

5. Environmental Consequences

The purpose of this chapter is to identify, describe, and compare effects of the three alternatives proposed in this draft of the Tetlin National Wildlife Refuge (Refuge) Comprehensive Conservation Plan (Plan) (including current management direction under Alternative A) on the physical, biological, and socioeconomic environments. Current Management (Alternative A) provides the basis for comparing the effects of two action alternatives—Alternative B (Preferred Alternative) and Alternative C.

The description of the effects to various resources and opportunities from each alternative can be compared using a set of general terms to describe the intensity, duration, scale, and nature of impacts. For the purposes of this environmental assessment, these terms are defined as follows:

Intensity of the impact:

- Negligible—Impacts resulting from the specified management action that can not be reasonably expected to affect identified refuge resources or recreation opportunities at the identified scale.
- Minor—Impacts resulting from the specified management action that can be reasonably expected to have detectable though limited affect on identified refuge resources or recreation opportunities at the identified scale.
- Moderate—Impacts resulting from the specified management action that can be reasonably expected to have detectable and apparent affect on identified refuge resources or recreation opportunities at the identified scale.
- Major—Impacts resulting from the specified management action that can be reasonably expected to have readily apparent and substantial affect on identified refuge resources or recreation opportunities at the identified scale.

Duration of the impact:

- Short-term—Effects on identified refuge resources or recreation opportunities that occur during implementation of the management action but no longer.
- Medium-term—Effects on identified refuge resources or recreation opportunities that occur during implementation of the management action that are expected to persist for some time into the future, though not throughout the life of the Plan (not longer than 20 years).
- Long-term—Effects on identified refuge resources or recreation opportunities that occur during implementation of the management action that are expected to persist throughout the life of the Plan and possibly longer (longer than 20 years).

Scale of the impact:

- Site-specific—Beneficial or adverse impacts occurring at a specific site that is relatively small in size (e.g., a trailhead or nest site).
- Local—Beneficial or adverse impacts occurring throughout a specific area that is large in size (e.g., along an entire trail or throughout an entire home range.).
- Refuge-wide—Beneficial or adverse impacts occurring throughout the Refuge, but generally not affecting identified resources or recreation opportunities outside the Refuge.
- Regional—Beneficial or adverse impacts occurring throughout or nearly throughout the entire Upper Tanana Valley or generally an area including, and much larger than, the Refuge.

Nature of the impact:

- Positive—Impacts resulting from management actions that maintain or enhance the quality and/or quantity of identified refuge resources or public use opportunities.
- Negative—Impacts resulting from management actions that degrade the quality and/or quantity of identified refuge resources or public use opportunities.

All resources, species, and opportunities on the Refuge are important, but many are not expected to experience change as a result of implementing any of the alternatives. For this reason, not all species or resources within the Refuge are discussed in this chapter. An analysis of the effects of management actions on the physical and biological environments has been conducted for the following:

- Permafrost and soils
- Air quality
- Water quality and aquatic habitats
- Vegetation and terrestrial habitats
- Fish populations
- Bird populations
- Mammal populations

An analysis of effects on the human environment has been conducted for the following:

- Local economy and commercial uses
- Cultural resources
- Subsistence
- Visitor services and recreation opportunity
- Environmental education and interpretation
- Wildlife observation and photography
- Recreational fishing
- Trapping and recreational hunting
- Opportunities to engage in supporting public uses of Tetlin Refuge
- Public health and safety

Site-specific environmental effects of activities that would require National Environmental Policy Act (NEPA) documentation will be addressed in subsequent environmental assessments or environmental impact statements.

5.1 Assumptions of the Impact Analyses

5.1.1 Impacts to the Physical and Biological Environment

Information gathered about Tetlin Refuge since the original Plan was written in 1987 indicates that populations of fish, wildlife, plants, and their habitats remain substantially unaffected by human activities. In most cases these populations remain healthy and are stable or increasing. Research has been conducted throughout the United States and Canada to assess impacts to these resources from public use activities and fire management actions similar to those proposed by the alternatives in this Plan. Results from these studies allow us to predict what impacts are most likely to occur on Tetlin Refuge, but we are unable to quantify the level of impact without conducting specific studies within the Refuge itself. However, through our analyses, we are able to predict the relative duration, scale and intensity of impact likely to occur as a result of each alternative.

In terms of the Refuge and its purposes, the presence of wildfire, flooding, and other natural processes in the boreal ecosystem are generally accepted as positive influences. Within the Upper Tanana Valley, these processes continue, with most deviations as a result of land management activities confined to relatively small areas around communities, facilities, and other developments.

Public use and associated facilities such as roads, trails, and buildings proposed in each of the Plan alternatives generally represent negative impacts to abiotic and biotic resources within the Refuge. While these negative impacts may range from negligible to major, these uses and facilities generally do not improve soil conditions, water quality, survival of individuals or populations, biological diversity, or habitat integrity within Tetlin Refuge.

5.1.1.1 Climate Change

Changes in climate in recent decades have resulted in warmer and dryer conditions throughout the Arctic (Serreze et al. 2000; Folland et al. 2001; Stone et al. 2002) and within Tetlin Refuge (Tetlin National Wildlife Refuge 2005a). These changes are generally anticipated to continue for the foreseeable future. We assume that climate change may exert a strong influence on the consequences and impacts of actions proposed in this document. Rapid climate change and thawing permafrost will have a profound impact on the water resources of the Upper Tanana Valley and the Refuge. The altered flow regime, and changes to the volume, timing, frequency, magnitude, and duration of hydrologic events will alter Refuge habitat and, in turn, the flora and fauna at a landscape level.

Changes in climate will likely affect habitats and may provide greater opportunity for invasive species to spread (Inkley et al. 2004). Disturbed areas such as those along the Alaska Highway have provided the type of suitable habitat in which invasive plants thrive. Potential changes in climate may influence the spread of invasive plants into Refuge lands. The risk of unintentionally spreading these species into the Refuge as a result of actions common to all three alternatives is a major concern. Monitoring efforts currently in place along a portion of the Alaska Highway will provide rapid assessment of the spread of invasive plants.

Changes in climate could also lead to more frequent fires and/or greater probability of catastrophic fires (Inkley et al. 2004). A decrease in average annual precipitation could lead to reductions in fuel moistures and, in turn, to increased probability of ignition, fire intensity and rate of spread. Furthermore, there is concern that changes in the extent and distribution of permafrost (Jorgenson et al. 2001), coupled with changes in the distribution of vegetation (Kittel et al. 2000) due to continued warming in the Arctic, could affect fire regimes in the region (Bourgeau-Chavez et al. 2000). Decreases in soil moisture could also lead to drought stress on plants, making them more vulnerable to disease and pest outbreaks, thereby increasing mortality. These additional dried fuels would contribute further to increased fire behavior. A combination of increased human ignition sources, extensive penetration of forest land by suburban and intensified rural development, and prolonged warmer and drier weather could set the stage for highly destructive wildland-urban interface fires (Juday et al. 1997).

5.1.1.2 Subsistence Harvest of Fish and Wildlife

Many social and environmental factors that collectively influence subsistence harvest levels and the impacts on of such harvests on Refuge fish and wildlife resources are subject to change and often hard to predict. Among those factors are human population changes in local rural areas; social and economic conditions; regulatory changes affecting seasons, bag limits, allowable methods of harvest, and the size of the geographic areas and number of communities determined eligible to harvest

subsistence resources; and changes in fish and wildlife populations, distributions, and habitats due to weather, fire, harvest pressures outside the Refuge, and other factors.

Local population growth of 28 percent is anticipated to result in an additional 1,078 rural residents eligible to participate in subsistence use of Tetlin Refuge by the year 2018 (Alaska Department of Labor 2004; Table 3.1). This projected increase in the rural population, when combined with cost of living increases and regulatory changes allowing additional communities to be eligible for subsistence harvest, is likely to increase hunting and fishing pressure within the Refuge over the next 10 to 15 years.

The Refuge does not regulate the subsistence harvest of fish and wildlife resources or determine eligibility for subsistence harvests. The Federal Subsistence Board establishes subsistence hunting and fishing regulations on Federal public lands in Alaska, except for subsistence migratory bird hunting, through a formal process in response to subsistence needs, changes in fish and wildlife populations, and other management needs. Federal subsistence regulations adopted by the Board must be found to be consistent with the conservation of healthy populations of wildlife. Subsistence harvests of migratory birds in Alaska is managed by the Alaska Migratory Bird Co-management Council, which attempts to maintain regulations that provide continued opportunities for traditional subsistence uses and conserve migratory bird populations. The Refuge will continue to participate in both regulatory programs to try to ensure that subsistence uses are managed in a manner consistent with sound conservation of the resources and with Refuge purposes.

5.1.2 Impacts to the Human Environment

This part of the impact analysis evaluates how the local economy, commercial uses, subsistence uses, visitor experiences, recreation opportunities, and public health safety might vary among the three alternatives. The analysis is qualitative rather than quantitative because of the conceptual nature of the alternatives and the limited information available relating to visitor use patterns and local economic factors. Consequently, professional judgment was used to reach reasonable conclusions as to the scale, intensity, duration, type, and distribution of various activities, uses, and associated impacts.

Temporary displacement and/or disturbance to wildlife can occur during motorized boat use, aircraft take-offs and approaches to landings, use of snowmachines, and at campsites, trails, facilities, or other areas of concentrated human activities. In addition some localized vegetation damage generally occurs in the immediate vicinity of cabins, campsites, other facilities, and commonly used points and routes of access. We anticipate these disturbances to wildlife, plants, and their habitats will have varying degrees of indirect impacts on subsistence opportunities, and will generally follow impacts described in this Environmental Assessment for each resource. However, because subsistence uses and opportunities do not necessarily correlate directly with resource abundance and availability, we assume these adverse impacts will occur at a smaller scale and will be of lesser intensity than impacts to subsistence resources. Harvest seasons and limits, weather patterns, adequate snow cover, competition with other users, travel costs and travel conditions, and a variety of other factors influence participation in subsistence activities. The Refuge does not have subsistence use or harvest data of sufficient detail to accurately estimate to what degree indirect impacts to subsistence opportunity will differ from direct impacts to subsistence resources as a result of specific actions proposed under each alternative. Subsistence use and harvest data for the Refuge in general indicate there are no known long-term impacts to refuge wildlife populations from the disturbance or displacement associated with public use within

the Refuge. The anticipated effects of Alternative B (the preferred alternative) are described under section 5.9.

Tourism-There are several indications that for the foreseeable future Alaska tourism will continue to grow in response to a weaker U.S. dollar and an increasing number of Americans reaching retirement age and having more leisure time. From 2000 through 2004, the number of travelers on the Alaska Highway declined 19 percent (from 124,535 visitors in 2000 to 100,913 in 2004) (USDOT 2007). From 1999 through 2005, summer visitation along the Alaska Highway steadily declined, partly in response to higher fuel prices. Despite this decline, the average annual number of travelers during this time period is 3 percent greater than for the prior seven-year period (1992 through 1998). Based on projections by Bowker (2001) and Bowker et al. (1999) we expect annual summer visitation and travel along the Alaska Highway to increase 25 percent by the year 2025 to about 250,000 people annually regardless of any action taken by Tetlin Refuge.

5.2 Impacts Common to All Alternatives

Many actions proposed by the Refuge through this Plan are common elements in each of the three alternatives. For these actions, the type, duration, and magnitude of the effects are described in this section. In other cases, the type of action is common to all three alternatives, but the anticipated magnitude of the impact may differ among alternatives due to different levels of management activity. In these cases, the reader will find a more detailed discussion in subsequent sections for each alternative.

For comparison purposes this discussion of common impacts is divided into three sections:

- Fire and fire suppression impacts to the physical and biological environment
- Facilities and public use impacts to the physical and biological environment
- Impacts to the human environment (as a result fire suppression, facilities, and public use)

5.2.1 Fire and Fire Suppression Impacts to the Physical and Biological Environment

Under all alternatives, some mix of natural fire, prescribed fire, mechanical fuels treatments, and fire suppression will continue to be used to meet management goals. Each alternative proposes altering the proportion of the Refuge affected by these activities, which will lead to varied magnitude of impact among the alternatives. The assumption is made that due to the way in which prescribed fire is used within Tetlin Refuge, its impacts to physical and biological resources on any particular area are similar to those expected from lightning caused wildfire in the same location.

5.2.1.1 Permafrost and Soils

It is generally accepted that in a post-fire landscape, permafrost tends to retreat increasing the depth of the active layer (Yoshikawa et al. 2002). Fire may transform areas characterized by continuous permafrost to discontinuous permafrost sites or even remove permafrost altogether. On slopes and sites with well-drained soils, melting of the permafrost creates dryer conditions as water is allowed to flow downhill or seep deeper into the ground. In low-lying areas and sites with poorly drained soils, water remains to create wet meadows, ponds, and even small lakes. In addition, burning of plants and the organic layer returns nutrients to the soil. Fire severity and its effects on permafrost and soil vary greatly under natural conditions. Permafrost conditions, soil moisture, and soil nutrient cycling are largely the product of the natural fire regime and form the basis for plant community succession in the boreal ecosystem.

Under all alternatives, a variety of mechanical fuel reduction techniques may be employed on or near Refuge lands. These range from chainsaw thinning by hand crews to thinning or clearing by use of heavy mechanical equipment. Removal of overstory vegetation associated with these treatments can lead to warmer soil temperatures and, consequently, deeper active layers (though there is some evidence that active layer depth may decrease subsequent to chainsaw thinning) (Jandt 2002). Heavy equipment use may lead to soil compaction and erosion. Mechanical fuels treatments on the Refuge have been, and will remain, small in scale (typically less than 500 acres per year) under all alternatives. These activities generally occur in or near previously disturbed areas in the vicinity of structures, roads, or other improvements.

Fire suppression activities such as dozer and hand line construction may lead to soil compaction and erosion. Under all alternatives, suppression activity will continue to occur in the northern portion of the Refuge and within the Alaska Highway corridor. Fires in these areas are generally detected and suppressed when small, thus limiting the extent of compaction and erosion. The construction of fire lines and other fire suppression activities have the potential to cause moderate to major, medium to long-term negative impacts to specific sites associated with individual fires, but these impacts will continue to be mitigated to the extent possible by minimum impact suppression techniques and post-fire rehabilitation efforts.

5.2.1.2 Air Quality

Overall air quality will not be substantially affected by actions in Alternative A, B, or C. Smoke of varying density and duration has been a recurring presence in the Upper Tanana Valley for thousands of years. Impacts vary by year, however, and it should be noted that significant amounts of smoke produced by fires as far away as Russia can be transported into the area by winds. Occasional large fires within the Refuge may contribute the majority of smoke and have moderate to major adverse effects on air quality during brief periods, but in any given year, refuge fires usually account for only a small proportion of smoke in the Upper Tanana Valley. When considering long-term annual impacts, the greatest proportion of smoke will continue to come from off-refuge fires in the Tanana Valley and elsewhere throughout interior Alaska. No management action implemented on the Refuge or even across the entire Upper Tanana Valley could eliminate the impact of smoke on air quality. For example, during August 2005, the Valley experienced severe smoke impacts over several weeks without any active fires in the Tok Area. Regardless of fire management alternatives chosen for the Refuge, fires that burn throughout Canada and elsewhere in Alaska will continue to have varying degrees of adverse impacts on regional air quality in the Upper Tanana Valley.

5.2.1.3 Water Quality and Aquatic Habitats

The impact of fires on water quality include: 1) immediate direct impacts to streams (e.g., increased temperature, changes to water chemistry); and 2) delayed or indirect impacts associated with runoff such as erosion and turbidity. Fires that burn adjacent to streams can remove vegetation that would normally reduce the flow of run-off and debris into waterways and affect water quality. The impact of fire on water quality varies proportionally with fire intensity and size of the area burned. Effects are generally immediate and short-term as vegetation recolonizes the area in the years following the fire, with more fires of medium to high intensity resulting in moderate impacts. The impact of fire is also regulated by factors influencing runoff and erosion such as slope, gradient, soil type, and soil depth.

Under all alternatives, riparian areas could be negatively impacted by contamination from fire fighting foams and retardant. These chemicals, when applied to wildland ecosystems, can be

washed away through overland flow during storms (surface runoff) or leached through the soil profile and carried through drainage channels to streams and other water bodies. Entry of fire-fighting chemicals into aquatic environments could adversely affect algae and aquatic invertebrates, thus disrupting ecosystem function. Many fire retardants are toxic to fish and can have detrimental influences on fish populations if applied inappropriately. Suppression activities such as the placement of dozer lines and hand lines could channel runoff and increase the movement of sediments into adjacent streams and waterbodies. As with all fire suppression activities, negative impacts will continue to be mitigated to the extent possible by minimum impact suppression techniques and post-fire rehabilitation efforts. As a result, we anticipate minor, short to medium-term adverse impacts to water quality from fire suppression actions will remain relatively isolated to specific sites associated with individual fires within the Refuge.

5.2.1.4 Vegetation and Terrestrial Habitats

Fire can cause dramatic and immediate changes in vegetation, eliminating some species or causing others to appear where they were not previously present. In the boreal forest, cottongrass, fireweed, and other herbaceous plants typically re-establish following fire. Berry producing shrubs follow, and are, in turn, replaced by species such as willow, aspen, and birch. After 100 to 200 years (occasionally much sooner, depending upon fire severity), black and white spruce return as dominate overstory species until the next fire. A continuous carpet of feathermosses and low hanging limbs make these forests susceptible to fire. Fire removes these thick accumulations that would otherwise depress site productivity, prepares seedbeds, releases nutrients, and renews early successional vegetation important as browse for many animal species (Juday et al. 1997). Time of year, moisture, wind speed and direction, and biomass accumulation since the last fire help determine the vegetative mosaic created following succeeding wildfires. Because temperatures in Alaska remain cool much of the year, the rate of vegetation decay and nutrient release is very slow compared with other forest types. The boreal forest is considered a fire-dependent ecosystem; recurring fires are necessary to maintain the flora and fauna that have adapted to fire and the resulting forest mosaic (Kelsall et al. 1977).

A single large fire will likely reduce diversity within the immediate burn area. At the larger scale of the Refuge or the entire Upper Tanana Valley, numerous fires of varying intensities over many years have the effect of maintaining a high level of diversity across the landscape. Some wildlife species adapt well to the rapid change in the environment caused by fire, and others do not. Over the short-term, the habitat for some species may be greatly improved by burning, while for others it may be degraded or even eliminated within the burn area. Fire can reduce immediate forage quantity for wildlife by removing vegetation and can also reduce availability of winter forage if deadfall inhibits travel and snow interception by trees no longer occurs. Studies have stressed the importance of fire in the boreal forest for creating habitat for species such as moose, snowshoe hare, and other wildlife dependent upon early seral stage vegetation (see summary by Klein 1982). Gasaway and Dubois (1985) documented moose in their study area were not displaced from traditional summer ranges when a portion of their range was altered by fire as unburned vegetation within the fire boundary apparently met their forage needs.

Early and mid-successional forests with dense coniferous and deciduous plant regeneration provide cover and browse, important components of snowshoe hare (Wolff 1980, Keith 1990) and, therefore, lynx habitat (Johnson et al. 1995). In Alaska, burns that are 15 to 30 years old create good quality habitat for hares, although lynx will occupy burns as early as 5 years and as long as 50 years post-fire (Stephenson 1984, Johnson et al. 1995). Within burns in Alaska, lynx demonstrated strong selection against mature forest in some habitats (Kesterson 1988, Staples

1995). It has been suggested that upland fire creates refugia for snowshoe hare that can influence the abundance and distribution of lynx (Paragi et al. 1997). The quality of habitat for snowshoe hare also declines as the forest matures, resulting in a decline in hare densities (Keith et al. 1984). It has been suggested that if fire frequency decreased in interior Alaska, the potential to support hares and lynx may also decrease if large areas of mid-successional forest advance past the optimal state for snowshoe hares (Johnson et al. 1995).

The progressive exclusion of wildland fire from the boreal forest has caused concern for the maintenance of adequate moose habitat in interior Alaska and other northern forests (Andrews 1998, Collins and Schwartz 1998). Moose browse production is greater in burned stands than in unburned areas; generally, stands appear to furnish abundant moose browse for 15 to 20 years post-fire (Wolff and Zasada 1979, Weixelman et al. 1998). However, the relationship between moose and their habitat is complex, and habitat management must consider more than just browse production (Bowyer et al. 1997, Franzmann and Schwartz 1997, Augustine and McNaughton 1998, Collins and Schwartz 1998, Weixelman et al. 1998).

While wildland fire increases overall vegetative diversity and productivity, it destroys fruticose lichens in Alaska's boreal forest. These lichens, if available, are major constituents of caribou winter diets; replacement may take more than 50 years (Joly and Adams 2002, Joly et al. 2003). Caribou do appear to avoid recently burned areas (less than 10 years), but early successional vascular forages present in burns may be attractive to caribou in early winter and spring, providing important nutrients for a short time period (Joly et al. 2003). Numerous investigators suggest fire may rejuvenate older lichen ranges by altering moss-lichen relationships, reducing overstory, or removing decadent lichens (Joly et al. 2003); lichen productivity and quality is reduced in very old forest stands (Klein 1982). Fire may also alter caribou movements, thereby allowing recovery of over-grazed lichen ranges (Joly et al. 2003). Fire is a necessary component of the boreal forest, and while lichen may be reduced in the short-term, the overall, long-term effect of a natural fire regime may be a rejuvenated caribou winter range.

Grizzly bears have been shown to seldom use mature spruce forests as feeding habitat; most feeding habitat was found in open areas from past fires or in seral vegetation (Zager et al. 1983, Hamer and Herrero 1987). For furbearers such as marten, mature coniferous forests are generally perceived as optimal habitat. However, many researchers have suggested marten may be more opportunistic and will also use deciduous and mixed coniferous-deciduous forests, including recent burns (see summary by Johnson et al. 1995). In Alaska, juvenile marten used a burn in the tall-shrub sapling stage of post-fire succession; it was hypothesized the burn was a sink for immature and transient marten dispersing from mature forests (Paragi et al. 1996).

Fire, whether naturally occurring or manually ignited, results in habitat alterations and subsequent changes in breeding bird communities. Several studies have demonstrated early post-fire habitats are important for songbirds (Morissette et al. 2002), but the degree of change depends largely on the pre-burn vegetation and the species of birds affected.

The effects described in this section are positive for certain species and habitats but negative for others. However, any action which conserves the natural fire regime and the resulting diversity of habitats represents an overall major, long-term positive impact to the Refuge, adjacent areas, and other resources within the Upper Tanana Valley that also benefit from those effects.

Under all alternatives, suppression efforts along the Alaska Highway corridor and in the northern portion of the Refuge will reduce the extent of these fire effects during the short-term. Suppression

actions such as line and camp construction and retardant drops may lead to further negative impacts. These lands represent a relatively small portion of the Refuge characterized by a high proportion of non fire-prone wetlands. These factors help to minimize the effects of suppression activities as well as reduce fuel buildup and loss of natural barriers that would otherwise increase the probability of a large catastrophic fire and reduced landscape scale diversity.

5.2.1.5 Fish, Bird, and Mammal Populations

Impacts to fish and wildlife populations from fire or fire suppression activities vary significantly among different species. There are both immediate and direct short-term impacts resulting from the fire, and indirect long-term impacts that occur as a result of habitat changes discussed previously. Most wildlife species can disperse from areas of fire activity or can escape into burrows, streams, ponds, or other protected areas. Direct mortality from heat or smoke primarily affects those individuals who cannot avoid advancing flame fronts. The number of animals killed is small when compared with other natural causes of mortality; thus, the direct impacts are relatively minor and short-term when considering an entire population. More significant long-term impacts on Refuge wildlife populations will generally result in response to habitat changes that occur during the progression of successional stages that follow a fire. Although fish are not directly exposed to fire, minor to moderate impacts on fish populations may occur in response to changes in water quality, and changes to aquatic and riparian habitats following a fire.

5.2.2 Facilities and Public Use Impacts to the Physical and Biological Environment

5.2.2.1 Permafrost and Soils

Under all alternatives, the construction of trails and other facilities, along with impacts from hiking, snowmobiling and other public use activities, will adversely impact soil resources. Negative impacts occur through the following:

- Removal of litter from the soil surface
- Reduction in soil organic matter content
- Slowing development of soils and soil organic layers
- Soil compaction
- Soil erosion

Development of additional interpretive sites and visitor opportunities (e.g., Seaton Roadhouse), continued administrative cabin use, and campground improvements will have moderate to major, long-term negative impacts on permafrost and soil; however, the effects should remain confined to individual sites such as campsites, parking area, or trails, thereby causing only negligible widespread degradation. Impacts from snowmachine use will continue to be mitigated by allowing use only during periods of adequate snow cover. To ensure impacts do not exceed the compatibility threshold, impact standards will be included in the revised Refuge Visitor Services Plan. This step-down plan will outline strategies for inventorying areas prior to the establishment of new uses or developments. Any activities which could cause noticeable impacts (biological or social) will be monitored to ensure impacts remain within acceptable limits.

5.2.2.2 Air Quality

Impacts will be similar to those described in the following discussion of two-stroke motor impacts to water quality and aquatic habitats.

5.2.2.3 Water Quality and Aquatic Habitats

Little is known about pollution on the Refuge. Water quality is believed to be generally good and most river waters contain only natural minerals (Matz et al. 2005). Under all alternatives, increased use of the Refuge by visitors and increasing use and development on private lands have the potential to affect water quality. For example, swimming, cleaning fish, boat launching, and motor boating were suspected to have caused higher observed concentrations of coliform bacteria, phosphates, and nitrogen in the Boundary Waters Canoe Area in northeastern Minnesota (King and Mace 1974). Dietrich and Mulamootil (1974) also examined the bacteriological quality of reservoir water and correlated those results with the intensity of recreational use. Under all alternatives, we anticipate public use will remain below levels sufficient to cause measurable impacts from improper human waste disposal.

Two-stroke engines, such as those in the majority of motorized boats (National Park Service 1999) and snowmachines, are commonly used within Tetlin Refuge. It has been documented that conventional two-stroke engines pollute far more than direct-injection or four-stroke engines (National Park Service 1999). Factors affecting the quantity of compounds exhausted from two-stroke motors include horsepower rating, crankcase size, composition of fuel mixture, tuning of engine, and speed of operation (Jackivicz and Kuzminiski 1973). On average, 20 to 30 percent of all fuel used by two-stroke motorboat engines fails to combust and is flushed into the water (Environmental Protection Agency 1991 as cited in DeLong 2002). For every five gallons of fuel and lubricating oil used, one gallon is released directly into the water (DeLong 2002). Snowmobile activity on frozen ponds, especially in powder-snow conditions, has also been shown to introduce toxic chemicals into the water (Waller et al. 1999). Studies by Adams (1974) showed that hydrocarbons from snowmobile exhaust can reach levels potentially harmful to fish at ice-out in small ponds. However, no significant changes in air or water quality due to use of motorboats or snowmachines are anticipated as a result of any alternative proposed in this Plan. Changes to Federal emission standards and regulations are scheduled to be fully implemented over the next 10 to 15 years (40 CFR Parts 89, 90, 91, 94, 1048, 1051, 1065, and 1068). We anticipate these regulations will offset the effects of increased snowmachine and powerboat use anticipated under all three alternatives and may reduce overall pollution levels in the Refuge. Overall, any adverse impacts to water quality from two-stroke engines as a result of Refuge actions would likely be of short or moderate duration and negligible.

Under all alternatives, rainbow trout will continue to be periodically restocked in Hidden Lake (previously unpopulated by this species) (ADF&G 2007). A number of negative impacts to native aquatic ecosystems can occur when fish species are introduced to waters that historically did not support such populations. These include negative impacts to amphibians, invertebrates, and large zooplankton (Braña et al. 1996, Dunham et al. 2004). These impacts can range from reduced survival and productivity to complete elimination of native species. These impacts, in turn, affect populations of other predators such as other fish and birds and cause an overall loss of biodiversity. Introduced trout can alter nutrient cycles, productivity, and community structure either by acting as nutrient sinks or by removing nutrients from lake systems altogether (Dunham et al. 2004).

No monitoring has been conducted to determine the impacts of fish stocking to the Hidden Lake water quality or aquatic habitat. This lake is an isolated waterbody not connected to other streams or lakes, and any impacts that might have occurred presumably have stabilized. There have been no reports of escaped rainbow trout occurring in the Refuge outside of Hidden Lake. While continued stocking could have a moderate or even major, long-term negative impact to water

quality and habitat in this lake system, the impacts would be relatively minor in terms of the entire Refuge.

Anglers may be vectors for undesirable pathogens, parasites, and other nonnative species, such as New Zealand mud snails (*Potamopyrgus antipodarum*), which are rapidly spreading throughout waters in and adjacent to Yellowstone National Park (Richards et al. 2001). Anglers also create trails to and around lakes that can damage riparian vegetation, which, in turn, decreases bank stability and increases erosion thereby reducing water quality.

Outside the Alaska Highway corridor, the majority of human activities taking place within Tetlin Refuge occur on or adjacent to some type of waterbody. Wildlife use riparian zones disproportionately more than any other habitat type, and associated species are particularly vulnerable to the effects of recreational activities concentrated in these zones (Gaines et al. 2003). Under all alternatives, the Refuge will continue to provide and promote public access by watercraft. These uses can reduce marsh and bank vegetation and cause bank erosion, and thereby negatively impact important habitats for semi-aquatic mammals such as beaver, muskrat, river otter, and mink (Waller et al. 1999). Habitat for beaver and muskrat especially may be the most impacted semi-aquatic mammal because of their obvious presence (e.g., dams, lodges, push-ups) on waterways or lakes. For example, boaters may destroy beaver dams deliberately or unintentionally to gain access to a beaver pond or other stream sections (Waller et al. 1999).

5.2.2.4 Vegetation and Terrestrial Habitats

Under all alternatives, human activities will have a number of effects on vegetation including: 1) direct effects of trampling; 2) indirect effects of soil and snow compaction; 3) removal of small stems in the shrub layer; 4) mutilation or vandalism of larger or mature trees; and 5) possible introduction of invasive plants.

As visitation to currently undisturbed areas of the Refuge increases under all alternatives, the likelihood of invasive plants being introduced will also increase. Invasive plants are most likely to become established in areas where native vegetation has been disturbed (e.g., burned areas, flooded gravel bars, cabin sites, campgrounds, hiking trails, snowmobile trails, roads, and fire suppression lines). Most invasive plant species also need some form of transportation to reach new areas. These modes of transportation or “vectors” continually travel throughout the Upper Tanana Valley in the form of highway vehicles, boats and boat trailers, aircraft, people, pets, stock, and fire fighting equipment, most of which originate in other states or countries.

Existing facilities maintained by the Refuge and new improvements or facilities proposed under all alternatives (e.g., Seaton Roadhouse, campground facilities, and interpretive trails) will have or will continue to have major long-term negative impacts on vegetation at the site-specific scale as the actual trail, campsite, or other development results in removal of nearly all vegetation. The analyses under each alternative deal primarily with potential impacts to vegetation resulting from use and activities associated with these trails, campsites, and other developments. Areas around these facilities are seasonally trampled, and new facilities will require removal of vegetation. It is also possible more unwanted trails between sites will develop in recreation areas, causing increased trampling and disturbance and thereby increasing the opportunity for the spread of invasive plants. Camping and campgrounds can cause direct changes in bird habitat, followed by indirect changes in species diversity and abundance (DeLong 2002). Some forest birds, such as American robins, are attracted to campgrounds that occur within riparian areas along roads and trails (Blakesley and Reese 1988, Marzluff 1997). In contrast, species that are ground- or shrub-

nesting and ground-foraging are often missing from campground areas (Blakesly and Reese 1988). Species such as the black-capped chickadee, fox sparrow, and song sparrow have been shown to be negatively associated with campgrounds due to both displacement and habitat loss (see summary by Gaines et al. 2003). In the long-term, the effects of continuous campground use will likely inhibit seedling reproduction and soil structure, resulting in a reduced area of plant cover. The resulting bird community will decrease in species diversity and density, and only the most strongly human-attracted species are likely to persist (Garton et al. 1977).

Access into previously undisturbed areas of the Refuge could contribute to fragmentation of limited, high-value habitats, causing some of the most severe impacts to songbirds (Hamann et al. 1999). Many songbirds are primarily restricted to riparian habitats (Hutto 1995). Roads and trails break up forest patches and increase nest predation and parasitism rates (see summary by Gaines et al. 2003). Fragmentation of riparian habitats with corridors (e.g., trails, roads) also affect songbirds on a landscape scale (Hamann et al. 1999).

5.2.2.5 Fish Populations

Management that affects the location, distribution, or level of public use can have some influence on fishery resources. Indirect disturbances are commonly associated with access and boating (Delong 2002). Under all alternatives, we anticipate that any direct disturbances and mortality associated with changes in public use would have a relatively minor impact to fish populations.

Continued restocking of rainbow trout at Hidden Lake is expected to have minor, if any, impacts on other fish populations within the Refuge, unless stocked fish escape and become established in waters outside Hidden Lake. The State's fish stocking program could potentially reduce harvest of natural fish stocks on the Refuge. In light of the fact that Hidden Lake lacks surface connection to other water bodies and ADF&G's rainbow stocking programs in other lakes in the Upper Tanana River Valley have not been known to result in trout escaping or establishing populations outside of stocked waters, the potential for establishment of rainbow trout on the Refuge appears minimal.

5.2.2.6 Bird Populations

Tetlin Refuge was set aside in part for its unique waterfowl values, and opportunities for continued traditional subsistence harvest of resources such as waterfowl is one of the purposes for Tetlin Refuge. While hunting and other public uses within the Refuge do affect individual birds, these activities are not currently negatively affecting bird populations.

Recent amendments to subsistence migratory bird harvest regulations for Alaska, made pursuant to changes in the Migratory Bird Treaty Act, initially went into effect in 2003. They allow eligible rural Alaska residents to harvest 92 species of migratory birds and their eggs within the Refuge between March and September of each year without bag limits. The potential for increased harvest of migratory birds resulting from these regulation changes will have unknown impacts on the long-term health and stability of bird populations within Tetlin Refuge. Regular monitoring of certain species of waterfowl will indicate if changes in population levels occur and will be used to evaluate the impacts of hunting and other factors over the next 10 to 15 years.

General impacts to birds and bird populations caused by public uses include:

- Direct mortality from hunting
- Displacement from important feeding, nesting, and breeding habitats
- Reduced foraging time (due to displacement and disturbance) and subsequent reduction in fat reserves needed during migration and breeding

- Reduced resting periods
- Reduced nesting success and brood survival
- Increased predation of eggs and/or hatchlings
- Habituation to human activities/disturbances

New public use facilities along the Alaska Highway corridor are proposed under all alternatives. These facilities, including interpretive pullouts, trails, boardwalks, upgraded campgrounds, wildlife observation blinds, and parking lots, would result in increased human use and have the potential to affect birds on a site-specific and localized scale. Direct impacts cause physiological effects, behavioral modifications, or death. Indirect impacts are identified as alterations to habitat, such as availability of food, shelter, and living space. Public use activities can also affect productivity of waterfowl and colonial waterbirds resulting in fewer numbers of breeding pairs, nest abandonment, egg mortality owing to exposure, increased predation of eggs and hatchlings, breaking up or scattering broods, lower feeding rates on wintering and staging grounds, and avoidance of otherwise suitable habitat (Hamann et al. 1999, summary by Gaines et al. 2003). Some species known to be impacted by human activity include the common loon, trumpeter swan, and harlequin duck (Hamann et al. 1999, Gaines et al. 2003). Diving ducks (e.g., lesser scaup, common goldeneyes) are especially vulnerable to disturbance (Hamann et al. 1999). Waterbirds (e.g., plovers, sandpipers, phalaropes, gulls, terns) are also negatively affected by activities that cause shoreline degradation, and disruption of nesting and feeding areas. Threshold responses vary within a species, between species groups, and with duration and location of the disturbance. For example, Titus and VanDruff (1981) reported that population characteristics, nest and egg production, nest and egg losses, flushing distances, and hatching and brood rearing success for common loons was influenced by human activities such as hiking and boating, regardless of activity intensity.

Within the last 20 years, more people have begun to participate in non-consumptive wildlife activities (e.g., observing, photographing wildlife). Approaching birds on foot can be the most disruptive aspect of the usual visitor activities (Klein 1993). Wildlife photographers in particular create the most disruption as they are most likely to stop, leave their vehicles, and approach wildlife. Photographers and birdwatchers often get too close to nesting, brooding, or foraging birds, forcing them to shift habitats or abandon nests (Sexton 2005). Some species groups appear to be more tolerant of human activity than others. For example, woodpeckers and secondary cavity-nesting birds as a group do not appear to be affected significantly by disturbance from recreation. However, raptors appear to be sensitive to many disturbances, both recreational and other, during the breeding season (Hamann et al. 1999). During courtship and nest building, raptors are extremely sensitive to disturbance and may abandon nest sites (Hamann et al. 1999). Reported responses of bald eagles to disturbance included spatial avoidance of activity and reproductive failure, although in some cases, eagles tolerate human disturbances (see summary by Gaines et al. 2003).

It is possible the influence of recreational trails on bird communities is due to the combination of the physical presence of the trail and the associated human disturbance (Miller et al. 1998). In some areas, impacts to bird abundance, species composition, and nest predation were related to the distance from a heavily-used recreational trail (Miller et al. 1998).

Under all alternatives, the Refuge will continue to provide and promote public access by watercraft. How wildlife respond to boat use is based on boats size, speed, amount of noise they make, and how close they get to wildlife (DeLong 2002). Canoes and small boats, because of their shallow draft, can penetrate farther into the shallows and cause considerable disturbance to

nesting waterbirds (Speight 1973). In some cases, however, habituation may occur and negate impacts of canoeing disturbance (Hulbert 1990). Rapid movement and loud noise (e.g., power boats, airboats, aircraft on floats) are generally the most disruptive to waterfowl, followed by movement with little noise (e.g., sailing, rowing, canoeing) (Dahlgren and Korschgen 1992). The presence of fast-moving boats also caused the most significant modifications to the amount of time animals spent feeding and resting (DeLong 2002).

Environmental education programs, coupled with the use of observation and photography blinds or guided tours will continue under all alternatives and could help mitigate some negative impacts from public use of the Refuge.

5.2.2.7 Mammal Populations

Management actions by the State and other authorities make it difficult to anticipate the overall impacts of the Plan alternatives on wildlife populations. For example, in 2004 and 2005 the State of Alaska began multi-year wolf and brown bear population reduction programs in GMU 20E and northeastern GMU 12 adjacent to Tetlin Refuge. Wildlife populations that occur on Tetlin Refuge will likely be affected by these and other large-scale management efforts in the future; however, the long-term implications are unknown. Below is a brief summary of the type of impacts anticipated as a result of public use under all alternatives for those species or groups of species for which information is available. Typically, the impacts to mammal populations from actions relating to facilities and public use occur either directly—as wildlife are removed through hunting or displaced by other activities—or indirectly, as habitats are altered or impacted sufficiently to cause changes in behavior, productivity, or survival of these species or the relationships between them. The reader should keep in mind that other species may be positively or negatively impacted, but assessing such impacts would be speculative.

A number of studies have substantiated differences between harvested and unharvested wildlife populations, in which harvested populations functioned differently. For example, hunted populations of ungulates are more wary, stay closer to cover, and feed in the open mainly at night (King and Workman 1986). Under all alternatives, direct and indirect impacts from hunting will continue.

Public use activities proposed under all alternatives can have different effects on different mammal species. For example, some species of wildlife have been found to avoid snowmobile trails while others gain increased mobility by accessing trails (Neumann and Merriam 1972).

Wintertime public use activities (e.g., snowmobiling, cross-country skiing, snowshoeing, skijoring, and dogsledding), although currently at low levels on the Refuge, have the potential to increase with improved trail access proposed in all alternatives of this Plan. Some studies have shown that cross-country skiers and snowshoers can be as disrupting or possibly more disrupting to wildlife than snowmobiles (see summary by Canfield et al. 1999; Reimers et al. 2003), suggesting that the most detrimental disturbances to wintering wildlife may be unanticipated (Parker et al. 1984). The effects of recreational dogsledding and skijoring on wildlife have not been specifically addressed, but observations indicate that dog teams cause greater disturbance to caribou than snowmobiles (Powell 2004). In general, domesticated dogs can disrupt habitat use, cause displacement, and injure or kill wildlife (Sime 1999). Domestic dogs can also potentially introduce various diseases (i.e., canine distemper, rabies, parvovirus, leptospirosis, giardia, and muscle cysts) (Sime 1999); and transport parasites (i.e., ticks, keds, tapeworms, and fleas) (Thorne et al. 1982) into wildlife habitats.

5.2.2.8 Small Mammals

Snowmachine use contributes to snow compaction, which may affect small mammals that burrow in the snow or under the ground. Small mammals can suffocate as a result of the compaction, and their movements can be altered owing to impenetrable compact snow (Gaines et al. 2003).

5.2.2.9 Wolf, Fox, Coyote, and Lynx

Coyotes and red fox coexist readily with humans and do not appear to suffer adverse effects from human related activities other than hunting and trapping. Human activities that compact snow provide easy travel routes for wolves into areas that would otherwise be difficult to reach in deep snow (Paquet et al. 1996). Wolves and coyotes commonly use human travel routes such as roads, snowmobile trails, and cross-country ski trails; they may seek them out preferentially (Claar et al. 1999, Crête and Larivière 2003), which may, in turn, alter competitor/predator communities—particularly in areas not normally accessible (Koehler and Aubry 1994, Buskirk 1999, Ruediger et al. 2000). Mowat et al. (1999) reported that lynx appeared to tolerate moderate levels of snowmobile activity and human presence.

5.2.2.10 Ungulates (Moose and Caribou)

Ungulates generally respond to recreational activities by avoiding areas near roads, recreational trails, and other types of human activity (see summary by Gaines et al. 2003). Displacement by snowmobiles and avoidance along trails has been documented for ungulates (Dorrance et al. 1975, summary by Powell 2004). Snow compaction caused by snowmobiles also has effects; the energy cost for caribou digging through snow compacted by a snowmobile to reach forage buried underneath was 2-4 times as great as for uncrusted snow (Fancy and White 1985). As previously discussed, wolves and coyotes also utilize winter routes compacted by snowmachines or other uses. This may increase predation on ungulates by wolves (O’Karma et al. 1995). Bergerud and others (1984) noted that wolf use of snowshoe trails, roads and seismic lines may give a hunting advantage and possibly lead to caribou avoidance of trails.

Bergerud and others (1984) also suggested that caribou can withstand periodic severe disturbance without harmful effects on productivity and survival. However, persistent energy expenditure may ultimately have negative consequences, and there is no consensus on whether or not caribou can habituate to human activities in key habitat (Powell 2004). Moose do appear to show some tendency for habituation to humans, although flight and stress response in moose are most likely when disturbances are unpredictable, intense, and in close proximity (Olliff et al. 1999). However, moose densities have also shown to be significantly different between disturbed areas and those located in more inaccessible areas (Hancock 1976).

5.2.2.11 Bear and Wolverine

Trails and roads have been shown to displace both black and brown bears (Claar et al. 1999, summary by Gaines et al. 2003). Sharp increases in visitation can cause increased bear-human conflict (DeBruyn 1999), overcrowding, habituation of bears to people, and displacement of bears from important habitats (National Park Service 1996). Winter public use activities can disturb bears in winter dens (see summary by Gaines et al. 2003) and displace wolverines from important natal dens in subalpine cirques (Hornocker and Hash 1981, Copeland 1996). Other impacts to bears from increased human access include increased potential for harvest, collisions with vehicles, and chronic negative human interactions at campgrounds and campsites accessible by roads or trails. Many human-bear conflicts involve food-conditioned bears seeking human foods or bears seeking natural foods within developed areas and along roadsides (Gunther 1994). Food-

conditioned bears are more likely to seek food from people, cause damage to property, and be killed (Herrero 1985). Bears occupying multiple-use and other highly impacted habitats can become negatively conditioned to humans, resulting in loss of habitat and foraging opportunities (Kasworm and Manley 1990, Mace and Waller 1996).

5.2.3 Impacts to the Human Environment

5.2.3.1 Local Economy

Seasonal fire management projects will continue to have a minor to moderate positive impact on the local economy under all alternatives. The Refuge will continue to work with local communities and businesses when possible to complete mechanical thinning projects for reducing hazardous fire fuels and for aerial fire detection and monitoring when Refuge aircraft are unavailable. Lands in the northern portion of the Refuge and along the Alaska Highway will remain in either the Full or Modified Suppression option under all alternatives. Tok Forestry Division of Natural Resources will continue to employ seasonal firefighters to suppress fires in these areas. Emergency fire fighting employment will continue to play a role in local economies; however, the work will remain seasonal and intermittent.

Additional short interpretive trails, development of the Seaton Roadhouse site, and Refuge administration of the planned Tok Interagency Alaska Public Lands Information Center (Tok APLIC) will create additional day-use recreational opportunities which, in turn, could encourage visitors to spend more time and money in and around local communities. Visitors spending additional time in the Upper Tanana Valley will presumably result in more frequent overnight stays, additional multi-night stays, and increased spending at area businesses. The additional staff and Refuge funding needed to provide and maintain these facilities will also generate new job opportunities and increase spending in local communities. Because this increase in Refuge spending for visitor facilities and maintenance is part of all three alternatives proposed in this Plan, estimates are not provided as part of this analysis.

5.2.3.2 Cultural Resources

It is our trust responsibility on Refuge lands to assess the impacts of any management decision that may affect cultural resources. The Service definition of cultural resources includes archaeological resources, historic properties, cultural items, and traditional/religious values. Traditional values are defined as places or resources that are deemed to be important and integral to maintaining a Native American tribal group's traditional culture or religion (614 FW 1.7C[5]). Many local residents value important places and sites not only for their historic value, but also for their association with subsistence resources and uses.

The majority of archaeological resources, historic properties, and cultural items currently identified within the Refuge will remain within existing areas of Modified or Full fire suppression under all alternatives. Prescribed burns, thinning, and other management actions will continue to be used to protect identified cultural resources. Potential impacts to cultural resources from prescribed burning (e.g., unintentional burning of unidentified cabins or other structures) and fire suppression actions (e.g., inadvertent alteration of historic trails or other sites through fire line construction) will be mitigated to the extent possible by following the guidance in various acts, regulations, and Service policies outlined in the Alaska Interagency Wildland Fire Management Plan, the Tetlin Refuge Cultural Resource Guide, the Tetlin Refuge Fire Management Plan, site-specific burn plans, and other Refuge planning efforts that identify and prioritize cultural resource sites and artifacts and define contemporary uses.

The traditional value of many cultural sites is linked to the current seral stage of the forest. Over time, it will become increasingly difficult to unnaturally maintain the seral stage and associated cultural values of many sites by excluding fire. Even if fire is successfully excluded from a site, other natural disturbances such as insect infestation, disease, and subsequent die-off and wind-throw will eventually alter it. By attempting to maintain a balance among varied seral stages throughout the Refuge, we are much more likely to succeed over time in supporting the connection between the past and the present, the land and the people—despite alteration or loss of certain resources or specific sites where activities have traditionally occurred.

5.2.3.3 Subsistence Opportunity

Most subsistence activities occur within the Alaska Highway corridor, along river corridors, and in the northern portion of the Refuge. Most Refuge lands in these areas will remain under Full or Modified fire suppression options under all alternatives. Impacts to vegetation, terrestrial habitats, and mammal populations described previously under the discussion of fire and fire suppression impacts common to all alternatives (Section 5.2.1) could, over time, reduce the amount of some resources available for subsistence use but could also increase the availability of other resources. While these impacts may have only a minor effect on Refuge habitats and wildlife populations as a whole, they will occur primarily in areas of relatively high subsistence use.

Local residents have expressed concerns relating to competition and conflict in areas traditionally used for subsistence as a result of improved access and increasing visitor use since the establishment of Tetlin Refuge (Halpin 1987). Access and opportunities for public use will continue to expand under all alternatives. The resulting increase in use will create some competition between local rural subsistence users and non-local recreational users under all alternatives. Most impacts are anticipated to be associated with expanded use of existing facilities, improved access, and new public facilities. However, most impacts will occur during brief periods in spring and fall when subsistence activities and recreational uses overlap. None of the alternatives are anticipated to result in impacts that would significantly restrict subsistence use within the Refuge. The Refuge will continue public education and outreach to mitigate potential impacts.

Development of the Seaton Roadhouse site will create concentrated summer visitor use in this relatively small (120-150-acre) area within the Refuge. The short half-mile interpretive trail near the Tetlin Refuge Visitor Center will also result in additional summer use of the Refuge. Because subsistence activities in and around these locations occur primarily in early spring, fall, and winter, there will be minimal competition with recreational users. Instead, the development of these sites will more likely result in improved access for subsistence users. The Seaton Roadhouse site has been traditionally used for the harvest of certain subsistence resources. As we anticipate few conflicts with other users, improvements to the access road, parking area, and other facilities proposed at this site would likely result in a long-term, minor increase of spring, fall, and winter subsistence opportunities for local residents.

5.2.3.4 Visitor Services and Recreation Opportunities

Environmental Education and Interpretation. Tetlin Refuge will create opportunity for a distinct interpretive experience by maintaining the Tetlin Refuge visitor center, interpretive panels, kiosk, and trails; managing the planned Tok APLIC; and constructing additional short interpretive trails. Each interpretive facility will focus on a special feature under the overarching theme of natural history in the Upper Tanana Valley. The interconnected and thematic nature of these facilities will encourage visitors to stop at multiple facilities for longer periods of time during their

trip through the Upper Tanana Valley and could attract other visitors who would not otherwise stop at unrelated or random facilities along the highway.

Under all alternatives, the planned Tok APLIC will have the capacity to provide off-Refuge interpretive and environmental education opportunities for more than 2,000 visitors per day (which exceeds projected visitation during the life of this Plan and allows for long-term future growth in tourism). The interpretive theme and facilities of the planned Tok APLIC will differ from those of the Tetlin Refuge Visitor Center near the Alaska-Yukon border and we anticipate visitation will be additive rather than compensatory. We estimate actual visitation to the Tok APLIC and Tetlin Refuge Visitor Center will approach 60,000 to 80,000 visitors annually by year 2020 as annual summer highway use increases to between 225,000 to 250,000 people (Bowker et al. 1999). While this is a rough estimate, we believe it is conservative considering current visitation to comparable facilities such as the Kenai Visitor and Cultural Center, which has averaged just over 50,000 visitors annually since it opened in 1992; and visitation rates of 60 to 80 percent of all travelers were reported for visitor centers in Yukon Territory, Canada (Government of the Yukon Department of Tourism 1999).

The suite of existing and proposed facilities will also improve the Refuge's ability to provide greater variety through current and new environmental education and interpretive programs. These programs will include expanded opportunities for interpretive talks and walks; self-guided walks and audio tours; and new opportunities through audio visual programs, interpretive exhibits, and K-12 outdoor classes previously not possible. The planned Tok APLIC and associated network of trails in Tok will greatly increase the Refuge's ability to provide year-round interpretive programs to visitors and local residents and to continue building upon an already strong environmental education program for grades K-12 and occasional adult-oriented courses.

Under all alternatives, the existing Tetlin Refuge Visitor Center, the new proposed Tok APLIC, and associated interpretive trail development will have a moderate to major, long-term, overall beneficial impact on environmental education and interpretation within the Refuge and the Upper Tanana Valley due to their ability to accommodate a larger number of visitors while continuing to provide quality opportunities not found anywhere else in the region. These changes would represent long-term positive impacts for both visitors and local residents, with only limited impacts to current refuge users.

Wildlife Observation and Photography. See following discussions under each alternative.

Recreational Fishing. All alternatives allow for continued recreational fishing opportunities throughout the Refuge. Periodic restocking of Hidden Lake, which is allowed under all alternatives, will continue to have a major, medium-term positive effect on recreational fishing opportunities at this lake.

Trapping and Recreational Hunting. See following discussions under each alternative.

5.2.3.5 Opportunity to Engage in Supporting Public Uses

Supporting public uses are those uses and activities that are associated with or necessary for the public to engage in when conducting other compatible uses on the Refuge. In the case of Tetlin Refuge, these compatible uses include recreational fishing, recreational hunting, wildlife observation, wildlife photography, environmental education and interpretation, commercially guided big-game hunting services, commercial transporter services, subsistence activities,

trapping, and State of Alaska management activities (Appendix E). Opportunities for supporting uses of the Refuge will continue with some increased opportunity for hiking along short interpretive trails at the Tetlin Refuge Visitor Center. The development of these public use facilities represent moderate to major, long-term beneficial effects on the amount and type of recreation opportunities provided, but effects will be limited primarily to these specific sites. In terms of the entire Refuge or the region, these affects will be minor.

Refuge administrative cabins and campgrounds will continue to provide opportunities for camping and extended trips in and around the Refuge with the added safety and comfort of permanent structures and associated amenities. As refuge operations and use of the administrative cabins continue to increase over the next 10 to 15 years, the availability of the public use opportunities associated with the cabins could be diminished somewhat. These minor, site-specific negative impacts will occur only occasionally and for short periods, primarily during the fall hunting season.

5.2.3.6 Public Health and Safety

Under all alternatives, the Upper Tanana Valley will continue to be affected by smoke from wildland fires. Occasional large fires within the Refuge may contribute the majority of smoke during brief periods, resulting in moderate to major, short-term adverse effects on local air quality. The majority of smoke over the next 10 to 15 years will continue to come from off-Refuge fires in the Tanana Valley and elsewhere across interior Alaska. There are two sources of health and visibility hazards produced by forest fire smoke: water vapor and particulate matter (Achte-meier et al. 1998). Water vapor is important because it can affect visibility near a fire. Particulate matter can be released in large amounts by smoke emissions and can make up approximately one to three percent of the total mass released (Achte-meier et al. 1998). The U.S. Environmental Protection Agency (EPA) has the responsibility under the Clean Air Act to propose, revise, and promulgate National Air Quality Standards. However, the EPA does recognize that conflicts between natural resource objectives and air quality objects can and do exist (Achte-meier et al. 1998).

Smoke impacts include the following:

- Respiratory health hazards
- Reduced highway visibility
- Reduced aviation visibility
- Viewshed degradation.

Overall air quality is not anticipated to be substantially affected by actions in Alternative A, B, or C. Some prescribed fires and wildland fire-use fires will have moderate to major, short-term adverse effects on air quality in localized areas near active fires, but long-term effects will remain minor to negligible as fires throughout Alaska and parts of Canada continue to contribute the majority of smoke and result in far greater impacts to regional air quality. Anticipated differences in impacts attributable to refuge management actions are described in the following discussions of alternatives.

5.3 Anticipated Impacts of Alternative A (Current Management)

The reader should keep in mind the following section discusses several impacts that in addition to those discussed previously under section 5.2 Impacts Common to All Alternatives.

5.3.1 Impacts to the Physical and Biological Environment**5.3.1.1 Permafrost and Soil**

Refer to previous discussions under section 5.2 Impacts Common to All Alternatives.

5.3.1.2 Air Quality

Refer to previous discussions under section 5.2 Impacts Common to All Alternatives.

5.3.1.3 Water Quality and Aquatic Habitats

The introduction of fish to three land-locked lakes within the Refuge would likely cause negative impacts to aquatic habitats as described previously under facilities and public use impacts common to all alternatives (section 5.2.2). When considering the entire Refuge, impacts to native habitats, natural diversity, and ecological stability would likely be only minor to moderate unless stocked fish escape the stocked waters and become established in other waterbodies. These localized impacts from stocking rainbow trout in three lakes, as allowed in Alternative A, and the potential for escapement of stocked fish to other unstocked waters on the Refuge, would be greater than the potential or anticipated impacts from Alternative B (Preferred Alternative) or Alternative C, which would limit the State's restocking program to one lake.

5.3.1.4 Vegetation and Terrestrial Habitats

Fire would be managed as a natural part of the boreal forest ecosystem over most of the southern portion of the Refuge, helping to perpetuate a mosaic of vegetation in various stages of succession. Impacts of wildland fire and prescribed fire would be as described previously under fire and fire suppression impacts common to all alternatives (section 5.2.2). Prescribed fire would be used more frequently and in larger areas than under Alternative B (Preferred Alternative) or C.

Where prescribed fire is applied continually to maintain the proposed 13-mile-long fuel break south of Northway, regular burning would artificially maintain these habitats in an earlier stage of forest succession where white and black spruce would not be allowed to become established as the dominant overstory species. These changes represent moderate, long-term negative impacts at a localized scale, but overall a relatively minor impact to habitats, as the total area burned to maintain the fuel break would remain less than two percent of lands managed by the Refuge.

Minor to moderate, long-term, localized adverse impacts from the use and development of public facilities discussed under actions common to all alternatives (section 5.2) would be at those sites where facilities are developed and public use increases due to easier and more publicized access.

5.3.1.5 Fish Populations

Under this alternative, the Refuge would seek to manage Arctic grayling and northern pike populations to provide trophy recreational fishing opportunities. Fish populations are typically comprised of several age groups, with younger and smaller fish making up the largest proportion of the total population. This distribution is part of a healthy and relatively stable aquatic ecosystem with natural fluctuations occurring over time. This alternative would redistribute the population of these fish species toward older, larger fish. This, in turn, would lower the abundance of fish as the larger fish consume a greater proportion of the available food and nutrients, which would disrupt the current balance within the food chain and could decrease the diversity of these systems as other species are displaced or eliminated by competition from larger Arctic grayling

and northern pike. These actions would result in a, moderate to major, medium-term, localized adverse impact to fish populations within drainages where this management direction is applied.

5.3.1.6 Bird Populations

Long-term adverse impacts from the use and development of public facilities discussed under actions common to all alternatives (section 5.2) would likely be moderate at specific sites associated with campgrounds, trails, and canoe routes, and more minor at the larger local scale. Direct impacts to the feeding and nesting birds would occur as wildlife observation, photography, and boating increase and are introduced into previously inaccessible areas of the Refuge. Indirect impacts as a result of these disturbances would include reduced fitness, productivity, and survival. Major short-term or moderate-term impacts to bird populations could occur as a result of increased waterfowl harvest and/or hunting pressure. However, the Refuge would seek to mitigate such adverse impacts by submitting proposals to alter Federal migratory waterfowl hunting seasons and harvest limits as appropriate and necessary.

5.3.1.7 Mammal Populations

Impacts would be similar to those described previously under facilities and public use impacts common to all alternatives (section 5.2.2) and would remain confined to trail corridors, waterways, campgrounds, pullouts, visitor centers, and the Seaton Roadhouse site. We anticipate these minor to moderate adverse impacts would be primarily seasonal and short-term in nature as summer visitation to trails and waterways within the Refuge increases, and impacts would likely be confined to only specific sites or areas where public use occurs and where facilities are located or planned to be constructed. When compared with Alternative B (Preferred Alternative) and Alternative C, this alternative would have the least impact to mammal populations within the Refuge.

5.3.2 Impacts to the Human Environment

5.3.2.1 Local Economy and Commercial Uses

Fires that burn over trapping areas may cause some loss of capital improvements (e.g., shelters, caches), increased labor of re-clearing trails or establishing a new trapline, and potential loss of future income until furbearer numbers return to pre-burn levels (Stephenson 1984). Because participation in trapping is currently low, these medium or long-term, site-specific negative impacts would be important to a few individuals, but relatively minor in terms of the local economy as a whole.

Information relating to economic impacts of lake stocking throughout Upper Tanana Valley was used to estimate the effects of stocking additional lakes within Tetlin Refuge. In a report prepared for ADF&G, it was estimated the 42 rural stocked lakes in the Upper Tanana Valley create 2,569 angler fishing days and an economic effect of \$165,169 annually (Northern Economics 2004). Taking these figures and subtracting the estimated costs for hatchery rearing and fish transportation we estimate the net economic effect of three additional stocked lakes within the Refuge (as proposed under this alternative) to be approximately \$6,000-\$7,000 annually. However, these estimates do not take into account long-term costs such as administrative overhead, law enforcement, vehicles, eventual hatchery replacement, or potential damage to native lake ecosystems as a result of fish stocking. These costs can easily double the total cost of lake stocking and lead some to question the cost effectiveness of hatchery programs for catchable fish (Dunham et al. 2004). In the case of Tetlin Refuge, doubling the total stocking costs under this alternative would result in a net economic gain of approximately \$1,000-\$1,500 annually. Even

with three additional lakes stocked as proposed under this alternative, the long-term overall benefit to the local economy would be minor or negligible.

Current commercial uses, in the form of big-game guides and transporters (both air-taxi and boat operators), would continue. These services are considered necessary for providing wildlife-dependant recreational opportunities to certain segments of the public that would otherwise be unwilling or unable to visit Tetlin Refuge. Other compatible commercial uses would continue to be allowed on a case-by-case basis throughout the Refuge.

Full implementation of this alternative would increase spending to meet prescribed burning objectives within the Refuge. Current data are not sufficient to calculate actual economic value of these increases to local communities, but full implementation of this alternative would increase Refuge spending in the local area by an estimated \$176,000 to \$193,000 per year. Overall, the stocking of additional lakes within the Refuge and spending associated with fire management and suppression capabilities represent a beneficial, but relatively minor, long-term impact on the local economy. This alternative represents the least overall impact to the local economy when compared with Alternatives B (Preferred Alternative) or Alternative C.

5.3.2.2 Cultural Resources

Mitigation measures described previously under impacts common to all alternatives (section 5.2) do not necessarily assure all cultural resources would remain undisturbed. When compared with Alternatives B (Preferred Alternative) and Alternative C, the amount of construction and facilities development proposed under this alternative is least likely to result in disturbance of cultural resources. This alternative proposes the least amount of fire suppression activities that may result in a greater number of cultural sites being affected by prescribed fire or wildland fire use, but, conversely, the least likelihood of direct impacts from suppression activities such as the digging of fire lines and the clearing of landing sites and campsites. Overall, these actions, especially the limited use of mechanical or manual fire suppression actions, would result in a minor to moderate, long-term beneficial impact to cultural resources associated with individual sites.

5.3.2.3 Subsistence Opportunity

Deadfalls and wind-throw from prescribed burning and wildfire under this alternative could impede access to traplines and traditional subsistence use areas within the Refuge. Long-term benefits to the health and diversity of subsistence resources throughout the Refuge would outweigh the short-term costs of reduced access to these specific areas.

The increased number of lakes within the Refuge stocked with fish, while primarily for recreational purposes, would also provide subsistence users fishing opportunities where none previously existed. These lakes would be selected based upon their isolation from other waterbodies and ease of access from the Alaska Highway, and it is anticipated they would be used on a year-round basis. Because suitable lakes are typically shallow, have no outlet or inlet streams, and have not historically supported fish populations, we anticipate low overwinter survival and limited growth in these fish. The resulting long-term increase in subsistence opportunity at these individual lakes would be relatively minor compared with the more abundant natural and traditional fish resources found in various other lakes and the Tanana River and its tributaries.

Overall, we anticipate fire and fisheries management actions under this alternative would have minor to moderate, short-term impacts on subsistence. We also anticipate minor to moderate,

long-term, positive effects from improved access at the Seaton Roadhouse site, and maintaining species and habitat health and diversity at the larger local and Refuge-wide scales.

5.3.2.4 Visitor Services and Recreation Opportunities

Overview. A key element of providing visitor services under this alternative would be the maintenance and administration of the Tetlin Refuge Visitor Center, Lakeview and Deadman Lake campgrounds, and development of the Seaton Roadhouse site. These facilities would help meet visitor demands for semi-primitive camping and day-use hiking opportunities, which have been consistently expressed through public comment to Refuge staff and registers at the Tetlin Refuge Visitor Center and campgrounds.

The Refuge would continue to maintain existing facilities and also provide new recreational opportunities through the stocking of fish in additional lakes and the construction of various facilities previously described. These additional recreational opportunities would be similar to those already available in the region and would do little to meet demand for other types of recreational activities or other recreational settings. The increased capacity created through this alternative would allow current visitor experiences to be maintained.

Environmental Education and Interpretation. Under this alternative, one or two short interpretive trails and other supporting facilities at the Seaton Roadhouse would be constructed. When compared with Alternative B (Preferred Alternative) and Alternative C, this alternative proposes facilities but on a smaller scale and would, therefore, provide opportunities primarily for short-term use (20-60 minutes for the average visitor) with no facilities for overnight camping or extended stays. As such, these facilities would have a moderate, site-specific, beneficial impact on environmental education and interpretive opportunities but a minor effect in terms of the entire Refuge and the overall public use program as most interpretation would likely be opportunistic during the day (as staff interpreters encounter visitors) or indirect (through signs, brochures, or other media).

Wildlife Observation and Photography. Opportunities for wildlife observation and wildlife photography will increase largely due to the construction of facilities (see previous discussion in Chapter 2 of Public Use Facilities and Access as part of Alternative A). Visitors participating in wildlife observation and wildlife photography will have some opportunities to experience a relatively quiet, semi-primitive setting. Due to the proximity of these new facilities to the Alaska Highway, the species of wildlife seen would most likely be those most habituated to human disturbance and activities and most commonly seen from highways throughout northern Canada and interior Alaska. However, the availability of short trails and viewing areas will provide visitors a safer and quieter environment in which to observe and photograph these species in their natural habitats. The experience at these sites would be similar to those available at existing facilities such as the Hidden Lake trail or Lakeview and Deadman Lake campgrounds; as a result, the actions under this alternative would likely result in a minor, long-term benefit to wildlife observation and photography opportunities at these sites.

Recreational Fishing. The addition of up to three highway-accessible stocked lakes within the Refuge would only slightly increase the recreational fishing opportunities in the Upper Tanana Valley. In a report prepared for ADF&G, it was estimated the 42 rural stocked lakes in the Upper Tanana Valley create 2,569 angler fishing days (Northern Economics 2004). Using these figures, it is estimated that the addition of three stocked lakes would result in an additional 184 angler

fishing days each year. While precise numbers are not available, a certain number of these angler days would result from use by local residents.

This alternative would also seek to establish trophy recreational fishing opportunities for northern pike and Arctic grayling within the Refuge. The most cost-effective means of accomplishing this objective would be through proposals to the Alaska Board of Fisheries for the establishment of reduced recreation harvest limits, adjustments of fishing seasons, changes to allowable gear types, or catch-and-release regulations—all of which could result in larger fish. By leaving these larger fish in the population, trophy recreational fishing opportunities could be provided even with increased fishing pressure. However, these fish populations would continue to be harvested under Federal subsistence regulations that would not include similar measures. Anecdotal information indicates northern pike may have decreased in size over the past several years (Friend, C. and R. Mason, 2001). Therefore, regulations passed by the Board of Fisheries would likely have only a minor to moderate impact on the number of larger-than-average fish necessary to provide trophy recreational fishing opportunities. Overall, we anticipate this alternative would have a minor to moderate, medium-term, beneficial impact on recreational fishing opportunities within localized areas where these management strategies would be applied.

Trapping and Recreational Hunting. Direct effects on trapping and recreational hunting opportunities would be negligible under this alternative. Existing supporting facilities such as boat launches, remote cabins, undesignated winter trails and commercial big-game guide services would maintain current access, opportunities, and visitor experiences. However, trapping and hunting opportunities would be indirectly affected by changes in wildlife populations and availability resulting from proposed fire management actions, which were addressed previously.

5.2.3.5 Opportunity to Engage in Supporting Public Uses

Deadman Lake and Lakeview campgrounds would continue to accommodate tent camping and smaller recreational vehicles. Visitors at these facilities would continue to have opportunities for quiet and occasional solitude in a rustic, semi-primitive, and scenic setting. Other impacts would be as described in the previous discussion of impacts common to all alternatives (sections 5.2).

5.2.3.6 Public Health and Safety

Despite every attempt to predict their outcome and maintain the safest conditions possible, prescribed fires have inherent risks. Weather conditions after ignition may change and potentially cause these fires to increase beyond their intended size and intensity—creating health risks from increased smoke and threatening private property, structures, communities, and other protected resources.

As proposed under this alternative, the use of prescribed fire to establish a large 13-mile-long fire fuel break would presumably reduce the threat of wildfire to the community of Northway and other resources. This fuel break would be relatively permanent and continually in place, thereby reducing the need for additional fire suppression resources able to quickly stop or extinguish nearby wildfires. However, the use of fire to establish this type of physical barrier to fire also has risks. Even the most carefully planned prescribed burn initiated under optimal conditions could escape, causing the very damage it is intended to prevent. Due to these risks, the fuel break would be established some distance (perhaps six to seven miles) from Northway itself and would not protect against wildfires which start inside the break—closer to Northway. Since the original Plan was written in 1987, the proposed 13-mile-long fire fuel break has yet to be fully established due to the lack of adequate funding and conditions necessary to regularly execute safe and effective prescribed

burns. During that time, several wildfires in the southern portion of the Refuge were allowed to burn without posing a threat to the community of Northway or other residences.

The level of risk from fire management direction in this alternative is similar to that from Alternative B (Preferred Alternative), which proposes thinning and other mechanical fuel treatments in conjunction with additional fire suppression resources able to respond more quickly to wildfires in the Northway area. However, due to the specific weather, moisture, wind, and fuel conditions needed for igniting prescribed fires, this alternative is less likely to be fully established even with adequate funding. Overall, the proposed fuel break could have long-term benefit, but it may have a minor or even negligible effect on local public health and safety due to the low likelihood of the fuel break actually being established. When compared with expanded fire suppression on the Refuge as proposed under Alternative C, this alternative presents a slightly higher level of risk in the short-term but a lower level of risk in the long-term.

Based upon highway accident statistics (ADTPF 2004), the amount of vehicle traffic exiting and entering the Alaska Highway to use existing Refuge facilities does not appear to be creating hazardous driving conditions. Enlargement of the parking lot at the Refuge Visitor Center to accommodate additional parking associated with the interpretive trail will improve visibility, and planned exit and entrance lanes at the Seaton Roadhouse site will reduce the potential for congestion and maintain safe driving conditions.

Half of all vehicle accidents in Alaska during 2002 occurred at intersections; however, only 7.2 percent of these accidents occurred at on ramps, off ramps, or driveways (including private residences, businesses, and public facilities). Due to slower speeds associated with these types of accidents, only 0.5 percent were fatal (or roughly five accidents in 1,000). Most vehicle accidents involved passenger cars and light trucks, with motor homes accounting for 0.3 percent of 2002 vehicle accidents in Alaska (ADTPF 2004). Under this alternative, we anticipate the increased risk associated with additional vehicles entering and exiting the Alaska Highway would be negligible or minor, and we anticipate the likelihood these changes would contribute to a fatal accident to be very low.

This alternative would not take additional steps to improve highway pullouts or provide additional facilities. The amount and type of waste currently being deposited at these State-maintained sites would continue to present unsanitary conditions and associated health hazards.

Boat launches maintained by the Refuge (the Chisana River boat launch in particular) would continue to present moderate to major difficulties and safety hazards to the public, resulting in accident or injury due to their poor location and recurring maintenance needs.

5.3.2.7 Cumulative Effects

The primary way this alternative would impact the human environment is through the maintenance and construction of facilities for recreation along the Alaska Highway. The overall area affected by these actions would remain relatively small and primarily outside the Refuge itself. The integrated theme of these facilities would improve the public's ability to enjoy and understand the fish, wildlife, plants, and their habitats within the Upper Tanana Valley and would enhance the overall quality of the visitor experience.

5.4 Anticipated Impacts of Alternative B (Preferred Alternative)

The reader should keep in mind the following section discusses several impacts that are in addition to impacts discussed previously as common to all alternatives (section 2.5).

5.4.1 Impacts to the Physical and Biological Environment**5.4.1.1 Permafrost and Soils**

Refer to previous discussions under impacts common to all alternatives (section 5.2).

5.4.1.2 Air Quality

Refer to previous discussion under impacts common to all alternatives (section 5.2).

5.4.1.3 Water Quality and Aquatic Habitats

Refer to previous discussion under impacts common to all alternatives (section 5.2).

5.4.1.4 Vegetation and Terrestrial Habitats

Fire would be managed as a natural part of the boreal forest ecosystem over most of the southern portion of the Refuge, helping to perpetuate a mosaic of vegetation in various stages of succession. Impacts of wildland fire and prescribed fire would be as described previously under fire and fire suppression impacts common to all alternatives (section 5.2.1). Prescribed fire would be used less frequently and in smaller areas than under Alternative A (Current Management), but more frequently than under Alternative C.

The construction, maintenance and public use of facilities under this alternative would likely have a minor to moderate, long-term, negative impact on vegetation at a localized scale. Public use facilities under this alternative would be similar to, but slightly larger and more extensive than, those proposed in Alternative A, but less extensive than those proposed in Alternative C. Resulting impacts to vegetation and habitats from this alternative would fall between Alternative A (Current Management) and Alternative C.

5.4.1.5 Fish Populations

Refer to previous discussions under impacts common to all alternatives (section 5.2).

5.4.1.6 Bird Populations

Increased wildlife observation, wildlife photography, fishing, and waterfowl hunting associated with the establishment of canoe routes and improved boat access (especially in important breeding or nesting areas) could cause considerable disturbance to nesting birds and reduced productivity. Actions under this alternative would have long-term negative impacts on individual birds and bird populations similar to those discussed under actions common to all alternatives (section 5.2) and Alternative A (Current Management). Due to the expected increase in public use resulting from improved public access to the Refuge, it is anticipated that impacts would be moderate at specific sites such as boat launches and trailheads, and minor at a larger local scale as visitors are provided access to a larger portion of the Refuge through trails and canoe routes. This alternative is anticipated to have a level of impact between that described for Alternative A (Current Management) and Alternative C.

5.4.1.7 Mammal Populations

Trails (especially snowmobile trails) developed for public use would be used by trappers and could increase trapping in areas of the Refuge that are currently undisturbed (Claar et al. 1999). For example, wolverine and marten are renowned for their vulnerability to trapping and susceptibility to overharvest (see summary by Claar et al. 1999). For wolverine especially, researchers have emphasized the importance of untrapped, remote wilderness areas for the long-term viability of

wolverine populations (Hornocker and Hash 1981). The effects of activities that result in increased snow compaction (e.g., snowmobile trails) can also increase competition among wildlife species. For example, deep, low-density snow allows lynx to exploit higher elevation areas during winter that typically exclude competitors such as coyotes; increased competition for food by coyotes may reduce lynx in some parts of their range where snowshoe hare numbers are low (Claar et al. 1999).

The relative inaccessibility of the Refuge and surrounding lands is one reason these lands currently support a healthy and stable moose population (Collins et al. 2005). The marking and improvement of undesignated canoe routes or trails and the accompanying increased public access provided by this alternative could negatively impact the long-term viability of the local moose population. However, hunting regulations can be changed in response to management needs. The likelihood of these impacts is further tempered because improved trails would provide access to limited portions of the Refuge, and use would remain primarily confined to trail and river corridors.

We expect public use of trails and waterways within the refuge would increase under this alternative and become nearly year-round throughout localized areas of the Refuge. While the effects of the actions under this alternative and the resulting public use are difficult to predict, we anticipate minor to moderate adverse impacts of medium to long-term duration. Overall, these effects should fall between Alternative A (Current Management) and Alternative C in terms of duration, scale, and intensity.

5.4.2 Impacts to the Human Environment

5.4.2.1 Local Economy and Commercial Uses

As under Alternative A (Current Management), increased funding would be required to fully implement the proposed fire management actions under Alternative B. While funding would likely be similar to that required to implement Alternative A (Current Management), spending would be directed toward reducing the response time of suppression resources to fires along the highway corridor rather than increasing prescribed burning in the Refuge backcountry. This difference would eliminate the need for an annual helicopter contract (for which there are no local operators) and would instead provide seasonal employment opportunities for an additional local fire engine module.

The re-establishment or improvement of existing trails and the establishment of canoe routes within the Refuge in conjunction with additional primitive campsites and backcountry cabins would create additional incentive for summer travelers to spend larger portions of their trip in and around Tetlin Refuge. This additional recreational use would result in some increased patronage to local businesses and recreational vehicle campgrounds.

In contrast to Alternative A (Current Management), the sale of sand, gravel and other common variety minerals from lands under Moderate Management and the commercial harvest of timber and firewood from lands under Minimal Management would be allowed under this alternative. The purpose of this change is to adopt region-wide management direction for commercial uses. Currently there are no proposals to allow these activities on refuge lands, and any future commercial use must contribute to the refuge purposes and would be the minimum size and scale necessary with little or no net economic benefit to the local economy. A more detailed description of regulations and policies for allowing commercial uses within the Refuge can be found in the Management Direction section of this Plan.

The overarching focus of this alternative would be to establish Tok as a “Gateway Community.” Under the gateway community concept, we would formally recognize the role of Tok in providing essential services to the Refuge and refuge visitors. The Refuge would work with local partners not only to establish cooperative agreements for long-term maintenance of pullouts and associated facilities along the Alaska Highway, but to also formulate collaborative strategies to address conservation issues, provide recreational opportunities compatible with the purposes for Tetlin Refuge, and increase economic benefits to Tok and other communities and tribal governments in the Upper Tanana Valley. If this framework proves successful, it could establish long-term local economic stability.

If additional basic services such as potable water can be provided at Deadman or Lakeview campgrounds, a mandatory fee system could be implemented. The impacts to other private campgrounds in the local area from these Refuge fees would be less than the minor or negligible impacts described under Alternative C because no new campsites would be constructed.

The establishment of canoe routes would improve access and ease of travel but would have only limited or negligible impacts (if any) on local commercial operators and on the local economy overall. Most canoers access the Refuge from the Alaska Highway; commercial operators will continue to provide access to more remote and inaccessible areas of the Refuge.

Current data are not sufficient to calculate actual economic value of this alternative to local communities, but full implementation of this alternative would increase refuge spending in the local area by \$200,000 to \$219,000 per year with an additional \$3.6-\$3.9 million spent for construction contracts (associated with additional facilities proposed under this alternative). These opportunities would strengthen the refuge commitment to community partners and help support a struggling local economy. When combined with impacts to the local economy common to all alternatives (section 5.2.3), this alternative would have a noticeable and moderate positive impact to the local economy greater than that anticipated from Alternative A (Current Management) but less than that anticipated from Alternative C.

Overall, we anticipate this alternative would have negative to neutral negligible impacts on the local economy over the medium-term, but increased local employment for fire suppression and establishment of Tok as a “Gateway Community” would have a moderate, positive impact over the long-term.

5.4.2.2 Cultural Resources

The amount of fire suppression activity under this alternative would also fall between Alternative A (Current Management) and Alternative C. As a result, the amount of area impacted by prescribed fire would be less than under Alternative A, and the potential for impact from suppression activities such as the digging of fire lines and the clearing of landing sites and campsites would be less than under Alternative C.

This alternative falls between Alternative A (Current Management) and Alternative C in terms of construction, facilities development, and commercial uses that could affect cultural resources. This alternative and Alternative C propose marking or improving existing trails within the Refuge. These activities would not necessarily disturb these areas, in which case a formal archaeological survey would not be required. However, many of these trails and routes were established by Native people, trappers, and miners in historic and prehistoric times and as such, are considered cultural resources. Increased public use as a result of signing and clearing could unintentionally affect the appearance of these trails and possibly associated sites or artifacts. If such negative

impacts were to occur, they would be irreversible and would represent a permanent loss of historical knowledge and information.

Overall, the combination of fire suppression activities and increased development of public use facilities would increase the potential for moderate, long-term, adverse impacts to site-specific cultural resources.

5.4.2.3 Subsistence Opportunity

This alternative would improve existing trails for snowmobiling, horseback riding, dogsledding, cross-country skiing, and other compatible forms of access used in pursuit of subsistence activities. While some existing trails are cleared and somewhat maintained during the winter by local trappers, other historic trails traditionally used before construction of the Alaska Highway currently receive little or no use and have become blocked by thick brush and fallen trees over the years. Re-establishing and/or improving these trails would create new trapping and subsistence hunting opportunities and would prevent loss of access in some parts of the Refuge from blowdown or windthrow following wildfire. Because most trails suitable for improvement within the Refuge are more than 70 miles from Tok and 20-30 miles from Northway Junction, it is anticipated that use would increase only slightly.

Improvement of access roads to Deadman Lake and Lakeview campgrounds would allow for a longer season of use and additional spring and fall subsistence use. Subsistence use of these lakes has traditionally been for waterfowl hunting, and we anticipate the greatest increase in use would be during the spring waterfowl hunting season. It is anticipated that some competition and conflict would occur as periods of visitation from subsistence and recreational users begin to overlap due to increased campground access and availability. Refuge public education and outreach activities would seek to mitigate these impacts

The establishment of canoe routes, marking of portages, and upgrade of boat launches within the Refuge would likely result in additional spring subsistence use and summer recreational use. Summer subsistence activities are primarily limited to the harvesting of fish and berries, and we anticipate few conflicts would occur between recreational and subsistence users during this time.

Overall, the benefits associated with developing Seaton Roadhouse combined with actions under this alternative would have a moderate, long-term, positive impact on subsistence use opportunities and access to localized areas of the Refuge.

5.4.2.4 Visitor Services and Recreation Opportunities

Overview. In working to establish Tok as a “Gateway Community,” the Refuge would initiate opportunities for community partners and businesses to provide essential services to refuge visitors and employees. We would work with local business and non-profit entities to develop sustainable programs that would characterize Tok as a full service destination hub for recreational activities within the Refuge and throughout the Upper Tanana Valley. Under this alternative, the Refuge would work to forge new cooperative agreements with local communities, tribes, and other partners to develop additional off-refuge environmental education, interpretation and recreation opportunities. Through this increased capacity, the Refuge would reach a larger and more diverse public audience through its programs.

Compared with Alternative A (Current Management), opportunities for outdoor activities such as hiking, camping, and wildlife observation would increase with additional trails and a few primitive campsites at the Seaton Roadhouse site, the establishment of canoe routes, upgrade of highway

pullouts, marking of existing backcountry trails, upgrade of campground access roads, and construction of day-use facilities at both Deadman Lake and Lakeview campgrounds. The Refuge would also work with partners to build capacity and services near local communities to meet growing demand from highway travelers—especially those with large recreational vehicles or those people with special needs. These additional facilities, services, and recreational opportunities would create a more interesting, comfortable, and enjoyable experience for tourists and travelers.

Existing recreational opportunities would be maintained, with a number of new opportunities further but still accessible from the Alaska Highway. The most notable change would result from increased development of the Seaton Roadhouse site and establishment of canoe routes. While other areas in the region provide wildlife observation and wildlife photography opportunities, the combination of maintained trails, canoe routes, primitive off-road campsite facilities, and semi-primitive setting (characterized by boreal forest and wetland easily accessible from a major highway) as proposed under this alternative does not exist anywhere else in the region. The opportunities provided under this alternative would be similar to those under Alternative C but would be smaller in scale and designed to provide a more primitive experience.

Environmental Education and Interpretation. Upgrades and improved maintenance of existing pullouts proposed as part of this alternative would not create additional interpretive opportunities along the Alaska Highway, but the cleaner appearance of these sites would alleviate many current problems associated with litter and human waste. These improvements to interpretive pullouts would make them more attractive to visitors, thereby increasing their use and improving the quality of the visitor experience.

Under this alternative, the voluntary fee donation program at Deadman and Lakeview campgrounds would convert to a mandatory fee program only if it will not discourage participation in refuge interpretive and educational programs and basic amenities (primarily potable water) can be provided. These two conditions are expected to ensure visitors receive basic services in exchange for their fee, and negative impacts to refuge environmental education and interpretive programs are avoided.

Development of the Seaton Roadhouse site would include slightly longer hiking trails than those proposed in Alternative A (Current Management). Longer hiking trails would increase the Refuge's capacity for providing environmental education and interpretive programs. Trail sections furthest from the Alaska Highway would provide more intimate interpretive opportunities by allowing visitors to more accurately experience the diversity and overall remoteness of Tetlin Refuge. These trails would also disperse visitors away from the parking area and Alaska Highway and slightly improve opportunities for solitude in a quiet, semi-primitive setting. Through barrier-free design and layout, trails would provide some opportunities for disabled visitors and easy walking over routes of different lengths to accommodate people with varying abilities and available time.

In addition to several off-refuge facilities proposed under Alternative A (Current Management), increased opportunities provided through this alternative would be associated primarily with permanent on-refuge facilities designed to accommodate a slightly greater number of people. The added capability to deliver staff-directed interpretive programs and education to both day-use and overnight visitors in a quiet, secluded setting represents a minor to moderate, long-term positive impact for both visitors and local residents using these sites, with only limited impact to current Refuge users through increased visitation.

Wildlife Observation and Photography. Extending trails and providing designated primitive campsites near the Seaton Roadhouse site, improving existing trails and points of access to the Refuge, establishing designated canoe routes, and increasing information about these opportunities would make backcountry travel within the Refuge easier and more attractive to visitors seeking wildlife observation and wildlife photography opportunities. Demand for these types of recreational opportunities has been expressed through public comments to refuge staff and in registers at the Tetlin Refuge Visitor Center and Refuge campgrounds.

Trails and facilities at the Seaton Roadhouse site would be similar to those described under Alternative A (Current Management). Due to the slightly longer trails, which lead to areas further from the Alaska Highway and associated human activity and disturbances, visitors would have the opportunity to observe and photograph a number of wildlife they would not likely see in this area under Alternative A (Current Management). The longer hiking trails under this alternative would provide access to a few dispersed campsites away from highway traffic noise and other motorized uses, allowing visitors the opportunity to camp overnight and view or photograph wildlife during their periods of greatest activity (late evening and early morning).

With the unique nature of wildlife observation and wildlife opportunities provided at the Seaton Roadhouse site under this alternative, we anticipate visitors such as cyclists and backpackers who travel without large recreational vehicles would utilize these campsites to capacity during the summer months. These campsites represent a long-term but rather minor increase in visitor use that would remain confined to a relatively small area within the Refuge. This small area is currently used by some local residents, but anticipated impacts to these current users from increased visitation would be minor and short-term due to different activities and only some overlap in the seasons of use.

Opportunities for wildlife observation and photography would increase slightly with the designation of canoe routes. These routes would enable less experienced visitors to venture into diverse wetland habitats where a number of species presently occur that are not commonly seen along the Alaska Highway. Canoe routes would provide opportunities for a more remote wildlife observation experience away from most noise and disturbance associated with the Alaska Highway, but improved boat access would result in some additional motorboat use. As a result, wildlife observation experiences would be similar to those found along smaller rivers and streams within Tetlin Refuge that are currently boat accessible.

The marking or improvement of existing unofficial trails (primarily for winter use) within the Refuge for access by snowmachine, dogsled, horseback, and other traditional uses besides hiking would slightly improve opportunities for wildlife observation and photography. However, most visitors who seek wildlife observation opportunities travel on foot or by boat and seek areas away from motorized vehicles and other sources of noise and/or disturbance. Therefore, we anticipate only a few visitors would sporadically use these more primitive trails for wildlife observation and photography.

Overall, this alternative would have minor to moderate, long-term, positive impacts on opportunities for wildlife observation and photography at the local scale. These benefits would primarily be the result of increased length of trails with non-motorized use during the summer months, which would provide access to a greater diversity of wildlife habitats in more quiet, remote portions of the Refuge than are currently available.

Recreational Fishing. Alternative B would allow ADF&G to continue periodic restocking of Hidden Lake to increase recreational fishing opportunities, but management direction for the stocking of additional lakes within the Refuge would not be pursued. Stocking lakes to provide recreational opportunity can be an effective means of reducing harvest pressure on wild fish stocks, but anticipated recreational fishing pressure in the Upper Tanana Valley will remain below a level sufficient to cause a measurable adverse impact to wild fish stocks. Currently a wide variety of recreational fishing opportunities can be found within the Refuge and other areas of the Upper Tanana Valley. These opportunities include remote fly-in fishing for lake trout, boat-accessible fishing for northern pike, burbot, and Arctic grayling, and highway-accessible fishing for stocked rainbow trout at Hidden Lake and Four Mile Lake (off-refuge). Access to other recreational fishing opportunities would be improved through the establishment of canoe routes within the Refuge and upgrades to existing boat launches. The continued periodic restocking of Hidden Lake under this alternative would have a major, medium-term, positive impact on recreational fishing opportunities at the lake, but overall effects would be negligible in terms of opportunity throughout the Refuge.

Trapping and Recreational Hunting. The improvement of access roads to Deadman Lake and Lakeview campgrounds, the establishment of canoe routes, improved boat launches, construction of longer trails near the Seaton Roadhouse site and re-establishment of other existing trails would improve access to refuge lands for trapping and recreational hunting. Most big-game hunters in the Upper Tanana Valley and Fortymile Region prefer to access hunting areas by boat, airplane, or all-terrain vehicle. Because this alternative would only slightly improve boat access through established canoe routes and improved boat launches, the localized long-term positive impact on opportunities for recreational big-game hunting within the Refuge would likely be minor or negligible. The positive impacts on recreational waterfowl, small game, and upland bird hunting opportunities would be somewhat greater. These changes may result in some increased competition with local subsistence users. Most participation in trapping is from local residents, and this pattern of use is expected to continue even with additional and more accessible opportunities created as a result of this alternative.

5.4.2.5 Opportunity to Engage in Supporting Public Uses

Opportunities for hiking would be greater than under Alternative A (Current Management) as a result of slightly longer trails at the Seaton Roadhouse site. Other existing unofficial trails would be marked or upgraded to improve access and overall trail conditions. These improvements would result in some increased summer use, but the majority of trail use would occur during the winter. While summer trail use is confined to non-motorized uses such as hiking and horseback riding, winter travel would likely include snowmobiling, dogsledding, and cross-country skiing. These various types of travel are not always compatible with one another, and some user conflict is anticipated. In particular, some conflict between non-motorized users and snowmachine users and perhaps between dog mushers and trappers who also use these trails is expected. However, the majority of winter recreation within the Refuge is trapping and hunting by snowmachine, with other uses occurring only occasionally. As a result anticipated adverse impacts to opportunity and quality of recreation experiences from these conflicts would be minor, short-term, and confined to specific areas within the Refuge. Through monitoring and contact with local users, the Refuge would determine when or if trail conflicts do occur and take appropriate actions as needed. These actions would begin with education and outreach, but, if necessary, could also include seasonal trail closures, limits on the level or amount of trail use, or the designation of certain trails for

specific types of travel. Such actions would follow direction provided through applicable Federal regulations and Service policies.

The designation of canoe routes under this alternative would result in minimal on-the-ground changes. A few signs would orient visitors to put-in and take-out locations, with the majority of visitor information provided through brochures, Internet websites, and contact with Refuge staff. Increased availability of information would likely result in additional use of these routes by visitors with a moderate amount of boating experience who are willing to navigate various hazards such as log jams and beaver dams, and locate difficult portages through dense spruce forest, muskeg, and tussocks. Opportunities would be improved for boaters who prefer a pre-determined route, but the typical visitor who currently uses these areas would continue to have opportunities to plan and discover their own routes with few Refuge signs and little evidence of previous visitors. The establishment of these routes would represent a minor to moderate, long-term, localized positive impact on recreation opportunities within these drainages. The moderate amount of increased public use along these routes would likely have a minor or negligible adverse impact on the few people who currently use these areas during the summer months.

Refuge administrative cabins would remain available to the public under a first-come, first-served reservation system as under Alternative A (Current Management), but through increased outreach efforts, visitors would be better able to plan their trips, and the Refuge would be able to better schedule cabin use to maximize use for refuge operations and public use.

If campground improvements, such as potable water, can be provided and mandatory fees are implemented, camping and other associated recreational opportunities at Deadman Lake and Lakeview campgrounds would closely resemble other summer opportunities currently available at public sites near the Alaska-Yukon border, Northway Junction, and Tok (e.g., Clearwater Creek, Moon Lake, and Tok River campgrounds). This alternative would provide greater use opportunities during the winter months, with year-round access and use possible when other local area campgrounds are typically closed. Implementation of mandatory fees may discourage some summer use of refuge campgrounds because visitors may choose other campgrounds that would charge only a slightly higher fee but are located closer to community centers and services. This reduction in refuge visitation should be short-term as visitation along the Alaska Highway continues to increase over the next 10 to 15 years. If certain improvements can not be provided, the Refuge would implement a voluntary campsite donation program, which would have no effect on visitor use at Refuge Campgrounds.

5.4.2.6 Public Health and Safety

This alternative would abandon Current Management direction directed toward the use of prescribed fire to establish a large fuel break between Northway and the southern portion of the Refuge. Management direction would focus instead on more immediate fuels reduction efforts in and around communities and other areas at risk in conjunction with improvements in fire suppression capabilities along the Alaska Highway corridor.

Even with fire suppression resources in the immediate area, the risk of extreme conditions resulting in a wildfire escaping initial attack efforts and causing damage to structures or other resources would remain. Once implemented, the fire management program proposed under Alternative B would result in fire suppression resources being more available and mobile. In addition, the increased use of mechanical thinning over time would provide additional protection in and around communities and other resources that must be protected. Examples of past successes

with this type of treatment include thinning at Northway Junction, which helped protect the community against the 2004 Gardiner Creek Fire, and thinning adjacent to Port Alcan near the Alaska-Yukon border, which simplified structure protection contingency efforts during the 2005 Island Lake Fire. Overall, fuel reduction efforts proposed under this alternative would have a more moderate, long-term and positive effect on public health and safety at both the site-specific and local scales due to the higher probability of implementation and success than other strategies such as prescribed burning of large contiguous areas or complete wildfire suppression. When compared with expanded fire suppression on the Refuge as proposed under Alternative C, this alternative presents a slightly higher level of risk in the short-term, but a lower level of risk in the long-term.

The marking of trailheads and other refuge access points may increase the risk of accidents as vehicles using these access points enter and exit traffic. These potential risks will be considered and mitigated to the extent possible when choosing vehicle access points to mark (including identifying and clearing areas for potential parking) and in the placement of signs and other associated structures.

Improvements and waste disposal facilities at highway pullouts would reduce the amount of litter and provide more sanitary and safe conditions for travelers. These improvements would also enhance the natural beauty of these sites and the quality of the visitor experience.

Existing boat launches maintained by the Refuge are usable but their location and condition present a number of difficulties and hazards when launching and trailering larger boats (greater than 14 feet in length). Improving these launch sites would not only reduce these difficulties, but would also increase public safety.

5.4.2.7 Cumulative Effects

The primary way in which this alternative would impact the human environment is through the maintenance and construction of facilities for recreation along the Alaska Highway and public access to Tetlin Refuge. The establishment of these facilities and their associated public use would most likely occur where direct public access from the Alaska Highway to the Refuge is possible (primarily between the Hidden Lake trailhead and the Canadian border). The cumulative impacts associated with these various facilities and their associated use would not significantly affect fish, wildlife, or plant populations or their habitats throughout the Refuge but would result in some substantial adverse impacts at the localized and site-specific scales. The addition of facilities to accommodate more recreational opportunities and improve access to more remote portions of the Refuge would enable the Refuge to provide a greater spectrum of wildlife-dependant public use opportunities.

5.5 Anticipated Impacts of Alternative C

The reader should keep in mind the following section discusses several impacts that are in addition to impacts discussed previously as common to all alternatives (section 5.2).

5.5.1 Impacts to the Physical and Biological Environment

5.5.1.1 Permafrost and Soils

Under this alternative, attempts would be made to suppress most fires within the Refuge as quickly as possible. Impacts to soils from fire suppression activities described previously under fire and fire suppression impacts common to all alternatives (section 5.2.1; with the exception of

bulldozed fire lines) would not remain confined to the northern portion of the Refuge and along the Alaska Highway corridor, but instead would occur at various locations throughout much of the Refuge. Most fires would be contained at a small size, limiting the extent of these negative impacts from suppression activities.

Impacts associated with public use and facilities would be similar to those described under Alternative B but slightly larger in scale due to the larger size and more intensively developed trails, campgrounds, and canoe routes under this alternative. When combined with adverse impacts from fire suppression activities, we anticipate this alternative would have moderate to major, short-term adverse impacts at the local scale.

Over the next 50 years, a more uniform active soil layer depth would develop across the Refuge as forested areas are maintained in late successional stages of mature spruce forest. Eventually, some fires would escape initial attack with a much higher probability of becoming very large due to fewer natural fuel breaks and an accumulation of fuels. This may have the effect of promoting a much larger patch size in the forest mosaic than under Alternative A (Current Management) or Alternative B (Preferred Alternative). The distribution of permafrost would likely be altered from its natural state, and the area would not maintain the current mosaic of vegetation. These changes represent moderate, long-term adverse impacts throughout the Refuge.

5.5.1.2 Air Quality

Refer to previous discussions under impacts common to all alternatives (section 5.2).

5.5.1.3 Water Quality and Aquatic Habitats

Fire suppression impacts to water quality would be somewhat greater than from Alternative A (Current Management) or Alternative B (Preferred Alternative) and would occur throughout much of the Refuge. Increased suppression would make contamination from foams and retardants more likely. Short-term impacts to water quality from fires would be lessened through a reduction in the number and acreage of fires within the Refuge. However, long-term suppression would increase the probability of an escaped fire growing very large and may result in entire watersheds affected by a single fire within the next 30-50 years. By concentrating fire activity into infrequent, large events, the natural processes that have adapted to increased nutrients, runoff, and erosion following natural fire would be overwhelmed, causing major, long-term negative impacts.

5.5.1.4 Vegetation and Terrestrial Habitats

Under this alternative, suppression would be the primary fire management tool, and an attempt would be made to exclude fire from most of the Refuge. In the short-term, this could lead to a preponderance of unnaturally advanced seral stages, increased patch size within the mosaic, and consequently less diversity. In the absence of fire, biological diversity decreases at both the stand and landscape level as early-successional broadleaf species are replaced by spruce (Foote 1983, Haggstrom and Kelleyhouse 1996). Over time, active suppression could contribute to a shift in the mosaic of vegetation towards mature seral stages and a more homogeneous landscape. Homogenous environments generally lead to larger, more uniform fires (Ryan 2002). Some authors have further theorized that a suppression-caused shift in forest characteristics increases the probability of large, severe fires (Haggstrom 2001). If the occurrence of fire were sufficiently delayed, the eventual size and intensity could cause major, long-term negative impacts to habitats across entire watersheds or even the Refuge, ultimately reducing wildlife abundance and diversity as well.

Other impacts would be similar to the types described previously under facilities and public use impacts common to all alternatives (section 5.2.1). Construction of new facilities, in addition to those proposed under Alternative A (Current Management) and Alternative B (Preferred Alternative), would result in further removal of native vegetation and wildlife habitat, increased trampling, increased trailing through undesignated areas, and increased opportunity for invasive species establishment. As a result, negative impacts to wildlife habitat would likely be moderate and would occur at a slightly larger local scale as well.

5.5.1.5 Fish Populations

Refer to previous discussions under impacts common to all alternatives (section 5.2).

5.5.1.6 Bird Populations

Active fire suppression as proposed under this alternative could contribute to a landscape dominated by mature seral stages. This would most likely cause moderate to major, long-term negative impacts to some bird species throughout the Refuge, specifically boreal forest bird communities that have adapted to natural seral stages with distinct structural differences—including woodpeckers (Murphy and Lehnhausen 1998), hawk owls (Hannah and Hoyt 2004) and similarly specialized species that would be of management concern if few post-fire forests remain on the landscape (Hobson and Schieck 1999). Many studies have noted that forest management should mimic, to the extent possible, the natural disturbance regimes of forests to preserve bird populations (see summary by Schulte and Niemi 1998, Hobson and Schieck 1999).

In addition to anticipated adverse impacts common to all alternatives (section 5.2.1), this alternative could further reduce nesting productivity and suitable habitat for raptors, waterfowl, and shorebirds compared with Alternatives A and B. This alternative would result in increased public use and development sufficient to cause both moderate, short-term, site-specific impacts and moderate, long-term negative impacts to a variety of bird populations at the local scale.

5.5.1.7 Mammal Populations

This management alternative would have greater negative impacts to mammal populations than would Alternative A (Current Management) or Alternative B (Preferred Alternative). Because of more aggressive fire suppression activities under this alternative, long-term fire-related impacts discussed as common to all the alternatives may be more significant under this alternative to mammal populations. As described previously under vegetation and terrestrial habitats and bird populations, the same long-term impacts associated with fire suppression could result in similar impacts on mammal populations. In addition, the construction of new trails, canoe portages, and cabins would provide additional access for hiking, backpacking, camping, snowmachine use, hunting, and trapping throughout much of Tetlin Refuge and would likely result in wildlife disturbance and harvest sufficient to alter populations of large furbearers, moose, and caribou under existing hunting and trapping regulations. Changes to harvest seasons and bag limits by the Alaska Board of Game and/or the Federal Subsistence Board could mitigate these impacts in the short-term, but participation in other activities could be sufficient to cause adverse effects over the long-term. Therefore, under this alternative, the refuge manager would likely be required to take action in the future to ensure wildlife populations are conserved. These management actions could include the closure or limited use of public use facilities such as cabins, trails, or campsites; alteration of hunting seasons within the Refuge; or other measures to reduce the amount of wildlife disturbance and/or harvest. When compared with other alternatives, Alternative C proposes to establish the greatest number of public use facilities and, consequently, the highest

amount of public use spread throughout the greatest proportion of the Refuge. As a result, moderate to major adverse impacts to mammal populations within the Refuge would likely be anticipated over the long-term.

5.5.2 Impacts to the Human Environment

5.5.2.1 Local Economy and Commercial Uses

The aggressive suppression of wildfire under this alternative (increased areas of Full and Moderate suppression options) would result in suppression of all active wildfires on nearly 30 percent of refuge lands during the peak of the fire season each year. This level of suppression would require more seasonal firefighters than Alternatives A (Current Management) or B (Preferred Alternative). It is possible a larger contract helicopter would be required to support this alternative. The economic benefits of any helicopter contract would have very minor impacts on the local economy due to the lack of a local operator. In the long-term, the more aggressive suppression of wildfires would allow build up of fuels and increase the likelihood of an escaped fire growing very large and severely impacting local communities. The potential property loss from escaped wildlives may negate all positive effects.

Establishing Tok as a “Gateway Community” and cooperative agreements for maintenance of facilities along the Alaska Highway would have long-term, positive economic impacts similar to those described for Alternative B (Preferred Alternative).

Increased capacity at Deadman Lake and Lakeview campgrounds would be supported through a refuge-administered fee system. These campgrounds would provide additional opportunities for highway travelers similar to those provided in campgrounds near Northway and Tok. More than 400 camping sites are provided in Tok and at nearby State campgrounds, and this alternative would have only a minor or negligible economic impact from competition with these private businesses and contracted maintenance at State facilities. The addition of refuge fee campgrounds represents a greater negative impact to businesses near the Alaska-Yukon border and Northway Junction, which provide fewer sites with presumably lower profit margins than those operating in Tok. These negative impacts would likely be minor to moderate and short-term, as we anticipate both refuge campgrounds (even with additional campsites) would be at capacity during the summer season due to improved campground facilities, with added comfort and convenience and increased traffic along the Alaska Highway projected over the next five to ten years (Bowker et al. 1999, Bowker 2001).

The addition of public use cabins accessible from the Alaska Highway could attract some users who would otherwise visit existing remote Refuge cabins or who would stay at developed campgrounds. Many people who use existing administrative cabins participate in hunting and fishing, and often hire a commercial air-taxi for access. Air-taxi operators, in turn, spend part of their revenues on fuel and other business-related items in the area. We anticipate most big-game hunters would continue to utilize air-taxi services to existing lakeside administrative cabins. Therefore, the addition of public use cabins proposed under this alternative is anticipated to have a minor to negligible positive impact on local air-taxi businesses or the local economy.

This alternative proposes the greatest number of new recreational opportunities, including both day-use associated with existing facilities along the Alaska Highway and overnight-use associated with additional backcountry trails, campsites, and cabins. Increased capacity for both summer and winter recreation under this alternative, in combination with current demand in local communities, is likely to move Tok from an overnight rest stop for travelers to a destination for a

small but steady number of tourists on a year-round basis. This increase in tourism would also utilize and increase demand for services and facilities in smaller, surrounding communities such as Northway and Chicken.

Full implementation of this alternative would increase spending to reduce fire suppression response time and increase the level of fire suppression within the Refuge. Current data are not sufficient to calculate actual economic value of these increases to local communities, but full implementation of this alternative would increase Refuge spending in the local area by an estimated \$490,000 to \$495,000 per year, plus an estimated \$4.6-\$4.9 million spent for construction contracts (associated with additional facilities proposed under this alternative). Overall, this alternative is likely to have a more moderate or major, long-term positive impact on the local economy than either Alternative A (Current Management) or Alternative B (Preferred Alternative). These impacts would be most noticeable in the community of Tok, with lesser benefits to communities and businesses outside of Tok. However, the increased probability of a large catastrophic wildfire resulting from long-term aggressive fire suppression under this alternative may far outweigh all economic benefits.

5.5.2.2 Cultural Resources

In the short-term, suppression of fires throughout much of the Refuge would lessen the potential negative impacts from fire but would increase the probability of negatively impacting unidentified or unknown sites or artifacts through fire suppression activities (e.g., the digging of handlines, clearing of helicopter landing areas and campsites). Over time, escaped fires would have an increased probability of growing very large, and threats to cultural resources by a single fire may increase.

This alternative proposes the greatest amount of construction, facilities development, and commercial uses when compared with Alternative A (Current Management) and Alternative B (Preferred Alternative). When these effects are considered along with effects from fire suppression activities, this alternative may have a moderate, long-term adverse impact on cultural resources on a localized scale and has the greatest potential to disturb cultural resources when compared with other alternatives.

5.5.2.3 Subsistence Opportunity

In addition to trail construction and maintenance proposed under Alternative A (Current Management) and Alternative B (Preferred Alternative), this alternative would result in the construction of new trails, backcountry public use cabins, and development of new Refuge access points and parking areas along the Alaska Highway—which would likely lead to increased year-round subsistence use of the Refuge. In addition to established canoe routes described under Alternative B (Preferred Alternative), the cleared and maintained portages proposed under this alternative would connect frozen lakes and streams during winter months—effectively creating new winter trails and thereby increasing opportunities for subsistence hunting, fishing, and trapping during periods of adequate snow cover. The development of these facilities would have a moderate to major, short-term positive impact on subsistence opportunities in localized areas of the Refuge.

However, the cumulative effect of an interconnected trail system within the Refuge and associated cabins, highway access points, and improved campgrounds (allowing for a longer season of use) would also result in increased harvest of resources and additional recreational use, including waterfowl hunting, moose hunting, wildlife observation, wildlife photography, trapping, and other activities occurring on a year-round basis in more remote areas of the Refuge. This increased level

of harvest may require changes in current hunting regulations to assure sustainable populations of game animals and prevent an overall negative impact. A noticeable amount of competition between recreational and subsistence users is anticipated, particularly during the fall and winter hunting and trapping seasons. As a result, increased recreational use of public use facilities and decreased biodiversity through fire suppression proposed under this alternative may have a moderate, long-term negative impact on subsistence opportunity within the Refuge.

5.5.2.4 Visitor Services and Recreation Opportunity

Overview. The Refuge would serve as a leader in creating educational and interpretive opportunities for visitors and residents to develop a better understanding and deeper appreciation for the Upper Tanana Valley's unique natural and cultural history. The combination of additional facilities, recreational opportunities, and community partnerships to make Tok a Gateway Community could begin to establish the Upper Tanana Valley as both a summer and winter tourist destination area.

Primitive campsites at the Seaton Roadhouse site and along established canoe routes and the availability of backcountry cabins accessible by trail from the Alaska Highway would help meet demand from a number of travelers who do not prefer the more crowded, developed, and highly structured nature of recreational vehicle campgrounds such as those proposed at Deadman Lake and Lakeview campgrounds and other locations throughout the Upper Tanana Valley. Improvement of existing trails, boat launches, campgrounds, and access roads, combined with the construction of new trails, canoe portages, cabins, and trailhead pullouts along the Alaska Highway would greatly improve public access to large portions of the Refuge throughout the year. In contrast to Alternative A (Current Management) and Alternative B (Preferred Alternative), this alternative would increase the ability of the Refuge to meet demand during the summer and would also create a number of winter recreation opportunities.

Unlike many trails in the areas surrounding Tetlin Refuge, the new trails proposed under this alternative would be designed for both summer and winter use. This proposed network of trails connecting existing Refuge facilities, new facilities (such as backcountry cabins) and adjacent public lands (such as the Wrangell-St. Elias National Park and Preserve) would create year-round recreational opportunities for wildlife observation and photography, fishing, hunting, and trapping currently not available anywhere in the region. When considered in combination with other opportunities proposed under this alternative and those already available throughout the Upper Tanana Valley, this alternative would provide visitors the same diversity of recreational activities as would Alternative B (Preferred Alternative), but on a larger and more developed scale than either Alternative A (Current Management) or Alternative B (Preferred Alternative). However, the expansion and construction of facilities along the Alaska Highway (i.e., campgrounds, kiosks, pullouts, and visitor centers) would be a priority, and the establishment of backcountry trails, canoe routes, and cabins would be dependant upon increased funding. As a result, impacts to visitor services and recreation opportunity will most likely be associated with off-Refuge programs and facilities along the Alaska Highway to be constructed first.

Environmental Education and Interpretation. Actions under this alternative would establish a wide variety and number of public use facilities over and above those described in Alternative A (Current Management) and Alternative B (Preferred Alternative). Facilities under this alternative that would have the greatest impact on environmental education and interpretive opportunities include additional kiosks and wildlife observation platforms at a few existing pullouts along the Alaska Highway. Location of these facilities would be selected based on

opportunities to view Refuge habitats, adequate space for trash facilities and restrooms, parking capacity for large recreational vehicles, and sight distance necessary to safely enter and exit the highway. The proposed kiosks and viewing platforms, in conjunction with these site characteristics, would most likely increase use of these pullouts to their maximum capacity during summer and would provide opportunities for visitors to take extended rest stops.

The implementation of a mandatory fee at Deadman and Lakeview campgrounds would likely result in a number of visitors choosing other campgrounds that may charge a higher fee but provide more services and/or easier access to services. This would, in turn, negatively impact participation in refuge environmental education and interpretive programs. These effects represent moderate to major, negative impacts because they effect refuge purposes, but are anticipated to be short-term as campground use grows with increased visitation along the Alaska Highway over the next 10 to 15 years, and six new campsites are constructed at Deadman Lake. Other impacts could result as visitor expectations increase with the implementation of fees, and the type of visitor changes from one seeking a more quiet, semi-primitive setting to one seeking an experience characterized by activity, development, and more crowded conditions.

Environmental education and interpretive opportunities provided under this alternative are in addition to those provided under Alternative A (Current Management) or Alternative B (Preferred Alternative). These additional opportunities are primarily associated with permanent off-refuge facilities designed to accommodate a much greater number of people than in either of the other alternatives. Because environmental education and interpretation are purposes for Tetlin Refuge, these changes represent major, long-term positive impacts for both visitors and local residents at the regional level with little or no impact to current Refuge users through increased visitation.

Wildlife Observation and Photography. Under this alternative, the addition of longer trails near the Seaton Roadhouse site, new public use cabins accessible from the Alaska Highway, maintained canoe portages, and new trails allowing access to more remote parts of the Refuge and surrounding public lands (such as Wrangell-St. Elias National Park and Preserve) would provide a greater number and wider range of wildlife observation and wildlife photography opportunities than either Alternative A (Current Management) or Alternative B (Preferred Alternative).

Additional trails under this alternative would link existing trails, facilities, and shorter trails (less than 10 miles in length) at the Seaton Roadhouse site described in Alternative B (Preferred Alternative). This would provide opportunity for multi-day wildlife observation trips through Tetlin Refuge and into surrounding public lands. With access to more remote habitats in very primitive and quiet settings away from other people and disturbances such as vehicles and campgrounds commonly associated with the Alaska Highway, visitors would have a better chance to view and photograph many of the wildlife species found in the Upper Tanana Valley. Winter wildlife observation and photography opportunities (currently low in demand) would not increase noticeably due to snowmachine use and trapping associated with trail improvements.

Opportunities along the Alaska Highway would increase through additional wildlife observation platforms, kiosks and other interpretive facilities associated with pullouts along the Alaska Highway. Pullouts with these additional facilities would likely be used at or near capacity during the summer months.

The marking and maintenance of boat launches, in combination with portages and campsites along established canoe routes, would improve access to productive riverine and wetland areas for

wildlife observation and photography. However, opportunities for wildlife observation and photography would be reduced by increasing waterfowl harvest near campgrounds and along established canoe routes and contact with other groups using these routes. These factors would also reduce the sense of solitude and remoteness that are currently important and would be provided under Alternative A (Current Management) and Alternative B (Preferred Alternative). Conditions under this alternative may actually reach a point of diminishing returns at which additional opportunities for wildlife observation and photography do not occur because wildlife would be displaced by increased public use.

Overall, the establishment of a system of primitive trails and backcountry public use cabins under this alternative should have a moderate to major, long-term positive impact on opportunities for wildlife observation and photography at local areas associated with these facilities. However, the level of development proposed for campgrounds and canoe routes under this alternative would likely have a minor to moderate, long-term negative site-specific impact to wildlife observation and photography.

Recreational Fishing. Impacts to recreational fishing opportunities would be as described in the previous discussion under Alternative B (Preferred Alternative).

Trapping and Recreational Hunting. This alternative would increase recreational hunting opportunities over and above those anticipated in Alternative A (Current Management) or Alternative B (Preferred Alternative) through marked and maintained portages along canoe routes, a network of longer trails connecting existing trails and trails on surrounding public lands (such as Wrangell-St. Elias National Park and Preserve), and additional backcountry public use cabins accessible year-round by trail from the Alaska Highway. Pullouts and parking areas would be built at trail access points, increasing visitor safety and ease of access.

The effect of new public use cabins on recreational hunting opportunities is somewhat speculative. Waterfowl hunters use existing administrative cabins because they are comfortable, convenient, and provide easy access to quality hunting opportunities with little or no competition. If comfort and convenience of the cabins are the primary factors, then additional cabins proposed under this alternative would provide additional hunting options. If the quality of hunting at these particular locations is the primary factor, new cabins would have little influence on waterfowl hunting opportunities for current visitors but would instead provide a more affordable alternative for people who would not otherwise hunt within the Refuge. Because public use cabins proposed under this alternative would be accessible only by foot or horseback during the fall moose season, few big-game hunters would likely utilize them.

During the winter months, additional public use cabins would serve as safe and comfortable accommodations for winter visitors thus encouraging more use. While increased public use as a result of this alternative would be managed to be compatible with the purposes of the Refuge, it could result in a moderate long-term increase in recreational use by several user groups, including hunters, trappers, dog mushers, and cross-country skiers within the Refuge.

5.5.2.5 Opportunity to Engage in Supporting Public Uses

The expanded trail system and increased number of trails within the Refuge and associated trailheads proposed under this alternative would provide more access than Alternative A (Current Management) or Alternative B (Preferred Alternative). Because these trails would only accommodate non-motorized use in the summer, we anticipate use during these months would remain fairly low and intermittent over the next 10 to 15 years. As with many such trail systems,

use would be concentrated within one or two miles of access points and would quickly diminish along more distant trail sections. The greatest amount of use would likely occur during winter months when trails become accessible to snowmachines, dogsleds, and cross country skiers.

The marking and maintenance of boat launches, canoe route portages, and designated campsites along canoe routes would improve access to productive riverine and wetland areas. These improvements would attract boaters with a wide range of skills and abilities but may discourage some visitors who prefer a greater sense of adventure, more solitude, and less evidence of management and other users. Boaters would have little trouble finding and following marked routes, maintained portages and designated campsites. Signs along these routes and maps available from the Refuge would allow visitors to find the easiest route possible and would prevent unintentional trespass on private lands. Groups would occasionally encounter one another while boating, but the establishment of primitive campsites would ensure suitable sites approximately one day traveling distance apart and out of sight or sound of other groups. Increased use is not anticipated to exceed the number of campsites made available; as a result, visitors would have opportunities for solitude in a semi-primitive environment even if most or all campsites were occupied at one time.

Campground improvements and upgrades combined with additional campsites and backcountry cabins would increase both day-use and extended recreational use in and around these sites and would make year-round use possible. Opportunities at Deadman Lake and Lakeview campgrounds would closely resemble other opportunities currently available at public campgrounds and some private commercial campgrounds near the Alaska-Yukon border, Northway Junction, and Tok. As a result, the long-term benefits of campground improvements would only be minor or negligible as the diversity of recreational opportunities for these types of activities within the Upper Tanana Valley is diminished. Even under current conditions, refuge campgrounds are near capacity during the summer months, and this trend is expected to continue even with a nominal campsite use fee for additional amenities such as larger parking spaces, a sewage dump station and potable water. These changes represent a more moderate to major, long-term negative impact to 3,000 to 4,000 visitors (estimated maximum capacity) who might otherwise use Refuge campgrounds each year and presumably prefer a more primitive, quiet, and unconfined experience than is provided in communities such as Tok. As a result, other State and BLM campgrounds in the region that would continue to provide these more primitive experiences (e.g., Clearwater Creek, Moon Lake, and Tok River, and West Fork campgrounds) would likely receive moderate increased use.

5.5.2.6 Public Health and Safety

Increased fire suppression may have immediate moderate to major, short-term benefits by reducing the threat of wildfire, but as wildfire history in Alaska has illustrated (see affected environment discussion), a large uncontrollable wildfire would eventually occur. If suppression efforts are successful for an extended period of time, fire would nearly be eliminated from the Refuge leading to a large accumulation of fire fuels, and thus, greater probability for a large catastrophic event. Because of the increased probability of a large catastrophic wildfire due to expanded fire suppression efforts on the Refuge, this management direction would likely have a major, long-term negative impact on public health and safety and presents the highest level of risk to public health and safety over the longterm when compared with Alternative A (Current Management) or Alternative B (Preferred Alternative).

Designated parking areas would be provided in conjunction with signage of river and trail access points to the Refuge. This would still present some traffic flow impacts and associated risks with additional vehicles exiting and entering the highway, but any associated safety hazards would be mitigated or eliminated to the extent possible as discussed in Alternative B (Preferred Alternative). Positive impacts associated with the upgrade of highway pullouts and boat launches described previously from Alternative B (Preferred Alternative) would also occur as a result of this alternative.

Newly constructed cabins would offer an added margin of safety for Refuge visitors, especially during winter months. Many people are apprehensive to take extended trips within the Refuge due to inexperience, concerns about bears, or fear of extremely cold weather. The availability of additional cabins would allow visitors to plan extended trips with overnight stops at one or more cabins providing a much higher degree of safety. These same cabins would also serve as emergency shelter following an accident, injury, or during unexpected weather conditions.

The construction of backcountry cabins and designated parking areas and pullouts for access would have a moderate to major, long-term positive impact on public health and safety (limited to public use in areas associated with these specific sites).

One potential negative impact of additional facilities and trails extending far into the Refuge backcountry is increased probability of large human-caused fires. Currently most public use occurs within the highway corridor, allowing early detection of accidental fires. As a result, these fires can be more easily extinguished while still small in size. As the public gains access to more remote parts of the Refuge under this alternative, such fires would burn undetected or for longer periods of time, resulting in larger and less easily controlled fires.

5.5.2.7 Cumulative Effects

This alternative would establish a greater number of public use facilities than either Alternative A (Current Management) or Alternative B (Preferred Alternative). The establishment of campsites, cabins, and other facilities interconnected by a network of waterways, canoe routes, and year-round and seasonal trails would result in a cumulative effect on fish, wildlife, and plant resources across a significant portion of Tetlin Refuge extending from the Alaska Highway to the Wrangell-St Elias National Park and Preserve. When further coupled with extensive fire suppression activities and the subsequent increased fuel load and fire danger, this alternative would ultimately result in substantial alteration of Refuge character and damage to refuge resources and ecological function.

5.6 Relationship between Short-Term Use of the Environment and Long-Term Productivity

Under all alternatives, the primary short-term uses of the Tetlin Refuge and its resources are by recreational users, subsistence hunters, fisherman, and gatherers and trappers. Except for on-site recreational activities, the primary uses of harvested resources are off-refuge, such as food, in the production of handicrafts, and as a source of cash (sale of handicrafts and furs). Monitoring and regulation of harvested fish and wildlife populations by ADF&G and the Service should ensure the long-term productivity of fish and wildlife populations. None of the short-term uses described in any of the alternatives would affect the long-term productivity of the ecosystem.

5.7 Irreversible and Irretrievable Commitment of Resources

No irreversible and irretrievable commitment of resources would occur with implementation of any of the alternatives. Each alternative defines options for a different management direction for the Refuge. Each action described in the alternatives can be changed and, in fact, would be examined on a regular and recurring basis. Significant changes would initiate a revision of the Conservation Plan; a scheduled revision would occur every 15 years.

5.8 Environmental Justice

A Federal agency is required to identify and address, as appropriate, any disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations (Executive Order 12898, February 11, 1994; amended January 30, 1995, by Executive Order 12948). This includes health risks and other impacts for people who rely principally on fish or wildlife for subsistence. As described in chapter 3, communities associated with Tetlin Refuge are rural and contain many low-income households, and many local residents maintain subsistence lifestyles. The nature of the proposed action, revision of the Conservation Plan for the Refuge, is very different from the proposals often associated with environmental justice issues such as closing of pollution-causing facilities. None of the alternatives evaluated in the draft environmental assessment (EA) would place a disproportionate weight of any adverse effects on low-income or minority populations. Conservation of fish and wildlife populations and habitat in their natural diversity, maintaining water quality, and providing opportunities for subsistence are legislated purposes of the Refuge; the Service cannot compromise these values and their associated uses under any management alternative. While the alternatives contain slightly different approaches for meeting Refuge purposes, none would favor activities or projects that would direct negative impacts toward low-income or minority populations.

5.9 Section 810 Evaluation

The Alaska National Interest Lands Conservation Act (ANILCA) Section 810 requires an evaluation of the effects on subsistence uses for any action to withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of public lands. The evaluation consists of three parts:

- A finding of whether or not a proposed action would have a significant restriction on subsistence uses
- A notice and hearing if an action is found to have a significant restriction on subsistence uses
- A three-part determination prior to authorization of any action, if there is a significant restriction on subsistence uses

Chapter 3 of this document describes current uses of the Refuge for subsistence, and this chapter describes anticipated effects of each alternative on those subsistence uses. Because this is a long-range programmatic plan that describes possible changes in management direction for Tetlin Refuge, it does not propose any site-specific development or allow any new types of uses or development that would pose risks to subsistence uses of the Refuge.

The Preferred Alternative (Alternative B) does not contain actions that would reduce subsistence uses because of direct effects on wildlife or habitat resources or that would increase competition for resources.

Similarly, the Preferred Alternative would not change the availability of resources by altering their distribution or location. The general goal is to maintain habitat and wildlife populations naturally occurring on the Refuge.

Finally, the Preferred Alternative would not reduce subsistence uses because of limitations on access, by physical or legal barriers, to harvestable resources. This evaluation concludes that the action would not result in a significant restriction of subsistence uses.

5.10 Summary Comparison of Environmental Effects

Table 5-1 provides a summary of the environmental effects described in this chapter. Definitions describing the nature, duration, and intensity of the impacts are important to understand the impacts described in the table. These definitions are found at the beginning of this chapter.

Table 5-1. Summary comparison of impacts by alternative

Resource/ Value	Alternative A (Current Management)	Alternative B (Preferred Alternative)	Alternative C
Permafrost and Soils	Moderate to major, medium-term site-specific negative effects (fire suppression activities). Moderate to major, long-term site-specific negative effects (development of public use facilities and increasing levels of use).	Same as Alternative A.	Moderate, long-term refuge-wide negative effects (substantially altered fire regime). Effects from fire suppression activities and development of public use facilities (more facilities are proposed and use anticipated to increase) same as Alternative A.
Air Quality	Moderate to major, short-term local negative effect (prescribed and wildland fires within the Refuge). Negligible, long-term regional negative effect (smoke from prescribed and natural fire management).	Same as Alternative A.	Same as Alternative A.

Resource/ Value	Alternative A (Current Management)	Alternative B (Preferred Alternative)	Alternative C
Water Quality and Aquatic Habitats	Potentially moderate to major, long-term site-specific negative impact at three stocked lakes. (fish-stocking). Minor, short-term site-specific negative impact (fire suppression activities).	Potentially moderate to major, long-term negative effects at the site-specific scale (fish-stocking, only one stocked lake) and Refuge-wide scale (aggressive fire suppression activities).	Same as Alternative B.
Vegetation and Terrestrial Habitats	Major, long-term refuge-wide positive effect (natural fire regime). Minor to moderate, long-term negative site-specific effects at the site-specific scale (public use, development of facilities, and fire suppression activities) and local scale (fire fuel break management).	Effects of change to natural fire regime same as Alternative A. Effects of increasing public use, development of additional facilities, and changing fire suppression activities the same as Alternative A.	Moderate to major, long-term negative effects at the site-specific scale (trails and other facilities), local scale (public use activities), and refuge-wide scale (substantially altered fire regime).
Fish Populations	Moderate, medium-term negative effect at the local scale (altering size and age distribution of native Arctic grayling and northern pike populations) and site-specific scale (non-native rainbow trout population and alteration of additional lake ecosystems).	Minor, medium-term site-specific negative effect (non-native rainbow trout population).	Same as Alternative B.
Bird Populations	Moderate, long-term site-specific negative effects (public use and development of facilities).	Moderate, long-term site-specific negative effects and minor, long-term local, negative effects (public use, and development of facilities, trails and canoe routes).	Major, short-term site-specific negative effects and moderate, long-term local negative effects (public use and development throughout large portions of the Refuge). Moderate to major, long-term refuge-wide negative effects on some bird species (substantially altered fire regime).

Resource/ Value	Alternative A (Current Management)	Alternative B (Preferred Alternative)	Alternative C
Mammal Populations	Minor to moderate, short-term site-specific negative effect (public use and development of facilities).	Minor to moderate, medium to long-term local negative effect (increased public use and development of facilities).	Moderate to major, long-term refuge-wide negative effect (increased public use and development of facilities throughout large portions of the Refuge).
Local Economy and Commercial Uses	Minor, long-term positive effect (additional lakes stocked for recreation opportunity and employment for fire management/ suppression).	Moderate, long-term positive effect from employment for fire management and suppression and establishment of Tok as "Gateway Community".	Moderate to major, long-term positive effect (fire management/ suppression employment, increased Refuge staffing). Minor to moderate, short-term negative effect (competition with private sector through development of facilities)
Cultural Resources	Minor to negligible, long-term site-specific positive effect (increased inventory of resources).	Moderate, long-term site-specific negative effect (fire suppression activities, increased public use and maintenance of facilities).	Moderate, long-term local negative effect (aggressive fire suppression activities and development of facilities).
Subsistence Opportunity	Minor to moderate, long-term refuge-wide positive effect (improved access and maintaining species and habitat health and diversity). Minor to moderate, short-term site-specific negative effect (prescribed and wildland fire management).	Moderate, long-term local positive effect (increased boat, trail, and highway site access).	Moderate to major, long-term refuge-wide negative effect (substantially altered fire regime and increased competition with other Refuge users).. Moderate, short-term local positive effect (improved facilities and access).
Visitor Services and Recreation Opportunities	Current opportunities maintained or slightly improved.	Minor, long-term increase in seasonal use to a level between Alternative A (Current Management) and Alternative C. Increased use on a portion of the Refuge.	Long-term moderate increase in year-round use to a level greater than other alternatives. Increased use throughout the Refuge.

Resource/ Value	Alternative A (Current Management)	Alternative B (Preferred Alternative)	Alternative C
<i>Environmental Education and Interpretation</i>	Moderate, long-term site-specific positive effect (increased indirect contact between refuge staff and visitors). Moderate to major, long-term regional positive effect (visitor centers and interpretive trails).	Minor to moderate, long-term refuge-wide positive effect (greater diversity of opportunities and more direct contact between refuge staff and visitors). Major, long-term regional, positive effect (Seaton Roadhouse, visitor centers and interpretive trails).	Major, long-term regional, positive effects (Seaton Roadhouse, visitor centers, and interpretive trails). Moderate to major, short-term site-specific negative effect (campground development and fees).
<i>Wildlife Observation and Photography</i>	Minor, long-term site-specific positive effect (additional opportunities).	Minor to moderate, long-term local positive effect (increased and more diverse remote viewing opportunities).	Moderate to major, long-term local positive effect (additional trails and public use cabins). Minor to moderate, long-term site-specific negative effect (boating and campground development)
<i>Recreational Fishing</i>	Minor to moderate, medium-term local positive effect (fish stocking and trophy management).	Major, medium-term positive effective at the site-specific scale (restocking of rainbow trout) and long-term positive effects at the refuge-wide scale (maintaining ecosystem health and diversity).	Same as Alternative B.
<i>Trapping and Recreational Hunting</i>	Negligible, long-term positive effect at the site-specific and local scales (maintaining current access).	Minor to negligible, long-term positive effect at the site-specific scale (improved access) and local scale (canoe routes).	Moderate, long-term site-specific positive effect (improved access and additional facilities). Minor to moderate, long-term site-specific negative effect (increased competition with other user groups).

Resource/ Value	Alternative A (Current Management)	Alternative B (Preferred Alternative)	Alternative C
Opportunities to Engage in Supporting Public Uses of Tetlin Refuge	<p>Minor to moderate, long-term site-specific positive effect (maintaining current access and range of opportunities).</p> <p>Minor, medium-term site-specific negative effects (fewer opportunities to use administrative cabins).</p>	<p>Minor to moderate, long-term local positive effect (additional canoe routes and improved trail access).</p> <p>Minor to moderate, long-term site-specific negative effect (potential fees, increased public use, and perceived crowding by current visitor).</p>	<p>Minor to negligible, long-term, positive effects at the regional scale (increased availability of common opportunities) and site-specific scale (additional public use cabins).</p> <p>Moderate to major, long-term regional negative effects (reduced diversity of recreational opportunities).</p>
Public Health and Safety	<p>Minor to negligible, long-term local positive effect (low probability of implementing prescribed fire fuel break).</p> <p>Moderate to major, short-term local negative effect (smoke from prescribed or wildland fires within the Refuge).</p>	<p>Minor to moderate, long-term positive effect at the site-specific and local scales (greater probability of implementing successful fire suppression actions).</p> <p>Moderate to major, short-term local negative effect (smoke from prescribed or wildland fires within the Refuge).</p>	<p>Moderate to major, short-term site-specific positive effect (more aggressive fire suppression and reduced danger).</p> <p>Major, long-term refuge-wide negative effect (higher risk for catastrophic fire following long-term fire suppression).</p> <p>Moderate to major, long-term site-specific positive effect (pullouts and additional backcountry cabins).</p>