatened and Endangered Species section. Impacts to terrestrial amphibians and reptiles would be similar to those described under Terrestrial Mammals for management and public use activities. We would expect some minor, temporary impacts that range from displacement to direct loss from herbicide treatments in the freshwater ponds and when mosquito management is implemented on Morris Island. Controlling invasive species would benefit amphibians and reptiles by contributing to the restoration and propagation of native plants and their associated insects that are essential prey resources. Applying herbicides to control invasive species also needs to be done with care to avoid herbicide chemicals and surfactants intended for terrestrial use from getting into the freshwater ponds and wetland areas, where they would be lethal to developing amphibian eggs, larval stages, and tadpoles. Great care would be exercised to mitigate potential damage by adhering strictly to label directions.

We would expect to see an increase in disturbance to amphibian and reptile species under alternative B as a result of increased numbers in visitors to the refuge. Impacts would be the same as those discussed under Terrestrial Mammals.

We anticipate short-term impacts on amphibian species during prescribed fire activities; however, given the low-intensity duration and relatively small burn area we do not consider this to be a significant impact. According to a review by Russell et al. (1999), there are few reports of fire-caused injury to reptiles and amphibians, even though many of these animals, particularly amphibians, have limited mobility. The freshwater ponds may provide protection from fire, and activities such as breeding by aquatic species may be carried out with little interruption from fire (Russell et al. 1999).

Fisheries

Many of our management actions, such as controlling invasive plant species and maintaining native vegetation, would benefit aquatic resources and fish nursery habitats by protecting good water quality and functioning wetland ecosystems. Many marine fish use salt marshes as breeding grounds or nursery habitats for juveniles; in these places they find an abundant supply of prey such as worms, mollusks, and crustaceans, and few predators. Menhaden, flounder, sea trout, spot, and striped bass are just a few examples of game fish that use salt marshes at some point in their lives. Non-game fish such as killifish and mummichogs also rely on salt marshes and are key forage species for game fish such as striped bass and bluefish (Carlisle et al. 2002).

Negative effects on fish populations are not expected if proposed larvicides and pupacides are used according to label directions. Insects are crucial food components in aquatic habitats for fish species on the refuge.

Fishing seasons and limits are established by the Commonwealth of Massachusetts and adopted by the refuge. These restrictions ensure the continued well-being of overall populations of fish. Fishing results in the taking of many individuals within the overall population, but restrictions are designed to safeguard adequate population and recruitment from year to year.

Major concerns of any refuge fishing program are the accidental or deliberate introduction of nonnative fish used for bait, accidental introduction of invasive plants, pathogens, or exotic invertebrates attached to fishing boats, and overharvesting. Another common concern is the reduction or alteration of the prey base important to fish-eating wildlife. Refuge-specific regulations address this concern by following Massachusetts regulations and would adopt any State harvest limits that should become applicable to the fish species within the refuge's aquatic habitats. These limits are set to ensure that harvest levels do not cumulatively impact native fish resources to the point they are no longer self-sustainable. We also follow recommendations of Service fisheries biologists who may conduct periodic sampling of refuge ponds. Under alternatives B and C, effects on interjurisdictional fishes are expected to be unlikely from waterfowl hunting because the majority of the refuge would experience minimal, transitory use by hunters.

Salt water intrusion into freshwater marshes may result in direct mortality or stress on freshwater fish species from increased salinity. Large fish kills may result if saltwater intrusion is rapid. The stress of salt water on freshwater marsh vegetation may result in the loss of vegetative cover and subsequent decrease in dissolved oxygen levels due to decaying biomass.

Under alternatives B and C, expanded freshwater and salt water fishing and crabbing opportunities should coincide with increased monitoring of possible adverse effects on fish populations and habitat degradation from increased public use. Opportunities for lobstering, whelking, and crabbing (not horseshoe crabs) within the Declaration of Taking are expected to cause minimal impacts on fisheries resources. The hand harvest of scallops will have minimal impact on eelgrass beds. Non-motorized and motorized watercraft may indirectly impact fish nurseries if they destroy eelgrass meadows. Alternative C would benefit fish resources by not allowing motorized boats within the intertidal waters of the refuge wilderness. Not opening the refuge to fishing that is conducted in a manner that disturbs the bottom (e.g., dredging, otter trawling, hydraulic pumping) would reduce the likelihood of damage to eelgrass beds and benthic communities, combined with reduced overall human disturbance and reduced fishing harvest pressure.

Seals on South Monomoy Island

Jon Lanza 2013

In 2002, after extensive analysis and research demonstrating that refuge shorebirds eat horseshoe crab eggs, harvest of horseshoe crabs from the waters of Monomoy refuge was found to be incompatible. The ban on horseshoe crab harvesting within the refuge boundary would continue to protect these species as a valuable food resource for migratory

birds, while maintaining the biological diversity and environmental health of the intertidal ecosystem. Refer to the Horseshoe Crab Harvesting Finding of Appropriateness in appendix D for more information.

The larger size class shellfish sought by harvesters for human consumption is part of the available mature, breeding population for shellfish species that, like many other marine organisms, exhibit sporadic and somewhat unpredictable reproductive success. Direct and indirect mortality induced by shellfish harvest, recruitment, reproductive failures that delay population recovery, and shifts in species diversity toward smaller, short-lived and more mobile species can reduce the abundance of preferred prey items for higher trophic level predators such as amphipods, copepods, echinoderms, gastropods, crabs, fish, or birds (Peterson and Estes in press, Piersma et al. 2001, Verhulst et al. 2004).

Direct mortality or injury of shellfish can occur from harvesting rakes that contact shellfish, from trampling under foot, or from rough handling by the harvester during measuring and sorting (Heffernan 1999, Ferns et al. 2000, Johnson 2002). During shellfish harvest activities, many invertebrates are discarded, and returned to the intertidal flats near where they were taken, alive and intact, injured, or dead. Reasonably intact live individuals rebury themselves within a few minutes, leaving only moribund ones on the surface (Ferns et al. 2000). Invertebrates may be inadvertently reburied at depths exceeding their ability to migrate upwards or to extend filter-feeding structures into the water; smothering with anoxic sediments during harvesting and backfilling can cause benthic invertebrate mortality (Coen 1995, Cox 1991).

Many relevant studies have not shown long-term significant changes to benthic communities resulting from shellfish harvest, with the exception of changes in distribution of the target species. MacKenzie and Pikanowski (2004) found little to no effect on benthic communities resulting from raking in sandy, subtidal substrates, and attributed this lack of effect to invertebrates' adaptation for survival in environments where sediments are naturally re-suspended by severe storms.

Repeated physical disturbance can decrease productivity of affected communities (Odum 1985, Gray 1989). The effects of a single passage of a rake may be relatively limited, while chronic raking may produce long-term changes in benthic communities (Jennings and Kaiser 1998). If disturbance is routine, the post-disturbance benthic communities are likely to be less abundant and diverse than in undisturbed habitats (Ray 2005). Marinelli and Woodin (2002) demonstrated that disturbing the surface of soft sediments altered sediment chemistry, making it less attractive for recruiting infauna. Submerged and floating shellfish cultivation gear may also have negative impacts on essential marine habitats.

Although the rate of recovery from hand raking can be highly variable in space and time, this low-intensity traditional harvesting appeared to have little impact on benthic communities (Kaiser et al. 2001). Kaiser et al. concluded from benthic samples collected from plots more than a year after hand raking for cockles that small-scale variations in habitat heterogeneity had been altered, and suggest that, while effects of hand raking may be significant within a year, they were unlikely to persist beyond this time-scale unless larger, long-lived species are present within the community. A detailed discussion on the impacts of shellfishing to marine invertebrates and benthic fauna can be found in the Shellfishing Compatibility Determination in appendix D.

Derelict crab pots, also known as ghost crab pots, which are lost during storms or have been accidentally cut loose from their buoys by boat motors can also have a detrimental impact on marine invertebrates by catching individual species in the

traps and resulting in direct loss. This has not been an issue within the refuge boundary at the present time, nor do we anticipate it becoming one.

Terrestrial Invertebrates and Insects

The terrestrial invertebrate community is an important contributor and modifier in the functioning of refuge ecosystems and related food webs. Insects are part of every food chain and represent the most important component of food webs responsible for directly maintaining birds, fish, amphibians, reptiles, mammals, insects, and native plant resources on the refuge. As such, invertebrate community health and diversity is directly linked to our conservation of trust resources, such as all guilds of migratory birds.

Removing invasive species permits native flora to re-establish and expand. This especially benefits insects that coevolved with the native flora, particularly those that are host-specific such as the monarch butterfly, which mostly uses milkweed as the host plant for its eggs. Although the Service approves the herbicides we use in controlling invasive species because of their neutrality on animal life, should soft-bodied insects, eggs, pupae, or organisms with permeable skin come in direct contact with an herbicide or its surfactant, mortality, reduced fitness, or abnormal development may result. Many species of invasive, nonnative plants are not optimal hosts for native insects and do not contribute to the health or diversity of the pollinator community. We presume that any dependence on those plants is minimal and, therefore, removing them would not result in unacceptable losses in the insect populations.

To avoid invasive herbicide damage to host plants associated with pollinator insects, precautions can be taken, such as using back-sprayer or other similar targeting techniques. This would allow for the selective control of undesirable plants while avoiding negative impacts on nontarget beneficial larval host plants required by insect pollinator species.

The effects of prescribed fire on the upper ground layer can have consequences for insect communities. Some groups of invertebrates, such as beetles and some spiders, have been shown to increase after fire treatment (Sullivan et al. 2003). The vulnerability of insects and other invertebrates to fire depends on their location at the time of fire. While adult forms can burrow or fly to escape injury, species with immobile life stages that occur in surface litter or aboveground plant tissue are more vulnerable (Smith 2000). Seasonality of fire can also have an influence on the degree of impact for many invertebrates.

Mosquito Management

Under all alternatives, the refuge would follow the Service's Integrated Pest Management policy and the Biological Integrity Diversity and Environmental Health policy and continue to issue special use permits to the Cape Cod Mosquito Control Project (CCMCP) for annual mosquito monitoring and management. This management action only applies to several small pools within a 5-acre salt marsh located on Morris Island. Mosquito monitoring would be conducted on the basis of surveillance data indicating a need to do so, and would occur during the months of May through September.

The CCMCP would control mosquito populations by hand application of *Bacillus thuringiensis* var. *israelensis* (Bti). Like other varieties of the natural soil bacterium, *Bacillus thuringiensis* (Bt), Bti is a stomach poison that must be ingested by the larval form of the insect in order to be effective. Bt contains crystalline structures containing protein endotoxins that are activated in the alkaline conditions of an insect's gut. These toxins attach to specific receptor sites on the gut wall and, when activated, destroy the lining of the gut and eventually kill the insect. The toxicity of Bti to an insect is directly related to the specificity of the toxin and the receptor sites. The issue of Bti concentration is important with regard to impacts on nontarget organisms. The only long-

term study on the nontarget effects of Bti for mosquito control demonstrated significant adverse effects on the chironomid community of treated wetlands, and this translated into numerous significant negative effects within the food web (Hershey et al. 1998; Niemi et al. 1999). Chironomid (non-biting midge) larvae are often the most abundant aquatic insect in wetland environments and form a significant portion of the food base for other wildlife (Batzer et al. 1993; Cooper and Anderson 1996; Cox et al. 1998). Negative impacts on chironomid density and biomass could have deleterious effects on wetland wildlife food webs and could also lower biodiversity.

Bti is widely used because of its reportedly high specificity for target species and environmental safey (Ali 1981; Merritt et al. 1989). Laboratory and field studies have shown that Bti is toxic to some larval chironomids, but many factors, such as temperature, water depth, aquatic vegetation, and suspended organic matter, may act to reduce its toxicity to chironomids in the environment (Charbonneau et al. 1993; Merritt et al. 1989).

Adulticide treatments have rarely been used on the refuge, but were applied in Plymouth and Bristol counties during 2006, 2010 and 2012 as a public health emergency response to an outbreak of eastern equine encephalitis virus. Adulticides are inherently non-specific, i.e., they kill nontarget species, as well as mosquitoes. Adulticiding kills only mosquitoes that contact insecticide droplets. Although the local mosquito population is reduced for a few days, fogging does not prevent mosquitoes from re-entering the area.

No mechanical tidal circulation enhancements and restoration are anticipated under any alternatives on Monomoy NWR, including non-wilderness. Should this change, effects to nontarget organisms could include, at a minimum, temporary disturbance or displacement from their habitat. In the event that ditching, berm or levee breaching, or removal actions are conducted, effects could include injury or death to some mammal and bird species. In order to avoid impacts to wildlife, construction would be scheduled to avoid reproductive periods or extreme high tides. Removal of vegetation within the construction area can be scheduled during low tide to significantly reduce the likelihood of mammal or bird presence. As site-specific projects are identified, potential effects to wildlife will be further analyzed. Best management practices or conservation measures to eliminate or minimize any negative effects will be identified in a project-specific document.

The greatest concern the Service has with chronic mosquito chemical use is the potential degradation of biological integrity and diversity and disruption of vital food webs. Aquatic invertebrates play important roles in wetland ecology. They aid in the breakdown and recycling of freshwater and salt marsh-derived organic matter and provide important food resources for different life stages of fish, breeding and migrating birds, and other wildlife. As such, they are critically important and are directly linked to the future conservation and management of refuge-specific resources of concern listed in CCP goals and habitat objectives.

Impacts to birds, mammals, reptiles, or amphibians may occur as a result of ground access. However, bird and mammal impacts are considered limited because areas that need mosquito management are small in size and provide only limited habitat. The use of pesticides for the purpose of mosquito management may directly or indirectly affect resident and migratory bird, mammal, reptile, or amphibian populations of the refuge. Direct effects may occur from direct contact with the pesticides. Indirect effects are related to the potential reduction in the invertebrate food supply. Pesticide effects on reptiles and amphibians may occur through reductions in insects that serve as a food source (Hoffman et al. 2008), through direct individual effects from pesticide application or from trampling of individuals or habitat. Birds are often used as a surrogate for effects on reptiles and fish as a surrogate for amphibians (Hoffman et al. 2008). Bti has

practically no acute or chronic toxicity to mammals, birds, fish, or vascular plants (EPA 1998).

Migratory birds that depend on invertebrate food resources may not be mobile enough to seek alternative feeding sites if necessary post-treatment, particularly during the breeding season. Precocial young seek food items on their own. Since they are flightless, food items must be available within a relatively small home area. Therefore, reduction of invertebrate food resources within even a small geographic area may be detrimental to breeding wetland birds and precocial young.

The use of larvicides and pupacides for mosquito management are not likely to directly affect native mammal populations of the refuge. Negative effects on fish populations are not expected from proposed larvicides and pupacides. Adverse effects on mammals from Bti, methoprene, and Agnique (monomolecular film) are not expected when applied according to the label instructions. Extensive acute toxicity studies indicated that Bti is virtually innocuous to mammals (Siegel and Shadduck 1992). These studies exposed a variety of mammalian species to Bti at moderate to high doses and no pathological symptoms, disease, or mortality were observed. Methoprene is not considered toxic to mammals. Impacts to the mammalian community as a result of reduced invertebrate populations are not expected because most mammal species that inhabit wetlands of the refuge are herbivorous and invertebrates are not a primary component of their diet. Insectivorous shrews experiencing reduced arthropod food availability may be reduced post-treatment over the short term.

For more detailed information on the refuge's mosquito management, refer to the Mosquito Management Compatibility Determination in appendix D.

Effects on Wilderness Recommendations and Designation

Appendix E, Wilderness Review, describes the wilderness inventory process we undertook for this CCP. The majority of Monomoy NWR lands lying above mean low water were designated as wilderness in 1970. With the exception of excluded areas, the Monomoy wilderness boundary includes all lands extending to mean low water within the original 1944 Declaration of Taking that established Monomoy NWR. It also includes the 717-acre Nauset/South Beach accretion. Wilderness designation does not include subtidal or open water areas below mean low water. The Monomoy wilderness is currently the only nationally designated wilderness on the densely populated southern New England coastline. The 1970 wilderness designation excluded four parcels: (1) the 40-acre property on Morris Island that contains the refuge headquarters and visitor contact station; (2) the approximately half-acre Stage Island lot; and (3) the Inward Point and (4) Powder Hole areas on South Monomoy.

The refuge property on Morris Island along with two tracts on South Monomoy were excluded from the 1970 designation because they contained residences, permanent roads, summer cottages, and other facilities still being used or in private ownership. Those two wilderness designation exceptions on South Monomoy, totaling 595 acres, are Inward Point (432 acres) and Powder Hole (163 acres). Although not included in the wilderness designation because they contained summer cottages, historic light station structures, and other facilities then in use or private ownership, Congress expected that they would be designated as wilderness in the future once the cabins and other structures in these two areas were removed. Additionally, Congress directed the Secretary of the Interior to manage the entire area consistent with the concept of wilderness (House of Representatives, Report No. 91-1441).

In our wilderness inventory, we evaluated whether we could maintain, over the long term, the quality of wilderness values and character without compromising

our ability to meet refuge purposes and the Refuge System mission. We considered impacts from existing and planned resource and public use programs and activities based on the criteria that define a wilderness area: generally appears to have been affected primarily by the forces of nature, with the imprint of man substantially unnoticeable; has outstanding opportunities for solitude or a primitive and unconfined type of recreation; has at least 5,000 acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and may also contain ecological, geological, or other features of scientific, educational, scenic, or historic value.

No current non-wilderness portions of Monomoy NWR possess wilderness character sufficient for wilderness study area designation due to the remaining presence of some human structures and further detailed study is not planned to be conducted during the 15-year plan period. The refuge will undergo another wilderness review in 15 years as part of the next planning cycle, at which time wilderness study area designation and the wilderness study and recommendation phases will be reconsidered for the Inward Point and Powder Hole areas. We may also conduct a wilderness review prior to the next planning cycle should significant new information become available, ecological or other conditions change, or we identify a need to do so.

Wilderness Impacts Common to All Alternatives

All three alternatives manage the existing Monomoy wilderness to simultaneously secure an enduring resource of wilderness and accomplish refuge purposes in a way that preserves wilderness character. In all alternatives, we will continue managing the existing Monomoy wilderness and the Inward Point and Powder Hole non-wilderness exclusions to maintain or enhance their naturalness and outstanding opportunities for solitude or primitive and unconfined recreation, to the extent that it will not prevent us from fulfilling and carrying out refuge establishing purposes and the Refuge System mission, in accord with Service wilderness stewardship policy (610 FW).

Other than boats, the use of motorized vehicles, motorized equipment, and mechanical transport in the Monomoy wilderness would be allowed only for emergency purposes or when necessary to meet minimum requirements for administering the area as wilderness and accomplishing refuge purposes. Proposed or new refuge management activities, including the need to use motorized vehicles, motorized equipment, or mechanical transport for administrative purposes, would be evaluated through a minimum requirements analysis and NEPA compliance to assess potential impacts and identify mitigating measures to protect wilderness character.

The existing baseline character (Sudol 2012) of the Monomoy wilderness, and its natural values and opportunities for solitude and primitive recreation, will remain effectively unchanged under any CCP alternative. We would adjust our refuge management strategies and techniques to comply with the provisions of the Wilderness Act and Service wilderness management regulations (50 CFR 35) and policy (610 FW 5) to prevent degradation of wilderness character, natural values, and outstanding opportunities for solitude and primitive recreation. None of the alternatives propose actions that would directly or indirectly degrade the wilderness character or jeopardize the roadless character, size, or outstanding ecological or scenic features of the Monomoy wilderness or the Inward Point and Powder Hole inventory areas.

Monomoy NWR and surrounding areas have a long history of human use. The Inward Point inventory area includes the site of the former Monomoy Branting Club and seasonal camps. The Inward Point area is nearing but not yet free of visual evidence of permanent or human-made structures. While all the camps

that were located in this area when excluded from the original wilderness designation have since been removed, utility poles, building foundations and cisterns are still visible. The Powder Hole inventory area includes sites of the former Whitewash Village fishing community, where little evidence remains today, and the former Monomoy Point Lifesaving Service and Coast Guard Stations. In addition, the Powder Hole area also includes the "cherry stem" access trail corridor and approximately 4-acre site of the existing Monomoy Point Light Station buildings, designated on the National Register of Historic Places. These buildings and the remains of other structures, such as concrete building foundations, water cisterns, and utility poles, are signs of past human use and occupation that continue to serve as reminders that the Powder Hole and Inward Point non-wilderness areas have not yet attained a primeval, undeveloped, and natural condition. Restoration of the Monomoy Point Light station buildings began in 2010 and partial renovations were completed in 2012. The buildings were renovated firstly to preserve their National Historic Register value, and secondarily to accommodate staff during seasonal fieldwork.

Significant progress toward achieving wilderness character was made in both areas since 1970. Continuing to apply wilderness stewardship principles in both areas through the 15-year planning period will bring them still closer to achieving wilderness character, and they may once again be reviewed by the Service for suitability as additions to the National Wilderness Preservation System.

Human developments on the mainland and motorized boats are visible during clear weather from most locations within the Monomoy wilderness. It is also apparent that primeval, natural, and non-anthropogenic processes are at work, especially the constantly shifting sands and intertidal substrates that dominate within the Monomoy wilderness. Although the use of motorized vehicles are prohibited within the Monomoy wilderness, motorized equipment such as motorboats and aircraft introduce noise disturbance that may influence the distribution of wildlife and reduce the wilderness experience for some public visitors. This impact is reduced by the specified location of two boat landings and the minimum altitude of 2,000 feet for all aircraft flying over the refuge.

The Service's Wilderness Study Report (January 9, 1967) recognized that fin fishing and shellfishing have been significant factors in the economy and life of the local people and continue to provide a livelihood for mainland residents. Shellfish harvest using traditional hand raking methods within the Monomoy wilderness also potentially provides a rare, outstanding opportunity for unconfined, primitive outdoor recreation or solitude in a primarily natural-appearing coastal barrier system landscape. Non-mechanized shellfish harvest from intertidal refuge areas otherwise open to public use affords refuge visitors an opportunity to increase their understanding and appreciation of the refuge, its resources, resource management, and refuge regulations along with traditional, local, cultural practices. Shellfish harvesting on intertidal flats visible from or within the Monomoy wilderness may result in a diminished degree of solitude for some wilderness users, but should not adversely affect the overall wilderness character of the Monomoy wilderness.

The vast majority of the Monomoy wilderness will remain essentially unvisited and virtually undisturbed by intertidal shellfish harvesting. Visible impacts from hand digging are temporary, generally lasting a few weeks before all traces of digging are gone from a harvested area. Scrapes left on the edge of the flats from boat propellers are evident for quite some time. These physical disturbances are most evident near shellfish harvest sites but are not expected to significantly compromise the perception of naturalness of the Monomoy wilderness landscape nor impact the wilderness user experience (Cole 2002, Hendee and Dawson 2002).

With typically long sight-distances across Monomoy wilderness' rolling, nearly treeless, intertidal and coastal barrier landscape, too many individuals encountered or observed during visits by other Monomoy wilderness users can detract from the sense of solitude experienced by wilderness users (Stankey and Schreyer 1987, Hendee and Dawson 2002). Intertidal shellfish harvest use is still relatively dispersed across the intertidal flats open to public use, and offers outstanding opportunities for solitude and unconfined, primitive outdoor recreation that can be experienced by other Monomoy wilderness users. At this time, the level of intertidal shellfish harvest does not and is not expected to adversely impact the wilderness character of the Monomoy wilderness.

At present, it seems that nearby developments have not trammeled the wilderness' physical processes. Because most of the beaches north of Monomoy NWR are part of the Cape Cod National Seashore, the threat of deleterious coastal development appears low. The global danger of climate change may have a series of consequences on Monomoy NWR, the most serious of which is sea level rise and perhaps increased storm event frequency and magnitude. Some habitats may shift, but Giese (2010) predicts that the historical coastal processes of accretion and erosion should continue.

The Monomoy wilderness and the Inward Point and Powder Hole inventory areas are currently accessible only by boat. In general, however, Monomoy NWR is subject to public entry at many locations along its shoreline that may affect solitude. The limited topographic relief and generally low-growing or sparse vegetation means that when human intrusions occur, they are often observable from considerable distances. At the time of its designation, the Service recognized that the preservation of the Monomoy wilderness offered a special mission: "It is a natural refuge for birds and an ideal retreat for people willing to undertake the journey for the sake of its rewarding seclusion." Under all alternatives, the refuge's outstanding opportunities for solitude and primitive recreation would be preserved and available consistent with seasonal closures.

Sunset on the refuge

Ravin Thomasson 2013

All alternatives propose the use of prescribed burning to reduce habitat suitability for nesting laughing gulls (a competitor species of terns), increase habitat for nesting terns, and reduce shrubby vegetation that provides shelter for mammalian predators. Impacts from fire management are discussed under Effects on Air Quality and Effects on Soils.

Under all alternatives, the refuge would continue to prepare minimum requirements analyses (MRA) to evaluate proposed refuge management actions and determine how they can be conducted to minimize their impact on wilderness character. In addition, we would develop a detailed wilderness stewardship plan to sustain these wilderness values in perpetuity. Refuge management strategies and techniques would be chosen to comply with wilderness stewardship principles and prevent degradation of wilderness character. All refuge management activities and uses that would require use of motorized vehicles, motorized equipment, and mechanical transport would be evaluated through a minimum requirements analysis, either on a programmatic or case-by-case basis, to determine if the activities are necessary and to identify measures to mitigate impacts to

wilderness character. Additionally, proposed refuge management activities that modify ecosystems, species, or natural processes would be subject to the MRA process. We would conduct or authorize such activities only if we demonstrate that it is necessary both to meet the minimum requirement for administering the area as wilderness and to accomplish refuge purposes.

Wilderness Recommendations and Designation Impacts of Alternative A (Current Management)

None of the proposed management actions under any alternative would adversely impact the untrammeled, undeveloped, and natural qualities of the wilderness or its capacity to provide outstanding opportunities for solitude or a primitive and unconfined type of recreation.

Refuge visitors are currently only permitted during daylight hours and are not permitted to camp overnight on the refuge. Although refuge staff do stay overnight in tents for short periods at a primitive, seasonally operated field camp or at the light keeper's house, the field camp is temporary and removed annually after the bird nesting season ends. Within the Monomoy wilderness, humans are visitors who do not remain. Visitors to the Monomoy wilderness can see from horizon to horizon across open grassland and undulating dunes to vast open water, and feel unconfined and small.

Some ways that refuge staff and volunteers conduct resource management, such as the base camp near the tern colony, roseate tern attraction devices, using blinds to collect biological information or to control predators, have short-term impacts to the wilderness character. Some birding groups exceed a maximum size of 20 and can impact the sense of solitude. Visitors who choose to recreate within the wilderness may engage in activities such as swimming and sunbathing that could impact the wilderness experience for other visitors who seek the sense of solitude and primitiveness of Monomoy wilderness. However, all these uses or practices are short-term and are either done in an area that is closed to the general public or are isolated in and of themselves, with refuge visitors rarely disturbed by other visitors.

This alternative would implement a prescribed burn every 3 to 5 years within a 35-acre unit in the Monomoy wilderness in order to restore a more natural fire regime while improving habitat for the tern colonies. For the most part, however, the Monomoy wilderness would continue to be impacted primarily by natural forces. There would be no changes in land use or land ownership and no new or expanded refuge management activities or refuge uses that would significantly alter the existing physical landscape of the wilderness. For most of the year, wilderness visitors would experience solitude that is unique among the Atlantic seaboard barrier beaches and islands, all within sight of exceptionally popular tourist destinations on the Cape Cod mainland.

As part of the Service's effort to reduce energy consumption, alternative A would continue to seek funding to develop alternative energy at the Monomoy Point Light Station. Should funding become available and construction of a solar panel array at the Monomoy Point Light Station begun, all efforts would be made to keep the wilderness area untrammeled by confining construction activity to the existing trail and boat landing outside the wilderness. The proposed solar panel array would cover a surface area of approximately 4,000 square feet. Solitude within the Monomoy wilderness on South Monomoy would temporarily be interrupted, as there would be a higher than normal amount of people on the island and increased noise during the construction phase of this project; that would return to normal once construction is completed. Transportation of renewable energy system components to and from the light station would be on an existing abandoned road footprint and would avoid sensitive habitat and minimize impacts on the wilderness and other environmental values.

The Monomoy Point Light Station site is an already developed non-wilderness site; the addition of a solar array at this site under alternative or B would add a new unnatural, i.e., human-made, feature visible from within portions of the Monomoy wilderness. With the exception of a solar panel array, no other areas would be developed and the naturalness of the environment would otherwise remain the same. The refuge would prepare a MRA prior to starting work on the proposed solar panel array to ensure that the project is carried out in a manner that does not degrade the untrammeled, natural, primeval, undeveloped wilderness character or opportunities for solitude or unconfined primitive recreation of the Monomoy wilderness. In addition, we would employ best management practices.

Wilderness Recommendations and Designation Impacts of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))

Under alternative B, all management actions in the Monomoy wilderness would be evaluated and modified as necessary to ensure wilderness character is preserved. This may result in modifying how we conduct certain activities, if conducted at all. We would still conduct active habitat management, but would ensure that we use the simplest tools possible and conduct the management in a manner consistent with the protecting wilderness values.

Under alternative B, the refuge expects the greatest increase in public use. This could have impacts on the wilderness values of solitude and primitiveness, but we do not anticipate that it would significantly detract from the overall wilderness character of the refuge or Monomoy wilderness. It is possible that having a majority of the visitors arrive by concessionaire would decrease solitude in the immediate vicinity of the pickup and drop off locations but could increase solitude elsewhere on the refuge if the majority of visitors arrive at the refuge via a concessionaire rather than their own motorized transportation. Alternative B explores the possibility of opening the historic Monomoy Point Lighthouse to the public for tours. In order to maintain the wilderness character of the Monomoy wilderness, we would likely limit group size, frequency, and duration of visits on South Monomoy. Hiring a wilderness ranger would benefit the Monomoy wilderness by raising awareness about its importance and value, and educating the public about wilderness stewardship and ethics.

Alternative B would place a greater focus on wilderness stewardship in outreach and education programs on the refuge. The completion of a wilderness stewardship plan and obtaining baseline data regarding visitor use thresholds within the wilderness would allow us to implement a minimum access program to reduce any potential adverse impacts on wilderness character. Implementing a limited group size access pass would further enhance our ability to manage the refuge to maintain outstanding opportunities.

Alternative B proposes prescribed burning within 90 acres of the Monomoy wilderness, a 55-acre increase compared with alternative A. However, as this management action aims to restore natural processes in a fire-dependent ecosystem, we do not anticipate any significant impacts beyond those already addressed in Effects on Air Quality and Effects on Soils.

Impacts from the proposed installation of solar panels would be the same as described under alternative A.

Wilderness Recommendation and Designation Impacts of Alternative C (Natural Processes)

Alternative C would most likely provide the greatest benefits to sustaining the wilderness characteristics of solitude, primitive recreation, and being affected primarily by the forces of nature. Management actions such as removing all signs and only allowing nonmotorized transportation within the Monomoy wilderness would contribute to the criterion of being “affected primarily by the forces of nature” and improve opportunities for “solitude or primitive and unconfined recreation.”

The decision not to install solar panels at the Monomoy Point Light Station would not necessarily benefit or adversely impact the wilderness character, as this area is already developed and the structure is not located within designated wilderness. Management actions to not maintain the light station structures and decrease the use of boats for staff transport to North Monomoy Island and South Monomoy would further benefit the values of wilderness character.

Effects on Public Uses and Access

As described previously, the Cape Cod region is a major attraction for outdoor recreation enthusiasts. Although the refuge is not typically the primary destination of most visitors, it does enhance the experience by offering public access to premiere sites with outstanding opportunities for wildlife-dependent recreational activities. Since refuge lands are held in the public trust by the Service, access is generally allowed for compatible, priority, wildlife-dependent public uses. Uses are limited when Federal trust resources will be impacted or when the activity will detract from achieving refuge purposes or the refuge System mission. Use limits also occur if a commercial use or refuge economic activity does not contribute to the purpose of the refuge or when administrative resources are not available to ensure a safe, quality experience for visitors. Monomoy refuge is currently open to five priority wildlife-dependent public uses: fishing, wildlife observation, photography, environmental education, and interpretation. Other popular activities allowed on the refuge include, but are not limited to, sunbathing and motorized and nonmotorized boating. In the text that follows, we describe in general terms the beneficial and adverse impacts of these uses. For more specific information on the potential beneficial and adverse impacts of these uses, especially in relation to alternative B, refer to the attached compatibility determinations (appendix D).

Impacts on Public Use and Access Common to All Alternatives

Regardless of the alternative, Monomoy NWR would remain open to five of the priority wildlife-dependent public uses: wildlife observation, wildlife photography, fishing, environmental education, and interpretation. Opportunities to observe and photograph wildlife exist daily in designated areas on the refuge, exceping seasonal closures to benefit certain wildlife species that are particularly sensitive to human disturbance. We would continue to provide the public with wildlife interpretation and environmental education opportunities. To support public use, we would continue to maintain refuge facilities including a refuge headquarters, visitor contact station, maintenance facility and dormitory on Morris Island, public restroom on Morris Island, the Morris Island and Stage Island parking lots, Morris Island Trail, and interpretative kiosks. Under all three alternatives, the refuge would explore ways to implement recommendations from the transportation study, including shuttle service, improved signs, and bicycle corridors.

Of the management activities that would not vary by alternative, the following would benefit or adversely affect public use and access on the refuge: protecting land, maintaining facilities, and implementing existing priority public use opportunities. A discussion of the general impacts follows.

Operating Hours—In all the alternatives, we would continue to open the refuge for public use from ½ hour before sunrise to ½ hour after sunset, 7 days a week. Access to Morris Island would continue to be allowed 24 hours a day, 7 days per week, for surf fishing. However, unpredictable emergency situations may arise on the refuge resulting in closures.

Existing Priority Public Use Opportunities—The beneficial impacts of providing the existing level of wildlife-dependent activities include helping meet existing and future demands for outdoor recreation and education, as documented in the State Comprehensive Outdoor Recreation Plan (MA EOEEA 2006). Anglers, birders, and photographers would find high quality opportunities to engage in their favored pastimes. Visitor use is increasing over time as local residents and visitors become more aware of refuge opportunities, and as we progress in

Ravin Thomasson 2013

Wildlife photography is a popular activity at the refuge.

creating new facilities and programs. The economic benefits of increased tourism likely would also benefit local communities.

Eventually, the level and means of use resulting from this increase in visitation could change the nature of the experience for many visitors. Some may choose to forgo certain recreation due to issues of crowding or behavior, or will go elsewhere. Because currently the refuge provides opportunities for only a small portion of the area's visitors, if that shift occurs, it is not imminent and would likely occur outside the 15-year period of this plan. If it does occur, it could put additional strains on other public lands, or diminish the refuge contribution to the broader Refuge System mission. We would work to avoid that by continuing to moderate our programs and facilities to minimize conflicts among users.

Maintaining Facilities—Having well-maintained visitor facilities is important for encouraging and welcoming visitors to public lands. It reflects on the Service's responsibility to spend taxpayer dollars effectively and efficiently. It is also important to protect public safety and refuge resources, both of which can be directly impacted or compromised when facilities deteriorate. Under all alternatives, we would continue to take this responsibility seriously and insure all facilities are up to Service standards and safe conditions.

Wildlife Observation and Photography—Opportunities to observe and photograph wildlife exist daily in designated areas on the refuge, except for seasonal closures for wildlife that vary in space and time. We would continue to maintain a self-guided interpretive trail and two viewing platforms in the headquarters area, allow canoeing and kayaking within the refuge's waters, and support opportunities for commercial boat tours (motorized (alternatives A and B) and non-motorized within the refuge wilderness (alternative C)) through a concession or special use permit to provide visitors with wildlife viewing and photography opportunities. The refuge also supports occasional wildlife-related events such as birding field trips and special events, which would continue under any of the alternatives.

Guided tour activities may also conflict with other refuge users. For example, commercial tours would most likely use the same areas as independent wildlife viewers, kayakers, canoeists, and anglers during open seasons. Unregulated or inadequately regulated commercial guiding operations may adversely affect the safety of other refuge users, the quality of their experience, and the equity of opportunity. Proposed stipulations for commercial guides should mitigate these concerns by volume and space restraints.

Environmental Education—As regional tourism and coastal populations increase, the demand for local outreach and environmental education programs is also increasing. In all the alternatives, we would continue to provide at least limited environmental education and outreach. That includes hosting college or public school field trips as requested and as timing and resources allow, taking part in local events, speaking to local organizations, releasing newspaper articles, and providing refuge brochures to chambers of commerce and information centers upon request.

Staffing is a limiting factor in the refuge's ability to provide additional opportunities for environmental education. The renewed involvement with our Friends group, volunteers, and partners is essential to the long-term success of this wildlife-dependent activity.

Interpretation—We would continue to provide interpretive materials such as information signs, brochures, and a refuge Web site, and develop interpretive exhibits that inform the public about the Refuge System and wildlife present at Monomoy. In all the alternatives, we would continue to provide at least the current level of interpretation. Interpretive activities that coincide with other public use activities would not disrupt them.

Wilderness Protection—In all the alternatives, we would continue to manage the Monomoy wilderness as part of the National Wilderness Preservation System and adhere, as much as possible, with the Wilderness Act and Service wilderness policy (610 FW 1-5). Preservation of the wilderness character of the refuge and implementation of our wilderness stewardship plan, once written, are important commitments.

Fishing and Shellfishing—Fishing is a priority, wildlife-dependent use. We would continue to allow fishing in accordance with State and Federal regulations on all refuge lands and waters otherwise open to the public from ½ hour before sunrise to ½ hour after sunset. We would also allow 24-hour access for surf fishing on Morris Island. Fishing in the offshore open waters above the submerged lands would be conducted in accordance with State and Federal regulations. This includes demersal long line fishing; mid-water trawl fishing; hook and line/rod and reel fishing; lobster, crab, and whelk pot fishing; and, hand harvest of scallops. Seasonal closures to protect wildlife would vary each year based on their nesting, breeding, and staging activities, as well as changes in habitat due to dynamic shoreline changes. These closures would occur regardless of the alternative selected, although the size of the area and length of the closure would be extended under alternatives B and C. These limits are set to ensure that harvest levels do not cumulatively impact native fish resources to the point they are no longer self-sustainable.

The Service will continue to allow the harvesting of some shellfish under all alternatives, but with some variance in the species that can be harvested. The harvesting of clams in the intertidal and nearshore zones in the Cape Cod region is not only significant to the State's economy, but is also a traditional and historic way of life for the community of Chatham. We would continue to allow Chatham residents and refuge visitors to harvest some shellfish using traditional, non-mechanized, hand raking methods in accordance with town regulations. All areas, unless otherwise posted, would be open to the public for this use. Seasonal closures would continue to limit some portion of the refuge for this use. As mentioned above, the size of the area and length of the closure would be extended under alternatives B and C. We have no current information on the level of harvest or the number of harvesters using the refuge intertidal areas, as the Town of Chatham issues shellfishing permits. Monitoring the level of use and harvest within the refuge's Declaration of Taking is needed to determine how Federal trust resources are affected. Other potential impacts of fishing and shellfishing are detailed in the findings of appropriateness and compatibility determinations in appendix D.

Impacts on Public Use and Access of Alternative A (Current Management)

Demand and Access—Areas on North Monomoy Island and South Monomoy would remain open to the public from October to March, with designated closures during the nesting season. The majority of the refuge would remain open and we do not expect significant impacts to public access. Under the current alternative, access to the portion of the refuge at Morris Island would continue to be a problem during the summer due to limited parking. Transportation on the

refuge would remain restricted to foot travel, although boats would continue to be allowed to land anywhere along the refuge shoreline (with the exception of the seasonally posted closed areas). Although these actions may limit public access to some extent, we believe the benefits resulting from these actions far outweigh any adverse effects.

Visitation is expected to increase slightly in alternative A. Eventually the level of use could change the nature of the experience for many visitors. Should that occur, some visitors would choose either to give up certain recreation due to issues of crowding or behavior, or to visit alternate locations. We do not anticipate that this increase would adversely affect resources or their use or enjoyment by visitors, because the increases we project for the refuge would be well distributed.

Public Use Opportunities—Alternative A would maintain the current level of programs and types of public use opportunities on the refuge. We would not expand permitted uses, programs, or facilities. The refuge would continue to prohibit the following activities: camping, bicycling off-road, kite boarding, use of all-terrain vehicles or off-road vehicles, and use and landings of personal water craft (wave runners, jet skis). Dogs would still not be permitted on North Monomoy Island and South Monomoy. These activities are deemed inappropriate on the refuge, have the potential to adversely affect refuge resources and wildlife, and can cause conflict with members of the public engaged in priority public uses, i.e., fishing, wildlife observation, and photography. We believe the benefits associated with prohibiting these uses are greater than any adverse effects resulting from limiting these activities.

Wildlife-dependent priority uses and non-priority public use opportunities would continue to be provided, albeit to the extent allowed by current funding and staffing. Without sufficient law enforcement staff to enforce regulations, there is the continued potential for visitors to engage in activities deemed not appropriate with refuge purposes, such as entry into seasonally closed areas, allowing pets off leash, camping, or kite boarding.

Wildlife Observation and Photography—According to results from the USGS National Wildlife Refuge Visitor Survey Results: 2010/2011 (Sexton et al. 2011), the top three activities visitors engaged in during their visit to the refuge were hiking, wildlife observation, and bird watching.

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American oystercatcher banding

Being in a natural, undeveloped area and experiencing a serene environment are equally important to their refuge experience as well as the trails that afford this opportunity (Sexton et al. 2011). These are activities that are equally important to consumptive and non-consumptive use visitors. Survey respondents reported that they were satisfied with the photography and bird watching opportunities on the refuge (Sexton et al. 2011). Adequate opportunities for wildlife observation (trails, viewing platform) would continue to be provided.

Environmental Education, Interpretation, and Outreach—The refuge would continue to host college or public school field trips as requested and as resources

allow. A growing percentage of the local and regional community would continue to become aware of the refuge through our outreach program. We would continue the activities we describe in chapter 2, such as information kiosks and seasonal interpretive programs. Under alternative A, we would continue to provide at least the current level of interpretation, as well as explore the appropriateness of virtual technology to conduct interpretation. Interpretive activities that coincide with other public use activities would not disrupt them. Other beneficial impacts of the current level of onsite interpretative activities are incorporated in providing general access and opportunities discussed previously.

Environmental education would not become more developed under this alternative. Staffing is a limiting factor in the refuge's ability to provide additional opportunities for environmental education. A formal, curriculum-based program would not become available to area schools, and the number of field trips supported by the refuge is not likely to increase. We would educate a limited number of people about the significance of the refuge for birds and other wildlife. As a result, our ability to foster an appreciation of conservation and encourage the public to make environmentally responsible decisions would remain at low levels.

Although this alternative would explore virtual technology as a tool to reach a wider audience, the onsite resources would continue to be overwhelmed. The visitor contact station would not be expanded and would continue to be inadequate to meet the needs for onsite environmental education and interpretation programs.

Fishing and Shellfishing—Same as the fishing and shellfishing impacts described under the section on "Impacts on Public Use and Access Common to All Alternatives."

Impacts on Public Use and Access of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))

Demand and Access—Alternative B would increase opportunities for wildlife-dependent public use and access by enhancing those programs and facilities at the refuge. Providing new public recreation opportunities would enable people to participate in outdoor activities where they otherwise could not. Increased public awareness, improved community relations, and enhanced support of the refuge mission would result as a byproduct of this new interaction. A 25 percent increase over current visitation and an increase in opportunities for compatible, wildlife-oriented, consumptive and non-consumptive uses would combine to increase the risk of conflicts between humans and wildlife and habitat damage. We would help meet demands from the communities where we are located, and from tourists, for outdoor recreation and education, as documented in the Massachusetts Comprehensive Outdoor Recreation Plan (2006). By attracting visitors from outside the area, local communities should experience economic benefits from sales of food, lodging, and supplies.

The development of an alternative visitor contact station in either downtown Chatham or Harwich with shuttle services to Morris Island would allow the public greater access, reduce traffic congestion, and ease parking problems. A concessionaire would be used as the primary means of access to North Monomoy Island and South Monomoy. The benefits of a concessionaire include protecting the natural environment; providing additional opportunities for safe and quality recreational experiences and guided trips; ensuring that visitors practice a "leave no trace" ethic on the refuge; disseminating information about the refuge to the general public; and contributing jobs and income to the local community. Concessionaires also furnish the convenient access to the refuge and are a benefit to those individuals who do not have a private boat or are not physically able to kayak across the Morris Island channel into the Southway. We would also coordinate with the Town of Chatham to implement some of the strategies from the alternative transportation study, such as a multi-use bicycle and pedestrian path along the causeway and improved directional signs. A concessionaire

operating from an offsite parking location would also reduce traffic congestion and ensure visitors would get to the Morris Island trail, or to fish on Morris Island, as they would not have to worry about finding a parking spot.

Paid parking may deter some visitors, but the effect is expected to minimal. Adverse effects due to seasonal closures of selected areas on North Monomoy Island and South Monomoy are expected to be minimal, as described under alternative A.

Implementing a wilderness access permit may also reduce the number of visitors accessing North Monomoy Island or South Monomoy. However, the permit would be easy to obtain and we do not expect any substantial effects following implementation.

Public Use Opportunities—Under alternative B, dogs would not be allowed anywhere on the refuge, including Morris Island and Nauset/South Beach. In addition, beach sports, grilling, and shade tents would no longer be permitted on the refuge, including North Monomoy Island and South Monomoy Island. Dog and pet walking is not a wildlife-dependent activity and is not considered appropriate on the refuge. There may be a slight reduction in the number of visitors (particularly repeat visitors who are primarily on the refuge to walk their dogs). This would inconvenience and anger some refuge visitors, but we believe the overall impact would be minor, as there are other areas in the vicinity of the refuge available for dog walking where dogs are allowed. Furthermore, the benefits associated with prohibiting this use on the refuge outweigh any adverse effects caused by discontinuing the use. Some visitors may be upset that some beach use activities would not be allowed, but others will appreciate that this restriction will result in less disturbance to wildlife and will improve the quality of the visitor engaged in wildlife-dependent activities.

Proposed Infrastructure—As we state in chapter 3, we propose to expand our facilities for environmental education and visitor services programs and make incremental progress in constructing new interpretation and information signs on the refuge. We predict that constructing these facilities would increase public awareness of, and visitation to, the refuge and would enable staff to provide better visitor service.

Constructing new interpretive and informational signs would provide opportunities for providing a conservation message to visitors, increasing their awareness, and possibly, their support of the refuge. The addition of a visitor contact station in the local community would further increase the effectiveness of an expanded visitor services program, as well as improve the refuge's exposure to new visitors who would receive information about the refuge.

We would expect a certain level of inconvenience during the construction of refuge facilities. Our use of practices that alert and safeguard refuge visitors should mitigate those effects somewhat. The adverse effects generally are short-term, and more than offset by the long-term gains in public education and appreciation.

Wildlife Observation and Photography—Wildlife observation and photography opportunities would increase under this alternative with installation of a critter cam, designated photography locations, and a concession-based operation that would provide interpretative natural and cultural history tours. We would also work to better orient, inform, and guide the visiting public, and help create a more fulfilling wildlife observation and photography experience through a variety of means, including additional roving interpreters, and trailheads. Opportunities for commercial photographers might be reduced, since we would ensure there is a direct benefit to the Service before issuing a special use permit. However,

amateur nature photographers would directly benefit from construction of an additional viewing platform or photography blind on Morris Island.

Environmental Education, Interpretation, and Outreach—Alternative B offers the greatest expansion of our environmental education and interpretive programs. Expanded programs would include developing formal programs of study to meet State and Federal education standards. This would enable more school groups to be accommodated and would likely result in a larger component of the regional population becoming aware of the refuge, its limited and vulnerable natural resources, and the need to protect Federal trust resources.

Opportunities for interpretation would also be increased and improved compared to alternative A. Alternative B would provide greater protection of beach, coastal dune, and intertidal habitats in balance with expanded opportunities for the five priority public uses. Expanded opportunities for the priority public uses, with an emphasis on wildlife observation and interpretation would be provided through a more coordinated Friends program, expanded refuge tours via a concessionaire, seasonal interpretive programs, and interpretive materials.

The visitor contact station interpretive materials would be redesigned using a formal storyline and professionally designed exhibits. These would be designed to be used in either the existing visitor contact station or a new, offsite center. We would place informational kiosks with current information on refuge mission, rules and regulations, and the Monomoy wilderness on Morris Island, and develop a self-guided interpretive brochure for the trail from Powder Hole to the Monomoy Point Light Station. A visitor contact station in Chatham or Harwich would provide additional opportunities for interpretation. We expect these actions to have an overall positive effect by increasing public understanding and awareness of the Service and refuge, and the need to protect habitats and wildlife.

More opportunities exist to provide public education and information for visitors. Those opportunities would foster more public understanding and appreciation of resource issues and needs, which could lead to increased support and funding, and positively affect fish and wildlife resources on the refuge. Increased outreach could also positively affect land use decisions by local governments and private landowners outside the refuge, leading to increased populations of fish and wildlife over a broader area.

Fishing and Shellfishing—The fishing impacts described for open water are the same as those described under "Impacts on Public Use and Access Common to All Alternatives." We would officially open the ponds on the South Monomoy to freshwater fishing during daylight hours. Under alternative B, fishing in the intertidal area, the refuge shoreline, or from refuge ponds may be affected by small expansions to existing seasonal closures to protect wildlife (e.g., shorebirds, waterbirds, seals, and horseshoe crabs).

Under alternative B, we will require commercial fishing guides to obtain a special use permit to ensure high quality opportunities are offered. The refuge expects these guides would help increase quality fishing opportunities for less experienced anglers by ensuring an added level of safety in a remote, exposed, and occasionally dangerous area. We would also conduct an annual fishing event to raise awareness of this recreational activity on the refuge and further help promote the Refuge System and Service.

Alternative B proposes to prohibit the harvest of shellfish that grow above the sediment line except for the recreational harvest of scallops using hand harvest methods only. We would allow only the harvest of subterranean species of shellfish (e.g., softshell clams, quahogs, and razor clams) and only using hand tools and no other artificial means, such as salt or chlorine. Mussels would not be allowed to be harvested. We would prohibit the activity of mechanical harvesting, (e.g., dredging) any where on the refuge.

Within the Monomoy wilderness, we would also prohibit the use of carts or any equipment with wheels. This restriction on the use of carts to move clams from harvest sites to boats would result in some clammers avoiding the refuge. In alternative B, we also take a more proactive approach to minimizing disturbance to migrating and staging birds on the intertidal flat which might affect access for shellfishing. We would conduct outreach and education to visitors to explain the sensitivity of the area and the need for active management. We would also more closely monitor the potential impacts of harvest levels and, should it be necessary, implement additional regulations that protect species and habitats of concern. We would obtain harvest records from the Town of Chatham Shellfish Warden and work more closely with the town and State to promote and ensure sustainability of the shellfish resource within the refuge. While the same areas are open to scallop harvesting under alternatives A and B, we would only allow hand harvesting of scallops under alternative B. This would eliminate opportunities for people who harvest scallops by other methods.

Waterfowl Hunting—Alternative B would be open to waterfowl hunting. This use would only occur in designated areas within the declaration of taking (open water boundary) and certain portions of the western shoreline of North Monomoy Island and South Monomoy, including Minimoy. Commercial waterfowl guides would be required to obtain a special use permit from the refuge prior to taking clients hunting on the refuge. The number of permits would be based on the refuge area, and permits are intended to minimize conflicts between users. If we receive comments or complaints about user conflicts, we would investigate and adjust refuge programs as needed.

Impacts on Public Use and Access of Alternative C (Natural Processes)

Benefits

Demand and Access—Alternative C would decrease opportunities for wildlife-dependent public use and access from both alternatives A and B. Under this alternative, we would no longer allow motorized transportation in the wilderness area, including intertidal waters. We would establish a concessionaire to provide non-motorized access to the refuge. Not allowing personal motor boats, nor commercially guided motorized watercraft within refuge wilderness waters, which includes the tidal waters out to mean low tide, would severely limit the public's access to North Monomoy Island and South Monomoy. This could adversely impact the relationship of the Service with the local community over the long term, though it might provide a new business opportunity for some entrepreneurs.

We anticipate that wilderness enthusiasts would benefit the most under this alternative. There would be significantly greater opportunities to experience the solitude of the Monomoy wilderness, since we expect that fewer individuals would engage in non-motorized access to the refuge. Impacts would be similar to those in alternative B if we choose to implement a wilderness access pass.

Implementing an entrance fee system may deter some visitors, but the effect is expected to be minimal. Impacts from seasonal closures are previously discussed.

Proposed Infrastructure—Impacts from proposed construction would be similar to those in alternative B.

Fishing and Shellfishing—Impacts would be the same as those under alternative B, except that we would eliminate the use of motorboats in the intertidal waters of the Monomoy Wilderness. This restriction would reduce the numbers of anglers fishing on or from the refuge shoreline, and could potentially push more anglers to Morris Island and its nearshore waters where motorboats would still be allowed. The restriction on motorboats would not impact fishing and shellfishing occurring in the open, subtidal waters above submerged lands, as these waters are outside designated wilderness. With regard to shellfishing,

the prohibition on the use of motorboats within the refuge wilderness, including the intertidal waters, would result in less shellfishing on the refuge, at least on the north and west sides of the Monomoy Islands. Similar to alternative B, wheeled carts would not be allowed in the wilderness area. However, without motorboats, clammers would need to walk further and transport their harvest by non-mechanized means to their boats, which would likely be anchored just off the flats in shallow, subtidal (nonwilderness) waters. This would increase competition for harvestable shellfish in other Chatham waters, and reduce harvests for some Chatham shellfish harvesters unless they can find alternate harvest locations.

Wildlife Observation and Photography—Wildlife observation and photography would be the same as in alternative B; however, access to these opportunities would be limited with the discontinuation of ferry services to the refuge.

Environmental Education, Interpretation, and Outreach—Impacts would be similar to those discussed in alternative B.

Waterfowl Hunting—Impacts would be the same as those under alternative B.

Effects on Socioeconomic Resources

In analyzing the socioeconomic consequences of the actions under the three alternatives, we evaluated our refuge revenue sharing, refuge visitor expenditures in the local economy, and refuge staff and work-related expenditures in the local economy.

Socioeconomic Impacts Common to All Alternatives

Under provisions of the Refuge Revenue Sharing Act, local towns receive an annual payment for lands that have been purchased in full fee simple acquisition by the Service. In Massachusetts, the payments are based on three-quarters of 1 percent of the appraised market value. The exact amount of the annual payment depends on the congressional appropriation, which in recent years have tended to be less than the amount to fully fund the authorized level of payments. For the 2011 fiscal year, the payment to the Town of Chatham was $22,533. The Service is not proposing any new fee simple acquisition, but the level of refuge revenue sharing will rise with increased land ownership in Chatham. We do not expect any major changes in the level of revenue sharing payments, unless Congress changes its annual appropriation for revenue sharing.

In the sections under each of the alternatives, the effects of visitors, commercial activities associated with the refuge, and refuge expenditures on the socioeconomic environment are assessed. For the purposes of this draft CCP/EIS, actual differences in dollars generated and lost under each of the alternative were not estimated, and only relative impacts were compared.

Wilderness Management
The socioeconomic impacts of designated wilderness areas include direct use benefits, such as recreation, community quality of life; scientific benefits, such as research and education; offsite benefits, such as increased property values; biodiversity conservation; ecological services; and passive benefits, such as conserving wild lands for future generations (Philips 2004). Often, there is general misunderstanding of the types of recreation and activities that can occur on Federal lands. These concerns and issues would be addressed in environmental education and interpretation programs about the refuge's wilderness management program. Furthermore, wilderness management activities proposed under all alternatives would have some direct beneficial impact on the socioeconomic environment of the region, as this would ensure that no development could occur on South Monomoy.

Impacts on Socioeconomic Resources of Alternative A (Current Management)

Refuge Visitor Expenditures—Refuge visitors benefit the local economy through their expenditures. Currently, about 33,000 visitors annually come to the refuge. They would continue to contribute to the local economy through consumption of goods and services, equipment rentals, and other expenditures associated

with recreational opportunities made available on the refuge. Total direct expenditures associated with refuge visits in the year 2012 accounted for more than $1 million in sales and services to the local economy. Over 95 percent of the stimulus came from non-resident expenditures. Non-consumptive activities, such as wildlife observation and beach recreation, accounted for about 85 percent of refuge activity expenditures.

Table 4.6 summarizes the total economic impact to the regional economy from expenditures related to the visitation at Monomoy NWR in 2012. The table shows that the grand total impact to the region in 2012 was over $1.5 million (Maillett 2013). These expenditures created approximately 15 jobs with an average salary of about $33,500. More than $250,000 was generated in tax revenues. General beach recreational visits accounted for the majority of the economic contributions.

Table 4.6. Total Economic Impacts of Refuge Visitation Expenditures to Monomoy NWR in 2012.

Activity	Resident Daily Expenditures	Non-Resident Daily Expenditures	Total Resident Expenditures	Final Demand	Jobs	Job Income	Tax Revenue
Consumptive Use							
Fishing: Saltwater	$11,181	$88,765	$99,946	$141,572	1.4	$47,696	$23,700
Non-Consumptive Use							
Visitor Contact Station	$6,566	$283,952	$290,518	$415,979	4.2	$139,809	$69,525
Wildlife Observation	$4,403	$190,389	$194,792	$278,913	2.8	$93,742	$46,616
Beach/Water Use	$11,170	$483,045	$494,215	$707,642	7.1	$237,836	$118,272
Total	**$33,320**	**$1,046,151**	**$1,079,471**	**$1,544,106**	**15.5**	**$519,083**	**$258,112**

Source: Division of Economics, U.S. Fish and Wildlife Service, February 2013 (Maillett 2013).

Refuge Administration—Alternative A maintains the current work force of three full-time employees. Refuge projects and base salaries would total approximately $180,000 annually. Recurring costs associated with salaries and annually completed refuge projects would total approximately $86,000 per year, and some percentage of this would be spent in the surrounding area.

The energy efficiency improvements made in 2011 at the refuge headquarters and dormitory helped to stimulate local employment and contribute to the economic recovery using funding provided under the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

Refuge Revenue Sharing—In fiscal year 2011, the Town of Chatham received about $22,500 in sharing monies. The refuge revenue sharing program (RRS) is one of two programs that distribute revenue to local governments hosting national wildlife refuges.[2] Revenue is funded by money earning operations on refuges, such as gas wells, haying, or timber harvesting, and congressional appropriations. The Refuge Revenue Sharing Act (16 U.S.C. § 715s) seeks to reimburse, "those units of local government which have incurred the loss or reduction of real property tax revenues by reason of the existence of" Fish and Wildlife Service units. The formula for the reimbursement amount is based on the number of acres of Service land in the local government unit.

[2] The payment in lieu of taxes program (PILT) is the other program and applies to Federal lands managed by several different agencies that are not subject to local property taxes. It is funded by an appropriation and operated by the Department of the Interior.

Impacts on Socioeconomic Resources of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))

Refuge Visitor Expenditures—In 2012, the refuge reported the total number of visitors to be 33,150. With an increase in visitation of 25 percent, the refuge could expect to see an additional 8,288 visitors, increasing total visitation to 41,438. Assuming that the increase in visitation is proportional among the types of visitor activities (e.g., fishing, wildlife observation, and general recreation), the expected total amount of direct expenditures associated with these visits would increase to $1.35 million, compared to the estimate 2012 direct expenditures of $1.08 million (Maillett 2013). Total expenditures (i.e., final demand) are estimated to increase to $1.93 million compared to the 2012 estimate of $1.54 million. Table 4.7 shows the breakdown of direct expenditures, final demand, jobs, job incomes, and tax revenues affiliated with a total visitation of 41,438 to the refuge.

Under this objective, the Service intends to develop and implement a recreational entrance fee program and require paid parking at the Morris Island parking lot. While both entrance fees and parking fees have yet to be established, the Service is intending for the parking fees to be required during the peak visitation season of June 1st through September 15th. During this period, a 4-hour parking limit would be enforced on a daily basis. Because alternative B does not offer any further information regarding the pricing of entrance or parking fees, an impact of the fees and associated revenue stream to the refuge cannot be estimated at this time.

Table 4.7. Total Economic Impacts Associated with Visitation to Monomoy NWR under Alternative B.

Activity	Resident Daily Expenditures	Non-Resident Daily Expenditures	Total Resident Expenditures	Final Demand	Jobs	Job Income	Tax Revenue
Consumptive Use							
Fishing: Saltwater	$13,976	$110,956	$124,932	$176,965	1.8	$59,620	$29,624
Non-Consumptive Use							
Visitor Center	$8,208	$354,940	$363,148	$519,974	5.2	$174,761	$86,906
Wildlife Observation	$5,503	$237,987	$243,490	$348,641	3.5	$117,177	$58,270
Beach/Water Use	$13,962	$603,806	$617,768	$884,553	8.9	$297,295	$147,840
Total	**$41,650**	**$1,307,689**	**$1,349,338**	**$1,930,132**	**19.4**	**$648,853**	**$322,640**

Source: U.S. Fish and Wildlife Service Division of Economics.

We would continue to support commercial guiding on the refuge, but would have a better understanding of how many guides are operating on the refuge, including when and where they are fishing (or waterfowl hunting) and what they are harvesting. Current special use permit holders that provide ferry service would not be able to continue to operate on the refuge, including the Monomoy Island Ferry, which operates out of the refuge headquarters. These local businesses as well as other individuals or organizations would be eligible to compete for a concessionaire permit, which could seasonally employ several individuals on a part-time or full-time basis each year.

Refuge Administration—Under this alternative, the draft CCP plans to increase current staffing to 10 positions, by proposing 7 additional full-time refuge employees to meet the refuge's proposed management requirements. An additional seven full-time staff would make a small contribution to employment and income in the local community. If fully funded, recurring salary and project costs would be approximately $700,000 annually. We would also need to purchase more vehicles, boats, fuel, office furniture, and supplies to support the additional staff. Many of these purchases can be made from local businesses.

We would expand the current facilities at Morris Island (headquarters/visitor contact station, dormitory/maintenance building) through remodeling. Furthermore, we would explore opportunities for additional refuge staff onsite and offsite housing. Additionally, we would work to establish a visitor contact station in downtown Chatham or Harwich, which would include parking and a shuttle option to help increase exposure and reduce the parking issues at Morris Island. The current visitor contact station would be converted to serve predominantly administrative functions.

Impacts on Socioeconomic Resources of Alternative C (Natural Processes)

Refuge Visitor Expenditures—Alternative C has the same goal as alternative B, that is, the Service aims to increase the number of visitors by 25 percent. The economic impacts associated with a 25 percent increase in visitation over the reported 2012 number of visits would be the same as that calculated for alternative B.

Under alternative C, we would discontinue motorized ferry services to North Monomoy Island and South Monomoy. We acknowledge that this would result in the loss of revenue to the commercial entities currently providing these services under a special use permit. However, these businesses could compete for the concessionaire contract. Not allowing motorized access to the refuge would constitute a major change in the way the two current permittees operate; they would need to sell their equipment and obtain new equipment in order to provide non-motorized access to the refuge.

Alternative C also proposes to institute an entry fee that visitors must pay to enter the refuge. The entry fee proposed is $4 per car or $12 for an annual pass. The revenues from this fee would help the refuge improve visitor services. The fee would most likely be collected at the entrance to the Morris Island visitor contact station. Based on a recent survey of visitors conducted by the U.S. Geological Service, there were on average four persons in each group party visiting the refuge. Assuming that all 33,150 visitors drove into the refuge at Morris Island there would have been 8,288 vehicle trips. Again assuming that each party visited the refuge only once and paid the $4 entry fee, the total revenue collected by the refuge would be $33,150. Total revenue collection would likely be less, as a significant number of visitors visit the refuge more than once and would most likely pay for a $12 annual pass to save money. Because we lack data to estimate the number of parties visiting more than once and only have a count of total visitors, the economic analysis conservatively assumes that each visit reported is by a unique visitor visiting the refuge only once during the year.

View from the lighthouse

USFWS

Refuge Administration—Under alternative C, we would increase staffing to nine positions, by proposing six additional full-time refuge staff. This level of staffing would help ensure that the refuge could meet the objectives outlined under this alternative. Base salaries and refuge projects would be approximately $500,000 annually. We would need to acquire additional vehicles, boats, fuel, and office supplies, but less than that proposed under alternative B. Facility improvements or expansions would be the same as under alternative B.

Effects on Cultural, Historical, and Archaeological Resources

In protecting our cultural and historical resources, we are guided by specific executive orders, policies, laws, regulations, standards, and guidelines. We would comply with all appropriate legal mandates in our efforts to protect and manage the cultural resources on the refuge. Our actions that have the potential to affect archaeological and historic sites are routinely reviewed and assessed under provisions of section 106 of the National Historic Preservation Act. The most recent project requiring such review on the refuge was the rehabilitation and renovation of the historic Monomoy Point Light Station.

It is probable that unrecorded coastal archaeological sites exist on current refuge lands. Many of these are likely to include shipwrecks or Native American artifacts.

Chapter 2, Refuge Archaeological, Historical, and Cultural Resources describes in more detail the refuge's two Native American sites and 12 historic sites. Despite the presence of 14 known archaeological sites, there has been no comprehensive, professional cultural resources overview of Monomoy NWR. The likelihood of locating additional prehistoric or historic sites on the refuge is high, both due to the history of human settlement and land use on the refuge lands, and from tidal drift.

Impacts on Cultural, Historic, and Archaeological Resources Common to All Alternatives

Regardless of which alternative we select, we would protect known cultural, archaeological, and historical resources. We would continue our outreach and education and use of law enforcement, if necessary, to protect against the loss of or damage to those resources.

In all the alternatives, we would conduct evaluations before implementing any activity with the potential to affect these resources. Those evaluations would provide additional information to share in outreach and education programs.

The Service recognizes the importance of continued compliance with the National Historic Preservation Act and other Federal laws and mandates that guide the protection of these resources to ensure that known sites are protected and any sites that are found in the course of refuge management and public use are properly addressed. While no adverse impacts to cultural or historic resources are anticipated as a result of this CCP process, we will send this draft CCP/EIS to the State Historic Preservation Officer for review in compliance with section 106 of the National Historic Preservation Act. Regardless of which alternative is selected, we will consult with our regional archaeologist(s), State Historic Preservation Officer, and Tribal Historic Preservation Officer as needed to ensure compliance with National Historic Preservation Act and other applicable laws and regulations. In particular, we would continue to consult with the State Historic Preservation Officer and regional archaeologist(s) prior to conducting any ground-disturbing activities.

Refuge lands are vulnerable to artifact looting, despite our best efforts at outreach, education, and law enforcement. Refuge visitors may inadvertently or even intentionally damage or disturb known or undiscovered cultural artifacts or historic properties. We would continue our vigilance in looking for this problem, and use law enforcement where necessary. However, we also recognize we may not discover every incident. Erosion, especially along cliffs and dune beaches,

and sea level rise, are continual threats to cultural and archaeological resources on the refuge. We will promote awareness of the Archaeological Resources Protection Act and the prohibition against vandalism and removal of cultural artifacts from Federal land.

Impacts on Cultural, Historic, and Archaeological Resources of Alternative A (Current Management)

Under alternative A we would follow Service protocol to prevent the loss of cultural, historic, and archaeological resources, record items or sites as they are encountered, and comply with the provisions of the National Historic Preservation Act. We would also maintain the historic Monomoy Point Light Station. Maintenance and repairs to the light station and associated structures would help preserve those historical resources from weather damage. This alternative would not increase our knowledge of the history of the island per se; however, it would minimally ensure some action is taken to preserve what cultural resources exist on the refuge in compliance with Federal mandates.

Refuge activities have the potential to impact cultural resources either by direct disturbance during habitat and species management projects or maintenance and repair of facilities related to public use or administration and operations. Indirect impacts may occur by exposing artifacts during actions such as managing for early successional habitats or prescribed burning. Although the presence of a cultural resource in and of itself cannot stop a Federal undertaking, all undertakings are subject to section 106 of the National Historic Preservation Act and, at times, other laws. We would work to ensure compliance with section 106 during all stages of an undertaking, from planning and design through construction, to ensure the avoidance, preservation, and appropriate management of significant cultural resources.

We currently lack staff with training in the Archaeological Resources Protection Act and National Historic Preservation Act, or a refugewide cultural resources overview, cultural resources plan, and partnerships to cooperatively protect resources; this prevents us from being fully proactive in evaluating and protecting sites. Also, the limited law enforcement staff under this alternative would not allow us to adequately prevent or address Archaeological Resources Protection Act violations. We would continue to be unable to adequately maintain our historic structures, specifically the Monomoy Point Light Station, due to funding and limited staff, and probably could not address future maintenance and stabilization requirements. Increased information on the distribution and types of archaeological resources would help us better protect these sites. The light station would benefit from installation of a renewable (solar) electric-powered radiant heating system that would maintain the interior temperature and humidity levels during the winter season and help preserve the structural integrity and historical appearance of the wood-frame lightkeeper's house.

Impacts on Cultural, Historic, and Archaeological Resources of Alternative B (Enhanced Management of Habitat and Public Uses (Service-preferred))

The benefits for cultural and historic resources would increase in alternative B, because we would complete a cultural resources overview, maintain an inventory of known and newly found sites and structures, develop a cultural resources management plan, conduct archaeological surveys to determine the limits and integrity of the Whitewash Village archaeological site complex on South Monomoy, and assess the condition of the two known Native American sites on Morris Island.

This alternative would allow us to make an important, positive contribution toward meeting our cultural resource public trust responsibilities. We would have sufficient resources to survey, map, catalog, monitor, and protect archaeological and historic resources. We would establish a protocol with the Massachusetts Board of Underwater Archaeological Resources for the examination and assessment of historic shipwreck remains that may appear within or near the refuge's Declaration of Taking. The historic lighthouse would benefit from improvements to the interior structure that would reinforce it against the

destructive natural forces present on the island. The installation of solar panels would support a functional heating and ventilation system to preserve the historic structure against temperature and moisture damage.

Archaeological resources are best protected under this alternative, and cultural resources and important elements of Monomoy's heritage are best preserved and understood under this alternative. However, the risk of impacts seen in alternative A actually could be greater in alternative B, because of the increased acreage in active management. As in alternative A, we would conduct site assessments and surveys in consultation with our Regional Historic Preservation Officer prior to any ground-disturbing activity. In addition, we would notify our Regional Historic Preservation Officer immediately if we encountered unanticipated cultural materials or features during construction of any project.

Impacts on Cultural, Historic, and Archaeological Resources of Alternative C (Natural Processes)

In addition to the actions mentioned in alternative A, this alternative provides a moderate level of cultural resource protection from the effects of erosion. Under this alternative we would only conduct routine maintenance and repair of the Monomoy Light Station. If erosion poses an imminent threat to the site of the Monomoy Point Light Station in the next 15 years, we would develop a mitigation plan for the light station to implement an interpretive program of exhibits, documentary research, archaeological investigation, and possible relocation of structures, prior to the destruction of this National Register site by natural forces. We would conduct the cultural survey to thoroughly document the historical value of the resource in order to mitigate the effects of this action.

Adverse impacts to cultural and historic resources have the potential to be reduced under alternative C than under alternatives A and B. The natural processes habitat management approach in alternative C would result in less manipulation of refuge habitats, particularly in managing for early successional habitats, conducting wildlife projects, and prescribed burning.

Cumulative Impacts

According to the CEQ regulations on implementing NEPA (40 CFR 1508.7), a cumulative impact is the impact on the environment that 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 other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time. This cumulative impacts assessment includes the actions of other agencies or organizations, if they are interrelated and influence the same environment. Therefore, this analysis considers the interaction of activities at the refuge with other actions occurring over a larger spatial and temporal frame of reference. Potential impacts for the proposed alternatives are described below.

Air Quality

None of the proposed alternatives are expected to have significant cumulative adverse impacts on air quality in coastal Massachusetts or elsewhere in the region. Some short-term, local deterioration in air quality would be expected from management-ignited prescribed burns and from refuge visitors' automobile emissions. However, prescribed burns would only occur under the stipulations of the fire management plan (refer to appendix F); these stipulations are specifically designed to minimize air quality impacts. Further, while visitors would primarily access the refuge by automobile or motorized boat, most would drive less than 50 miles. Most of these visitors are already in the area on vacation and seek out the refuge for day trips. Monomoy refuge is rarely the primary destination for Cape Cod visitors; the presence of the refuge should only be accountable for a very small percentage of vehicle emissions generated in this area.

Some areas in Massachusetts periodically experience high ozone levels (MA DEP 2007); however, the coastal location of the refuge ensures relatively good local air quality. Although the refuge would continue to use prescribed fires for

maintaining grassland and maritime shrubland habitats, we anticipate that air quality impacts associated with those actions would be temporary and localized. The cumulative impacts of prescribed burning throughout a region may be short term and moderate (Zeng et al. 2008); the temporary and periodic nature of the proposed fire regime on Monomoy, coupled with its isolated location, minimizes any contribution to potential cumulative effects in the region.

Similarly, occasional herbicidal applications to refuge habitats are for the most part applied through backpack sprayers and are very target specific. This type of application would not be anticipated to have any impacts to air quality, as they would be directly applied to the target plants.

While wilderness designation may not essentially alter habitat management activities, it could potentially reprioritize management methods. This designation would create no adverse impacts, and may provide slight benefits to local and regional air quality through wilderness policy compliance.

We expect none of the activities on the refuge to contribute to any measurable incremental increase in ozone levels or other negative air quality parameters. We expect none of the alternatives to cause any greater than negligible cumulative adverse impacts on air quality locally or regionally.

Water Quality and Soils

None of the alternatives would produce significant adverse cumulative impacts on water quality or soils. We would continue to use best management practices and measures to control erosion and sediments in habitat management activities and any ground-disturbing operations to ensure impacts are minimal.

Monomoy NWR is exposed to the natural coastal processes of accretion and erosion, the deposition and removal, of sand along shorelines. Sand that is eroded, or removed, from one beach will be transported downdrift and will accrete, or be added, on another. These processes are influenced by many factors, which include currents, tides, winds, sea floor bathymetry, and human modifications. The dynamic nature of these systems means that the same beach can both accrete and erode seasonally within a given year, and can fluctuate between accretion and erosion over long periods of time. These movements of sand provide changing coastlines and habitats for many species of wildlife. The coastal dunes and barrier beaches are important in storm damage prevention and flood control. Working collaboratively to maintain this dynamic system is important in achieving cumulative benefits to water quality and soils.

Management actions would also respond to address climate change and sea level rise cumulative impacts on the physical environment. All three alternatives include beach nourishment of the eroding strip of U.S. land on the eastern shore of Morris Island, and alternatives A and B would evaluate the appropriateness of using dredge material from ongoing non-refuge projects or other habitat alteration techniques in non-wilderness areas to protect habitats from the effects of erosion and sea level rise.

In varying degrees, all the alternatives emphasize maintaining the biological integrity, diversity, and environmental health of lands within the refuge boundaries, which also contributes to conserving a scenic landscape.

Monomoy NWR is primarily surrounded by the Atlantic Ocean. The only source of fresh water on the island is from precipitation and infiltration. The waters immediately surrounding the refuge, in particular the Outer Cape Cod region, are designated as a No Discharge Area. Boats may not discharge any sewage, treated or otherwise, in these waters immediately adjacent to Monomoy refuge, to protect this ecologically and recreationally important area. Enforcing this restriction will continue to be important to protect quality of nearshore waters.

Alternative C would provide the greatest benefit to improving water quality within refuge waters by not allowing the use of motorized watercraft, thereby reducing the likelihood of catastrophic spills.

The greatest present adverse impacts on refuge soils occur from prescribed burns and invasive plant control. We would continue to use best management practices when maintaining or setting back succession in dune grassland and shrubland habitats, prescribed burning, or when selecting various chemical, biological, or mechanical methods to ensure cumulative beneficial impacts for soils. Under all alternatives, where we remove invasive plant species and restore native plant communities, we expect to also improve nutrient recycling, restore native soil biota, and soil fertility.

Biological Resources

All the alternatives would maintain or improve Service trust resources and biological integrity, diversity, and environmental health on the refuge and in the region, although to varying degrees.

All alternatives would strive to maintain or improve biological resources on the refuge. Key partners and nearby landowners, including the National Park Service, Massachusetts Natural Heritage and Endangered Species Program, and Massachusetts Audubon Society, also manage coastal habitats for wildlife conservation and recreation in compliance with Federal and State threatened and endangered species laws. The combination of our management actions with those of our key partners would result in beneficial cumulative effects by:

- Maintaining or increasing protection and management for federally listed and State-listed threatened and endangered species, and other species of high conservation concern.
- Improving coastal habitats that are regionally declining including reducing invasive, nonnative plants and animals.
- Increasing understanding of species and habitat relationships and limiting factors to conservation recovery.
- Using adaptive management and the best science available to manage and promote regionally important habitats and natural communities.

Additional information will facilitate structured decision-making with wide-ranging cumulative benefits for bird and wildlife populations. Collecting data about wildlife and vegetative populations and their response to conservation and wildlife management actions, plus enhancing monitoring studies, would add to the body of knowledge the Service will collect. Sharing this knowledge with other conservation partners would influence and improve natural resource decision-making, with cumulative benefits on the biological environment over a broader landscape.

In general, habitat and wildlife management would have considerable beneficial cumulative impacts on the environment, as we expect to contribute to biological integrity, diversity, and environmental health of coastal resources, which would support breeding and migrating shorebirds, nesting and staging terns, breeding and migrating land bird and waterbird species.

Native plant management, which includes a natural fire regime, cumulatively benefits the biological environment by increasing and enhancing healthy soil biota, restoring and enhancing native plant resources, increasing resident wildlife populations of mammals, fish, reptiles, and amphibians, and enhancing invertebrate production to sustain and perpetuate migratory bird resources.

Under each alternative, we would continue to allow activities that result in the direct loss of individual wildlife (fin and shell fishing); alternatives B and C would be open to a waterfowl hunt. While fishing falls under the priority public use category, we use temporary seasonal closures to ensure that non-target wildlife species are not significantly impacted. Another common concern is the reduction or alteration of the prey base important to fish and marine invertebrate-eating wildlife; however, State regulations address this concern to ensure that harvest levels do not cumulatively impact native fish resources to the point they are no longer self-sustainable.

Piping plover

Gene Niemien/USFWS

While a wilderness designation may not essentially alter habitat management activities, it would potentially reprioritize or pose more specific guidelines on management methods. Cumulative impacts from research activities are not expected but could occur if multiple research projects were occurring on the same resources at the same time or if the duration of the research was excessive.

Service staff recognize that all uses of refuge lands create some impact on refuge wildlife and their habitats. Those refuge uses, taken together, have the potential to accumulate impacts as the number of uses increases. Because of that potential, refuge uses are limited to those we have formally determined to be compatible with the purposes for which the refuge was established and the mission of the Refuge System. The refuge acknowledges that increasing public use could cumulatively impact biological resources and contribute to habitat degradation in the off-trail use zone where consumptive and non-consumptive use areas overlap. These uses that take place within the same general timeframe create an overall greater zone of disturbance than either use taken individually. When we review those formal compatibility determinations (every 10 to 15 years), we would consider possible accumulating affects that may have occurred in succeeding years, and would address them as necessary. We do not expect alternatives A, B, or C, to have major cumulative impacts.

Public Use

All alternatives with respect to public use would have cumulative impacts on biological resources because we expect the demand for all types of wildlife recreation would grow on the refuge as the amount of natural habitats and open space decreases off-refuge from increasing development pressures while the amount of refuge space and natural resources would remain relatively constant. The management objectives presented in alternatives B and C are our attempts to strike a feasible balance to ensure the refuge will remain a destination of choice for wildlife and people, while also protecting the biological environment for the long term and promoting wilderness character.

Three of the public use programs we offer, fin fishing, shell fishing, and waterfowl hunting, result in the direct loss of individual wildlife. We describe the site-specific impacts of our fishing and proposed hunting programs earlier in this chapter and in appendix D, Findings of Appropriateness and Compatibility Determinations. We would also complete a fishing plan and hunt plan that include an evaluation of cumulative effects. Based on current and anticipated levels of use, we do not think those programs have a significant cumulative effect on the respective populations of the wildlife species harvested.

Fin fishing and shellfishing seasons and limits are established by the State of Massachusetts and Town of Chatham, respectively, and adopted by the refuge. These restrictions ensure the continued well-being of overall populations of fin fish and shellfish. Fishing results in the taking of individuals within the overall

population, but restrictions are designed to safeguard adequate population and recruitment from year to year. Specific refuge regulations address equity and quality of opportunity for anglers, and help safeguard refuge habitat. Disturbance to other fish and wildlife does occur, but this disturbance is generally short-term and adequate habitat occurs in adjacent areas. Loss of plants or increases in water turbidity from boat motors is probably minor, or temporary, and is generally not concentrated since fishing pressure is well distributed.

Alternatives B and C would propose to open the refuge to waterfowl hunting. We will develop this in detail over the next 5 years, and conduct additional analysis and public review once details are available. We do not have enough detailed information to include them in this cumulative effects analysis.

We do not anticipate any significant cumulative effects on biological resources from other wildlife-dependent recreational activities, when those activities are conducted in accordance with refuge-established seasonal closures and regulations. Impacts caused by these activities can be found earlier in this chapter.

Socioeconomic Environment

We expect none of the three proposed alternatives to have a significant adverse cumulative impact on the overall economy of local towns or the county in which the refuge lies. We do not expect that any of the actions proposed under the alternatives, including fin fishing, would alter the demographic or economic characteristics of the local community. However, restrictions on fishing which results in disturbance of eelgrass beds or otherwise disturbs the sea bottom or involves the extraction of shellfish using motorized equipment or artificial means such as salt or chlorine proposed under this alternative would directly impact people engaged in these activities. The fish weir that is sometimes located within the Declaration of Taking area would not be allowed if the installation of that weir results in bottom disturbance. The actions we propose could impact the Town of Chatham's efforts to sustain a local fishing industry and have a financial impact on some individuals. While current conditions are not conducive to large-scale softshell clam harvest on the refuge, future conditions could be more favorable. In that case, if alternative C were selected, there would be a potentially significant impact on the softshell clam community if clammers decided that complying with wilderness regulations (no motorboats and no carts) imposed too much of a hardship and exited the fishery. This could damage or undermine fishing- related businesses or community organizations. All the alternatives would maintain the beauty and aesthetics of the refuge's natural landscape, enhance biological resources available for consumption, and provide wildlife experiences that promote a pleasurable quality of life for humans. All the alternatives could benefit the town through revenues generated directly or indirectly as a result of ecotourism visitation.

These varying alternatives would have cumulative impacts, because we expect the demand for nearly all recreation to grow while the amount of refuge space and natural resources stays relatively constant. In alternative A, current uses would continue without much change. Alternative B attempts to strike a reasonable balance to ensure the refuge remains a destination of choice for both wildlife and people. If successful, that integrated approach may prove more sustainable, with more positive, long-term impacts on natural resources on the refuge, and social and economic impacts on the communities beyond. Alternative C strikes a balance between the needs of wildlife and the public, with fewer staff providing fewer public use opportunities while reducing active management of refuge habitats.

Our working relationships with private landowners and others should improve in terms of responsiveness to inquiries and speed of joint projects under alternative B. That improvement mainly would result from increased staffing in key areas such as biology, public use, and maintenance. The overall coordination and communication with the public should improve under alternative B, because a new staff position would provide for enhanced visitor use and public information. Because some may oppose changes in one or more of the alternatives, or support them, the cumulative impact on the public perception of the refuge and the Service could be negative or positive.

Various objectives in alternatives B and C would have varying degrees of impact on the recreational use of the refuge. More emphasis on public education, outreach activities, and information in alternative B should foster greater understanding and appreciation of resource issues and needs, leading to increased support and funding, which would positively affect bird and wildlife resources on the refuge. The increased outreach of these alternatives could also positively affect land use decisions outside the refuge by local governments and private landowners, and lead to increased bird, fish, and wildlife populations over a broader area. There would be minor benefits affiliated with revenue sharing payments, refuge spending, and promoting ecotourism opportunities under alternative B. Fully funding the additional staff in alternatives B and C would also make a small, incremental contribution to employment and income in the local community.

Cultural, Historic, and Archaeological Resources

As stated previously in this chapter, we would comply with all applicable State and Federal laws and mandates protecting cultural and historic resources on the refuge. All the activities proposed in this document would comply with section 106 of the National Historic Preservation Act and other applicable regulations in order to avoid or minimize impacts to significant cultural resources. For these reasons, no cumulative impacts are expected.

Climate Change

Department of the Interior Secretarial Order 3226 (January 16, 2009) 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, this Secretarial Order calls for incorporating climate change considerations into long-term planning documents, such as this CCP.

To help meet the climate change challenge, the Service drafted a climate change strategic plan (USFWS 2009). The plan employs three key strategies to address climate change, adaptation, mitigation, and engagement, defined as follows:

- Adaptation: Minimizing the impact of climate change on fish and wildlife through the application of cutting-edge science in managing species and habitats.
- Mitigation: Reducing levels of greenhouse gases in the Earth's atmosphere.
- Engagement: Joining forces with others to seek solutions to the challenges and threats to fish and wildlife conservation posed by climate change.

The Association of Fish and Wildlife Agencies developed guidance for states as they update and implement their respective wildlife action plans (AFWA 2009). This publication, *Voluntary Guidance for States to Incorporate Climate Change into State Wildlife Action Plans and Other Management Plans*, also includes strategies that will help conserve fish and wildlife species, their habitats, and broader ecosystems as climate conditions change. The broad spatial and temporal

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Seals on South Monomoy

scales associated with climate change suggest that management efforts that are coordinated on at least the regional scale would likely lead to greater success.

Our review of proposed actions in this CCP suggests that two activities may contribute negligibly to stressors affecting regional climate change: our prescribed burn program, and our use of vehicles and equipment for refuge management and administration. We discuss the direct and indirect impacts of these activities elsewhere in chapter 4; we also discuss measures to minimize the impacts of both. 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, driving hybrid vehicles, and using recycled or recyclable materials, along with reduced travel and other conservation measures. Alternative C outlines the most aggressive measures for addressing climate change by minimizing our carbon footprint and greenhouse gas emissions from management activities and maximizing resiliency of natural communities. In our professional judgment, most of the management actions we propose would not exacerbate climate change in the region or the refuge area.

The Service is taking a major role among Federal agencies in distributing and interpreting information on climate change. There is a Web site dedicated to this issue at: *http://www.fws.gov/home/climatechange/* (accessed February 2013), which links to the Service's recently released *Strategic Plan for Climate Change*. The strategic plan includes two key elements: landscape conservation cooperatives and a national Fish and Wildlife climate adaptation strategy. Both elements bring together conservation partners to address climate change in a concerted effort. Strategies for adapting to and mitigating climate change are included in this CCP. Specific steps taken by the refuge will help reduce our greenhouse gas emissions. These include using energy-efficient equipment and vehicles where feasible, building and maintaining structures using sustainable, green building technologies, and conducting energy audits. In addition, we will rely on the habitat and species vulnerability assessments and other climate change research developed by the Northeast Climate Impacts Assessment and the Manomet Center for Conservation Sciences.

Climate change poses significant challenges for the management of migratory species. National wildlife refuges have played a critical role in the protection of migratory birds, even as specific management activities are largely confined to the refuges themselves. Climate change is likely to have a significant impact on habitats within refuges, which underscores the importance of climate change adaptation as part of refuge management. However, climate change is also likely to pose considerable risks to many migratory species throughout their lives (Glick 2012). As Robinson et al. (2009) highlight, one reason is that the life cycle

of migrants is usually tied to seasonal events such as coastal upwelling and the availability of key food sources, the timing of which may be altered under climate change. Long-distance migratory birds may be especially vulnerable, as high-latitude regions are among the fastest warming places on earth. We will continue to monitor the red knot, which serves as a key indicator species for migratory species, to help reduce these threats.

Climate change may increase opportunities for invasive species to spread because of their adaptability to disturbance; if this spread occurs, it would decrease biological integrity and diversity on the refuge. Invasive species control, including extensive monitoring and control measures, will be essential in avoiding larger impacts. Reducing invasive species would increase the resilience of habitat and its ability to adapt to climatic change.

Refuge managers should monitor climate change and its effects on wildlife and their habitats and use this information to adjust management techniques and strategies. Given the uncertainty regarding climate change and its impacts on the environment, relying on traditional methods of management may become less effective as time goes on. We agree that an effective and well-planned monitoring program, coupled with an adaptive management approach, will be essential in dealing with the future uncertainty of climate change. We have built both aspects into our CCP. We would develop a detailed step-down inventory and monitoring plan designed to test our assumptions and management effectiveness in light of ongoing changes. With that information in hand, we will either adapt our management techniques, or re-evaluate or refine our objectives as needed.

Relationship Between Short-term Uses of the Human Environment and Enhancement of Long-term Productivity

NEPA section 102(C)(iv) (CEQ regulations part 1502.16) requires Federal agencies to disclose the relationship between local short-term uses of the human environment and the maintenance and enhancement of long-term productivity. The Service expects that the proposed alternatives would lead to long-term productivity through the life of the CCP (15 years). This discussion focuses on the tradeoffs between short-term environmental costs and long-term environmental benefits.

Under all three alternatives, our primary aim is to maintain or enhance the long-term productivity and sustainability of natural resources on the refuge, in the State of Massachusetts, and in New England and the North Atlantic region. All the alternatives strive to maintain or enhance the long-term productivity and sustainability of natural resources on the refuge and in the region, and migratory birds across all landscape scales. The alternatives strive to conserve our Federal trust species and the habitats they depend on. Outreach and environmental education are a priority in each alternative to encourage visitors to be stewards of our environment and ensure they are informed about our unique natural resources. Encouraging members of the public to support conservation efforts can ultimately lead to long-term benefits for the environment. We believe that our management actions, including controlling invasive plant species, managing for native vegetation, and enhancing habitats for conservation species such as the endangered roseate tern, threatened piping plover, and northeastern beach tiger beetle, may have short-term adverse impacts but would enhance long-term productivity of the refuge. 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.

In summary, we predict that the alternatives would contribute positively in 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 and minimal inconvenience or loss of opportunity for the American public.

Unavoidable Adverse Effects

Unavoidable adverse effects are the effects of those actions that could cause harm to the human environment and that cannot be avoided, even with mitigation measures. There would be some minor, localized unavoidable adverse effects under all the alternatives. For example, constructing a visitor contact station under alternatives B and C would produce minor, localized, adverse effects. Installing fencing, signs, and a kiosk has negligible adverse effects, which are more than offset by the benefits of protecting resources and guiding public uses. None of the identified adverse effects would rise to a considerable level, and all the actions listed would have long-term beneficial impacts. Furthermore, all those impacts would be mitigated with best management practices; our conclusion is that none of the alternatives would cause significant, unavoidable cumulative impacts.

Potential Irreversible and Irretrievable Commitments of Resources

NEPA section 102(C)(v) (CEQ regulations part 1502.16) requires Federal agencies to consider any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented.

Irreversible commitments of resources are those that cannot be reversed, except perhaps in the extreme long term or under unpredictable circumstances. An example of an irreversible commitment is an action that contributes to a species' extinction. Once extinct, it can never be replaced. No irreversible commitments of resources are predicted as a result of management activities on Monomoy refuge.

In 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 period of time. In our professional judgment, there are a few actions proposed that could be considered irretrievable; these primarily relate to the construction of new infrastructure. They are considered irretrievable because, in the future, any facility we construct could potentially be dismantled and the site restored; however, while standing, they represent a loss in habitat productivity. We could consider kiosks and alternative energy facilities irretrievable commitments of resources. However, we can dismantle those facilities and restore the sites if resource damage is occurring. The construction of an offsite visitor contact station under alternatives B and C would result in irretrievable commitment of resources; however, given the limited footprint of such a facility, coupled with the benefits from engaging the community and visitors in learning about barrier-beach ecosystems, we do not believe a significant cumulative impact would result. The loss of the Monomoy Point Light Station due to a lack of funding to conduct occasional expensive repairs, such as a roof replacement or installation of a heating supply to protect the keeper's house from the adverse effects of humidity, would be an irretrievable loss of a national historic resource.

Environmental Justice

On February 11, 1994, President Clinton signed into Executive Order No. 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. It was designed 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. Agencies are required to ensure that these potential effects are identified and addressed.

The EPA defines environmental justice as, "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 laws, regulations, and policies." In this context, fair treatment means that no group of people should bear a disproportionate share of negative environmental consequences resulting from the action.

Lastly, additional facilities proposed under alternatives B and C would be located on existing refuge lands, or newly acquired refuge lands, and are not expected

to be located in a way that would disproportionally affect minority or low-income persons.

We believe, based on our analysis of socioeconomic and environmental consequences, that none of the proposed alternatives would place a disproportionately high, adverse environmental, economic, social, or health burden on minority or low-income persons. Our programs and facilities are open to all who are willing to adhere to the established refuge rules and regulations, and we do not discriminate in our responses for technical assistance in managing private lands. The proposed parking and entrance fees may deter some low-income individuals from visiting the refuge. None of the socioeconomic and environmental impacts we have identified would be localized or focused primarily or unequally on minority and low-income communities or individuals residing near the refuge. The local town and county would experience only very minor adverse effects along with some significant beneficial effects if the refuge is managed under any of the three proposed alternatives. Adverse impacts, such as minor increases in traffic and related emissions due to increased visitation at the refuge would not disproportionately affect minority and low-income populations compared to other segments of the general population. The same is true of any negligible mobile-source air emissions from the operation of refuge equipment and vehicles. Beneficial impacts include maintaining natural vegetation that improves air and water quality; increased revenue sharing payments to the Town of Chatham to offset any property tax loses; and enhanced and free public uses of the refuge under all three alternatives.

Sunset on the refuge

Jennifer Goyette 2013

Table 4.8. Matrix of Environmental Consequences by Alternative.

Alternative A: Current Management	Alternative B: Enhanced Management of Habitat and Public Uses (Service-preferred)	Alternative C: Natural Processes
Effects on Air Quality		
Current management activities neither substantially benefit nor adversely affect local and regional air quality. Minor long-term benefits in air filtration and carbon sequestration from shrubland, grassland, and aquatic vegetation. We would continue energy efficient practices and adopt additional practices as feasible, such as hybrid vehicles. Limited ground disturbance activities and limited introduction of new emission sources would contribute to short-term, temporary impacts. Negligible adverse effects from prescribed burning on up to 35 acres every 3 years to maintain native habitats and control invasive species. Anticipated increase in annual refuge visits by motor vehicles would cause a minor increase in air emissions in the long term and contribute minimally to potential cumulative effect.	Same energy efficient practices as in alternative A, which would extend to the Monomoy Point Light Station. Additions to the Morris Island trail, infrastructure, and other proposed projects would contribute to an increase in short-term adverse effects from vehicle and equipment emissions and dust during construction. An increase in annual visitation over the next 15 years would result in more motor vehicles and therefore higher local air pollutant emission levels than in alternative A over the longer term, and would increase the potential for cumulative effects. However, implementation of alternative transportation measures would reduce emissions directly at the refuge.	Long-term benefits to improved air quality would be similar to alternative B, with a small increase as a result of allowing natural succession take place. Same energy efficient practices as in alternative A. Elimination of all motorized boat transportation within the refuge boundary would benefit air quality. Similar effects as under alternative B from proposed construction projects. Similar to alternative B in predicted vehicle emissions based on expectation of increased levels of visitation.
Effects on Climate Change		
The natural carbon sequestration occurring on refuge lands and actions to reduce emissions from vehicles and facilities would have a small, but positive effect with respect to climate change.	Similar to alternative A, except that benefits may increase if refuge pursues beach renourishment to offset impacts of sea level rise and erosion. Alternative transportation measures would also have a positive effect on climate change.	Benefits to improve climate change would be greatest under this alternative as a result of not allowing motorized transportation within the wilderness waters of the refuge.

Alternative A: Current Management	Alternative B: Enhanced Management of Habitat and Public Uses (Service-preferred)	Alternative C: Natural Processes
Effects on Water Quality		
Impacts Common to All Alternatives		
None of our proposed management activities would violate Federal or State standards for contributing pollutants to water sources; all three would comply with the Clean Water Act. We would use integrated pest management, utilizing a variety of mechanical, biological, or chemical means to control invasive species. When used appropriately, chemical products do not have direct or indirect negative impacts on water quality. We would use best management practices for any beach renourishment projects.		
Refuge-related activities that could impact water quality are oil or gas leaks from motorized boat use, refuge vehicles, or offshore boats, although the impacts to water quality are likely to be negligible from these activities. If the Monomoy Point Light Station is used to accommodate staff and visitors, there may be the potential for long-term impacts from activities such as waste disposal.	Under alternative B, invasive plant treatment would be more intense. We only use herbicides that are safe for aquatic habitats. There are higher risks of short-term adverse effects on water quality associated with renovation of existing facilities directly on the refuge and new construction of facilities offsite. Impacts from use of the light station would be the same as under alternative A. Under alternative B, there may be short-term temporary impacts from the use of dredge material.	Under alternative C, water quality impacts would be considerably lower compared with alternatives A and B since the refuge would only allow the use of nonmotorized personal watercraft within the wilderness waters in the refuge. The freshwater wetlands would be subject to natural processes, unless invasive species posed a direct threat to wetland integrity or became stand-replacing.
Effects on Soils		
Impacts Common to All Alternatives		
All three alternatives strive to maintain the dynamic nature of accretion and erosion and to adapt to the changing habitat conditions from these shifting sands. We will continue to maintain native vegetation cover on the refuge that stabilizes and minimizes soil losses through erosion. Regardless of which alternative is selected, we will continue to use best management practices, conduct all prescribed burns under a strict prescription and in optimal weather conditions, use approved herbicides to control invasive plants, and limit public use to designated areas.		
Impacts would be minor, short-term, localized soil compaction and long-term loss of productive soils where soils are removed or surfaced for installation of a wind turbine at the Morris Island headquarters, renovation projects, and an alternative energy facility at the Monomoy Point Light Station. The greatest adverse impacts to soils likely would occur under alternative A, given the level of public access and use coupled with the lack of enforcement and onsite Service presence.	Alternative B would provide more onsite Service presence; this would help restore and protect dunes by designating authorized trails and directing foot traffic away from sensitive areas. In addition to the impact on soils described under alternatives A and C, this alternative would cause some additional soil disturbance as a result of upgrading additional trail areas on Morris Island. A cultural resource overview is proposed, which may result in additional short-term soil disturbance activities. We anticipate minor, short-term impacts from the possible use of dredge material. We will follow MassDEP's Best Management Practices for Beach Nourishment to minimize any potential adverse impacts.	Under alternative C, we expect the greatest benefit to soils, as we consider limiting the number of visitors at one time in the Monomoy wilderness. We anticipate fewer visitors on the refuge under this alternative as a result of no longer allowing motorized transportation to the refuge; however, there could be increased soil compaction from the number of individuals hiking. Minor, short-term, localized adverse impacts to soils would be similar to alternative A from proposed construction projects, albeit on a smaller scale.

Alternative A: Current Management	Alternative B: Enhanced Management of Habitat and Public Uses (Service-preferred)	Alternative C: Natural Processes
Effects on Dune and Beach Habitat		
Impacts Common to All Alternatives		
Regardless of which alternative we select, we will manage these habitats to benefit the federally listed piping plover, roseate tern, and northeastern beach tiger beetle, as well as other species of conservation concern. Minimizing human disturbance would increase nesting and foraging opportunities on overwash habitats to increase shorebird nesting productivity. Indirect benefits on shorebirds result from educating the public about special beach closures with news releases and other outreach mechanisms to engage the public to understand the needs of nest shorebirds. Under each alternative, we would continue to prohibit the use of all-terrain vehicles and over-sand vehicles on the refuge. All alternatives would incorporate actions, where possible and as funding allows, that monitor for any impacts to the refuge due to sea level rise. Direct impacts affiliated with increased visitation would include minor damage or loss of vegetation from off-trail use. Indirect impacts could result from the activity of visitors trampling dune and grassland vegetation, as well as potential impacts associated with habitat restoration or general service activities, including maintaining a field camp and conducting surveys.		
Continued protection of 30 acres of dune and beach habitat to benefit priority bird species and enhance 2 acres of nesting habitat for roseate terns. The spread of invasive species would potentially degrade the quality of the vegetated dune habitat for focal species, where invasive plants are left untreated. The presence of a seasonal camp poses some minor impacts to the surrounding vegetation due to trampling and high use. Predator management would benefit tern and other coastal bird species. Visitors would continue to utilize the existing and unmaintained footpaths created from extensive use near the lighthouse. Without sufficient law enforcement staff to enforce regulations, there is the continued potential for visitors to engage in activities deemed not appropriate with refuge purposes, such as camping or hiking.	In addition to the benefits derived from alternative A, an additional 45 acres of nesting habitat would be protected for common terns and an additional 8 acres of prime nesting habitat for roseate terns would be provided. More onsite refuge seasonal staff would provide greater protection to habitat through increased public awareness, enforcement of closures, and additional signs. In this alternative, we would increase management to protect nesting piping plovers in a manner consistent with preserving wilderness character by closing all available high-quality habitat to the public by mid-April. We would continue to rely on symbolic fencing, but with greater use of adaptive management and onsite presence to determine location and duration to protect habitat and dune processes. The quality of this habitat would improve as a result of a more regular burning regime and removal of woody and invasive plant species. Invasive species management would be more aggressive under alternative B by aiming for a target of less than 10 percent coverage refugewide of nonnative invasive plant species throughout the dune grasslands. This would benefit all nesting species in this habitat type. More proactive land protection efforts with partners would provide opportunities to permanently protect more coastal dune and shoreline habitats and create a larger area of continuous protection for species like the roseate and common tern, piping plover, least tern, American oystercatcher, and northeastern beach tiger beetle.	Under alternative C, we would protect only 10 acres of nesting habitat for common terns and maintain an additional 2 acres of prime nesting habitat for roseate terns. We would only conduct vegetation manipulation in this 10-acre area, therefore it is likely that woody species may begin to dominate in some areas and nonnative invasive plants would spread. We would continue to conduct annual inventories for focal species, but overall, our monitoring efforts would be focused on federally listed species. We would decrease vegetation monitoring to once every 15 years. This may limit our efforts to conduct habitat management. There may be fewer visitors under this alternative, as well as limited numbers at one time from implementation of a wilderness access pass, but impacts on the habitat and wildlife would be similar to those described under alternative B.

Alternative A: Current Management	Alternative B: Enhanced Management of Habitat and Public Uses (Service-preferred)	Alternative C: Natural Processes
Effects on Maritime Shrubland		
Impacts Common to All Alternatives		
All alternatives would tolerate nonnative rugosa rose to remain on the refuge in areas where wading birds nest. This could potentially result in the spread of a nonnative plant species into adjacent habitats and subsequent loss of native beach dune grass habitat. We do not consider this to be a significant impact due to the self-regulating habitat of the salt water environment. All the alternatives would use temporary symbolic fencing to close nesting areas in areas of high seasonal public visitation to provide disturbance-free nesting opportunities for wading birds. There would be varying degrees of disturbance between the three alternatives, but the impacts would all be similar.		
Under alternative A, we would continue to minimally manage the approximately 500 acres of maritime shrubland to benefit wading and land birds, including the black-crowned night-heron and snowy egret. This habitat would continue to be degraded by invasive plants.	Under alternative B, we would actively manage the maritime shrubland habitat on the refuge to benefit wading and land birds, including black-crowned night-heron and snowy egret, in addition to evaluating the importance of native maritime shrubland habitat for neotropical migrant songbirds. We would utilize biological, mechanical, chemical, or fire management to reduce nonnative invasive species to no more than 5 percent of habitat composition. This habitat would further benefit from replanting native shrubs in areas where large stands of invasive plants are removed. Reintroduction of fire through prescribed burns would also benefit the quality of this habitat. Compared to alternative A, there may be a small expansion in public use closures in maritime shrubland habitats, if warranted by habitat changes, wildlife use changes, or level of visitation. We will also assess habitat on Nauset/South Beach. The benefit to nesting bird species would be the greatest compared with alternatives A and C.	Under alternative C, this habitat would fall under the umbrella management of BIDEH. Habitat management would be similar to alternative A, with the exception of controlling nonnative invasive species.
Effects on Intertidal Habitat		
Impacts Common to All Alternatives		
All the alternatives would employ seasonal closures to reduce human disturbance from public use activities. Under all the alternatives, we would continue our ban on horseshoe crab harvesting. Shellfishing for softshell clams and quahogs would continue to be allowed under all alternatives.		
Under alternative A, we would continue to passively oversee up to 2,500 acres of intertidal habitat to benefit marine mammals, such as seals, nesting waterbirds, and migrating shorebirds.	Under alternative B, we would expand our management within this habitat to protect up to 2,500 acres. The most significant adverse impacts of human disturbance include displacement of shorebirds from preferred resting areas and abandonment of nests. Compared to alternative A, there may be a small expansion in public use closures in intertidal habitats, if warranted by habitat changes, wildlife use changes, or level of visitation. We will also assess habitat on Nauset/South Beach. Additional portions of intertidal mudflat may be closed to all human access for several weeks if these areas are consistently highly productive and support large concentrations of foraging shorebirds. Compared to alternative A, the length of these closures may slightly expand if warranted by wildlife use or the level of visitation. In alternative B, we would allow only non-mechanized harvest of subterranean species (soft- shell clams, quahogs, and razor clams) and would prohibit harvest of mussels. By not allowing mussel harvesting, we are providing an added benefit to red knots and other migrating shorebirds who feed on these colonies.	Impacts will be the same as A, with the exception of only allowing the harvest of subterranean shellfish as under alternative B.

Alternative A: Current Management	Alternative B: Enhanced Management of Habitat and Public Uses (Service-preferred)	Alternative C: Natural Processes
Effects on Salt Marsh		
Impacts Common to All Alternatives		
Under each of the alternatives, management of salt marsh would not change in a manner that would directly impact this habitat. We would continue to work to prevent the public from walking through these areas and potentially damaging plants. Temporary symbolic fencing would be used under all alternatives to protect salt marsh habitat and benefit nesting saltmarsh sparrows and American oystercatchers by reducing human disturbance.		
Under alternative A, we would continue to minimally manage about 250 acres of salt marsh with the use of seasonal closures to minimize trampling of vegetation and invertebrates, and benefit nesting saltmarsh sparrows and American oystercatchers. This habitat has been expanding over the last few years, so we do not anticipate any adverse impacts from our passive management. Under alternative A, the refuge would continue to issue special use permits for nuisance mosquito control. Direct impacts of monitoring and control include temporary disturbance to habitat and possible direct effects to non-target wildlife. Areas of vegetation may be crushed under foot, with impacts ranging from temporary in nature to loss of habitat over time. Invasive weeds may be introduced or spread by foot. Indirect effects associated with mosquito control include reducing mosquito populations and other non-target species that serve as the base of food chains for wildlife species.	Under alternative B, we would take a more proactive approach by actively managing at least 150 acres of coastal salt marsh to ensure that the quality and natural function of the marsh is sustained. Invasive species management would be more aggressive under alternative B by aiming for a target of less than 10 percent coverage of nonnative invasive plant species throughout the salt marsh. This habitat would benefit from information gathered through a regionwide study of salt marsh integrity, in addition to determining the presence and abundance of purple marsh crabs. Under this alternative, we would continue to issue special use permits for mosquito monitoring and control in accordance with Service policy.	Under alternative C, impacts from vegetation and habitat management would be the same as alternative B.

Alternative A: Current Management	Alternative B: Enhanced Management of Habitat and Public Uses (Service-preferred)	Alternative C: Natural Processes
Effects on Wetland Habitat		
Under alternative A, there is no active management of this habitat. The freshwater ponds are used for fishing; we anticipate minimal vegetation trampling as a result. Fishing in the freshwater ponds is infrequent and does not pose an impact to the fish population of these ponds. The nonnative invasive plant species Phragmites is found on some of the freshwater ponds on South Monomoy; it has not been treated and will continue to exist.	Under alternative B, we would work to maintain the ecological integrity of approximately 150 acres of freshwater ponds and associated emergent and shrub wetlands to support breeding marshbirds and native plant communities. The removal of nonnative invasive plant species, predominantly common reed, would benefit wetland habitats and associated species. Potential impacts of fishing on open water and wetland habitats are expected to be similar to those described for alternative A.	Under alternative C, wetland impacts from management actions would be similar to alternative A, but would be evaluated through a BIDEH focus. This alternative would benefit from nonnative invasive species management similar to alternative B.
Effects on Nearshore Marine Open Water		
Impacts Common to All Alternatives		
The refuge would remain open to fin fishing (except using techniques that disturb the bottom); lobster, crab, and whelk pot fishing; and the hand harvest of scallops under all alternatives. Shellfishing has the potential to damage aquatic vegetation; however, hand tools are generally used in the intertidal zone where eelgrass does not occur. Activities that result in the disturbance of the bottom would not be allowed. This will prevent damage to existing eelgrass beds, the reestablishment of eelgrass beds, and benthic communities. Maintaining an undisturbed bottom supports aquatic life which in turn supports migratory birds and other refuge wildlife species.		

Alternative A: Current Management	Alternative B: Enhanced Management of Habitat and Public Uses (Service-preferred)	Alternative C: Natural Processes
Effects on Wilderness Recommendations and Designation		
Impacts Common to All Alternatives		
None of the alternatives propose actions that would directly or indirectly jeopardize the roadless character, size, or outstanding ecological or scenic features of the Monomoy wilderness and the Inward Point and Powder Hole (currently non-wilderness) exclusions. Under all alternatives, the refuge's outstanding opportunities for solitude and primitive recreation would be preserved and available consistent with the seasonal closures. Motorized equipment, motorboats, and aircraft introduce noise disturbance may influence the distribution of wildlife and reduce the wilderness experience for public visitors. Under all alternatives, the refuge would continue to prepare minimum requirements analyses to evaluate refuge management actions and determine how they can be conducted in a way that minimizes their impact on wilderness character. Under all alternatives, continue managing the existing Monomoy wilderness, and the Inward Point and Powder Hole (currently non-wilderness) exclusions to maintain or enhance their size, naturalness, and outstanding opportunities for solitude or primitive and unconfined recreation to the extent that it will not prevent us from fulfilling and carrying out refuge establishing purposes and the Refuge System mission, in accord with Service wilderness stewardship policy (610 FW).		
Resource management activities, such as the base camp near the tern colony, roseate tern attraction devices, use of blinds, etc. can have short-term impacts on wilderness character. Some birding groups exceed a maximum size of 20 and can impact the sense of solitude. There would be no changes in land use or land ownership and no new or expanded refuge management activities or refuge uses that would significantly alter the existing physical landscape of the islands. Solitude within the Monomoy wilderness would temporarily be interrupted during the construction of an alternative energy facility, as there would be a higher than normal amount of people on the island and increased noise during the construction phase of this project; it would return to normal once construction is completed.	Under alternative B, the refuge expects the greatest increase in public use. This could have impacts on the wilderness values of solitude and primitiveness, but we do not anticipate that it would significantly detract from the overall wilderness character of the refuge or Monomoy wilderness. Impacts from the proposed alternative energy facility would be the same as described under alternative A.	Under this alternative, we would not install any form of alternative energy at the Monomoy Point Light Station and motorized transportation to the refuge uplands and tidal flats would be replaced with nonmotorized forms. This would bring the greatest benefit to sustaining wilderness characteristics of solitude, primitive recreation, and being affected primarily by the forces of nature

Alternative A: Current Management	Alternative B: Enhanced Management of Habitat and Public Uses (Service-preferred)	Alternative C: Natural Processes
Effects on Public Uses and Access		
Impacts Common to All Alternatives		
Under all alternatives, we would continue to provide compatible wildlife-dependent activities that can be supported with respective staff and budget projections. We would maintain our infrastructure to support those activities and provide safe access. We would continue to conduct outreach to visitors and the local communities to instill an appreciation of the Refuge System and the refuge, its resources, and our priorities for management.		
We would maintain the existing programs for five of the six priority public uses. Adequate opportunities for wildlife observation and photography would continue to be provided. Under alternative A, we would continue to provide at least the current level of interpretation and explore the appropriateness of virtual technology to conduct interpretation. Environmental education would not become more developed under this alternative. We would continue to allow Chatham residents and refuge visitors to harvest shell fish using traditional (non-mechanized) hand raking methods. The visitor contact station would not be expanded and would continue to be inadequate to meet the needs of the staff and environmental education and interpretation programs on the refuge.	Alternative B proposes that we work toward meeting the increased demand for opportunities to observe wildlife by constructing additional trails, observation areas, and photography blinds, and making the boardwalk Americans with Disabilities Act-compliant. The development of an alternative visitor contact station in either downtown Chatham or Harwich with shuttle services to Morris Island would allow the public greater access, reduce traffic congestion, and ease parking problems. We would increase and improve our environmental education and interpretation programs, which would provide the indirect benefit of a greater understanding by the public of the importance of the refuge and its management. Adverse impacts related to increased visitation would be greater under this alternative due to the increased number of education and interpretation opportunities. Paid parking may deter some visitors, but the effect is expected to minimal. Seasonal area closures to protect wildlife, as well as short-term closures during construction for the safety of our visitors, would continue to inconvenience some visitors. Constructing new interpretive and informational signs would provide opportunities for providing a conservation message to visitors, thus increasing their awareness, and possibly, their support of the refuge. The addition of a visitor contact station in the local community would further increase the effectiveness of an expanded visitor services program, as well as improve the refuge's exposure to new visitors who would receive information about the refuge. The installation of an alternative energy facility at the Monomoy Point Light Station would provide electricity and support the eventual use of this site for cultural history tours. Under this alternative, we would allow the harvest of subterranean shellfish species by using hand tools and no other artificial means, such as salt or chlorine. Hand harvest of scallops and the harvest of lobster, crab (not including horseshoe crab), and whelk would be allowed. We would prohibit the harvest of mussels. We would prohibit the activity of mechanical harvesting (i.e., dredging) above mean low tide, as well as the use of carts or any equipment with wheels within the Monomoy wilderness. Some individuals engaged in clam harvest will be inconvenienced by the restriction on carts; some may decide to harvest clams elsewhere. Some individuals may move to other areas in Chatham to harvest scallops, mussels and oysters. This could increase competition among individuals and result in some people not harvesting as many of those shellfish species.	Alternative C would decrease opportunities for wildlife-dependent public use and access from alternatives A and B. Under this alternative, we would no longer allow motorized transportation to the refuge and would establish a concessionaire to provide nonmotorized access to the refuge. We anticipate that wilderness enthusiasts would benefit the most under this alternative. There would be significantly greater opportunities to experience the solitude of the Monomoy wilderness, since we expect that fewer individuals would engage in nonmotorized access to the refuge. Implementing an entrance fee system may deter some visitors, but the effect is expected to minimal. Raising funds will enable refuge staff to provide services or public use facilities that it would not be able to do otherwise. Alternatives to those who harvest shellfish are the same as alternative B.

Alternative A: Current Management	Alternative B: Enhanced Management of Habitat and Public Uses (Service-preferred)	Alternative C: Natural Processes
Effects on Socioeconomic Resources		
Impacts Common to All Alternatives		
Regardless of which alternative we select, we would continue to pay refuge revenue sharing each year to the Town of Chatham. Refuge management jobs, income, and expenditures would have negligible benefits to the local economy, but the expenditures of refuge visitors would continue to add some benefits for the local economy. The socioeconomic impacts of designated wilderness areas include direct use benefits, such as recreation, community quality of life; scientific benefits, such as research and education; offsite benefits, such as increased property values; biodiversity conservation; ecological services; and passive benefits, such as conserving wild lands for future generations.		
The expected increase in visitation of an average 1.5 percent annual rate of increase over the next 15 years would continue to contribute to the local economy through the consumption of goods and services, equipment rentals, and other expenditures associated with recreational opportunities made available on the refuge. Alternative A would maintain the current work force of three full-time employees. Refuge projects and base salaries would total approximately $180,000 annually.	The addition of seven full time staff would minimally increase benefits for the local economy in jobs, income, and expenditures. If fully funded, recurring salary and project costs would approximate $700,000 annually. Construction activities like renovation of the existing headquarters or a downtown visitor contact station would temporarily provide several construction jobs to the local area, although would have a minimal effect to the region's overall economy. Enhancing refuge programs, and using a concessionaire who could employ several individuals, would support an increase in visitors, thereby increasing their expenditures in the local economy.	The addition of five full-time staff would minimally increase benefits for the local economy in jobs, income, and expenditures. Benefits would be similar to those under alternative B, with an annual recurring cost estimated at $86,000.

Alternative A: Current Management	Alternative B: Enhanced Management of Habitat and Public Uses (Service-preferred)	Alternative C: Natural Processes
Effects on Cultural and Historical Resources		
Impacts Common to All Alternatives		
Regardless of which alternative we select, we would protect known cultural and historic resources. Further, under all scenarios, the refuge would communicate the importance of understanding and appreciating the area's rich cultural history and how it relates to our natural history. We would also continue to do section 106 compliance for all individual projects. Our habitat management activities have the potential risk of disturbing unknown sites, as well as the risk that some visitors may inadvertently or intentionally damage or disturb known or undiscovered sites.		
Under alternative A, we would follow Service protocol to prevent the loss of cultural, historic, and archaeological resources, record items or sites as they are encountered, and comply with the provisions of the National Historic Preservation Act. We would also maintain the historic Monomoy Point Light Station. Maintenance and repairs to the light station and associated structures would help preserve those historical resources from weather damage. We lack staff with training in the Archaeological Resources Protection Act and National Historic Preservation Act, a refugewide cultural resources overview, a cultural resources plan, and partnerships to cooperatively protect resources; this currently does not allow us to be fully proactive in evaluating and protecting sites.	In addition to the beneficial impacts as described under alternative A, we would maintain the historic Monomoy Point Light Station using volunteers and would foster a greater appreciation of its value by potentially opening it up to public visitation. The benefits for cultural and historic resources would increase in alternative B because we would complete a cultural resources overview, maintain an inventory of known and newly found sites and structures, develop a cultural resources management plan, conduct archaeological surveys, and assess the conditions of the two known Native American sites on Morris Island.	In addition to the actions mentioned in alternative A, this alternative provides a moderate level of cultural resource protection from the effects of erosion. If erosion poses an imminent threat to the site of the Monomoy Point Light Station in the next 15 years, we would develop a mitigation plan for the light station.