

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter provides an evaluation of the potential impacts of each of the alternatives. For each impact topic selected for detailed analysis (see Section 1.5.1), direct, indirect, and cumulative impacts have been described. This evaluation is based on the assumption that all monitoring and mitigation would be implemented.

4.1 IMPACT CRITERIA

Summary impact levels (characterized as negligible, minor, moderate, major or impairment), are given for each impact topic and are based on the intensity, duration, and context of the impact. Definitions are provided below.

Intensity

- Low: A change in a resource condition is perceptible, but it does not noticeably alter the resource's function in the park's ecosystem, cultural context, or visitor experience.
- Medium: A change in a resource condition is measurable/observable and an alteration to the resource's function in the park's ecosystem, cultural context, or visitor experience is detectable.
- High: A change in a resource condition is measurable/observable and an alteration to the resource's function in the park's ecosystem, cultural context, or visitor experience is clearly and consistently observable.

Duration

- Temporary: Impacts would last only a single visitor season or for the duration of discreet activity, such as construction of a trail (generally less than two years).
- Long term: Impacts would extend from several years up to the life of the plan.
- Permanent: Impacts are a permanent change in the resource that would last beyond the life of the plan even if the actions that caused the impacts were to cease.

Context

- Common: The affected resource is not identified in enabling legislation and is not rare either within or outside the park. The portion of the resource affected does not fill a unique role within the park or its region of the park.
- Important: The affected resource is identified by enabling legislation or is rare either within or outside the park. The portion of the resource affected does not fill a unique role within the park or its region of the park.
- Unique: The affected resource is identified by enabling legislation and the portion of the resource affected uniquely fills a role within the park or its region of the park.

Overall Summary Impact Levels

Summaries about the overall impacts on the resource synthesize information about intensity, duration, and context, which are weighed against each other to produce a final assessment. While each summary reflects a judgment call about the relative importance of the various factors involved, the following descriptors provide a general guide for how summaries are reached.

- Negligible:** Impacts are generally low intensity, temporary, and do not affect unique resources.
- Minor:** Impacts tend to be low intensity or of short duration, although common resources may have more intense, longer-term impacts.
- Moderate:** Impacts can be of any intensity or duration, although common resources are affected by higher intensity, longer impacts while unique resources are affected by medium or low intensity, shorter-duration impacts.
- Major:** Impacts are generally medium or high intensity, long term, or permanent, and affect important or unique resources.
- Impairment:** A resource would no longer fulfill the specific purposes identified in the park's establishing legislation or its role in maintaining the natural integrity of the park.

4.2 CUMULATIVE IMPACTS

As defined in 40 CFR 1508.7, cumulative impacts are the incremental impacts on the environment resulting from adding the impacts of an alternative to the impacts resulting from other past, present, and reasonably foreseeable future actions, including those taken by both federal and nonfederal agencies, as well as actions undertaken by individuals. Cumulative impacts may result from singularly minor but collectively significant actions taking place over a period of time. A cumulative impacts analysis has been prepared for each impact topic under each alternative below. These analyses are based on the following list of relevant past, present, and reasonably foreseeable future actions.

- The population of the State of Alaska has steadily grown for the last 30 to 40 years, and this trend is likely to continue. Park visitation is also likely to increase over the next 20 years. According to the U.S. Census, the Cantwell population has grown from 17 people in 1939 to 183 people when ANILCA was enacted in 1980 to 222 people in the latest census in 2000. The population is expected to continue increasing.
- Since 1980, new housing and commercial development has occurred around Cantwell. The gradual development spreading out from the Parks Highway corridor is likely to continue, creating increased interest in access to the eastern and southern boundaries of the national park, particularly the park additions.
- The National Park Service and its partners have assisted in promoting winter visitation in the park entrance area by hosting an annual Winterfest that began in 2001.
- The overall number of hunters on general State lands within GMU 13E is increasing. This, combined with tightening of regulations for hunting on these State lands, increases the competition for subsistence opportunities.
- ORV use has been unlimited on State land adjacent to the TUA, and ORVs are likely to continue to be allowed on these lands in the future.
- Past motor vehicle use in the TUA has resulted in the loss of 14.8 ha (~37 acres) of vegetation.
- ANILCA allows snowmachines for subsistence, for traditional activities, and for travel to and from villages and homesites (ANILCA 811 and 1110). During the 1990s, technological improvements in snowmachines enabled a large but unquantified expansion of snowmachine use in Denali. Accurate estimates of snowmachine users are difficult to make, but during

March and April of 1999, the NPS estimated that there were between 1,500 and 2,000 snowmobile users along the Parks Highway, primarily in the region from Cantwell to the West Fork of the Chulitna River and the Tokositna River area (NPS 2000a).

4.3 EFFECTS ON SOILS

4.3.1 Soils Impact Methodology

Soils information in the area of the TUA is primarily from an NRCS report, "Soil Survey of Denali National Park Area, Alaska, by Clark and Duffy, 2004 (NPS 2004d). This seven year soil-ecological mapping effort resulted in digital maps and descriptive products for several characteristics including climate zones, natural vegetation, permafrost areas, landforms, geomorphic processes, lithology, and soils temperature regimes, parent materials, life zones, and NRCS land classifications. Additionally, soils information is supplemented by field work done by an NPS botany/vegetation crew, mostly during the 2005 field season (Liebermann and Roland 2006).

4.3.2 General Impacts of ORVs on Soils

Native soils are impacted primarily as a function of how ORV use affects the support or growth of vegetation (in non-barren areas). Thus, soils impacts occur where surface or subsurface disturbance is to the degree that the soils no longer support local plant life, or the disturbance alters the existing plant community. These impacts are usually of a mechanical nature (stripping, shearing, abrasion, compaction, hydraulic mixing), although chemical changes (i.e. changes in pH, CaCo₃ ...) can also alter the soil character. Both mechanical and chemical changes to soil are greatly amplified by a change in water regime that affects hydration and oxidation/reduction.

Where a surface area is used as a trail or other travel route, soils "impacts" are actions that degrade the operational utility of the surface (as a trail) by weakening the structural integrity of the soils through mechanical, chemical and/or hydrological change. It should be emphasized that most degraded soils conditions develop in areas of excessive water or poorly drained areas when traversed by trails or other human use. Soil degradation may then be defined as the condition where trail use exceeds soils resilience, creating such problems as extensive rutting, erosion, muddy sections or ponding that may require formal or casual re-routing that expands the impact to adjacent areas, or to mitigate the problem areas by proper engineering and construction.

Potential soils and other resource impacts related to trail use in Alaska are well covered in a USDA Forest Service document entitled "Managing Degraded Off-Highway Vehicle Trails in Wet, Unstable, and Sensitive Environments" (Meyer 2002). Meyer provides a useful description of soil impacts and trail degradation:

"Direct mechanical impact has several components: abrasion, compaction, shearing, and displacement. Abrasion strips surface vegetation and roots. Compaction reduces soil voids and causes surface subsidence. Shearing is the destructive transfer of force through the soil. Displacement results in the mechanical movement of soil particles. "

"Indirect impacts include hydraulic modifications, such as the disruption of surface water flow, reductions in infiltration and percolation, surface ponding, and the loss of water-holding capacity. Other indirect impacts include those associated with erosion--both the loss of soil particles by wind or water erosion and deposition of transported particles. An

associated impact is the hydraulic pumping that occurs when a destructive flow of water is forced through a saturated soil.”

ORV impacts to soils involves any disturbance that changes, prohibits or degrades the natural conditions of the area (plant growth, water regime, or the natural soil stratigraphy), or involves any disturbance that changes, prohibits or degrades the practicability of traversing the area.

4.3.3 Impacts of Alternative 1 (No Action)

The primary mechanisms of soils impact in the TUA are from ORV wheel contact (abrasion, shearing, compression, displacement), damages to soils from impact (compaction; mixing; burying; and abrading), and secondary effects from the effects on impacted soils (erosion, deposition of eroded material, ponding). A summary of the agents, nature, and extent of ORV impacts is given in the General Soils Impact section above and in Liebermann & Roland (2006) for the 2005 survey of ORV impacts in the TUA, and Sinnott (1990) and Meyer (2002) for Alaska in general

Under Alternative 1, it is expected that ORV travel initially would continue to occur on most of the trails of the TUA, into non-impacted off-trail areas, and with occasional repeat travel over routes that were previously single-event off-trail paths. Travel on the Cantwell Creek and Bull River Floodplains also would be expected, and travel on some areas of the Windy Creek Floodplain is a possibility. Soils impacts could be expected both on-and off trail, intensifying in previously impacted areas and expanding to non-impacted areas in the TUA. Although style and frequency of trail use are impossible to predict, even continued use levels as occurred in the past would further tax the soils. With those continued historical use levels, and the sensitive soils involved in most of the TUA trail areas, implementation of Alternative 1 would result in the continuation of the same or similar impacts (see Table 3.1).

The 2005 inventory identified and estimated a minimum total of 36.5 acres of combined ORV impact of all types in the TUA stretching over 22.8 miles of linear distance, ranging from lightly visible travel paths to intense degradation. This area does not consider impacts off the trail or route area, such as erosion or sedimentation; it is the "footprint" of the ORV use. The greatest ORV impacts were found in wetland areas (Liebermann & Roland 2006), where vegetation and soils can be severely impacted by a single pass (NPS 1990, Sinnott 1990, Meyer 2002). These impacts would be expected to continue under this alternative. Increased trail use overall within the TUA might be most noticeable in areas of the greatest existing impacts as ORV drivers try to go around the old or newly evolving trouble spots, however correlations with certain soil types is not possible given the existing impact data (Table 3.1 and Figure 3.1)

Two trails (and associated off-trail areas) would be especially susceptible to the types of impacts described above. The Cantwell Creek West – Northwest trail (CCW-NW) involves 6.1 acres, while the Cantwell Creek West – Center trail (CCW-C) involves 7.1 acres, for a total of 13.2 acres of trail (see Figure 3.1 – Soils Mapping Units). The landform/soils involved are of the 9TP classification, with typical wet meadows and string bogs (very high water table) and mixed hydric soil conditions which are very susceptible to compaction, shearing, and hydraulic pumping. Lands of this type are generally characterized as wetlands, and as present conditions are assessed, are the highest impacted areas of the TUA.

Under this alternative, a number of factors would contribute to an expected increase in soil impacts off of the trails and areas mapped in 2005. The 2005 Determination that ORVs were traditionally employed in the TUA would serve as the basis for allowing ORV use anywhere in

the TUA for any subsistence-related purpose. Use levels would increase as this reduced regulatory ambiguity would encourage more NPS qualified subsistence users to operate ORVs in the TUA, including an authorization to leave the existing trails. The uses would not be restricted to hunting moose, caribou, and ptarmigan late in the summer, as hares, for example, are always in season. Firewood gathering, berry picking, and even scouting for game are other activities related to a subsistence lifestyle that would be supported by ORV use. Since there would be no restriction on types of ORVs or where they could be driven within the TUA, and because there would be no restrictions related to the condition of the soil or the weather, there would be an increased level of damage to the soil resources within the TUA due to increased travel through and damage to wetlands, increased parallel trail formation while evading trail obstacles, and increased occurrence and intensification of indirect impacts.

The amount of damage cannot be accurately predicted due to the unlimited amount of activity allowed under this alternative, but over the long term could result in degradation of soils on significant areas within the 32,159 acres of the TUA. However, most impacts probably would occur on the 2,900 acres of flat (i.e., less than 20% slope) and open terrain that's most easily accessed by ORVs (e.g., the open wetlands, low shrub-open wetland mix, tussock meadows, open gravel floodplains, lightly vegetated gravel bar, open water, and upland and alpine meadows).

Some foot travel for subsistence use can be expected for a small number of trails. Some further amount of soils damage could be realized by the method(s) chosen for retrieval of harvested game including use of horses. Horses can churn the soil strata, especially in sensitive soils. However, horse traffic is expected only during the hunting season, in limited numbers, and the use would create narrower travel corridors, resembling natural use from moose and caribou.

Cumulative Impacts

In addition to the current local use of the TUA trails and off-trail areas by subsistence permittees, there are other factors which could result in additional impacts to soil resources in the TUA.

The State population has steadily grown for the last 30 – 40 years, and this trend is likely to continue. Park visitation is also likely to increase over the next 20 years. Visitor use activities which would increase over the next 20 years would likely include summer hiking and horseback riding, while current or potential winter activities such as dog mushing and snowmachining would also increase. The summer activities can provide direct impacts to soils resources while other activities (snow machining, and mushing) can indirectly and more subtly affect the soils by snow compaction and subsequent alteration of the spring melt or on-site water regime. Sensitive soils, such as those of the TUA are quickly altered by nearly any changes in the natural environment.

Overall, Alternative 1 would result in major additional adverse impacts. The cumulative impact of Alternative 2 on soil resources coupled with any past, present, and future actions would likely be major.

Conclusion

Actions in this alternative would have a major adverse impact on soils in the Cantwell TUA because of intense, long-term ORV use in many areas of the TUA. Those soils would be affected by direct effects such as churning and rutting, and from secondary effects such as erosion. The level of impacts to soils anticipated from this alternative would be widespread and difficult to predict but over the long term could result in degradation of soils on significant areas within the

32,159 acres of the TUA. Most impacts probably would occur on the 2,900 acres of flat (i.e., less than 20% slope) and open terrain that's most easily accessed by ORVs.

The level of impacts to soils anticipated from this alternative would result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park, including the preservation of lands and waters for present and future generations, preservation of scenic values, the maintenance of sound habitat for wildlife, and the preservation of extensive unaltered ecosystems in their natural state.

4.3.4 Impacts of Alternative 2

Under this alternative, off-trail ORV use would be permitted by NPS qualified subsistence users only for retrieval of harvested moose and caribou. In addition, use of ORVs for all subsistence purposes would continue to be allowed on the following NPS-managed trails and routes: the existing Windy Creek Access (WC-CN), Windy Creek Bowl (WC-SW), Cantwell Airstrip (CW-S), and Pyramid Peak (CCN-C) Trails; the Bull River Access Trail (new construction); and on the Upper Cantwell Creek and Bull River Floodplain Trails/Routes. The 17b easement through Ahtna Inc. property in the Windy Creek area would continue to be managed as it has in the past but would be improved to mitigate impacts.

Table 4.1 Lengths & Areas for Four Trails Authorized by Alternative 2

Pyramid Peak T.	Windy Ck Access	Windy Ck Bowl	Cantwell Airstrip	Totals
1.2 miles	0.8 miles	0.5 mile	1.5 miles	4 miles
1.6 acres	1.2 acres	0.8 acres	2.2 acres	5.8 acres

Under Alternative 2, the four existing trails managed for continued subsistence ORV use would provide 4 miles of trail length (5.8 acre footprint) for ORV travel. The great majority of these trail areas involve the 7MS2 soils, which are generally eolian deposits over gravelly till, are poor to well drained and non-hydric, and have water tables at depths up to or greater than 18 inches. Three secondary soils units are also involved (7SA31, 9TM, and 7TP) with the majority falling into the 7TP unit. These soils are variously organic material over silty eolian deposits over gravelly till, are mostly poorly drained, are both hydric and non hydric, have shallow water tables (0 to 48 inches), and the 7TP discontinuously contains permafrost. Although the majority of the trail areas are on soils that are sensitive but more durable than others of the TUA, (see 7MS2 soils in Table 3.1), certain sections are currently problem areas in perhaps any of the four soil types, but these problem areas would be corrected by implementing the management prescriptions in Appendix 5.

Continued subsistence ORV use of the NPS-managed trails would likely concentrate many of the impacts to those trails; however, as just described, the four existing trails are among those with the least existing soils impacts. These trails would be made even more durable as a result of construction improvements made as prescribed for this alternative. This action, coupled with trail condition monitoring and management (with well-defined and established threshold limits, and well defined and measured impact parameters), closure options, and limitations on the type and weights of ORVs, would greatly minimize overall soil impacts on the retained trails.

Under this alternative, closures would reduce soil impacts from 36.5 acres to 5.8 acres. It is unknown how long natural recovery of soils would take in these areas, but regaining the complete soil profile would probably require several hundreds of years.

The primary mechanisms of soils impact in the TUA are from ORV wheel contact (abrasion, shearing, compression, displacement), damages to soils from impact (compaction; mixing; burying; and abrading), and secondary effects from the effects on impacted soils (erosion, deposition of eroded material, ponding).

Initially, under Alternative 2, four-wheel drive/track-equipped ORVs and those ORVs designed with Best Available Technology would be managed the same way and would not be allowed on slopes greater than 20% or across saturated soils such as found in open wetlands, low shrub/open wetland mixes, willow swamps, and streams and ravine corridor. This would mean 23,091 acres of the TUA would be closed to ORV use initially. Due to the elimination of ORV travel on wet and other sensitive soils, it is likely that the direct and indirect off-trail impacts to soils would be more dispersed and of low to medium intensity. However, using a range of between one-half mile-to-three miles for a one-way retrieval trip, it is estimated that between 51 to 959 acres of new off-trail impacts to soils would occur over 15 years, depending on the types of landscapes driven through (see Section 4.4.4 for additional assumptions supporting these estimates).

Under this alternative, a new ORV trail would be constructed to access the Bull River Floodplain. Construction of the Bull River Access Trail, assuming 1.7 miles of length, and up to an 8 foot average width of disturbance (to achieve a 6 foot drivable surface), would involve 1.7 acre of surface area, thus, 1.7 acres of soil loss. However, it is expected that the new trail would be designed so that adverse soils impacts from trail use (such as erosion) would not occur.

At most, construction of trails in the Upper Cantwell Creek and Bull River Floodplains would total approximately 2 miles and would affect about 2 acres of soils through trail hardening and use. Trail delineation and maintenance would produce soil impacts from brush clearing, surface blading, gravel capping, or other forms of hardening, cutting ramps on or off elevated bars, and creating cross drainage. The Bull River and Cantwell Creek open gravel floodplains would be available for subsistence ORV use under this alternative (approximately 250 acres), along flexible routes that would depend upon the day-to-day movements of the braided stream channels. Floodplain routes would be on gravel bars where compaction might be the most detectable impact, and track impressions should be erased annually by the day-to-day changes of the braided glacial river.

Some foot travel for subsistence use can be expected for a small number of trails. Some further amount of soils damage could be realized by the method(s) chosen for retrieval of harvested game including use of horses. Horses can churn the soil strata, especially in sensitive soils. However, horse traffic is expected only during the hunting season, in limited numbers, and the use would create narrower travel corridors, resembling natural use from moose and caribou.

Cumulative Impacts

Present and future conditions as outlined in the “Cumulative Impacts Associated with Alternative 1 are also applicable here. The expected population growth, coupled with tourism growth could increase direct and indirect impacts to the TUA trails and overland areas.

Overall, Alternative 2 would result in moderate additional adverse impacts. The cumulative impact of Alternative 2 on soil resources coupled with any past, present, and future actions would likely be moderate.

Conclusion

Actions in this alternative would have a moderate impact on soils in the Cantwell TUA because of widespread long-term ORV use in many areas of the TUA. An estimated 51 to 959 acres of new off-trail impacts to soils would occur over 15 years, depending on the types of landscapes driven through. Impacts would include churning and rutting, as well as erosion. In addition to these impacts, soils would be directly affected by construction on 1.7 acres for the new Bull River Access Trail, another 2.0 acres to maintain trails through the Bull River and Upper Cantwell Creek Floodplains, and by continued use on 5.8 acres of the four trails retained. NPS trail construction, maintenance and reinforcement activities, coupled with the more intensive monitoring included in this alternative, would minimize some of the potential soil impacts, especially the indirect impacts. As a result, overall soils impacts under this alternative are expected to be moderate.

The level of impacts to soils anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.3.5 Impacts of Alternative 3

Under Alternative 3, subsistence ORV use would continue on four existing trails, the newly constructed Bull River Access Trail, and the Bull River and Upper Cantwell Creek Floodplains. All other trails would be closed for recovery (same as Alternative 2). No off-trail ORV use would be permitted. The NPS would work with Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to implement a winter subsistence hunt by snowmachine, primarily in the area southwest of Cantwell Creek and into the Bull River area.

Like Alternative 2, continued subsistence ORV use on four NPS-managed trails would concentrate the impacts to those areas (a 5.8 acre footprint), especially given that the rest of the TUA would be closed to ORV use. Therefore, trail use impacts could increase by the additional concentrated use. However, also as described for Alternative 2, these four trail areas are among those with the least existing soils impacts, and, furthermore, these trails would be made even more durable as a result of construction improvements made as prescribed for this alternative. This action, coupled with trail condition monitoring and management, well-defined and established threshold limits, and well defined and measured impact parameters, and limitations on the type and weights of ORVs, would greatly minimize soils impacts.

At most, construction of trails in the Upper Cantwell Creek and Bull River Floodplains would total approximately 2 miles and would affect about 2 acres of soils through trail hardening and use. Trail delineation and maintenance would produce soil impacts from brush clearing, surface blading, gravel capping, or other forms of hardening, cutting ramps on or off elevated bars, and creating cross drainage. The Bull River and Cantwell Creek open gravel floodplains would be available for subsistence ORV use under this alternative (approximately 250 acres), along flexible routes that would depend upon the day-to-day movements of the braided stream channels. Floodplain routes would be on gravel bars where compaction might be the most detectable impact, and track impressions should be erased annually by the day-to-day changes of the braided glacial river.

Off trail use in Alternative 3 would not be allowed. As a result, the total soil condition of the TUA would improve as vegetative communities and the underlying soils previously impacted

would be allowed to naturally recover. It is unknown how long natural recovery of soils would take in these areas, but regaining the complete soil profile would probably require several hundreds of years.

Some foot travel for subsistence use can be expected for a small number of trails. Some further amount of soils damage could be realized by the method(s) chosen for retrieval of harvested game including use of horses. Horses can churn the soil strata, especially in sensitive soils. However, horse traffic is expected only during the hunting season, in limited numbers, and the use would create narrower travel corridors, resembling natural use from moose and caribou.

The winter hunt (snowmachine use) anticipated by this alternative could indirectly and subtly affect the soils by snow compaction, and subsequent altering the spring melt or on-site water regime. Sensitive soils, such as those of the TUA are quickly altered by nearly any changes in the natural environment, although the impacts would be minor from the amount of snowmachine use likely to occur.

Cumulative Impacts

Present and future conditions as outlined in the Alternative 1 Cumulative Impacts section are also applicable here. In quick review, the expected population growth, coupled with tourism growth could increase direct and indirect impacts to the TUA trails and overland areas.

Overall, Alternative 3 would result in moderate additional adverse impacts. The cumulative impact of Alternative 3 on soil resources coupled with any past, present, and future actions would likely be moderate.

Conclusion

Actions in this alternative would have a moderate impact on soils in the Cantwell TUA because soils would be directly affected by construction on 1.7 acres for the new Bull River Access Trail, another 2.0 acres to maintain trails through the Bull River and Upper Cantwell Creek Floodplains, and by continued use on 5.8 acres of the four trails retained. NPS trail construction, maintenance and reinforcement activities, coupled with the more intensive monitoring included in this alternative, would minimize some of the potential soil impacts, especially the indirect impacts.

The level of impacts to soils anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.3.6 Impacts of Alternative 4

Under Alternative 4 the Bull River Access Trail would not be constructed and ORV use would not be allowed on the Bull River Floodplain or on the Upper Cantwell Creek Floodplain. The four trails retained for use in Alternatives 2 and 3 would be available in this alternative, but ORV use for subsistence purposes would be authorized only from one week before the beginning of the fall moose and caribou hunting seasons through to the end of these hunting seasons.

This alternative would effectively close all other trails and all areas of the TUA to ORV use. The NPS would work with the Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Subsistence Advisory Council to implement a winter subsistence

hunt by snowmachine in the TUA. Additionally, alternative methods to retrieve harvested game would continue to be used, and may increase, such as horsepacking.

There would be a reduced impact on soils resources within the TUA by permitting ORV use only on 5.8 acres of the four retained trails. Shorter term ORV use (hunting season only) of the four authorized trails would further reduce the impacts to soils by limiting the use of the vehicular trails to the time of year when they are likely to be more durable. Coupled with NPS condition monitoring and management control, these impacts should be minimal.

Some foot travel for subsistence use can be expected for a small number of trails. Some further amount of soils damage could be realized by the method(s) chosen for alternative retrieval of harvested game including use of horses. Horses can churn the soil strata, especially in sensitive soils. However, horse traffic is expected only during the hunting season, in limited numbers, and the use would create narrower travel corridors, resembling natural use from moose and caribou.

The closure of all trails and off-trail areas would improve the total soil condition of the TUA because the vegetative communities and the underlying soils would be allowed to naturally recover. It is unknown how long natural recovery of soils would take in these areas, but regaining the complete soil profile would probably require several hundreds of years.

The winter hunt (snow machine use) anticipated by this alternative could indirectly and subtly affect the soils by snow compaction, and subsequent altering the spring melt or on-site water regime. Sensitive soils, such as those of the TUA are quickly altered by nearly any changes in the natural environment, although the impacts would be minor from the amount of snowmachine use likely to occur.

Cumulative Impacts

Present and future conditions as outlined in the Alternative 1 Cumulative Impacts section are also applicable here. The expected population growth, coupled with tourism growth could increase direct and indirect impacts to the TUA trails and overland areas.

Overall, Alternative 4 would result in minor additional adverse impacts. The cumulative impact of Alternative 4 on soil resources coupled with any past, present, and future actions would likely be moderate.

Conclusion

Actions in this alternative would have a minor impact on soils in the Cantwell TUA. Soils would be directly affected by continued use of ORVs on 5.8 acres of the four trails retained. NPS management of trail construction, maintenance and reinforcement activities, coupled with the more intensive monitoring included in this alternative, would minimize some of the potential soil impacts, especially the indirect impacts.

The level of impacts to soils anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified.

4.4 EFFECTS ON VEGETATION (INCLUDING WETLANDS)

4.4.1 Vegetation Impact Methodology

ORV impacts to vegetation occur based on many factors including weather, microtopography, driver attitude, and ORV use levels and patterns (see Sinnott 1990). To predict impacts with precision, data for existing impacts to trails would ideally be observed over numerous seasons and specifically correlated with use levels. Because this level of data is lacking for the TUA, the predictions below are based on the assumption that impacts documented in 2005 represent previous ORV use levels, and that similar impacts would result from similar use patterns in the future. From the 2005 inventory it is easier to tell susceptibility of a vegetation landscape type to damage than it is to determine how long those impacts would persist or when they were created.

Based on observations of the age and persistence of existing negative impacts in the TUA and elsewhere in Alaska (Liebermann & Roland 2006, Sinnott 1990, NPS 1990), the following are assumptions about minimum-time estimates for the duration of impacts on particular types of vegetation (see Section 4.4.2 for additional discussion on duration of impacts):

- If a trail's path is used for one or very few vehicle passes, negative vegetation and soil impacts could last as little as a year on some dry meadows and subalpine low shrub areas of the TUA.
- Herbaceous vegetation damage could last 1-5 years on a few- or single-pass path on moist but non-saturated soils, for example some wetland edge meadows.
- Negative impacts to vegetation could last much longer on some areas - 3-10 years on willow shrublands, 5-15 years on dwarf birch shrublands, or longer on the saturated soils of open peatlands where revegetation is very slow.
- In the area of heavy soil rutting in the Cantwell Creek West areas, it is possible that partial vegetation recovery would occur in 2-5 years, and partial soil recovery in 5-10 years.
- Wheel ruts from one to a few passes in saturated soils may last from 3-10 years; this can vary based on the depth and width of ruts and soil conditions at damage time and in subsequent seasons (see NPS 1990).
- Vegetation on some shallow or short eroded slopes could possibly recover in 5-10 years if use stopped, but longer or steeper areas would be unlikely to recover soils and vegetation without remediation because of ongoing erosion even if vehicle use ceased.

Another assumption used for analysis is that ORV use within the TUA would increase above present levels. In 2000, about 50% of the nearly 100 subsistence-eligible households in Cantwell attempted to harvest moose, with about 25% successful. It's assumed that at least 50 subsistence-eligible households would continue to engage in subsistence moose hunting. Further, they would hunt in the TUA first before going to other lands outside the TUA, because the 2005 NPS determination that ORVs are a traditional means of access for subsistence purposes within the TUA eliminated the uncertainty about ORV use for subsistence in the TUA. Additionally, the TUA is closer to Cantwell than other hunting lands and hunting there is unaffected by competition with non-local hunters (unlike on lands outside the TUA).

4.4.2 General Vegetation Impacts

Nature and Patterns of Vegetation Impacts

Impact-Causing Agents

ORVs are the main vehicle type used in the TUA for subsistence activities at present, and are the main agent of adverse impacts to vegetation. ORV use can damage both directly and indirectly vegetation by several mechanisms. The primary mechanisms of vegetation impact in the TUA are from direct ORV wheel contact (abrasion, shearing, compression, displacement), vehicle body contact (collision), damages to soils from impact (compaction; mixing; burying; and abrading). There are also indirect effects on vegetation that occur through changes to plant habitat (erosion, deposition of eroded material, ponding). A summary of the agents, nature, and extent of ORV negative impacts is given in Section 3.3.6 of this document and in Liebermann & Roland 2006 (the 2005 survey of ORV impacts in the TU), and Sinnott (1990) and Meyer (2002) for Alaska in general.

Direct vegetation impacts result from abrasion, crushing, or breakage of plant tissues through contact with the vehicle (e.g. tires or tracks). In addition, spinning or skidding of vehicle tires or tracks may cause soil shearing, mixing of soil or indeed partial burying of plants (Meyer 2002, Sinnott 1990). Damages from ORVs may include removal of vegetation, death of plant tissues or entire individuals, and alteration of the habitat for plant growth. Long-term impacts can result from alteration of the habitat through soil damage, erosion, or other secondary impacts. All of these vegetation impacts were documented in the TUA in 2005 (Liebermann and Roland, 2006). Each of these can have negative consequences for vegetation, ranging from mechanical damage, reduced productivity, changes in species composition, or long term changes in the appearance of the vegetation, to complete destruction or removal of the vegetation of an area.

In general, light amounts of ORV traffic may cause damage to vegetation, although the severity of damage usually increases on a given vegetation type with the number of passes. This increase is not necessarily linear, and the majority of negative impacts often occur in the first few passes of ORVs (NPS 1990; Sinnott 1990; Sparrow, Wooding & Whiting 1976; also see NPS 2005c for a review of ORV impacts in Alaska). Within the TUA, many areas with even a single pass had unacceptable vegetation and/or soil damages that would persist for many years, such as on the branching trails from the Windy Creek Bowl trail and areas of the Cantwell Creek West-Center area (Liebermann & Roland 2006).

Differential Response of Landscape Types to Impacts

The level of impact and vegetation response varies among ecosystems and is, based on the relative resilience of soils and vegetation. The resilience of the vegetation depends on the relative abundance of different plant growth forms, local soil qualities, and intensity and type of ORV use (NPS 1998, Wooding & Sparrow 1978, Sinnott 1990). Different vegetation types sustain and recover from damages at different rates and thus the amount of damage is difficult to predict with precision.

Fatal damages to plants are sustained more rapidly by herbaceous plants because their tissue is generally less structurally resilient compared to woody shrubs. Woody plants, on the other hand, are normally slower to recover fully because of their generally slower growth rates. Mesic graminoid meadows would recover more quickly and completely than saturated sedge meadow because of more productive soils and faster growing vegetation in the dry meadows.

In general, wetter, more open areas are more sensitive to **vegetation and soil disruption** from ORV travel, and drier areas are less so. This is because saturated soils have less structural resilience and the herbaceous wetland vegetation is more easily damaged both above and below the ground surface. Some saturated areas (such as willow swamps) may be able to initially withstand some wheel abrasion before forming deep ruts or similar soil-related damages because of the additional resistance provided by the woody roots, though repeated abrasion would eventually degrade the roots as negative impacts proceed. Areas with fewer woody plant roots in the soil (such as swales on the floodplain or wet meadows) have a greater susceptibility to soil disruptions that can permanently damage the vegetation after low numbers of passes; after several passes durability of the few roots is lost and the organic mat is easily damaged.

Shrub breakage and removal is often the most visible type of vegetation impacts resulting from ORV use, readily marking an area as an obviously ORV trail. This can cause single-pass routes to be reused when an operator is seeking a proven path to follow with the fewest obstructions (Wooding & Sparrow 1978, Sinnott 1990,). After several vehicle passes most shrub growth is killed or redirected from the wheel contact areas a trail path, creating a semi-permanent path (NPS 1990). Willow and dwarf birch shrublands show markedly differential responses and rates of recovery from disturbance. While willow may show more mechanical damage immediately following a single vehicle pass, they also recover more quickly from damage because of their faster growth rates. After several passes in wet terrain, however, if the root system and organic mat are severely damaged, negative impacts may be more long-lasting. Dwarf birch damages may not be as highly visible following a single pass due to its more prostrate form and thinner branch growth, but it apparently sustains damages to leaf buds and shoots more readily (NPS 1990, Sinnott 1990, ADFG 1996b) and recovers from mechanical damage more slowly than willow (Liebermann and Roland, 2006). Damage from a single pass has been found to be obvious in a dwarf birch shrubland years after the initial disturbance (NPS 1990, Wooding & Sparrow 1978, (Liebermann and Roland, 2006). Dwarf birch is a late-successional species and grows more slowly, on average, than does willow.

When vegetation is removed from wheel tracks, recovery can take considerably longer than if the plants were damaged but not removed. Additionally, different species (native or invasive) from the original native vegetation may occupy the newly exposed soil. If soils are damaged or removed, vegetation recovery may not occur for a very long time. Another form of vegetation "removal" occurs when wheel ruts bury and mix surface vegetation, though this is usually difficult to separate from non-mixing vegetation removal in field surveys.

Negative impacts to the vegetation-soil interface are much more severe when the organic mat is perforated. With the organic mat intact, roots and soils are protected and provide resistance to erosion and soil loss and give a bed for plant revegetation. If the organic mat is torn or perforated, erosion is much more likely and revegetation is much slower. Organic mat perforation is most common at present in areas of saturated soils and deep wheel ruts, on steep slopes that have undergone some erosion, and on heavily used trails.

Vegetation community composition change may occur when the plant habitat has been altered to the degree that recovery or regeneration of the existing plant community is hindered.

4.4.3 Impacts to Vegetation under Alternative 1 (No Action)

Under Alternative 1, the Cantwell TUA would remain open to the use of any type of ORVs by NPS qualified subsistence users for any type of subsistence purpose. However, it's assumed that

ORV use would continue to be concentrated along Cantwell Creek, Cantwell Airstrip Trail, and the Windy Creek trails during the moose and caribou hunting season in August and September.

On-Trail/Route Impacts

Negative impacts ranging from lightly visible travel passes to intense degradation would continue to occur on a total of 36.5 acres stretching over 22.8 miles of existing trail and area impacts (see Section 3.3.6). However, since ORV trails and routes tend to increase in length and expand at areas of obstructions or degradation (Sinnott 1990), an increase in ORV use impact area and intensity on existing trails and routes would be likely.

Impacts would be most severe on the most heavily used Windy Creek North, Cantwell Northwest, Cantwell Airstrip, and Cantwell Creek West trails. Because much of the travel to these areas would likely occur during the short hunting season, degradation such as mudholes and rutting may increase much more rapidly than if use levels were evenly distributed over more of the year, which would allow some partial recovery between vehicle passes (Sinnott 1990). This would result in increasing segments of existing trails becoming braided or impassible and the consequent creation of detour trails or braids around severely degraded areas, further increasing the "footprint" of the impacted area.

Existing trail and area impacts would not be expected to recover significantly in any areas that continue to be used for ORV travel and thus would be classified as "persistent" impacts.

Off-Trail/Route Impacts

Since there would be no restriction on types of ORVs or where and when they could be driven within the TUA, ORV users would likely pioneer new vehicle passes into previously non-impacted vegetation. These newly pioneered passes may be disproportionately on open or semi-open areas because of the ease of travel. Other users subsequently could use these paths because of the visible vegetation clearing, creating new frequently used trails. Many older trails that were mapped in 2005 appear to have started as single-use passes under similar circumstances.

Trails would create linear areas of damage, with obvious shrub breakage and scraping, herbaceous vegetation stripping, erosion, organic mat removal, soil compaction, and, especially in wet areas, soil mixing and rutting. Many of these types of damage could lead to alteration of habitat for plant growth and thus eventually to changes in plant community composition.

In addition to trail-related impacts, ORV travel on lightly or non-vegetated floodplain gravel bars could prevent or alter natural vegetation succession on newly abandoned surfaces by damaging, moving, or removing new vegetation or soils. (Note that similar impacts could occur naturally due to flooding.)

It is difficult to predict recovery times for heavily impacted areas based on existing information. Most adversely impacted areas probably would take 1 to 15 years or more to recover to the *appearance* of non-traveled areas, and longer to recover to the point at which impacts were beyond detection. Actual recovery times would depend on the vegetation type, amount of soil impact, and ORV use intensity (see Section 4.4.1). Thus, the entire area of new trail formation could increase for many years until trail creation is balanced with the recovery of non-used trails. In practice this point may not be reached if increasing travel distances on the expanded trail network or number of ORV users outbalances abandonment of trails.

Given that that ORV use in the TUA would increase, negative impacts to previously non-impacted lands could be widespread and common. Over the long term, vegetation could be adversely impacted throughout the 32,159 acre TUA. However, most impacts probably would occur on the 2,900 acres of flat (i.e., less than 20% slope) and open terrain composed of open wetlands, low shrub-open wetland mix, tussock meadows, open gravel floodplains, lightly vegetated gravel bar, open water (water greater than one inch deep), and upland and alpine meadows. This expectation is supported by available evidence of past ORV use in the TUA, which indicates that ORV users prefer wetlands and wetland margins for travel, because visibility for hunting is greater and there are fewer impediments to travel like shrubs and trees (Liebermann and Roland 2006).

Wetlands Impacts

As discussed in Section 3.3.6, approximately 13.5 linear miles and 22 acres of the existing trail and area impacts documented in the TUA are on wetlands. Impacts to these wetlands from ORV use would continue under this alternative.

Because use is permitted on wetlands under this alternative, ORV travel is likely to expand into approximately 2,292 acres of currently non-impacted open wetlands, low shrub-open wetland mix, and open water wetland types that are found below 20% slope. Negative impacts such as vegetation removal, rutting, trail braiding and creation of parallel paths, and water channel modification would be very likely. Within the floodplains, for example, ORVs would likely be driven off the floodplain across willow and open wetland areas in order to avoid having to cross deep flowing water. Frequent crossing from one bank to the other because of steep cutbanks would also likely occur. As a result of these conditions, much "route searching" via trial and error would be necessary to find a usable path. This would cause adverse impacts to sensitive floodplain wetland habitats.

Impacts to Rare Plants

Botrychium alaskense, a rare fern, occurs in river flats in this area of Denali NPP and is at the northern limit of its known range in the area. It would be expected to be found in the TUA, particularly on the Cantwell Creek and Bull River Floodplain. Unrestricted travel on the floodplain could disrupt this plant if it is present.

Invasive Plants Introduction

Another impact which is possible, but which has not yet been detected in the TUA, is invasive species colonization of ORV-disturbed areas. ORVs can transport exotic seeds or create areas of open soil and damaging less aggressive native vegetation. The most imminent threat is that of *Melilotus alba*, white sweet clover. It has invaded floodplains in central Alaska, including the Nenana River and some areas of Denali NP, and has apparently been seeded along the Parks Highway (Densmore et al. 2001). Invasion of forest clearings or meadows is also possible by this species. Almost all ORV's enter the TUA via the Parks Highway corridor where *M. alba* is established increasing the likelihood of invasion.

Vegetation Restoration

Under this alternative, the NPS would not close any areas for recovery; therefore, the existing impacts on vegetation, including wetlands, would remain as described above.

Impacts from Winter Hunt

The NPS would not seek to implement a winter subsistence moose hunt under this alternative; therefore, there would be no associated impacts.

Cumulative Impacts

Population growth of the area is likely to increase. Park visitation is also likely to increase over the next 20 years. Visitor use activities in this part of the park would likely include summer hiking and horseback riding. Winter activities such as dog mushing and snow machining would also likely increase. The summer activities can provide direct impacts to vegetation and wetlands resources while other activities (snow machining, and mushing) can directly affect the vegetation by damage to exposed branches, by damage to under-snow branches through compression and by subsequent alteration of the spring melt or on-site water regime. Population growth, coupled with tourism growth would increase direct and indirect impacts to the TUA trails and overland areas.

The above past, present, and reasonably foreseeable future actions would have a moderate adverse impact on vegetation. The implementation of Alternative 1 would result in additional major adverse impacts on vegetation and wetland resources; therefore, the total cumulative adverse impact on vegetation and wetland resources would be major.

Conclusion

Alternative 1 would have a major adverse impact on vegetation and wetlands because of widespread, intense, long-term ORV use in many areas of the TUA. Given that that ORV use in the TUA would increase, negative impacts to previously non-impacted lands could be widespread and common. Over the long term vegetation could be adversely impacted throughout the 32,159 acre TUA. However, most impacts probably would occur on the 2,900 acres of flat and open terrain composed of open wetlands, low shrub-open wetland mix, tussock meadows, open gravel floodplains, lightly vegetated gravel bar, open water, and upland and alpine meadows. This 2,900 acres of impact includes approximately 2,314 acres of wetland impacts.

The level of impacts to vegetation and wetlands anticipated from this alternative would result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park, including the preservation of lands and waters for present and future generations, preservation of scenic values, the maintenance of sound habitat for wildlife, and the preservation of extensive unaltered ecosystems in their natural state.

4.4.4 Impacts to Vegetation under Alternative 2

Under this alternative, off-trail ORV use would be permitted by NPS qualified subsistence users only for retrieval of harvested moose and caribou. In addition, use of ORVs for all subsistence purposes would continue to be allowed on the following NPS-managed trails and routes: the existing Windy Creek Access, Windy Creek Bowl, Cantwell Airstrip, and Pyramid Peak Trails; the Bull River Access Trail (new construction); and on the Upper Cantwell Creek and Bull River Floodplain Trails/Routes. The 17b easement through Ahtna Inc. property in the Windy Creek area would continue to be managed as it has in the past but would be improved to mitigate impacts.

On-Trail/Route Impacts

Alternative 2 would have the following impacts associated with ORV trails and the 17b easement:

- Implementing the closures would reduce existing trail and area impacts from 36.5 acres to 5.8 acres within primarily dwarf birch shrublands and spruce-willow/alder woodlands.
- Construction of the new Bull River Access Trail would result in removal of about 1.7 acres of vegetation, over half of which would be dwarf birch shrublands vegetation and the rest willow floodplain type wetlands.
- At most, construction of trails in the Upper Cantwell Creek and Bull River Floodplains would remove about 2.0 acres of primarily successional herbaceous and willow shrub floodplain vegetation.
- Improving the 17b easement would ensure vegetation impacts are restricted to a 1.7 mile by 6 foot wide corridor, or approximately 1.2 acres.

On improved trails, the new modifications would likely confine traffic mainly to the single path and sustain increased travel with less degradation than at present. Concentrating traffic to a few trails and the floodplain routes would also increase the amount of near-trail visible negative impacts such as from ORV vehicle pullouts. As this is most likely in and near wetland areas because of hunting habitat, these impacts would be more common on those areas. This impact to vegetation from ORV users pulling off the trail would be minimal.

Fill material for trail construction would come from either the trail alignment itself or from the nearby unvegetated gravel floodplain; therefore, obtaining the fill material would not create additional impacts to vegetation.

In addition to the trails, approximately 250 acres of open gravel bar and water channels (out of a total of 473 acres of floodplains within the TUA), would be available for flexible route-finding by ORV users on the Upper Cantwell Creek and the Bull River Floodplains. ORV travel on lightly or non-vegetated floodplain gravel bars could retard or alter natural vegetation succession on newly abandoned surfaces by damaging, moving, or removing new vegetation or soils. (Note that similar impacts could occur naturally due to flooding.) Invasion of non-native species as discussed below also is particularly likely on these areas. Access to and from the floodplain via floodplain slopes would result in erosion, vegetation stripping, and other damage to these slopes.

Delineating trails and routes in the Upper Cantwell Creek and Bull River Floodplains would eliminate the need for ORV users to “route search” via trial and error, thus, eliminating related adverse impacts to wetlands and other types of vegetation (see on-trail/route impacts described under Alternative 1).

Off-Trail/Route Impacts

Under this alternative, approximately 9,068 acres of non-wetland dominated vegetation would be open to off-trail ORV use for the purpose of retrieving harvested moose or caribou. However, impacts would be limited to the actual paths taken by ORVs for retrieval of the harvested animals. To estimate these impacts, the following assumptions were made:

- 8 moose and 4 caribou would be harvested annually in the TUA by subsistence hunters;
- 4 one-way ORV passes would be needed to retrieve a moose;
- 2 one-way passes would be needed to retrieve a caribou; and
- One-way retrieval trips would range from ½ mile to 3 miles distance.

Given the above assumptions, and the estimated duration of impacts on particular vegetation types (Section 4.4.1), retrieval of moose and caribou could create 51 to 959 acres of new off-trail

vegetation impacts over 15 years. The 51 to 959 acres of impact created would not be concentrated in one area, but would form of a "web" of vegetation impacts apparent from air and ground to other users of the TUA. Because of better visibility, more animals likely would be taken in low vegetation such as the wetland openings than in closed scrub vegetation. Therefore, the web of retrieval trails would be distributed primarily around these wetland areas.

To mitigate impacts, the NPS would require off-trail ORV users to abide by best management practices and also would implement degradation levels to identify and take management actions to reduce the potential for ORV impacts in the TUA (see Section 2.3.6). Regardless of these measures, however, the magnitude of impacts would range from low intensity damage such as stem breakage, to high intensity damage such as removal of the organic mat, heavy soil compaction, or other impacts that alter habitat for plant growth or change plant community composition. The 51 acre estimate represents a scenario with primarily low intensity impacts resulting from short retrieval routes (½ mile one-way) that cross vegetation types that for the most part recover from ORV impacts within 2 to 5 years (e.g., wetland edge meadows). On the other hand, the 959 acre estimate represents a scenario with primarily high intensity impacts resulting from long retrieval routes (3 miles one-way) that cross vegetation types that for the most part recover from ORV impacts within 6 to 15 years (e.g., willow and dwarf birch shrublands).

Wetland Impacts

Alternative 2 would result in the following wetland impacts related to trail construction:

- About 0.4 acres of wetlands within spruce-willow/alder woodlands and willow or alder shrublands would be adversely impacted by continued ORV travel on the Cantwell Airstrip and the Pyramid Peak Trails.
- Approximately 0.1 acre of wetland would be impacted by construction of the Bull River Access Trail, including wet willow shrublands and steep-sided ravines.
- At most, about 1 acre of willow floodplain type wetlands would be impacted by ORV trail construction in the Upper Cantwell Creek and the Bull River Floodplains.

Under this alternative, about 2,514 acres of open wetlands, willow swamps, low shrub/open wetland mixes, and streams and ravine corridors in the TUA would be closed to ORV use because they have saturated soils that are easily damaged by ORVs. This would include 21.6 acres of existing wetland impacts.

As described under "Off-Trail/Route Impacts," retrieval of moose and caribou could create 51 to 959 acres of new off-trail vegetation impacts over 15 years. Within this total, between 10 and 130 acres of scattered wetlands off-trail could be adversely impacted because several common vegetation types that would be open to off-trail ORV use have at least a 25% wetland component (i.e., river floodplain slopes, willow or alder shrublands, spruce-willow/alder woodlands, and willow floodplain) that could not be effectively separated out given the information available and the mapping scale used.

Although the NPS would close most saturated soils and wetlands to all ORV use under this alternative, in practice, it is difficult or impossible for an ORV operator to avoid driving across these areas when traveling off-trail. The area between Upper Cantwell Creek and Bull River is composed of a mosaic of wetlands and more durable vegetation. Within in this area, in order to retrieve harvested moose and/or caribou by ORV and abide by the closures, saturated soils and wetland areas would have to be skirted – a difficult task given the intricate nature of the mosaic. Even were ORV operators physically able to avoid the closed areas, it is unlikely the average

ORV operator could always reliably differentiate between the vegetation types that are open versus closed. As a result, many ORV operators would inadvertently drive across closed areas, with distances crossed ranging from several meters to several hundred meters. Given these conditions, the closures, which theoretically would reduce impacts to saturated soils and wetlands, would probably not meet that goal in reality.

Impacts to Rare Plants

There could be negative impacts to rare species on the floodplains; this is discussed under Alternative 1.

Invasive Plants Introduction

Improving the trails by adding soil, gravel, or vegetation from off-site could introduce alien plant species to the area, as has been a frequent problem in other areas of the Park. However, areas affected by construction would be revegetated with native species to minimize this possibility.

The introduction of invasive plants, particularly *Melilotus alba*, is possible, as discussed under Alternative 1. The construction of a new trail to the Bull River Floodplain would likely increase ORV use to that floodplain and increase the chance of this plant being introduced or facilitated there. *M. alba*, if introduced to the floodplain, would likely spread rapidly, displacing native species, and would be particularly likely to spread to floodplain areas where ORV-related soil and vegetation disruption has been sustained.

Vegetation Restoration

Under Alternative 2, the most severely impacted trails and area surveyed in the TUA would be closed to ORV use and recovery of vegetation could begin. No active restoration activities would occur, except on the Windy Creel Ravine trail and the closed section of the Windy Creek Bowl trail which would undergo active remediation.

Since most of the damage in the closure area is on open wetlands and involves deep soil ruts and mixing and organic mat damage, many impacted areas would likely require 10 years or longer to fully recover. Vegetation recovery may be somewhat faster; perhaps 4-7 years for open wetland areas where rutting and mudholes were not as severe. One ongoing problem would be ensuring that previously damaged vegetation is properly safeguarded so that the process of restoration is not reset before it is completed.

In terms of closures due to new impacts, there would likely be a time lag between identification of severe negative impacts observed in monitoring and the implementation of closures, with negative impacts potentially intensifying or expanding before restrictions are made.

Impacts from Winter Hunt

The NPS would not seek to implement a winter subsistence moose hunt under this alternative; therefore, there would be no associated impacts.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and their impacts are described under Alternative 1 (No Action-Alternative). Cumulatively, these actions have had a moderate adverse

impact on vegetation. The implementation of Alternative 2 would result in additional major adverse impacts on vegetation and wetland resources; therefore, the total cumulative adverse impact on vegetation and wetland resources would be major.

Conclusion

Under Alternative 2, adverse impacts on vegetation and wetlands would be major. Trail construction, improvement, and maintenance would adversely impact a total of 10.7 acres of primarily dwarf birch shrublands, spruce-willow/alder woodlands, willow floodplain type wetlands, successional herbaceous vegetation, and willow shrub floodplain vegetation. This total includes about 1.5 acres of wetlands. In addition, approximately 250 acres of open gravel bar and water channels could be impacted by ORV operators traveling along the Upper Cantwell Creek and Bull River Floodplain routes.

Off-trail ORV use for retrieval of harvested moose and caribou could impact from 51 acres to 959 acres. The 51 acre estimate represents a scenario with primarily low intensity impacts resulting from short retrieval routes (½ mile one-way) that cross vegetation types that for the most part recover from ORV impacts within 2 to 5 years (e.g., wetland edge meadows). On the other hand, the 959 acre estimate represents a scenario with primarily high intensity impacts resulting from long retrieval routes (3 miles one-way) that cross vegetation types that for the most part recover from ORV impacts within 6 to 15 years (e.g., willow and dwarf birch shrublands). Included within this off-trail range would be between 10 and 130 acres of adverse impacts to wetland vegetation (i.e., scattered wetlands within units of floodplain slopes, willow or alder shrublands, spruce-willow/alder woodlands, willow floodplain, and lightly vegetated gravel bars).

Were the upper level of impacts to be reached, this alternative would result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park, including the preservation of lands and waters for present and future generations, preservation of scenic values, the maintenance of sound habitat for wildlife, and the preservation of extensive unaltered ecosystems in their natural state.

4.4.5 Impacts to Vegetation under Alternative 3

Under Alternative 3, ORV use for all subsistence purposes would continue to be allowed only on the following NPS-managed trails and routes: the existing Windy Creek Access, Windy Creek Bowl, Cantwell Airstrip, and Pyramid Peak Trails; the Bull River Access Trail (new construction); and on the Upper Cantwell Creek and Bull River Floodplain Trails/Routes. The 17b easement through Ahtna Inc. property in the Windy Creek area would continue to be managed as it has in the past but would be improved to mitigate impacts. The NPS also would work to implement a winter subsistence moose hunt, primarily in the area southwest of Cantwell Creek and into the Bull River area.

On-Trail/Route Impacts

Like Alternative 2, Alternative 3 would have the following impacts associated with ORV trails and the 17b easement:

- Implementing the closures would reduce existing trail and area impacts from 36.5 acres to 5.8 acres within primarily dwarf birch shrublands and spruce-willow/alder woodlands.

- Construction of the new Bull River Access Trail would result in removal of about 1.7 acres of vegetation, over half of which would be dwarf birch shrublands vegetation and the rest willow floodplain type wetlands.
- At most, construction of trails in the Upper Cantwell Creek and Bull River Floodplains would remove about 2.0 acres of primarily successional herbaceous and willow shrub floodplain vegetation.
- Improving the 17b easement would ensure vegetation impacts are restricted to a 1.7 mile by 6 foot wide corridor, or approximately 1.2 acres.

On improved trails, the new modifications would likely confine traffic mainly to the single path and sustain increased travel with less degradation than at present. Concentrating traffic to a few trails and the floodplain routes would also increase the amount of near-trail visible negative impacts such as from ORV vehicle pullouts. As this is most likely in and near wetland areas because of hunting habitat, these impacts would be more common on those areas. This impact to vegetation from ORV users pulling off the trail would be minimal.

Fill material for trail construction would come from either the trail alignment itself or from the nearby unvegetated gravel floodplain; therefore, obtaining the fill material would not create additional impacts to vegetation.

In addition to the trails, approximately 250 acres of open gravel bar and water channels (out of a total of 473 acres of floodplains within the TUA), would be available for flexible route-finding by ORV users on the Upper Cantwell Creek and the Bull River Floodplains. ORV travel on lightly or non-vegetated floodplain gravel bars could retard or alter natural vegetation succession on newly abandoned surfaces by damaging, moving, or removing new vegetation or soils. (Note that similar impacts could occur naturally due to flooding.) Invasion of non-native species as discussed below also is particularly likely on these areas. Access to and from the floodplain via floodplain slopes would result in erosion, vegetation stripping, and other damage to these slopes.

Delineating trails and routes in the Upper Cantwell Creek and Bull River Floodplains would eliminate the need for ORV users to “route search” via trial and error, thus, eliminating related adverse impacts to wetlands and other types of vegetation (see on-trail/route impacts described under Alternative 1).

Off-Trail/Route Impacts

Under this alternative, there would be no off-trail/route impacts, because no ORVs would be authorized to travel off the NPS-managed trails and routes.

Wetland Impacts

Alternative 3 would result in the following wetland impacts related to trail construction:

- About 0.4 acres of wetlands within spruce-willow/alder woodlands and willow or alder shrublands would be adversely impacted by continued ORV travel on the Cantwell Airstrip and the Pyramid Peak Trails.
- Approximately 0.1 acre of wetland would be impacted by construction of the Bull River Access Trail, including wet willow shrublands and steep-sided ravines.
- At most, about 1 acre of willow floodplain type wetlands would be impacted by ORV trail construction in the Upper Cantwell Creek and the Bull River Floodplains.

Under this alternative, about 2,514 acres of open wetlands, willow swamps, low shrub/open wetland mixes, and streams and ravine corridors in the TUA would be closed to ORV use, as well as another 1,387 acres of wetlands within vegetation types dominated by upland characteristics. This would include 21.6 acres of existing wetland impacts.

Impacts to Rare Plants

There could be negative impacts to rare species on the floodplains; this is discussed under Alternative 1.

Invasive Plants Introduction

Improving the trails by adding soil, gravel, or vegetation from off-site could introduce alien plant species to the area, as has been a frequent problem in other areas of the Park. However, areas affected by construction would be revegetated with native species to minimize this possibility.

The introduction of invasive plants, particularly *Melilotus alba*, is possible, as discussed under Alternative 1. The construction of a new trail to the Bull River Floodplain would likely increase ORV use to that floodplain and increase the chance of this plant being introduced or facilitated there. *M. alba*, if introduced to the floodplain, would likely spread rapidly, displacing native species, and would be particularly likely to spread to floodplain areas where ORV-related soil and vegetation disruption has been sustained.

Vegetation Restoration

Under Alternative 3, the most severely impacted trails and area surveyed in the TUA would be closed to ORV use and recovery of vegetation could begin. No active restoration activities would occur, except on the Windy Creel Ravine trail and the closed section of the Windy Creek Bowl trail which would undergo active remediation.

Since most of the damage in the closure area is on open wetlands and involves deep soil ruts and mixing and organic mat damage, many impacted areas would likely require 10 years or longer to fully recover. Vegetation recovery may be somewhat faster; perhaps 4-7 years for open wetland areas where rutting and mudholes were not as severe. One ongoing problem would be ensuring that previously damaged vegetation is properly safeguarded so that the process of restoration is not reset before it is completed.

In terms of closures due to new impacts, there would likely be a time lag between identification of severe negative impacts observed in monitoring and the implementation of closures, with negative impacts potentially intensifying or expanding before restrictions are made.

Impacts from Winter Hunt

Under Alternative 3, a winter hunt would be implemented in the TUA, primarily in the area between Cantwell Creek and Bull River, though details are not yet complete. If snowmachines were used for this hunt, damage could result, particularly to vegetation not completely covered by snow such as willows, dwarf birch, blueberries, and small spruce trees. Snowmachine use could occur over much of the lower slopes of the TUA and directly affect the vegetation by breaking exposed branches, compressing and damaging undersnow branches, and by subsequently altering the spring melt or on-site water regime. As with all snowmachine use in the park, however, regulations at 43 CFR 36.11 require there be adequate snow cover to protect the underlying

vegetation and soil. This requirement would cushion most of the vegetation from serious damage, though adverse impacts would still be possible in some places because of the wide variety of terrain and climatic conditions and because the determination of adequate snow cover applies to relatively large areas.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and their impacts are described under Alternative 1 (No Action-Alternative). Cumulatively, these actions have had a moderate adverse impact on vegetation. The implementation of Alternative 3 would result in additional moderate adverse impacts on vegetation and wetland resources; therefore, the total cumulative adverse impact on vegetation and wetland resources would continue to be moderate.

Conclusion

Under Alternative 3, adverse impacts on vegetation and wetlands would be moderate. Trail construction, improvement, and maintenance would adversely impact a total of 10.7 acres of primarily dwarf birch shrublands, spruce-willow/alder woodlands, willow floodplain type wetlands, successional herbaceous vegetation, and willow shrub floodplain vegetation. This total includes about 1.5 acres of wetlands. In addition, approximately 250 acres of open gravel bar and water channels could be impacted by ORV operators traveling along the Upper Cantwell Creek and Bull River Floodplain routes. In addition, approximately 250 acres of open gravel bar and water channels could be impacted by ORV operators traveling along the Upper Cantwell Creek and Bull River Floodplain routes. If snowmobiles were used for a winter subsistence moose hunt, there is the possibility of vegetation damage from their use; however, regulations requiring adequate snow cover would minimize these impacts.

The level of impact under this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.4.6 Impacts to Vegetation under Alternative 4

Under Alternative 4, ORV use for all subsistence purposes would continue to be allowed only on the existing Windy Creek Access, Windy Creek Bowl, Cantwell Airstrip, and Pyramid Peak Trails. The 17b easement through Ahtna Inc. property in the Windy Creek area would continue to be managed as it has in the past but would be improved to mitigate impacts. The NPS would authorize this use only from one week before the beginning of the fall moose and caribou hunting seasons through to the end of these hunting seasons. The NPS also would work to implement a winter subsistence moose hunt, primarily in the area southwest of Cantwell Creek and into the Bull River area.

On-Trail/Route Impacts

Implementing the closures under Alternative 4 would reduce existing trail and area impacts from 36.5 acres to 5.8 acres within primarily dwarf birch shrublands and spruce-willow/alder woodlands. Improving the 17b easement would ensure vegetation impacts are restricted to a 1.7 mile by 6 foot wide corridor, or approximately 1.2 acres.

On the four improved NPS-managed trails, the new modifications would likely confine traffic mainly to the single path and sustain increased travel with less degradation than at present.

Concentrating traffic to a few trails would also increase the amount of near-trail visible negative impacts such as from ORV vehicle pullouts. As this is most likely in and near wetland areas because of hunting habitat, these impacts would be more common on those areas. This impact to vegetation from ORV users pulling off the trail would be minimal.

Off-Trail/Route Impacts

Under this alternative, there would be no off-trail/route impacts, because no ORVs would be authorized to travel off the NPS-managed trails and routes.

Wetland Impacts

Under Alternative 4, about 0.4 acres of wetlands within spruce-willow/alder woodlands and willow or alder shrublands would be adversely impacted by continued ORV travel on the Cantwell Airstrip and the Pyramid Peak Trails.

About 2,514 acres of open wetlands, willow swamps, low shrub/open wetland mixes, and streams and ravine corridors in the TUA would be closed to ORV use, as well as another 1,387 acres of wetlands within vegetation types dominated by upland characteristics. This would include 21.6 acres of existing wetland impacts.

Impacts to Rare Plants

Botrychium alaskense, a rare fern, occurs in river flats in this area of Denali NPP and is at the northern limit of its known range in the area. It would be expected to be found in the TUA, particularly on the Cantwell Creek and Bull River Floodplain. Because there would be no ORV use on these floodplains under this alternative, adverse impacts to this rare plant would not be anticipated.

Invasive Plants Introduction

ORVs can transport exotic seeds or create areas of open soil and damaging less aggressive native vegetation. The most imminent threat is that of *Melilotus alba*, white sweet clover. It has invaded floodplains in central Alaska, including the Nenana River and some areas of Denali NP, and has apparently been seeded along the Parks Highway (Densmore et al. 2001). Invasion of forest clearings or meadows is also possible by this species. Almost all ORV's enter the TUA via the Parks Highway corridor where *M. alba* is established increasing the likelihood of invasion.

Improving the trails by adding soil, gravel, or vegetation from off-site also could introduce species such as *Melilotus alba*. However, areas affected by construction would be revegetated with native species to minimize this possibility.

Vegetation Restoration

Under Alternative 4, the most severely impacted trails and area surveyed in the TUA would be closed to ORV use and recovery of vegetation could begin. No active restoration activities would occur, except on the Windy Creel Ravine trail and the closed section of the Windy Creek Bowl trail which would undergo active remediation.

Since most of the damage in the closure area is on open wetlands and involves deep soil ruts and mixing and organic mat damage, many impacted areas would likely require 10 years or longer to

fully recover. Vegetation recovery may be somewhat faster; perhaps 4-7 years for open wetland areas where rutting and mudholes were not as severe. One ongoing problem would be ensuring that previously damaged vegetation is properly safeguarded so that the process of restoration is not reset before it is completed.

In terms of closures due to new impacts, there would likely be a time lag between identification of severe negative impacts observed in monitoring and the implementation of closures, with negative impacts potentially intensifying or expanding before restrictions are made.

Impacts from Winter Hunt

As under Alternative 3, a winter hunt would be implemented in the TUA, primarily in the area between Cantwell Creek and Bull River, though details are not yet complete. If snowmachines were used for this hunt, damage could result, particularly to vegetation not completely covered by snow such as willows, dwarf birch, blueberries, and small spruce trees. Snowmachine use could occur over much of the lower slopes of the TUA and directly affect the vegetation by breaking exposed branches, compressing and damaging undersnow branches, and by subsequently altering the spring melt or on-site water regime. As with all snowmachine use in the park, however, regulations at 43 CFR 36.11 require there be adequate snow cover to protect the underlying vegetation and soil. This requirement would cushion most of the vegetation from serious damage, though adverse impacts would still be possible in some places because of the wide variety of terrain and climatic conditions and because the determination of adequate snow cover applies to relatively large areas.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and their impacts are described under Alternative 1 (No Action-Alternative). Cumulatively, these actions have had a moderate adverse impact on vegetation. The implementation of Alternative 4 would result in additional minor adverse impacts on vegetation and wetland resources; therefore, the total cumulative adverse impact on vegetation and wetland resources would continue to be moderate.

Conclusion

Under Alternative 4, adverse impacts on vegetation and wetlands would be minor. Trail improvement and maintenance would cause the continued vegetation loss on a total of 7 acres within primarily dwarf birch shrublands and spruce-willow/alder woodlands, including 0.4 acres of wetland vegetation. If snowmobiles were used for a winter subsistence moose hunt, there is the possibility of vegetation damage from their use; however, regulations requiring adequate snow cover would minimize these impacts.

The level of impact under this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.5 WILDLIFE

4.5.1 Wildlife Impact Methodology

The principal method for the impact analysis involved a review of published and unpublished literature regarding the effects of human activities on wildlife mortality and disturbance. In addition to literature review, the impact analyses were based on observations by park employees, discussions with residents, and best professional judgment based on previous experience with similar projects and activities.

4.5.2 General Wildlife Impacts

Moose and caribou populations can be reduced by hunting. At some point, reduction in numbers of animals leads to decreased fitness of moose or caribou populations. Additionally, it's been proposed that the hunting of trophy sheep can have evolutionary consequences on sheep populations, selecting for those with smaller horns because they survive to breed (Coltman, et al. 2003).

Noise from helicopters, airplanes, and ORVs could disturb moose, caribou, and other wildlife by causing behavioral or physiological changes (Klein 1973, Frid and Dill 2002, Lawler et al. 2005, AXYS Environmental Consulting 2001, Gaines et al. 2003). Based on the experience of park staff who regularly use helicopters and airplanes to facilitate research on wildlife in the park, large mammals appear more affected by helicopter noise than by other noise sources (NPS 2006b). For example, a grizzly or black bear is much more likely to run from helicopter noise, even when the noise is a great distance away, while the same bear is likely to tolerate airplane noise at much closer range.

During winter, snowmachine tracks funnel movements of wolves making them easier to find (Thurber et al. 1994, James and Stuart-Smith 2000). This effect could increase the harvest of wolves in the TUA.

4.5.3 Impacts to Wildlife Under Alternative 1 (No Action)

The Cantwell TUA would remain open to the use of ORVs by NPS qualified subsistence users for subsistence purposes. ORV use for subsistence purposes would occur at anytime with any type of machine. However, use would be concentrated along Cantwell Creek, Cantwell Airstrip Trail and the Windy Creek trails.

Actions in this alternative would have a major adverse impact on moose in the Cantwell TUA because levels of harvest would increase dramatically over the current average of 5 moose per year. In addition, noise from motorized equipment would disturb wildlife in general, causing minor impacts.

Moose Mortality

More subsistence moose hunters would be expected to use the TUA than in the past, and we can assume the 50 households that hunt would go to the TUA first because:

- a) The 2005 NPS Cantwell Subsistence Traditionally Employed ORV Determination removed any ambiguity about whether ORV use for subsistence purposes is authorized in the TUA;
- b) The TUA is right next to Cantwell;

- c) Subsistence hunting in the TUA is unaffected by competition with non-local hunters (unlike on lands outside the TUA);
- d) There would be continued improvements in the reliability of the ORVs themselves; and
- e) The TUA is open earliest and latest for moose.

This means as many as 50 households could use ORVs to scope for moose throughout the TUA before and during hunting season. Given that number (and also assuming that there is the right combination of cold enough weather early enough in the season to bring the bull moose into rut so they aggregate up with the cows in the middle to lower portions of the draws and drainages, putting them in much more accessible places for hunters to reach, and often putting the moose into more visible places), harvests in the TUA would be expected to initially increase over the current average of 5 moose.

For the purposes of this analysis, the NPS assumes harvest levels would initially double up to 10 moose. These numbers are high enough to potentially affect the health of moose populations in the TUA. In a November 2005 moose survey that encompassed a 55.8 square mile area that approximately corresponds to the TUA, 11 large bulls, 11 medium bulls and 7 yearling bulls were counted, along with 65 cows and 8 calves (NPS 2005b). If 10 bull moose were harvested out of a total of 29 bulls, then 34% of the bull moose population in the TUA would be removed. Removal of this many bulls could negatively affect fitness of the local population. There are limits to how uneven the sex ratio can get without jeopardizing the opportunities of all females to be bred. We don't know what those limits are. However, the selective (or random) removal of all but a few male moose would have the effect of breaking down the selective process, so that moose that would normally not have bred might have a large reproductive advantage. It would be difficult for the NPS to say it is maintaining natural and healthy wildlife populations if it allows human harvest to cause significant changes in sex ratio or other population parameters.

Between 1995-2003 conditions of the Federal Subsistence Registration Permits specified that the Bull River and Cantwell Creek drainages were closed to ORV use. The Bull River and Cantwell Creek drainages are believed to provide large areas of good moose habitat. Opening these areas to ORV use under this alternative would contribute to the doubling of current moose harvests because access to these potentially moose-rich areas would be greatly facilitated by permitting ORVs in these areas.

Wildlife Disturbance

This alternative assumes administrative helicopter, airplane, and ORV use for monitoring purposes, and a high level of ORV use for subsistence purposes during hunting season and prior to hunting season. It is assumed that this alternative would have the highest amount of administrative helicopter and ORV use. The amount of aircraft use for monitoring for any given place would usually be minimal, in that this would mostly be reconnaissance-level work over the area for periodic mapping, and then point-to-point shuttles to get crews out to do monitoring measurements, where needed. Generally, helicopters and airplanes would cross back and forth over the TUA several times a day for several days a week during this time period. Administrative helicopter use generally won't occur in the fall to avoid impacting hunters. Law enforcement use of airplanes would occur throughout the summer and fall seasons. For the monitoring effort, the park would try to avoid using ORVs. However, when ORVs were necessary, they would not be used off of NPS-managed ORV trails and routes. Wildlife would be expected to return to areas of disturbance once the disturbance is removed. Some individuals would be temporarily displaced but the duration and frequency of noise events is not expected to cause any population-level impacts.

Cumulative Impacts

The following past, present, or reasonably foreseeable actions would affect wildlife in the TUA:

- ANILCA allows snowmachines for subsistence, for traditional activities, and for travel to and from villages and homesites (ANILCA 811 and 1110). During the 1990s, technological improvements in snowmachines enabled a large but unquantified expansion of snowmachine use in Denali. Accurate estimates of snowmachine users are difficult to make, but during March and April of 1999, the NPS estimated that there were between 1,500 and 2,000 snowmobile users along the Parks Highway, primarily in the region from Cantwell to the West Fork of the Chulitna River and the Tokositna River area (NPS 2000a).
- The National Park Service and its partners use motorized transportation for research. This contributes noise to the backcountry.
- Past use of ORVs in the TUA has created many trails that exist today. Use of ORVs on these trails has contributed to noise disturbance to wildlife.

Due to noise disturbance caused by helicopters, airplanes, ORVs, and snowmachines, these past, present, and future actions would have a moderate adverse impact on wildlife in the TUA. The actions in this alternative would add major negative impacts due to higher rates of mortality. The cumulative impact of this alternative plus these past, present, and future actions would be major. Noise could occur year-round and for the duration of this plan, but noise impacts would be unlikely to cause any significant population-level impacts. This alternative would be responsible for a substantial portion of the adverse impacts primarily due to the increase in harvest levels.

Conclusion

Actions in this alternative would have a major adverse impact on moose in the Cantwell TUA because levels of harvest would increase dramatically over the current average. Sex ratios or other population parameters could be changed as a result. In addition, noise from motorized equipment would disturb wildlife in general.

The level of impacts to wildlife anticipated from this alternative would result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.5.4 Impacts to Wildlife Under Alternative 2

Under this alternative, off-trail ORV use would be permitted by NPS qualified subsistence users only for retrieval of harvested moose and caribou. In addition, use of ORVs for all subsistence purposes would continue to be allowed on NPS-managed trails and routes: Windy Creek Access Trail, Windy Creek Bowl Trail, Cantwell Airstrip Trail, Pyramid Peak Trail, and Bull River Access Trail (new construction). Both the Bull River and Upper Cantwell Creek Floodplains would be managed by the NPS for continued ORV use by NPS qualified subsistence users for all subsistence purposes.

Actions proposed in this alternative would have a moderate adverse impact on wildlife in the TUA because the number of moose harvested each year could increase above the current average

of 5 moose/year. The number of harvests would be capped to maintain natural and healthy populations. Noise from helicopters, airplanes, and ORVs would disturb wildlife.

Moose Mortality

Moose harvests in the TUA would at least continue to average 5 moose harvested/year (based on past 15-year average) or could increase up to set harvest limit levels. This is because:

More subsistence moose hunters would be expected to use the TUA than in the past, and we can assume the 50 households that hunt would go to the TUA first because of the reasons listed under Alternative 1.

ORV use would also increase because the NPS-managed trails would be maintained/improved in better condition, and the Bull River Access Trail would be constructed, making access of the Bull River Floodplain possible/easier. Construction of the Bull River Access Trail would open more territory to subsistence hunters and the maintained identified trails would attract more subsistence hunters because they would be in better condition and easier to drive on.

This means as many as 50 households could use ORVs on NPS-managed trails and routes to scope for moose primarily in August and September, as they have in the past. For purposes of this analysis we also assume that there is the right combination of cold enough weather early enough in the season to bring the bull moose into rut so they aggregate up with the cows in the middle to lower portions of the draws and drainages, putting them in much more accessible places for hunters to reach, and often putting the moose into more visible places.

These factors would encourage concentrated hunting along the Windy Creek Access Trail, Windy Creek Bowl Trail, Pyramid Creek Trail, Cantwell Airstrip Trail, Bull River Access Trail, Upper Cantwell Creek Floodplain Trail/Route, and Bull River Floodplain Trail/Route. These trails and routes occur in habitat that is preferred by moose. Since ORVs would be restricted to NPS-managed trails and routes for scouting moose and caribou, it is likely that more moose would be harvested closer to trails. Greater numbers of moose harvested near trails could affect local moose populations along the Bull River, Cantwell Creek, and Windy Creek trails and routes, though local populations may be replenished with moose from other places that would move into this available habitat.

The Bull River and Cantwell Creek drainages are believed to provide large areas of good moose habitat. Facilitating use of these areas under this alternative would contribute to increased moose harvests because access to these potentially moose-rich areas would be greatly facilitated by permitting ORVs in these areas; however, there would be some restrictions on ORV use in these areas (such as going off-trail only to retrieve an animal).

Off-trail use would be more challenging due to the restrictions imposed in this alternative; however, it is assumed that regardless of the closures and other restrictions, many hunters would drive ORVs off-trail to retrieve harvested moose/caribou, and there would be some level of impact from this use.

Overall, more subsistence hunters could result in increased harvests in the TUA over the current average of 5 moose per year. However, this alternative proposes that the NPS work with the Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to establish subsistence harvest limits for moose to maintain natural and healthy populations on park land within the TUA. So while the number of harvests could increase

slightly, the number of animals harvested per year would not negatively affect the health of moose populations in the TUA.

Wildlife Disturbance

This alternative assumes administrative helicopter, airplane, and ORV use for monitoring purposes, and a high level of ORV use for subsistence purposes during hunting season and prior to hunting season. The amount of aircraft use for monitoring for any given place would usually be minimal, in that this would mostly be reconnaissance-level work over the area for periodic mapping, and then point-to-point shuttles to get crews out to do monitoring measurements, where needed. Generally, helicopters and airplanes would cross back and forth over the TUA several times a day for several days a week during this time period. Administrative helicopter use generally won't occur in the fall to avoid impacting hunters. Law enforcement use of airplanes would occur throughout the summer and fall seasons. For the monitoring effort, the park would try to avoid using ORVs. However, when ORVs were necessary, they would not be used off of NPS-managed ORV trails and routes. Wildlife would be expected to return to areas of disturbance once the disturbance is removed. Some individuals would be temporarily displaced but the duration and frequency of noise events is not expected to cause any population-level impacts.

Cumulative Impacts

Cumulative impacts on wildlife resulting from past, present, and reasonably foreseeable future actions are the same as Alternative 1. Due to noise disturbance caused by helicopters, airplanes, ORVs, and snowmachines, these past, present, and future actions would have a moderate adverse impact on wildlife in the TUA. The actions in this alternative would add additional noise disturbance from ORVs, airplanes, and helicopters. The cumulative impact of this alternative plus these past, present, and future actions would also be moderate as impacts could occur year-round and for the duration of this plan, but impacts are not likely to cause any significant population-level impacts. This alternative would be responsible for a considerable portion of the adverse impacts, particularly during summer and fall when noise from motorized use would be greatest.

Conclusion

Actions proposed in this alternative would have a moderate adverse impact on wildlife in the TUA because the number of moose harvested each year would increase above the current average of 5 moose/year. The number of harvests would be capped to maintain natural and healthy populations. Noise from helicopters, airplanes, and ORVs would disturb wildlife but is not expected to cause any population-level impacts.

The level of impacts to wildlife anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.5.5 Impacts to Wildlife Under Alternative 3

There would be no off-trail use of ORVs for subsistence, or any other, purposes within the TUA. Instead, the NPS would work with the Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to implement a winter subsistence moose hunt, primarily in the area southwest of Cantwell Creek and into the Bull River area. The following trails would be managed by the NPS for continued ORV use by NPS qualified

subsistence users for all subsistence purposes: Windy Creek Access Trail, Windy Creek Bowl Trail, Cantwell Airstrip Trail, Pyramid Peak Trail, and Bull River Access Trail (new construction). The Bull River and Upper Cantwell Creek Floodplains would be managed by the NPS for continued ORV use by NPS qualified subsistence users for all subsistence purposes.

Actions proposed in this alternative would have a moderate adverse impact on wildlife in the TUA because the number of moose harvested each year would increase above the current average of 5 moose/year, and the number of wolves harvested would likely increase, though the number of harvests would be monitored and, if necessary, a limit would be proposed to maintain natural and healthy populations. Noise from helicopters, airplanes, ORVs, and snowmachines would disturb wildlife.

Moose and Wolf Mortality

Moose harvests in the TUA would at least continue to average 5 moose harvested/year (based on past 15-year average) or could increase up to set harvest limit levels. This is because more subsistence moose hunters would be expected to use the TUA than in the past because of the reasons listed under Alternative 1. ORV use would also increase because the NPS-managed trails would be maintained/improved in better condition, and the Bull River Access Trail would be constructed, making access of the Bull River Floodplain possible/easier. Construction of the Bull River Access Trail would open more territory to subsistence hunters and the maintained identified trails would attract more subsistence hunters because they would be in better condition and easier to drive on.

We can assume the 50 Cantwell households that hunt would go to the TUA first due to the reasons listed under Alternative 1. This means as many as 50 households could use ORVs on NPS-managed trails and routes to scope for moose before and during hunting season. For purposes of this analysis we also assume that there is the right combination of cold enough weather early enough in the season to bring the bull moose into rut so they aggregate up with the cows in the middle to lower portions of the draws and drainages, putting them in much more accessible places for hunters to reach, and often putting the moose into more visible places.

These actions would encourage concentrated hunting along the Windy Creek Access Trail, Windy Creek Bowl Trail, Pyramid Creek Trail, Cantwell Airstrip Trail, Bull River Access Trail, Upper Cantwell Creek Floodplain Trail/Route, and Bull River Floodplain Trail/Route. These trails and routes occur in habitat that is preferred by moose. This assumption is supported by US Fish and Wildlife Service records that identify 4 moose harvested by NPS qualified subsistence users within the TUA in 2005 and 3 moose harvested in the TUA in 2006 -- both years when a temporary ORV closure was in place on all but three trails/routes in the TUA. Since ORVs would be restricted to NPS-managed trails and routes, it is likely that more moose would be harvested closer to trails. Greater numbers of moose harvested near trails could affect local moose populations along the Bull River, Cantwell Creek, and Windy Creek trails and routes, though local populations may be replenished with moose from other places that would move into this available habitat.

Increased/concentrated ORV traffic on NPS-managed trails/routes may displace moose away from the trails and make it more difficult for hunters to kill moose from trails; however, some hunters would be able to call a moose to bring it closer to accessible areas before killing it and other hunters would just wait until the bull gets a reasonable distance to the trail. We also assume that most subsistence hunters would be able to hike at least ½ mile to pack a harvested moose back to an ORV parked on NPS-managed trails/routes or outside the park boundary.

The Bull River and Cantwell Creek drainages are believed to provide large areas of good moose habitat. Opening these areas to ORV use under this alternative would contribute to increased moose harvests because access to these potentially moose-rich areas would be greatly facilitated by permitting ORVs in these areas; however, there would be some restrictions on ORV use in these areas (such as having to stay on trails/routes).

Subsistence hunters would have additional opportunities to hunt moose during a winter hunt. Snowmachines would facilitate the hunt because snowmachines can cover more ground and access more moose habitat in a shorter period of time than an ORV or a hunter on foot. Providing a winter hunt would increase harvests because there are few other hunting opportunities in winter, snowmachines provide broader access than other means of transportation, cold weather makes it easier to prevent meat spoilage, snow cover provides an ideal substrate for clean handling of meat, and snowmachines and sleds provide an easier way to transport meat. The advantages of hunting by snowmachine (extended season, broader access, easier loading, cleaner conditions, and easier storage of meat) are likely to result in greater hunter participation and higher harvest levels. Assuming about 50 households in Cantwell say they try to hunt moose, and further assuming about half are successful in the summer, then the remaining 25 households would likely take advantage of the expanded winter moose hunt. This means about 25 additional snowmachine groups may use the traditional use area for the winter hunt.

While greater use would be expected on established trails in the fall and throughout the TUA in the winter, no use would occur off-trail during the fall. Therefore, off-trail areas would get very little use and few, if any, animals would be harvested in these areas during the fall hunting season.

Overall, more subsistence hunters could result in increased harvests in the TUA over the current average of 5 moose per year. However, this alternative proposes that the NPS work with the Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to establish subsistence harvest limits for moose to maintain natural and healthy moose populations on park land within the TUA. So while the number of harvests could increase slightly, the number of animals harvested per year would not negatively affect the health of moose populations in the TUA.

A winter hunt would also facilitate opportunistic hunting of wolves because more hunters would be active in winter. There would be greater potential for wolf harvest because it's easier to track wolves on snow and the winter landscape makes it easier to spot wolves than in summer when vegetation hides the wolves. Because of these factors, there is potential for a winter season hunt to affect wolf populations in the TUA; however, the National Park Service would monitor wolf harvest records from the TUA. If there were any indication of a substantial increase that would affect segments of the population, the NPS would take appropriate management action, which could include proposing a harvest limit. Such measures would ensure that impacts to wolf populations would be minimal.

Wildlife Disturbance

This alternative assumes administrative helicopter, airplane, and ORV use for monitoring purposes, and a high level of ORV use for subsistence purposes during hunting season and prior to hunting season. The amount of aircraft use for monitoring for any given place would usually be minimal, in that this would mostly be reconnaissance-level work over the area for periodic

mapping, and then point-to-point shuttles to get crews out to do monitoring measurements, where needed. Generally, helicopters and airplanes would cross back and forth over the TUA several times a day for several days a week during this time period. Administrative helicopter use generally won't occur in the fall to avoid impacting hunters. Law enforcement use of airplanes would occur throughout the summer and fall seasons. For the monitoring effort, the park would try to avoid using ORVs. However, when ORVs were necessary, they would not be used off of NPS-managed ORV trails and routes. Wildlife would be expected to return to areas of disturbance once the disturbance is removed. Some individuals would be temporarily displaced but the duration and frequency of noise events is not expected to cause any population-level impacts.

A winter hunt would introduce additional snowmachine use in the area. Noise from snowmachines would disturb wildlife throughout the winter, though it is not likely that the duration and frequency of snowmachine use that would occur for subsistence purposes would have any lasting impact on any wildlife population in the TUA because of the dispersed and temporary nature of the disturbance and the amount of snowmachine use that the hunt would produce, in comparison to existing levels of snowmachine use that occurs in the area for non-subsistence purposes.

Cumulative Impacts

Cumulative impacts on wildlife resulting from past, present, and reasonably foreseeable future actions are the same as Alternative 1. Due to noise disturbance caused by helicopters, airplanes, ORVs, and snowmachines, these past, present, and future actions have a moderate adverse impact on wildlife in the TUA. The actions in this alternative would add additional noise disturbance from ORVs, airplanes, helicopters, and snowmachines. The cumulative impact of this alternative plus these past, present, and future actions would also be moderate as impacts could occur year-round and for the duration of this plan, but impacts are not likely to cause any significant population-level impacts. This alternative would be responsible for a considerable portion of the adverse impacts, as moose harvest levels would increase and additional noise would be introduced throughout most of the year.

Conclusion

Actions proposed in this alternative would have a moderate adverse impact on wildlife in the TUA because the number of moose harvested each year would increase above the current average of 5 moose/year, and the number of wolves harvested would likely increase, though the number of harvests for moose and wolves could be capped to maintain natural and healthy populations. Noise from helicopters, airplanes, ORVs, and snowmachines would disturb wildlife.

The level of impacts to wildlife anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.5.6 Impacts to Wildlife Under Alternative 4

There would be no off-trail use of ORVs for subsistence or any other purposes within the TUA. Instead, the NPS would work with Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to implement a winter subsistence moose hunt, primarily in the area southwest of Cantwell Creek and into the Bull River area. The following trails would be managed by the NPS for continued ORV use by NPS qualified subsistence users

for all subsistence purposes *only* from one week before the beginning of the fall moose and caribou hunting seasons through to the end of these hunting seasons: Windy Creek Access Trail, Windy Creek Bowl Trail, Cantwell Airstrip Trail, and Pyramid Peak Trail.

Actions proposed in this alternative would have a minor adverse impact on wildlife in the TUA because the number of moose harvested would remain close to the current average of 5 moose per year, and the number of harvests would be capped to maintain natural and healthy populations. Wolves would be negatively impacted with the addition of a winter hunt, but the number of harvests would be monitored and, if necessary, a limit would be proposed to maintain natural and healthy populations. Noise from administrative use of helicopters, airplanes, ORVs, and snowmachines would disturb wildlife.

Moose and Wolf Mortality

Moose harvests in the TUA would continue to average 5 moose harvested/year (based on past 15-year average). This is because factors that would cause harvests to increase would be offset by factors that would cause harvests to decrease.

More subsistence moose hunters would be expected to use the TUA than in the past because of the reasons listed under Alternative 1. ORV use would also increase because the NPS-managed trails would be maintained/improved in better condition.

We can assume the 50 Cantwell households that hunt would go to the TUA first due to the reasons listed under Alternative 1. This means as many as 50 households could use ORVs on NPS-managed trails and routes to scope for moose one week before and during hunting season. For purposes of this analysis we also assume that there is the right combination of cold enough weather early enough in the season to bring the bull moose into rut so they aggregate up with the cows in the middle to lower portions of the draws and drainages, putting them in much more accessible places for hunters to reach, and often putting the moose into more visible places.

These actions would encourage concentrated hunting along the Windy Creek Access Trail, Windy Creek Bowl Trail, Pyramid Creek Trail, and Cantwell Airstrip Trail. These trails occur in habitat that is preferred by moose. This assumption is supported by US Fish and Wildlife Service records that identify 4 moose harvested by NPS qualified subsistence users within the TUA in 2005 and 3 moose harvested in the TUA in 2006 -- both years when a temporary ORV closure was in place on all but three trails/routes in the TUA. Since ORVs would be restricted to NPS-managed trails for scouting moose and caribou, it is likely that more moose would be harvested closer to trails. Greater numbers of moose harvested near trails could affect local moose populations along the trails, though local populations may be replenished with moose from other places that would move into this available habitat.

Since the Bull River and Upper Cantwell Creek Floodplains would not be open to ORV use, hunters would be limited to ORV use on four NPS-managed trails in the eastern part of the TUA. The Bull River and Cantwell Creek drainages are believed to provide large areas of good moose habitat. Closing these areas to ORV use under this alternative would lead to decreased moose harvests because access to these potentially moose-rich areas would be much more difficult.

Increased/concentrated ORV traffic on NPS-managed trails/routes may displace moose away from the trails and make it more difficult for hunters to kill moose from trails; however, some hunters would be able to call a moose to bring it closer to accessible areas before killing it and other hunters would just wait until the bull gets a reasonable distance to the trail. It is also

assumed that most subsistence hunters would be able to hike at least ½ mile to pack a harvested moose back to an ORV parked on NPS-managed trails/routes or outside the park boundary.

Subsistence hunters would have additional opportunities to hunt moose during a winter hunt. Snowmachines would facilitate the hunt because snowmachines can cover more ground and access more moose habitat in a shorter period of time than an ORV or a hunter on foot. Providing a winter hunt would increase harvests because there are few other hunting opportunities in winter, snowmachines provide broader access than other means of transportation, cold weather makes it easier to prevent meat spoilage, snow cover provides an ideal substrate for clean handling of meat, and snowmachines and sleds provide an easier way to transport meat. The advantages of hunting by snowmachine (extended season, broader access, easier loading, cleaner conditions, and easier storage of meat) are likely to result in greater hunter participation and higher harvest levels. Assuming about 50 households in Cantwell say they try to hunt moose, and further assuming about half are successful in the summer, then the remaining 25 households would likely take advantage of the expanded winter moose hunt. This means about 25 additional snowmachine groups may use the traditional use area for the winter hunt.

While greater use would be expected on established trails in the eastern portion on the TUA in the fall and throughout the TUA in the winter, no use would occur off-trail during the fall. Therefore, off-trail areas would get very little use and few, if any, animals would be harvested in these areas during the fall hunting season.

Overall, more subsistence hunters and an additional winter hunt could result in increased harvests in the TUA over the current average. Limitations on the use of ORVs in the TUA (restricted to four trails and starting only one week prior to hunting season) could decrease chances of taking moose during fall. This alternative also proposes that the NPS work with the Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to establish subsistence harvest limits for moose to maintain natural and healthy moose populations on park land within the TUA. This leads to the conclusion of an average of 5 moose per year taken in the TUA, the same as the current average. The number of animals harvested per year would not negatively affect the health of moose populations in the TUA.

A winter hunt would also facilitate opportunistic hunting of wolves because more hunters would be active in winter. There would be greater potential for wolf harvest because it's easier to track wolves on snow and the winter landscape makes it easier to spot wolves than in summer when vegetation hides the wolves. Because of these factors, there is potential for a winter season hunt to affect wolf populations in the TUA; however, the National Park Service would monitor wolf harvest records from the TUA. If there were any indication of a substantial increase that would affect segments of the population, the NPS would take appropriate management action, which could include proposing a harvest limit. Such measures would ensure that impacts to wolf populations would be minimal.

Wildlife Disturbance

This alternative assumes administrative helicopter, airplane, and ORV use for monitoring purposes, and a high level of ORV use for subsistence purposes during hunting season but not during most of the summer. The amount of aircraft use for monitoring for any given place would usually be minimal, in that this would mostly be reconnaissance-level work over the area for periodic mapping, and then point-to-point shuttles to get crews out to do monitoring measurements, where needed. Generally, helicopters and airplanes would cross back and forth over the TUA several times a day for several days a week during this time period. Administrative

helicopter use generally won't occur in the fall to avoid impacting hunters. Law enforcement use of airplanes would occur throughout the summer and fall seasons. For the monitoring effort, the park would try to avoid using ORVs. However, when ORVs were necessary, they would not be used off of NPS-managed ORV trails and routes. Wildlife would be expected to return to areas of disturbance once the disturbance is removed. Some individuals would be temporarily displaced but the duration and frequency of noise events is not expected to cause any population-level impacts.

A winter hunt would introduce additional snowmachine use in the area. Noise from snowmachines would disturb wildlife throughout the winter, though it is not likely that the duration and frequency of snowmachine use that would occur for subsistence purposes would have any lasting impact on any wildlife population in the TUA because of the dispersed and temporary nature of the disturbance and the amount of snowmachine use that the hunt would produce, in comparison to existing levels of snowmachine use that occurs in the area for non-subsistence purposes.

Cumulative Impacts

Cumulative impacts on wildlife resulting from past, present, and reasonably foreseeable future actions would be the same as Alternative 1. Due to noise disturbance caused by helicopters, airplanes, ORVs, and snowmachines, these past, present, and future actions would have a moderate adverse impact on wildlife in the TUA. The actions in this alternative would add additional noise disturbance from airplanes, helicopters, ORVs, and snowmachines. The cumulative impact of this alternative plus these past, present, and future actions would also be moderate as impacts could occur year-round and for the duration of this plan, but impacts are not likely to cause any significant population-level impacts. This alternative would be responsible for a noticeable portion of the adverse impacts, particularly during summer and fall when administrative use of airplanes would be greatest, and during winter when snowmachines are used for an additional subsistence hunt.

Conclusion

Actions proposed in this alternative would have a minor adverse impact on wildlife in the TUA because the number of moose harvested would remain close to the current average of 5 moose per year, and the number of harvests would be capped to maintain natural and healthy populations. Wolves would be negatively impacted with the addition of a winter hunt, but harvest levels would be monitored and a limit proposed to maintain natural and healthy populations. Noise from administrative use of helicopters, airplanes, ORVs, and snowmachines would disturb wildlife but is not expected to cause any population-level impacts.

The level of impacts to wildlife anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.6 WATER RESOURCES

4.6.1 Water Resources Methodology

The principal method for the impact analysis involved a review of published and unpublished literature regarding the effects of human activities on water quality, stream morphology, and

aquatic species. In addition to literature review, the impact analyses were based on observations by park employees, discussions with residents, and best professional judgment based on previous experience with similar projects and activities.

Information on fisheries in the Cantwell TUA was obtained by interviews and correspondence with fisheries biologists with the Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, as well as from publications of the former agency, which is responsible for managing both sport and commercial fisheries in the State of Alaska. Predictions of impacts were made on the basis of a literature review of the generic impacts of ORVs and other agents of disturbance on fishery (particularly salmonid) resources. In addition, the predictions of impacts on TUA soils and vegetation in this EA were consulted, because as explained below, impacts to fisheries are closely related to predicted impacts on soil and vegetation resources.

Since there is little current information on the status of specific fish stocks in Bull River, Cantwell Creek, and Windy Creek, the discussion of impacts under each alternative below is perforce general and somewhat hypothetical. No surveys have ever been conducted in these streams and the most recent surveys from ADFG on lakes in the Cantwell Creek drainage are nearly 20 years old. As discussed in Chapter 3 of the EA, state and federal fisheries biologists have indicated that fisheries resources in these three watercourses appear to be limited.

4.6.2 General Water Resources Impacts

Off-road vehicle activity nearly always results in greatly increased erosion (Hinckley et al.1984). ORVs compact and disrupt the soil reducing infiltration capacity resulting in increased frequency and duration of runoff. ORV activity also destroys or disperses surface stabilizers creating relatively smooth trails that entrain surface flow and enhance runoff effectiveness (Meyer 2002). Off road vehicles can contribute large suspended sediment loads to receiving waters especially during storm events (Ayala et al.2005).

Brown (1994) determined that as vehicle traffic increased so did sediment deposited in streams. When ORVs cross tributaries in the TUA, ORVs loosen and displace soil material, making it susceptible to being washed into the drainage network to become sediment. Trails can also act as channels that multiply sediment loads to the stream network during runoff events. Travel routes can increase runoff due to compaction of the soil, decreased infiltration and lack of vegetation. These types of impacts would occur locally at ORV crossings on tributaries throughout the TUA. It is also important to note that USGS topographic maps show less than 40 miles of clear-flowing streams or tributaries in the TUA, and not all of these would be accessible to ORVs.

While to date there have been no investigations on the effects of ORVs on aquatic resources in Denali National Park or in similar ecosystems, Rinella evaluated impacts from ORV crossings on clearwater streams on the Kenai Peninsula, Alaska, with relatively heavy and concentrated ORV use (Rinella et al 2003). He found that:

Biological impacts from sedimentation are pervasive and occur at every trophic level within the stream ecosystem. Increased turbidity limits light penetration, which can greatly decrease the primary productivity of benthic algae, the base of the stream food web (Lloyd et al 1987). Sediment can further reduce algal stocks by scouring and smothering (Van Nieuwenhuysen et al., 1986). Sedimentation can limit macroinvertebrate abundance through a reduction in algal food resources, mechanical scouring, and smothering when fine particles fill interstitial spaces in the streambed (Rosenberg et al 1978).

When operating within a watercourse or wetland of the Cantwell TUA, ORVs can have both direct and indirect adverse impacts on fishery resources. A direct impact would occur if an ORV were to actually run over and crush fish (juvenile or adult) or fish eggs. Healthy fish would be expected to be sufficiently swift and agile to evade an oncoming vehicle, but fish preoccupied with or exhausted from spawning could actually be at risk from a fast-moving ATV. Furthermore, fish eggs are sessile (immobile) and would also be potentially vulnerable to damage or lethal crushing from even a single pass of an ORV (Copper River Watershed Project, no date; Sowl and Poetter, 2004). Even if eggs were not crushed directly beneath a tire or tread, the displacement of gravel, rocks, and sand substrates around fish nests (redds) could damage egg development and viability. The indirect adverse impact would result from stirring up sediments when an ORV is within the water body itself.

Another general, indirect impact is that of disturbance, which is important in determining the character of aquatic communities, their structure, and their persistence. Disturbance tends to induce a simplifying effect on aquatic biota: reducing species diversity and simplifying trophic interactions until, at some point, certain species are unable to adapt and disappear from the modified environment. These can include more desirable species, such as sport fish, and rare or imperiled species. The vegetation and substrates at repeated crossing sites are disrupted; this in turn changes the nature of the benthic (bottom-dwelling) fauna, detrimentally affecting higher trophic levels, that is, those fish that feed on benthic macroinvertebrates such as worms, nymphs, and crustaceans. Shallow water areas, which may be more readily used or crossed by ORVs, often represent breeding sites for certain species during different parts of the year. These same areas often serve as nurseries for fish species throughout the year. Finally, the invertebrates found in shallow aquatic habitats are often diverse and abundant; these provide foods for many fish, including sport fish (TCAFS, 2005).

Even when ORVs are driven across uplands rather than directly through shallow water, especially if that land is sloped or in close proximity to waters, such as stream banks, ORV use can produce indirect, adverse impacts on fisheries. This potential indirect impact of ORVs on fisheries is a direct function of their impacts on soils and vegetation. As described in the soils section earlier in chapter 4, the shearing, abrasion, and compaction of the ground surface from tires or treads that can occur along an ORV route weaken the structural integrity of the soils, leading to rutting and, during rain events, erosion. Soil particles transported by sheet or rill water erosion are eventually carried downhill to water bodies with either standing or flowing water (e.g. ponds, lakes, streams, rivers). At first these particles, especially finer (smaller) ones like clays, are suspended, causing turbidity – muddy, cloudy, or opaque water. Sooner or later, depending on particle size and the kinetic energy of the water, the particles are deposited on the bed or substrate (bottom) of the water body. Higher velocity currents would tend to carry suspended sediments some distance before depositing them, while slower currents or slack water would allow the fine suspended particles to settle out sooner and over a smaller area.

At high enough levels, turbidity or suspended sediments alone may cause problems directly for fish. In one laboratory study, coho salmon exposed to high concentrations of suspended solids experienced observable signs of stress, such as rapid opercular and cough rates, as well as sediments that accumulated on the ends of their gill filaments, apparently interfering with respiration. In the same experiment, the ability of cohos to capture prey as decreased markedly as turbidity increased (Cederholm and Reid, 1979). Suspended sediments abrade the gills of fish and interfere with feeding because the fish have difficulty locating their prey or food (Parks Canada, 2005). Alaska Administrative Code (18 AAC 70) specifies that turbidity standards for fish, aquatic life and wildlife may not exceed 25 NTU above natural conditions.

The Alaska Department of Fish and Game states that the introduction of fine sediments to streams is one of the major human-induced impacts to stream and fishery resources in the state, and identifies ORV trails as a source of this introduction, along with timber harvest, roads, and development (Wiedmer, 2002). Sediments may clog the interstitial spaces of spawning gravels, thus reducing the reproductive success of fish species that are important both socially and commercially. Sedimentation may also reduce primary and secondary aquatic production, narrowing the base of the aquatic food pyramid and thus reducing the growth and survival of fish. Furthermore, ford or crossing sites in particular often destabilize stream banks and may block fish passage because of increased width/depth ratios (Wiedmer, 2002).

The introduction of sizeable quantities of silt to spawning streams adversely affects fish survival by reducing the permeability of gravel and interfering with the delivery of water and oxygen to incubating eggs and alevins (newly hatched fish that still have a yolk sac) (Washington Department of Fish and Wildlife, 2000). Fine sediments eroded from stream banks or transported from upstream can smother incubating fish eggs (Beck, 2006; Copper River Watershed Project, no date; Cederholm, et al., 1980). In addition, damage to streamside vegetation can reduce shade and result in higher water temperatures, which stress cold water habitat fish (Beck, 2006).

As discussed in Chapter 3, the fishery resources of the three major affected watercourses within the Cantwell TUA – Bull River, Cantwell Creek, and Windy Creek – appear to be rather marginal. These three streams support neither outstanding fish populations nor outstanding recreational fisheries (Brase, 2007a, 2007b; Rutz, 2007). Chapter 3 also indicated that the Cantwell Creek watershed contains several ponds and lakes that have supported both natural fish populations, including sport fish such as lake trout, as well as sport fisheries, over the years. This suggests that Cantwell Creek itself, in spite of being glacially occluded, contains fish, if only in limited numbers or seasonally as transients, as they migrate to and from spawning grounds, rearing and feeding areas, new habitat, etc. The marginal condition of the fishery is a consideration in the impact ratings that follow.

It should be noted, however, that since these lakes all drain into Cantwell Creek, that is, are upstream of it, they would be unaffected by turbidity and sedimentation problems in the creek itself.

4.6.3 Impacts to Water Resources Under Alternative 1 (No Action)

Under Alternative 1, it is expected that subsistence-related ORV travel would continue to occur on the existing trails as well as many off-trail areas throughout the TUA. Travel on the Windy Creek, Cantwell Creek and Bull River Floodplains would also be expected. No restrictions would be placed on the landscapes of the TUA that could be used for ORV travel, and thus, over time, travel could extend well beyond the areas currently mapped with ORV impacts, particularly on the lower elevation, wetland-shrubland mosaics similar to those that have been extensively trafficked for hunting to date (Liebermann and Roland 2006). ORV use would not be limited to access for hunting, but could also be used to support any other subsistence activity.

The analysis below shows that impacts to water quality, channel morphology, and aquatic species would be minor to moderate because use of ORVs would negatively affect turbidity, bank stability, and aquatic species of the few clear-flowing streams and tributaries within the TUA; however, impacts would largely be confined to crossing sites and impacts would not affect the overall health of the ecosystem.

More subsistence moose hunters would be expected to use the TUA than in the past, and we can assume the 50 households that hunt would go to the TUA first because:

- a) The 2005 NPS Cantwell Subsistence Traditionally Employed ORV Determination removed any ambiguity about whether ORV use for subsistence purposes is authorized in the TUA;
- b) The TUA is right next to Cantwell;
- c) Subsistence hunting in the TUA is unaffected by competition with non-local hunters (unlike on lands outside the TUA);
- d) There would be continued improvements in the reliability of the ORVs themselves; and
- e) The TUA is open earliest and latest for moose.

This means as many as 50 households could use ORVs to scope for moose and caribou throughout the TUA before and during hunting season. For the monitoring effort, the park would try to avoid using ORVs. However, when ORVs were necessary, they would not be used off of NPS-managed ORV trails and routes. Since there would be no restriction on where ORVs could be driven within the TUA, and there would be no restrictions related to the condition of the soil or the weather, there would be an increased level of damage to the soil resources within the TUA due to increased travel through and damage to wetlands and increased parallel trail formation while evading trail obstacles. The increase in the area and volume of soils disturbed by ORVs under this alternative would proportionately increase the material exposed to erosion, transport, and subsequent sedimentation in water bodies.

Impacts to water resources would occur wherever ORVs travel off-trail and cross clear-flowing streams or tributaries, or when ORVs travel on existing alignments that are not sustainable. Actions proposed in this alternative could increase turbidity, decrease bank stability, and negatively affect individual macroinvertebrates and fish at ORV crossings but because crossings would be widely dispersed throughout the TUA and impacts would be confined to the crossing site, at the time of the crossing, impacts would not affect overall health of any population of macroinvertebrate or fish species. USGS topographic maps show less than 40 miles of clear-flowing streams or tributaries in the TUA and not all of these are accessible to ORVs.

As described in the generic impacts section above, introducing fine suspended sediments into water bodies has a detrimental effect on aquatic ecosystems, and in particular fish. Suspended sediments may harm fish directly by abrading their gills, inhibiting respiration, and interfering with their feeding; deposition of suspended sediments (i.e. sedimentation) may harm fish stocks indirectly through potentially inhibiting their reproduction by smothering incubating eggs in gravel and other substrates. Species that could potentially be affected to some extent include coho salmon and Dolly Varden in the Bull River and grayling in Cantwell and Windy creeks. It is unknown if any of these species spawn in the streams in question, but they may be present occasionally or as transients. In addition, at least some of the other species described in Chapter 3 – including lake trout, burbot, whitefish, and sculpin – may occur in ponds or lakes that might be subjected to some degree of sedimentation; these species could thus potentially be adversely affected by this alternative.

The greatest impact to moving water resources would occur along the Windy Creek Access Trail where unchecked erosion currently occurs along the trail alignment. Stream capture is a geomorphic phenomenon that occurs when a stream or river from a neighboring drainage system or watershed erodes through the divide between two streams and "captures" another stream which then is diverted from its former bed and now flows down the bed of the capturing stream. While widespread stream capture is unlikely to occur throughout the TUA, active stream capture would continue to occur on Windy Creek North, in the ravine on the Windy Creek Access Trail, and

also on areas of the Cantwell Creek Northeast Trail. Collection and drainage mechanisms would continue to occur along the Windy Creek Access Trail alignment in the ravine and this contributes to water flow along the alignment as well (NPS 2007). Collection and drainage is also a potential problem along the Windy Creek Bowl alignment (NPS 2007). During spring thaw and periods of rain and heavy use, sediment is transported along the fall-line into Windy Creek. Increased use of this trail would exacerbate this sediment transport, which causes the impacts to water quality, channel morphology, and aquatic species that are described in the General Impacts section.

Use of ORVs along and across the Upper Cantwell Creek Floodplain would contribute small amounts of sediment into Cantwell Creek. ORV travel would have minimal impact to gravel bar morphology because gravel bars are by nature highly dynamic and the gravel surface is generally resistant to surface impact. In addition, travel over barren gravel bars is not generally restricted in any single track; therefore use is dispersed over a wide area.

Similar impacts would occur where ORVs cross the Bull River, though this area is currently difficult to access; consequently, impacts would be few and of low intensity.

Cumulative Impacts

The following past, present, or reasonably foreseeable actions would affect water resources in the TUA:

- Past use of ORVs in the TUA has created many trails that exist today. Use of ORVs on these trails has contributed to erosion.
- Past motor vehicle use in the TUA has resulted in the loss of 14.8 ha (~37 acres) of vegetation. Loss of vegetation could contribute to erosion and degraded water resources.

Due to erosion in the TUA caused by past use of motorized vehicles, these past actions would have a minor adverse impact on water resources in the TUA. The actions in this alternative would contribute minor to moderate adverse impacts due to ORVs crossing clear-flowing tributaries in the TUA. The cumulative impact of this alternative plus these past actions would be minor as impacts would not affect the overall health of the ecosystem. This alternative would be almost entirely responsible for the adverse impacts.

Conclusion

Impacts to water quality, channel morphology, and aquatic species would be minor to moderate because use of ORVs would negatively affect turbidity, bank stability, and aquatic species within the TUA; however, impacts would largely be confined to crossing sites and impacts would not affect the overall health of the moving water ecosystems. An increase in turbidity, sediment transport, suspended sediments, and sedimentation would be expected in Bull River, Cantwell Creek, Windy Creek, certain tributaries, wetlands, and possibly small ponds and lakes. Increased introduction of sediments into the TUA's water bodies would, in turn, adversely impact the relatively unexceptional fishery resources that may be present.

These resources fulfill several of the specific purposes identified in the legislation of the 1980 park additions, including the preservation of lands and waters for present and future generations, maintenance of sound habitat for wildlife (including fish), and the preservation of extensive

unaltered ecosystems in their natural state. The level of impacts to water resources anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.6.4 Impacts to Water Resources Under Alternative 2

Under this alternative, off-trail ORV use would be permitted by NPS qualified subsistence users only for retrieval of harvested moose and caribou. In addition, use of ORVs for all subsistence purposes would continue to be allowed on NPS-managed trails and routes: Windy Creek Access Trail, Windy Creek Bowl Trail, Cantwell Airstrip Trail, Pyramid Peak Trail, and Bull River Access Trail (new construction). Both the Bull River and Upper Cantwell Creek Floodplains would be managed by the NPS for continued ORV use by NPS qualified subsistence users for all subsistence purposes.

The analysis below shows that impacts to water quality, channel morphology, and aquatic species would be moderate for up to four years after implementation begins. During this time, use of ORVs would negatively affect turbidity, bank stability, and aquatic species in a portion of the TUA. Soils in the vicinity of the new Bull River Access Trail and Bull River and Upper Cantwell Creek Floodplains would be potentially vulnerable to erosion, and thus, capable of impacting aquatic resources including the modest fish stocks potentially present. Impacts would be minor after four years because water control, trail hardening, and other trail work would be completed. Cross-country use of ORVs would be somewhat restricted, monitoring degradation levels would mitigate damage, and impacts would be confined to where ORVs cross streams and tributaries.

More subsistence hunters would be expected to use the TUA than in the past because of the reasons listed in Alternative 1. ORV use would also increase because the NPS-managed trails would be maintained/improved in better condition, and the Bull River Access Trail would be constructed, making access of the Bull River Floodplain possible/easier. Construction of the Bull River Access Trail would open more territory to ORV use and the maintained identified trails would attract more subsistence hunters because they would be in better condition and easier to drive on. For the monitoring effort, the park would try to avoid using ORVs. However, when ORVs were necessary, they would not be used off of NPS-managed ORV trails and routes. Off-trail use would be more challenging due to the restrictions imposed in this alternative; however, it is assumed that regardless of the closures and other restrictions, many hunters would drive ORVs off-trail to retrieve harvested moose/caribou, and there would be some level of impact from this use. Because the level of ORV use would be expected to increase under this alternative, impacts to water resources would also be expected to increase. However, actions proposed in this alternative would mitigate many of those impacts, as described below.

Impacts to water resources would occur wherever ORVs travel off-trail and cross streams or tributaries. Under Alternative 2 these impacts would occur locally at crossings on tributaries that are within the portion of the TUA that would initially be open for ORV use. However, if future long-term studies find that ORVs designed with best available technology have minimal impacts on saturated soils or steeper slopes and that such impacts would be below the warning or action degradation levels proposed under this alternative, then they may be allowed across a larger area of the TUA. Riding ORVs across tributaries would exacerbate sediment transport, which causes the impacts to water quality, channel morphology, and aquatic species that are described in the General Impacts section. Impacts would not affect the health of the ecosystem because use of ORVs would be dispersed over a large area.

Impacts would also be mitigated by managing access when necessary in response to conditions reaching warning or action degradation levels, which include evidence of persistent sedimentation immediately below an ORV soft-substrate stream crossing (warning level), and evidence of persistent sedimentation 20 meters or more below an ORV soft-substrate stream crossing (action level). This monitoring and action scheme would ensure impacts would not become major in any location.

Implementation of hardened trail surfaces and other mitigation measures would likely occur within 1-4 years. In the meantime, these trails would continue to be used without mitigation, so impacts to water resources during those 1-4 years would be similar to impacts that would occur along these trails under Alternative 1 (increased sediment transport in Windy Creek and clear-flowing tributaries).

Actions proposed in this alternative would encourage concentrated use along the Windy Creek Access Trail, Windy Creek Bowl Trail, Pyramid Creek Trail, Cantwell Airstrip Trail, Bull River Access Trail, Upper Cantwell Creek Floodplain Route/Trail, and Bull River Floodplain Route/Trail. Continued subsistence ORV use of the designated trails would likely concentrate many of the impacts to those trails; however, as described in the soils section of Chapter 4, these four existing trails are among those with the least existing soils impacts (see Table 3.1). These trails would be made even more durable as a result of construction improvements made as prescribed for this alternative in Chapter 2. After implementation, stream capture, collection and drainage that would occur on trails under Alternative 1 would not occur in this alternative because the trails or trail sections that would be impacted in Alternative 1 would be either closed or improved to control erosion in this alternative. This in turn, would reduce the potential for introduction of suspended sediments into water bodies, and subsequent adverse impacts on any macroinvertebrates or fish stocks that may be present.

Gravel capping done as part of trail construction in the Bull River and Upper Cantwell Creek Floodplain may require gravel extraction from the active floodplain. However, any volumes of gravel removed from these floodplains would likely be replenished through natural sediment deposition within a short timeframe. In addition, trail segments and routes within the Bull River or Upper Cantwell Creek Floodplain would involve approximately 30 crossings of the main Bull River channel and secondary channels, and 35 crossings of Cantwell Creek and secondary channels. These crossings would increase sedimentation in the glacial rivers.

Similar impacts would occur from construction of the new Bull River Access Trail. However, ORV use on a new Bull River Access Trail would have little effect on water resources because trail design would have mitigated erosion control. Sediments would be introduced at river crossings along the floodplain, but because the floodplain is gravel, and not a soil bank, turbidity impacts would be inconsequential. Coho salmon and Dolly Varden that may be present seasonally in Bull River would probably not be adversely affected.

Cumulative Impacts

In addition to the actions described in Alternative 1, it is foreseeable that NPS qualified subsistence users would use horses to pack out meat. As ORV use is restricted, more people would use horses, which can contribute fecal contaminants to streams and increase turbidity at crossings, but it is unlikely that they would have any profound impact on water resources.

Due to erosion in the TUA caused by past use of motorized vehicles and future horsepacking, these past and future actions would have a minor adverse impact on water resources in the TUA.

The actions in this alternative would contribute moderate adverse impacts due to trail construction and ORVs crossing clear-flowing tributaries in the TUA for up to 4 years. After construction is complete, adverse impacts would be minor. The cumulative impact of this alternative plus these past actions would be moderate in the near term and minor in the long term as impacts would not affect the overall health of the ecosystem. This alternative would be largely responsible for the adverse impacts.

Conclusion

Impacts to water quality, channel morphology, and aquatic species would be moderate for up to four years after implementation begins. During this time, use of ORVs would negatively affect turbidity, bank stability, and aquatic species in a portion of the streams and tributaries in the TUA. Impacts would be minor after four years because NPS trail construction, maintenance and reinforcement activities, coupled with the more intensive monitoring included in this alternative, would minimize some of the potential soil impacts, including the potential for erosion and subsequent sedimentation in water bodies. Cross-country use of ORVs would be somewhat restricted, monitoring degradation levels would mitigate damage, impacts that did occur would be confined to places where ORVs cross streams and tributaries, and impacts would not affect overall health of the ecosystem.

The level of impacts to water resources anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.6.5 Impacts to Water Resources Under Alternative 3

There would be no off-trail use of ORVs for subsistence or any other purposes within the TUA. Instead, the NPS would work with Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to implement a winter subsistence moose hunt, primarily in the area southwest of Cantwell Creek and into the Bull River area. The following trails would be managed by the NPS for continued ORV use by NPS qualified subsistence users for all subsistence purposes: Windy Creek Access Trail, Windy Creek Bowl Trail, Cantwell Airstrip Trail, Pyramid Peak Trail, and Bull River Access Trail (new construction). The Bull River and Upper Cantwell Creek Floodplains would be managed by the NPS for continued ORV use by NPS qualified subsistence users for all subsistence purposes, and a trail/route would be constructed along these floodplains to facilitate access and protect resources.

The analysis below shows that impacts to water quality, channel morphology, and aquatic species would be minor to moderate for up to four years after implementation begins. During this time, use of ORVs would negatively affect turbidity, bank stability, and aquatic species in a portion of the streams and tributaries in the TUA. Impacts would be minor after four years because water control, trail hardening, and other trail work would be completed. Cross-country use of ORVs would be prohibited, monitoring degradation levels would mitigate damage, and impacts that did occur would be confined to where ORVs cross streams and tributaries.

More subsistence hunters would be expected to use the TUA than in the past because of the reasons listed in alternative 1. ORV use would also increase because the NPS-managed trails would be maintained/improved in better condition, and the Bull River Access Trail would be constructed, making access of the Bull River Floodplain possible/easier. This means as many as 50 households could use ORVs on NPS-managed trails and routes to scope for moose and caribou before and during hunting season. For the monitoring effort, the park would try to avoid using

ORVs. However, when ORVs were necessary, they would not be used off of NPS-managed ORV trails and routes. Because the level of ORV use would be expected to increase under this alternative, impacts to water resources would also be expected to increase. However, actions proposed in this alternative would mitigate most of those impacts, as described below.

Under this alternative, ORVs would be used for subsistence purposes only on identified trails and routes. Because ORVs would not be crossing any clear-flowing streams or tributaries in the TUA off trail, there would be no impact to water resources in areas where there are no trails or identified routes.

Closing off-trail areas to ORV use would encourage concentrated use along the Windy Creek Access Trail, Windy Creek Bowl Trail, Pyramid Creek Trail, Cantwell Airstrip Trail, Bull River Access Trail (new construction), Upper Cantwell Creek Floodplain Route/Trail, and Bull River Floodplain Route/Trail. Impacts to water resources would occur wherever these trails or routes cross streams or tributaries. In those areas, the types of impacts to water quality, channel morphology, and aquatic species would be the same as those described under Alternative 1. However, these trails and routes, including the sections of the Windy Creek Access Trail that are currently responsible for adding sediment to Windy Creek, would be maintained with the purpose of controlling erosion. Sediment-bearing water would be diverted off of trails so impacts to streams would be reduced. After implementation, stream capture, collection and drainage that would occur on trails under Alternative 1 would not occur in this alternative because the trails or trail sections that would be impacted in Alternative 1 would be either closed or improved to control erosion in this alternative.

The NPS-managed trails are among those areas with the least existing soils impacts (see Table 3.1), and these trails would be made even more durable as a result of construction improvements made as prescribed for this alternative. This action, coupled with trail condition monitoring and management, well defined and measured impact parameters, and limitations on the type and weights of ORVs, would greatly minimize soils impacts, and thus impacts on sedimentation rates and adverse effects to potentially occurring macroinvertebrates and fish that would be impacted by turbidity and sedimentation.

Gravel capping done as part of trail construction in the Bull River and Upper Cantwell Creek Floodplain may require gravel extraction from the active floodplain. However, any volumes of gravel removed from these floodplains would likely be replenished through natural sediment deposition within a short timeframe. In addition, trail segments and routes within the Bull River or Upper Cantwell Creek Floodplain would involve approximately 30 crossings of the main Bull River channel and secondary channels, and 35 crossings of Cantwell Creek and secondary channels. These crossings would increase sedimentation in the glacial rivers.

Similar impacts would occur from construction of the new Bull River Access Trail. However, ORV use on a new Bull River Access Trail would have little effect on water resources because trail design would have mitigated erosion control. Sediments would be introduced at river crossings along the floodplain, but because the floodplain is gravel, and not a soil bank, turbidity impacts would be inconsequential.

Impacts would also be mitigated by managing access when necessary in response to conditions reaching warning or action degradation levels, which include evidence of persistent sedimentation immediately below an ORV soft-substrate stream crossing (warning level), and evidence of persistent sedimentation 20 meters or more below an ORV soft-substrate stream crossing (action

level). This monitoring and action scheme would ensure impacts would not become major in any location.

The level of snowmachine use in the TUA would increase with a winter hunt. It is assumed that about 25 additional snowmachine groups may use the TUA for the winter hunt. Even with this increase, use of snowmachines in the TUA would not be high enough to produce a measurable change in water quality parameters or health of aquatic species. Snowmachines would not affect channel morphology because they travel above the surface of the stream.

Cumulative Impacts

In addition to the actions described in Alternative 1, it is foreseeable that NPS qualified subsistence users would use horses to pack out meat. As ORV use is restricted, more people would use horses, which can contribute fecal contaminants to streams and increase turbidity at crossings, but it is unlikely that they would have any profound impact on water resources.

Due to erosion in the TUA caused by past use of motorized vehicles and future horsepacking, these past and future actions would have a minor adverse impact on water resources in the TUA. The actions in this alternative would contribute minor to moderate adverse impacts due to trail construction and ORVs crossing streams and tributaries in the TUA for up to 4 years. After construction is complete, adverse impacts would be minor. The cumulative impact of this alternative plus these past actions would be minor to moderate in the near term and minor in the long term as impacts would not affect the overall health of the ecosystem. This alternative would be largely responsible for the adverse impacts.

Conclusion

Impacts to water quality, channel morphology, and aquatic species would be minor to moderate for up to four years after implementation begins. During this time, new construction and use of ORVs would negatively affect turbidity, bank stability, and aquatic species in a portion of the streams and tributaries in the TUA. The extent of this ground surface and soil disturbance has the potential, through erosion, to generate sediments that can degrade aquatic habitats and the fish species that depend on them.

Impacts would be minor after four years because water control, trail hardening, and other trail work would be completed. Cross-country use of ORVs would be prohibited, monitoring degradation levels would mitigate damage, and impacts that did occur would be confined to where ORVs cross streams and tributaries. Use of snowmachines in the TUA would not be high enough to produce a measurable change in water quality parameters or health of aquatic species.

The level of impacts to water resources anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.6.6 Impacts to Water Resources Under Alternative 4

There would be no off-trail use of ORVs for subsistence or any other purposes within the TUA. Instead, the NPS would work with Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to implement a winter subsistence moose hunt, primarily in the area southwest of Cantwell Creek and into the Bull River area. The following trails would be managed by the NPS for continued ORV use by NPS qualified subsistence users

for all subsistence purposes *only* from one week before the beginning of the fall moose and caribou hunting seasons through to the end of these hunting seasons: Windy Creek Access Trail, Windy Creek Bowl Trail, Cantwell Airstrip Trail, and Pyramid Peak Trail.

The analysis below shows that impacts to water quality, channel morphology, and aquatic species would be minor for up to four years after implementation begins. During this time, use of ORVs would negatively affect turbidity, bank stability, and aquatic species in a portion of the few streams and tributaries in the TUA that are adjacent to the four trails that would be open to ORV use under this alternative. Impacts would be negligible after four years because water control, trail hardening, and other trail work would be completed. Cross-country use of ORVs would not occur, and monitoring degradation levels would mitigate damage.

More subsistence hunters would be expected to use the TUA than in the past because of the reasons listed in Alternative 1. ORV use would also increase because the NPS-managed trails would be maintained/improved in better condition. This means as many as 50 households could use ORVs on NPS-managed trails and routes to scope for moose, but ORVs would be permitted only on four trails and only from one week before the beginning of the fall moose and caribou hunting seasons through to the end of these hunting seasons. This means that impacts to water resources would be confined to late summer and fall, and would only occur along the four open trails, so impacts would occur only streams and tributaries adjacent to those four trails. Because ORVs would not be crossing any streams or tributaries in the TUA off trail, there would be no impact to water resources in areas where there are no trails.

Closing off-trail areas to ORV use would encourage concentrated use along the Windy Creek Access Trail, Windy Creek Bowl Trail, Cantwell Airstrip Trail, and Pyramid Peak Trail. For up to four years, impacts to water resources would occur wherever these trails cross clear-flowing streams or tributaries. In those areas, the types of impacts to water quality, channel morphology, and aquatic species would be similar to those described under Alternative 1. However, within four years, these trails and routes, including the sections of the Windy Creek Access Trail that are currently responsible for adding sediment to Windy Creek, would be maintained with the purpose of controlling erosion. Sediment-bearing water would be diverted off of trails so impacts to streams would be reduced. After implementation, stream capture, collection and drainage that would occur on trails under Alternative 1 would not occur in this alternative because the trails or trail sections that would be impacted in Alternative 1 would be either closed or improved to control erosion in this alternative.

Impacts would also be mitigated by managing access when necessary in response to conditions reaching warning or action degradation levels, which include evidence of persistent sedimentation immediately below an ORV soft-substrate stream crossing (warning level), and evidence of persistent sedimentation 20 meters or more below an ORV soft-substrate stream crossing (action level). This monitoring and action scheme would ensure impacts would not become major in any location.

Some additional soils damage could be realized by the method(s) chosen for alternative retrieval of harvested game, including use of horses. Horses can churn the soil strata, especially in sensitive soils, and thus make those soils vulnerable to erosion. However, under Alternative 4, horse traffic is expected only during the hunting season and in limited numbers.

There would be no impacts to water resources in the Bull River or Cantwell Creek because ORVs would not be permitted there.

The level of snowmachine use in the TUA would increase with a winter hunt. It is assumed that about 25 additional snowmachine groups may use the TUA for the winter hunt. Even with this increase, use of snowmachines in the TUA would not be high enough to produce a measurable change in water quality parameters or health of aquatic species. Snowmachines would not affect channel morphology because they travel above the surface of the stream.

Cumulative Impacts

In addition to the actions described in Alternative 1, it is foreseeable that NPS qualified subsistence users would use horses to pack out meat. As ORV use is restricted, more people would use horses, which can contribute fecal contaminants to streams and increase turbidity at crossings, but it is unlikely that they would have any profound impact on water resources.

Due to erosion in the TUA caused by past use of motorized vehicles and future horsepacking, these past and future actions would have a minor adverse impact on water resources in the TUA. The actions in this alternative would contribute minor adverse impacts due to ORVs crossing streams and tributaries in the TUA in the near term and negligible impacts in the long term. The cumulative impact of this alternative plus these past actions would be minor as impacts would not affect the overall health of the ecosystem. This alternative would be largely responsible for the adverse impacts.

Conclusion

Impacts to water quality, channel morphology, and aquatic species would be minor for up to four years after implementation begins. During this time, use of ORVs would negatively affect turbidity, bank stability, and aquatic species in a portion of the few streams and tributaries in the TUA that are adjacent to the four trails open to ORV use under this alternative. Impacts would be negligible after four years because water control, trail hardening, and other trail work would be completed. Cross-country use of ORVs would not occur, on-trail use would occur only in late summer and early fall, and monitoring degradation levels would mitigate damage. Use of snowmachines in the TUA would not be high enough to produce a measurable change in water quality parameters or health of aquatic species.

The level of impacts to water resources anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.7 VISITOR EXPERIENCE

4.7.1 Visitor Experience Impact Methodology

The impact analyses were based on consultation with subject matter experts, discussions with park users, and formal and informal comments from public meetings.

4.7.2 Impacts to Visitor Experience Under Alternative 1 (No Action)

The Cantwell TUA would remain open to the use of ORVs by NPS qualified subsistence users for subsistence purposes. ORV use for subsistence purposes would occur at anytime with any type of machine. More subsistence moose hunters would be expected to use the TUA than in the past, and we can assume the 50 households that hunt would go to the TUA first because:

- a) The 2005 NPS Cantwell Subsistence Traditionally Employed ORV Determination removed any ambiguity about whether ORV use for subsistence purposes is authorized in the TUA;
- b) The TUA is right next to Cantwell;
- c) Subsistence hunting in the TUA is unaffected by competition with non-local hunters (unlike on lands outside the TUA);
- d) There would be continued improvements in the reliability of the ORVs themselves; and
- e) The TUA is open earliest and latest for moose.

This means as many as 50 households could use ORVs to scope for moose throughout the TUA before and during hunting season. While ORVs could be used throughout the TUA, use would be concentrated along Cantwell Creek, Cantwell Airstrip Trail and the Windy Creek trails.

The analysis below shows impacts to visitor experience would be moderate because standards for frequency and intensity of noise intrusions, number of encounters with people, evidence of modern human use, and signs of social trails, campsites, or cut or broken vegetation could be approached or exceeded during the summer. These factors would degrade the quality of the park setting.

During summer and fall, most park visitors are hikers, cyclists, or NPS qualified subsistence users. Most park visitors travel through the TUA on the same ORV trails. Since ORV use is assumed to increase under this alternative, visitors would encounter more ORVs and greater impacts from ORVs, including evidence of modern human use, signs of social trails, campsites, or cut or broken vegetation. Visitors would experience frequent noise disturbance and encounters with others during August and September, when NPS qualified subsistence users use ORVs for subsistence purposes.

Visitors would also experience noise intrusions from administrative helicopter, airplane, and ORV use for monitoring purposes. The amount of aircraft use for monitoring for any given place would usually be minimal, in that this would mostly be reconnaissance-level work over the area for periodic mapping, and then point-to-point shuttles to get crews out to do monitoring measurements, where needed. Generally, helicopters and airplanes would cross back and forth over the TUA several times a day for several days a week during this time period. Administrative helicopter use generally won't occur in the fall to avoid impacting hunters. Law enforcement use of airplanes would occur throughout the summer and fall seasons. For the monitoring effort, the park would try to avoid using ORVs. However, when ORVs were necessary, they would not be used off of NPS-managed ORV trails and routes. It is assumed that this alternative would have the highest amount of administrative helicopter and ORV use. Experiencing frequent noise intrusions would degrade the park experience since one of the most important reasons people visit parks is to experience natural soundscapes (NPS 1995a).

Because of the above conditions, it is likely that Management Area B standards for frequency and intensity of noise intrusions; number of encounters with people; ability to camp out of sight and sound of others; evidence of modern human use; and signs of social trails, campsites, or cut or broken vegetation (see Section 3.3.5) would be approached or exceeded during August and September, and periodically throughout the summer. If the park believes that standards are being approached or exceeded, management action would be required to protect park resources and opportunities for quality visitor experiences.

Most parts of the TUA would remain difficult to access since there would be no trail improvements; visitors would continue to use unimproved ORV trails.

Winter visitors would not be affected by actions in this alternative.

Cumulative Impacts Analysis

The following past, present or reasonably foreseeable actions would affect visitor use in the TUA:

- The population of the State of Alaska has steadily grown for the last 30 to 40 years, and this trend is likely to continue. Park visitation is also likely to increase over the next 20 years. According to the U.S. Census, the Cantwell population has grown from 17 people in 1939 to 183 people when ANILCA was enacted in 1980 to 222 people in the latest census in 2000. The population is expected to continue increasing.
- Since 1980, new housing and commercial development has occurred around Cantwell. The gradual development spreading out from the Parks Highway corridor is likely to continue, creating increased interest in access to the eastern and southern boundaries of the national park, particularly the park additions.
- The National Park Service and its partners have assisted in promoting winter visitation in the park entrance area by hosting an annual Winterfest that began in 2001.
- Past motor vehicle use in the TUA has resulted in the loss of 14.8 ha (~37 acres) of vegetation.
- ANILCA allows snowmachines for subsistence, for traditional activities, and for travel to and from villages and homesites (ANILCA 811 and 1110). During the 1990s, technological improvements in snowmachines enabled a large but unquantified expansion of snowmachine use in Denali. Accurate estimates of snowmachine users are difficult to make, but during March and April of 1999, the NPS estimated that there were between 1,500 and 2,000 snowmobile users along the Parks Highway, primarily in the region from Cantwell to the West Fork of the Chulitna River and the Tokositna River area (NPS 2000a).

These actions show that there is potential for increased visitor demand in the TUA. Some of these actions would increase the frequency of noise intrusions in the TUA, thus degrading the quality of the visitor experience. Past and present use of snowmachines in winter and ORVs in summer and fall may have displaced non-motorized users, thereby creating a moderate to major cumulative impact. The actions proposed in this alternative would have a moderate negative effect on visitor experience due primarily to increased frequency of noise intrusions, number of encounters with people, evidence of modern human use, and signs of social trails, campsites, or cut or broken vegetation. The cumulative impact of this alternative plus these past, present, and future actions would be major. This alternative would be responsible for a majority of the adverse impacts, particularly during August and September when ORV use for subsistence would be highest and when administrative use of aircraft and ORVs would occur, and in the summer when helicopter use would occur.

Conclusion

This alternative would have moderate negative impacts to visitor experience because standards for frequency and intensity of noise intrusions, number of encounters with people, evidence of modern human use, and signs of social trails, campsites, or cut or broken vegetation could be approached or exceeded during the summer. These factors would degrade the quality of the park setting and would likely put this part of the park out of compliance with the zoning scheme described in the 2006 *Denali National Park and Preserve Backcountry Management Plan*.

The level of impacts to visitor experience anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.7.3 Impacts to Visitor Experience Under Alternative 2

Under this alternative, off-trail ORV use would be permitted by NPS qualified subsistence users only for retrieval of harvested moose and caribou. In addition, use of ORVs for all subsistence purposes would continue to be allowed on NPS-managed trails and routes: Windy Creek Access Trail, Windy Creek Bowl Trail, Cantwell Airstrip Trail, Pyramid Peak Trail, and Bull River Access Trail (new construction). Both the Bull River and Upper Cantwell Creek Floodplains would be managed by the NPS for continued ORV use by NPS qualified subsistence users for all subsistence purposes. During the summer and fall seasons, these trails and routes would be rezoned from Management Area B to Corridor (see 2006 *Denali National Park and Preserve Backcountry Management Plan* for a description of the Corridor zone).

The analysis below shows negative impacts to visitor experience would be minor to moderate because the standards for Management Area B and newly-imposed Corridors would be met, although the quality of the experience would be somewhat degraded by frequent noise intrusions and encounters with other people, modern equipment, and damaged vegetation.

ORV use would increase because more subsistence hunters would be expected to use the TUA than in the past due to the reasons listed under alternative 1, because the NPS-managed trails would be maintained/improved in better condition, and because the Bull River Access Trail would be constructed, facilitating access to the Bull River Floodplain. ORV use would be concentrated on NPS-managed trails, so visitors would experience noise from ORVs, have frequent encounters with other groups, and see ORV tracks, campsites, and cut or broken vegetation, particularly in August and September when ORV use for subsistence is greatest. Visitors would also experience the visual impact of new ORV trail construction, which could include a hardened trail surface and gravel borrow sites along the Bull River and Cantwell Creek. An increase in ORVs and evidence of their use would negatively impact the quality of the visitor experience.

Visitors would also experience noise intrusions under this alternative from administrative helicopter, airplane, and ORV use. The amount of aircraft use for monitoring for any given place would usually be minimal, in that this would mostly be reconnaissance-level work over the area for periodic mapping, and then point-to-point shuttles to get crews out to do monitoring measurements, where needed. Generally, helicopters and airplanes would cross back and forth over the TUA several times a day for several days a week during this time period. Administrative helicopter use generally won't occur in the fall to avoid impacting hunters. Law enforcement use of airplanes would occur throughout the summer and fall seasons. For the monitoring effort, the park would try to avoid using ORVs. However, when ORVs were necessary, they would not be used off of NPS-managed ORV trails and routes. Experiencing frequent noise intrusions would degrade the visitor experience since one of the most important reasons people visit parks is to experience natural soundscapes (NPS 1995a).

Although the quality of the park setting would be somewhat degraded in summer and fall as described above, it would remain consistent with the Corridor Management Area standards for frequency and intensity of noise intrusions, number of encounters with people, evidence of modern human use, and signs of social trails, campsites, or cut or broken vegetation.

Access to the TUA would be enhanced for summer and fall users by improvements to the Windy Creek Access Trail, Windy Creek Bowl Trail, Pyramid Creek Trail, Cantwell Airstrip Trail, Bull River Access Trail, and Upper Cantwell Creek and Bull River Floodplains.

Winter visitors would not be affected by actions in this alternative.

Cumulative Impacts Analysis

Cumulative impacts on visitor experience resulting from past, present, and reasonably foreseeable future actions are the same as Alternative 1. These actions show that there is potential for increased visitor demand in the TUA, that nonmotorized users may be displaced, and that some of these actions would increase the frequency of noise intrusions in the TUA, thus degrading the quality of the visitor experience. These cumulative actions create moderate to major negative impacts on visitor experience. The actions proposed in this alternative would have a minor to moderate negative effect on visitor experience due primarily to increased frequency of noise intrusions and other impacts from ORVs. The cumulative impact of this alternative plus these past, present, and future actions would be major. This alternative would be responsible for a substantial portion of the adverse impacts, particularly during August and September when ORV use for subsistence would be highest and when administrative use of aircraft and ORVs would occur, and in the summer when administrative helicopter, airplane, and ORV use would occur.

Conclusion

Negative impacts to visitor experience would be minor to moderate because the standards for Management Area B and newly-imposed Corridors would be met, although the quality of the experience would be somewhat degraded by frequent noise intrusions and encounters with other people, modern equipment, and damaged vegetation.

The level of impacts to visitor experience anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.7.4 Impacts to Visitor Experience Under Alternative 3

There would be no off-trail use of ORVs for subsistence, or any other, purposes within the TUA. Instead, the NPS would work with Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to implement a winter subsistence moose hunt, primarily in the area southwest of Cantwell Creek and into the Bull River area. The following trails would be managed by the NPS for continued ORV use by NPS qualified subsistence users for all subsistence purposes: Windy Creek Access Trail, Windy Creek Bowl Trail, Cantwell Airstrip Trail, Pyramid Peak Trail, and Bull River Access Trail (new construction). The Bull River and Upper Cantwell Creek Floodplains would be managed by the NPS for continued ORV use by NPS qualified subsistence users for all subsistence purposes. During the summer and fall seasons, these trails and routes would be rezoned from Management Area B to Corridor (see 2006 *Denali National Park and Preserve Backcountry Management Plan* for a description of the Corridor zone).

The analysis below shows negative impacts to visitor experience would be minor to moderate because standards for the TUA could be approached or exceeded during winter, and the quality of the experience year-round would be somewhat degraded by increased frequency of noise

intrusions and increased potential of encountering other people, modern equipment, and campsites.

ORV use would increase because more subsistence hunters would be expected to use the TUA than in the past due to the reasons listed under alternative 1, because the NPS-managed trails would be maintained/improved in better condition, and because the Bull River Access Trail would be constructed, facilitating access to the Bull River Floodplain. ORV use would be concentrated on NPS-managed trails, so visitors would experience noise from ORVs, have frequent encounters with other groups, and see ORV tracks, campsites, and cut or broken vegetation, particularly in August and September when ORV use for subsistence is greatest. Visitors would also experience the visual impact of new ORV trail construction, which could include a hardened trail surface and gravel borrow sites along the Bull River and Cantwell Creek. An increase in ORVs and evidence of their use would negatively impact the quality of the visitor experience.

Visitors would also experience noise intrusions under this alternative from administrative helicopter, airplane, and ORV use. The amount of aircraft use for monitoring for any given place would usually be minimal, in that this would mostly be reconnaissance-level work over the area for periodic mapping, and then point-to-point shuttles to get crews out to do monitoring measurements, where needed. Generally, helicopters and airplanes would cross back and forth over the TUA several times a day for several days a week during this time period. Administrative helicopter use generally won't occur in the fall to avoid impacting hunters. Law enforcement use of airplanes would occur throughout the summer and fall seasons. For the monitoring effort, the park would try to avoid using ORVs. However, when ORVs were necessary, they would not be used off of NPS-managed ORV trails and routes.

Although the quality of the park setting would be somewhat degraded in summer and fall as described above, it would remain consistent with the Corridor Management Area standards for frequency and intensity of noise intrusions, number of encounters with people, evidence of modern human use, and signs of social trails, campsites, or cut or broken vegetation.

Access to the TUA would be enhanced for summer and fall visitors by improvements to the Windy Creek Access Trail, Windy Creek Bowl Trail, Pyramid Creek Trail, Cantwell Airstrip Trail, Bull River Access Trail, and Cantwell Creek and Bull River Floodplains.

If a winter hunt was instituted, snowmachines would travel throughout the TUA during the expanded winter moose hunting season. Assuming about 50 households in Cantwell say they try to hunt moose, and further assuming about half are successful in the summer, then the remaining 25 households would likely take advantage of the expanded winter moose hunt. This means about 25 additional snowmachine groups may use the traditional use area for the winter hunt. A winter hunt would introduce additional noise, encounters with others, and encounters with modern human equipment from snowmachine use in the TUA. Experiencing frequent noise intrusions would degrade the experience since one of the most important reasons people visit parks is to experience natural soundscapes (NPS 1995a). While the impact might be noticeable, the majority of snowmachine use and corresponding impacts would be from existing use. It is possible that standards for Management Area B for noise, modern equipment, and encounters could be approached or exceeded in the TUA during winter, putting this part of the park out of compliance with the zoning scheme described in the 2006 *Denali National Park and Preserve Backcountry Management Plan*.

Cumulative Impacts

Cumulative impacts on visitor experience resulting from past, present, and reasonably foreseeable future actions are the same as Alternative 1. These actions show that there is potential for increased visitor demand in the TUA, that nonmotorized users may be displaced, and that some of these actions would increase the frequency of noise intrusions in the TUA, thus degrading the quality of the visitor experience. These cumulative actions create moderate to major negative impacts on visitor experience. The actions proposed in this alternative would have a minor to moderate negative effect on visitor experience due primarily to increased frequency of noise intrusions during summer, fall, and winter. The cumulative impact of this alternative plus these past, present, and future actions would be major. This alternative would be responsible for a substantial portion of the adverse impacts as noise intrusions would be introduced nearly year-round, and zoning standards could be approached or exceeded during winter.

Conclusion

Impacts to visitor experience would be minor to moderate because standards for the TUA could be approached or exceeded during winter, and the quality of the experience year-round would be somewhat degraded by increased frequency of noise intrusions and increased potential of encountering other people, modern equipment, and campsites.

The level of impacts to visitor experience anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.7.5 Impacts to Visitor Experience Under Alternative 4

There would be no off-trail use of ORVs for subsistence, or any other, purposes within the TUA. Instead, the NPS would work with Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to implement a winter subsistence moose hunt, primarily in the area southwest of Cantwell Creek and into the Bull River area. The following trails would be managed by the NPS for continued ORV use by NPS qualified subsistence users for all subsistence purposes *only* from one week before the beginning of the fall moose and caribou hunting seasons through to the end of these hunting seasons: Windy Creek Access Trail, Windy Creek Bowl Trail, Cantwell Airstrip Trail, and Pyramid Peak Trail. During the summer and fall seasons, these trails would be rezoned from Management Area B to Corridor.

The analysis below shows impacts to visitor experience would be minor because standards for the TUA could be approached or exceeded during winter, and the quality of the experience would be somewhat degraded during fall by increased frequency of noise intrusions and increased potential of encountering other people, modern equipment, and campsites. The quality of the summer visitor experience would be improved by eliminating impacts from ORVs from the TUA during summer.

ORV use would increase because more subsistence hunters would be expected to use the TUA than in the past due to the reasons listed under alternative 1, and because the NPS-managed trails would be maintained/improved in better condition. ORV use would be concentrated on NPS-managed trails, so visitors would experience noise from ORVs, have frequent encounters with other groups, and see ORV tracks, campsites, and cut or broken vegetation. While evidence of use such as campsites or cut vegetation could be seen throughout summer, ORVs would be permitted only from one week before the beginning of the fall moose and caribou hunting seasons

through to the end of these hunting seasons. So while the park visitor would expect to encounter ORVs when they are permitted, they would not encounter ORVs during most of the summer.

Visitors would also experience noise intrusions under this alternative from administrative helicopter, airplane, and ORV use. The amount of aircraft use for monitoring for any given place would usually be minimal, in that this would mostly be reconnaissance-level work over the area for periodic mapping, and then point-to-point shuttles to get crews out to do monitoring measurements, where needed. Generally, helicopters and airplanes would cross back and forth over the TUA several times a day for several days a week during this time period. Administrative helicopter use generally won't occur in the fall to avoid impacting hunters. Law enforcement use of airplanes would occur throughout the summer and fall seasons. For the monitoring effort, the park would try to avoid using ORVs. However, when ORVs were necessary, they would not be used off of NPS-managed ORV trails and routes.

Although the quality of the park setting would be somewhat degraded in summer and fall as described above, it would remain consistent with the Corridor Management Area standards for frequency and intensity of noise intrusions, number of encounters with people, evidence of modern human use, and signs of social trails, campsites, or cut or broken vegetation.

Access to the TUA would be enhanced for summer and fall visitors by improvements to the Windy Creek Access Trail, Windy Creek Bowl Trail, Pyramid Creek Trail, and Cantwell Airstrip Trail.

If a winter hunt was instituted, snowmachines would travel throughout the TUA during the expanded winter moose hunting season. Assuming about 50 households in Cantwell say they try to hunt moose, and further assuming about half are successful in the summer, then the remaining 25 households would likely take advantage of the expanded winter moose hunt. This means about 25 additional snowmachine groups may use the traditional use area for the winter hunt. A winter hunt would introduce additional noise, encounters with others, and encounters with modern human equipment from snowmachine use in the TUA. Experiencing frequent noise intrusions would degrade the experience since one of the most important reasons people visit parks is to experience natural soundscapes (NPS 1995a). While the impact might be noticeable, the majority of snowmachine use and corresponding impacts would be from existing use. It is possible that standards for Management Area B for noise, modern equipment, and encounters could be approached or exceeded in the TUA during winter, putting this part of the park out of compliance with the zoning scheme described in the 2006 *Denali National Park and Preserve Backcountry Management Plan*.

Cumulative Impacts

Cumulative impacts on visitor experience resulting from past, present, and reasonably foreseeable future actions are the same as Alternative 1. These actions show that there is potential for increased visitor demand in the TUA, that nonmotorized users may be displaced, and that some of these actions would increase the frequency of noise intrusions in the TUA, thus degrading the quality of the visitor experience. These cumulative actions create moderate to major negative impacts on visitor experience. The actions proposed in this alternative would have a minor negative effect on visitor experience due primarily to increased frequency of noise intrusions primarily during fall. The cumulative impact of this alternative plus these past, present, and future actions would be moderate to major. This alternative would be responsible for a noticeable portion of the adverse impacts as noise intrusions would be introduced and zoning standards could be approached or exceeded during winter.

Conclusion

Impacts to visitor experience would be minor because standards for the TUA could be approached or exceeded during winter, and the quality of the experience would be somewhat degraded during fall by increased frequency of noise intrusions and increased potential of encountering other people, modern equipment, and campsites. The quality of the summer visitor experience would be improved by eliminating impacts from ORVs from the TUA during summer.

The level of impacts to visitor experience anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.8 WILDERNESS

ANILCA provides some exceptions to standard national park and wilderness management practices, including allowing the appropriate use of certain motorized means of surface transportation traditionally employed for subsistence purposes. The analysis in this section acknowledges that ORV use for subsistence purposes can be permitted in wilderness just like many other activities. However, all permitted activities, including those related to subsistence, are subject to evaluation and management. For example, hiking is also a permitted activity in wilderness, but the damage sometimes created by it, particularly the development of networks of social trails, is commonly found to be damaging to wilderness values, and is regulated as a result to confine or mitigate the impacts. Even in the special context of ANILCA, a permitted activity or use may cause major impacts or even impairment and can therefore become inappropriate or incompatible with wilderness or other resource values.

4.8.1 Wilderness Impact Methodology

The impact analyses are based on consultation with subject matter experts, discussions with park users, and formal and informal comments from public meetings.

4.8.2 General Wilderness Impacts

Direct impacts on natural conditions as expressed by changes in wildlife, soundscapes, and other natural resources are addressed in other sections of this document. The analysis in this section would focus on the dependence of wilderness character and wilderness experience on the presence of natural conditions and the lack of signs of modern human activity. A specific concern is the degree to which different forms of impact related to ORV use influence the perception that that human presence is altering natural condition. This includes the trails that are produced by ORVs and the presence of ORVs themselves. The physical, biological, and visual impacts that ORV trails create are all an indication of prior human use of the area. They are distinctly different than trail impacts from wildlife because they clearly represent assistance from devices of modern civilization. For the purpose of this analysis, the occurrence of networks of ORV trails would be considered a direct impact to wilderness character because they are an obvious reminder of modern human presence and mechanization.

4.8.3 Impacts to Wilderness Under Alternative 1 (No Action)

The actions in this alternative would result in adverse impacts to wilderness resource values within the TUA primarily from the cross country ORV use that would continue to occur throughout much of the area. As described in Impacts to Visitor Experience, park users would experience frequent noise disturbance, encounters with others, evidence of modern human use, signs of social trails, campsites, or cut or broken vegetation. Wilderness resource values such as the presence of natural conditions and solitude would be compromised by the extensive presence of ORVs in the area and the trail damage they would create. The continuation of dispersed ORV use and the resultant adverse impacts would necessitate the re-designation of the current status of the TUA from eligible for wilderness designation to ineligible.

Presence of natural conditions

The use of ORVs away from established trail corridors in the TUA would lead to the development of numerous additional trail impacts across the TUA. These impacts would be essentially permanent in nature due to the degree of damage to soils. They would develop in all habitats in the TUA rather than being confined to a limited number of narrow corridors. The linear nature and width of these trail impacts would be distinctly different from natural disturbances in the area. New trail formation would substantially alter the natural landscape and diminish its eligibility for wilderness designation.

Absence of Permanent Structures

There would be no effect, either positive or negative, to this aspect of wilderness resource values since no new permanent structures are proposed to be added or removed under this alternative.

Solitude and Reminders of Modern Human Use

As noted in Section 3.6 (Wilderness Affected Environment), one of the essential wilderness resource values, opportunities for solitude, is defined in part by freedom from the reminders of society and the absence of mechanization and signs of modern human presence. Increased levels of ORV use and few restrictions on that use would result in sustained and additional trail formation throughout the TUA. It would also result in intensification of damage along existing trails. These networks of user-created trails would negatively impact wilderness resource values by contributing reminders of modern human use throughout the TUA.

Cumulative Impacts

The following past, present or reasonably foreseeable actions would affect wilderness resource values in the TUA:

- The population of the State of Alaska has steadily grown for the last 30 to 40 years, and this trend is likely to continue. Park visitation is also likely to increase over the next 20 years. According to the U.S. Census, the Cantwell population has grown from 17 people in 1939 to 183 people when ANILCA was enacted in 1980 to 222 people in the latest census in 2000. The population is expected to continue increasing.
- Since 1980, new housing and commercial development has occurred around Cantwell. The gradual development spreading out from the Parks Highway corridor is likely to continue,

creating increased interest in access to the eastern and southern boundaries of the national park, particularly the park additions.

- Past motor vehicle use in the TUA has resulted in the loss of 14.8 ha (~37 acres) of vegetation.
- ANILCA allows snowmachines for subsistence, for traditional activities, and for travel to and from villages and homesites (ANILCA 811 and 1110). During the 1990s, technological improvements in snowmachines enabled a large but unquantified expansion of snowmachine use in Denali. Accurate estimates of snowmachine users are difficult to make, but during March and April of 1999, the NPS estimated that there were between 1,500 and 2,000 snowmobile users along the Parks Highway, primarily in the region from Cantwell to the West Fork of the Chulitna River and the Tokositna River area (NPS 2000a).

These actions contribute a moderate negative impact to wilderness resource values due to impacts from past and future visitor use, especially motor vehicle use, and from a potential increased demand for use of the TUA. The actions proposed in this alternative would have a major negative effect on wilderness resource values due primarily to expansion of many miles of new ORV trails throughout the TUA. The cumulative impact of this alternative plus these past, present, and future actions would be major. This alternative would be responsible for a majority of the adverse impacts as this alternative would compromise the wilderness eligibility of the TUA.

Conclusion

Alternative 1 would cause major adverse impacts on wilderness resources because the lack of proactive management would result in two important wilderness resource values, presence of natural conditions and opportunities for solitude, being compromised by the perpetuation of existing damage and the expansion of many miles of new ORV trails throughout the TUA. The level of these adverse impacts would necessitate the re-designation of the current status of the TUA from eligible for wilderness designation to one of ineligible.

The level of impacts to wilderness resource values anticipated from this alternative would result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.8.4 Impacts to Wilderness Under Alternative 2

Alternative 2 would result in major adverse impacts to wilderness resource values primarily from the continuation of dispersed ORV use and its displacement into new habitats and areas of the TUA. New trail impacts that would persist over a number of seasons are likely to be created under this alternative because of the number of retrievals every year combined with the limited amount of terrain and reasonable travel routes that are available to disperse this use, and the characteristics of the vegetation in areas where retrieval trips would take place. The trail formation would also shift to new locations and habitats by the closure of some previously impacted areas and the construction of a new trail into the Bull River drainage. Additionally, as described in Impacts to Visitor Experience, the quality of the visitor experience would be somewhat degraded by frequent noise intrusions and encounters with other people, modern equipment, and damaged vegetation.

Stipulations for off-trail ORV use under this alternative may slow the rate of new trail development. The closures would create some improvements over current conditions by allowing damaged areas to recover or prohibiting ORV use on saturated soils. However, positive effects

from these restrictions are likely to be offset by facilitating ORV use into the Bull River drainage and shifting use onto currently undisturbed travel corridors adjacent to the closed areas. Over time there would be a net expansion of visible trail impacts across the TUA, as described in Impacts to Vegetation under Alternative 2. As a result, there is a high probability that in the future additional management actions would be required. The continuation of dispersed ORV use and the resultant adverse impacts could necessitate the re-designation of the current status of the TUA from eligible for wilderness designation to one of ineligible.

Presence of Natural Conditions

Cross-country use of ORVs would lead to the development of numerous additional trail impacts. The net effect of this alternative would be to shift use and the resulting trail impacts into new environments. The linear nature and width of these trail impacts would be distinctly different from natural disturbances in the area. These new user formed trails would continue to alter the natural landscape.

Absence of Permanent Structures

The presence of permanent structures in the area would increase due to the development of three new trails or routes and the incorporation of several other existing trails into a network of permanently maintained trails.

Solitude and Reminders of Modern Human Use

Increased levels of ORV use and cross country travel, and the subsequent impacts to vegetation and soils, would serve as reminders of modern human use and mechanization in many parts of the TUA. The development of a new trail into the Bull River would facilitate ORV access into that area and reduce the opportunities for solitude that currently exist in that portion of the TUA. All areas and trails closed for recovery would be posted with closure signs, and barriers would be placed at the start of the closed trail sections. These modern conveyances would also serve as reminders of modern human use and detract from the natural setting of the area. Evidence of human use would be reduced by the maintenance of the existing trails that are retained because a sustainable trail does not appear to be heavily used the way an unsustainable trail, with mud holes, rutting, and braids, might give the impression of heavy or abusive use.

Cumulative Impacts

Cumulative impacts on wilderness resource values resulting from past, present, and reasonably foreseeable future actions are the same as Alternative 1. These actions contribute a moderate negative impact to wilderness resource values due to impacts from past and future visitor use, especially motor vehicle use, and from a potential increased demand for use of the TUA. The actions proposed in this alternative would have a major negative effect on wilderness resource values due primarily to expansion of many miles of new ORV trails throughout the TUA. The cumulative impact of this alternative plus these past, present, and future actions would be major. This alternative would be responsible for a majority of the adverse impacts as this alternative could compromise the wilderness eligibility of the TUA.

Conclusion

Alternative 2 would result in major negative impacts to wilderness resource values within the TUA because dispersed cross country ORV use would occur throughout much of the area. Two

important wilderness resource values, presence of natural conditions and opportunities for solitude, would be compromised by the perpetuation and expansion of several miles of user formed ORV trails. New trail construction would increase the presence of permanent human structures in the area.

The level of impacts to wilderness resource values anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.8.5 Impacts to Wilderness Under Alternative 3

The actions in this alternative would result in moderate adverse impacts to wilderness resource values. As described in Impacts to Visitor Experience, the quality of the experience would be somewhat degraded by increased frequency of noise intrusions and increased potential of encountering other people, modern equipment, and campsites. Most of the impact under this alternative would be caused by the development of a new maintained trail into the Bull River, and maintained routes or trails to both the Bull River and Upper Cantwell Creek Floodplains. New maintained trails would result in increased ORV use in these areas. Impacts associated with these trails would be somewhat mitigated by the restriction of ORV use to designated trail corridors which would allow the damage from past incursions to recover. Confining use to limited locations could retain the wilderness eligibility status for the TUA.

Presence of Natural Conditions

Developing new maintained trails into the Bull River and Cantwell Creek drainages would negatively impact natural conditions by facilitating ORV use of these areas. The presence of ORVs and their associated impacts would increase, which would degrade natural conditions.

On the other hand, restricting ORV use to identified trails would allow previously damaged cross country areas to recover. This action would help restore natural conditions.

The visual trail impacts from horsepacking for retrieval would be minor given the expected low level of use. Trails created by horses would be similar in character to animal trails from moose and caribou that are prevalent in the TUA, so they would appear more natural than tracks left by ORVs.

Absence of Permanent Structures

There would be an increase in the presence of permanent structures due to the development of three new trails or routes and the incorporation of several other existing trails into a network of permanently maintained trails.

Solitude and Reminders of Modern Human Use

The lack of dispersed ORV use would ensure that the visual footprint of human presence in the TUA is restricted solely to the identified trails. Confining the use of ORVs to trails would also keep motorized noise impacts within a localized areas rather than spreading the noise over the entire area. The combination of these changes would increase opportunities for solitude within the TUA.

Evidence of human use would be reduced by the maintenance of the existing trails that are retained because a sustainable trail does not appear to be heavily used the way an unsustainable trail, with mud holes, rutting, and braids, might give the impression of heavy or abusive use.

These beneficial changes would be somewhat offset by impacts from increased levels of ORV use anticipated from this alternative. Opportunities for solitude would be reduced on trails in the TUA since ORV use would be concentrated on these same trails and routes. Also, all areas and trails closed for recovery would be posted with closure signs, and barriers would be placed at the start of the closed trail sections. These modern conveyances would also serve as reminders of modern human use and detract from the natural setting of the area.

A winter hunt would contribute additional snowmachine use to the TUA. It would be expected to involve about 25 additional snowmachine groups. Opportunities for solitude in the TUA during winter would not be noticeably affected given the current level of snowmachine use that is already occurring in the area.

Cumulative Impacts

Cumulative impacts on wilderness resource values resulting from past, present, and reasonably foreseeable future actions are the same as Alternative 1. These actions contribute a moderate negative impact to wilderness resource values due to impacts from past and future visitor use, especially motor vehicle use, and from a potential increased demand for use of the TUA. The actions proposed in this alternative would have moderate negative impacts on wilderness resource values due primarily to new trail development. The cumulative impact of this alternative plus these past, present, and future actions would be moderate. This alternative would be responsible for a substantial portion of the adverse impacts.

Conclusion

Alternative 3 would result in moderate negative impacts to wilderness resource values. ORV use in areas such as the Bull River would increase. New trail development and designation of existing trails would add to the presence of permanent human structures in the area. These impacts would be somewhat offset by the recovery of currently impacted areas. Maintenance of trails would also reduce their obtrusiveness. Confining ORV use to trails or routes, and allowing damaged areas to recover, would retain eligibility for wilderness designation status for the TUA.

The level of impacts to wilderness resource values anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.8.6 Impacts to Wilderness Under Alternative 4

This alternative would result in moderate benefits to wilderness resource values due largely to the mitigation of past ORV impacts that have compromised the eligibility of the area for designation as wilderness. All ORV use would be confined to the trail corridors that were present at the time of the eligibility determination in 1986. This would allow recovery of off-trail areas. Restoring and maintaining trails would also benefit wilderness resource values by restoring damaged areas and reducing signs of motorized use.

As described in Impacts to Visitor Experience, the quality of the experience would be somewhat degraded during fall by increased frequency of noise intrusions and increased potential of

encountering other people. The experience would be improved during summer due to decreased noise from ORVs.

Presence of Natural Conditions

Natural conditions would be restored by allowing existing ORV impacts to recover. The trails that would be maintained for continued use would negatively affect natural conditions but are consistent with the footprint of impact that was considered to be acceptable in the context of the wilderness eligibility determination in 1986 for the TUA area.

The visual trail impacts from horsepacking for retrieval would be minor given the expected low level of use. Trails created by horses would be similar in character to animal trails from moose and caribou that are prevalent in the TUA, so they would appear more natural than tracks left by ORVs.

Absence of Permanent Structures

There would be a minor negative impact from permanent human structures due to the establishment of a permanently maintained trail system.

Solitude and Reminders of Modern Human Use

There would be continued presence of ORVs traveling on trails in the TUA; however, eliminating dispersed ORV use would reduce the visual footprint of human presence in the TUA and the area where ORVs could be encountered.

Evidence of human use would be reduced by the maintenance of the existing trails that are retained because a sustainable trail does not appear to be heavily used the way an unsustainable trail, with mud holes, rutting, and braids, might give the impression of heavy or abusive use.

A winter hunt would contribute additional snowmachine use to the TUA. It would be expected to involve about 25 additional snowmachine groups. Opportunities for solitude in the TUA during winter would not be noticeably affected given the current level of snowmachine use that is already occurring in the area.

Cumulative Impacts

Cumulative impacts on wilderness resource values resulting from past, present, and reasonably foreseeable future actions are the same as Alternative 1. These actions contribute a moderate negative impact to wilderness resource values due to impacts from past and future visitor use, especially motor vehicle use, and from a potential increased demand for use of the TUA. The actions proposed in this alternative would have a moderate positive effect on wilderness resource values due primarily to the elimination of ORV trails, routes, and dispersed ORV travel. The cumulative impact of this alternative plus these past, present, and future actions would be negligible. This alternative would be responsible for a majority of the positive impacts.

Conclusion

The actions in this alternative would result in overall moderate benefits to wilderness resource values, largely due to the elimination of ORV trails, routes, and dispersed ORV travel. There would be major improvements to the presence of natural conditions and solitude due to the

recovery of large areas of impact and a reduced scope of motorized use. Minor impacts to both of these values as well as the absence of human structures would remain as a result of the established system of trails. Impacts from horsepacking or the winter hunt would be negligible. This alternative would be fully consistent with the current eligibility determination for the area.

The level of impacts to wilderness resource values anticipated from this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the establishing legislation or that are key to the integrity of the park.

4.9 SUBSISTENCE OPPORTUNITIES

4.9.1 Subsistence Opportunities Impacts Methodology

The principal method for the impact analysis involved a review of published and unpublished literature, such as the *Denali National Park and Preserve Subsistence Management Plan*, and other materials regarding the effects of management activities on access and on wildlife mortality and disturbance. In addition to literature review, the impact analyses were based on consultation with subject matter experts, discussions with NPS qualified subsistence users, and formal and informal comments from public meetings.

4.9.2 General Impacts to Subsistence Opportunities

Impacts to subsistence include restricting access to subsistence resources, limiting the availability of subsistence resources, and increasing competition for subsistence resources. Availability of resources can vary under different management options. Different types of access options can affect the level of effort required, time involved, and the effectiveness of the hunt. Competition would increase or decrease depending on the management action. These items can negatively affect the subsistence user by making subsistence activities more difficult and time-consuming, limiting the amount of food or supplies the subsistence user can obtain, and altering the subsistence user's traditional way of life and quality of life.

4.9.3 Impacts to Subsistence Opportunities Under Alternative 1 (No Action)

Alternative 1 would result in major negative effects to subsistence moose resources and opportunities. There would initially be greater access to subsistence moose resources and improved opportunities because of the opening of the TUA to ORV use. While this would lead to easier hunting, it would eventually result in more pressure on moose populations and increased harvest and competition among hunters. Over the long term the lack of proactive management would mean that moose harvests, facilitated by easy ORV access, would be above the sustainable level and require hunting outside the TUA.

Subsistence resources

As explained in the impacts to wildlife section (see Section 4.6.3), Alternative 1 would have a major adverse impact on moose in the Cantwell TUA because levels of harvest would increase dramatically over the current average of 5 moose per year. Moose harvests would initially increase; then the population may become depleted as there is not a large enough bull moose population to sustain an annual taking of 10 moose.

While the initial increased moose harvest would benefit subsistence hunters, within a few years the hunting pressure would likely remove or displace moose in important hunting areas, reducing the number of moose that could be harvested from the TUA in general. This lower harvest level would mean that NPS qualified subsistence users would have to expend more time and effort hunting outside the TUA. Because of increased pressure on resources and increased competition outside the TUA, hunting outside the TUA would not guarantee success for subsistence hunters.

Access

Under Alternative 1, both on-trail and off-trail ORV use would be allowed for all subsistence purposes by NPS qualified subsistence users throughout the TUA. People would use ORVs primarily in August and September, anywhere in the TUA, with any type of machine. NPS qualified subsistence users would continue to drive ORVs throughout the TUA in search of moose and caribou both during the pre-season scoping period and during hunting season. Moose are typically in the headwaters of the draws in August and the early part of September and nearer the lower corridors later in September and October. Alternative 1 would provide complete access to both the lower drainages and the head waters because of the lack of restrictions on ORVs. The effect is that under this alternative a subsistence hunter could travel throughout the TUA by ORV for scouting, hunting, and game retrieval, improving their chances of a successful hunt. However, the number of moose harvested would continue to depend on where the moose were in any given year.

In this alternative, improvements to existing ORV trails would not be made, so while access would be very open, the condition of the ORV trails would continue to deteriorate.

Competition among NPS qualified subsistence users

Alternative 1 would result in increased competition among NPS qualified subsistence users because more subsistence moose hunters would be expected to use the TUA, greater access, and subsequent decrease in availability of moose. In 2000, about 50% of the nearly 100 households attempted to harvest moose, with about 25% successful. It is likely that Cantwell hunters would continue to try hunting in the TUA first because it is closest to them. This means as many as 50 households could use ORVs to scope for moose throughout the TUA (except recovery areas) before and during hunting season. The effect of these factors is that there would be an immediate increase in competition for limited numbers of moose.

Way of Life

Subsistence use would continue to provide a considerable proportion of the rural diet; however, the amount of moose meat in subsistence users' diets would decrease in the long term proportionate to the decrease in moose in the TUA. As the opportunity to hunt diminishes with a decrease in availability of moose in the TUA, successful hunts would be less likely and residents would have to supplement their diets. The opportunity for children to learn from elders to identify resources, methods of harvest, and efficient and non-wasteful processing and preparation of moose would decrease over time because of the loss of resources. The amount of time and effort required for a successful moose hunt would be shortened in the short term, but in the long term a hunt would require a lot more time and effort because there would be fewer moose available to hunt. There would be no displacement of less-mobile users because ORVs would be allowed throughout the TUA.

Economic Analysis

The economic analysis can be determined based on the effect of each alternative on the total annual number of moose harvested by Cantwell subsistence hunters both inside and outside the TUA. Competition for subsistence moose hunting opportunities on general State lands within GMU 13E is increasing, and Cantwell residents have started shifting their hunting effort towards park lands (park lands in Unit 13E Cantwell area and in Unit 20C Kantishna Hills). This trend would continue and subsistence hunters could depend on hunting on park lands for more than half of the moose the Cantwell community needs in the future (Callaway 2006). In 1999, 27 moose were harvested by the Cantwell community from State and park lands (ADFG 2002). Using this number as a baseline for how many moose harvests would continue to be needed by the community, then 13-14 of those moose would have to come from park lands in the future.

We assume that moose harvests would initially double to 10 (see Impacts to Wildlife), providing most of the 13-14 moose needed from the TUA; then they would decrease considerably because moose populations would be depleted. For this exercise, we assume that in the long term 1-2 moose would be harvested annually from the TUA. Therefore, subsistence hunters could have to turn to *other* park lands in 13E and 20C to find the remaining 11-13 moose they need. At most, if those 11-13 moose couldn't be harvested, it would be a loss of 11-13 moose for the community per year. If a dressed moose weighs 1,000 pounds, this is a loss of 11,000-13,000 pounds of moose meat to the community per year. At a market basket estimate of \$8/lb, this would be a shortfall in dollars of nearly \$88,000 to \$104,000 – or a loss of \$880 to \$1,040 per household (assuming 100 subsistence households in Cantwell residence zone).

Though income levels in Cantwell may fluctuate from year to year, the median family income for Cantwell for 2000 was \$39,792 (U.S. Census 2000). An economic loss of \$880 to \$1,040 for a family would be a loss of 2.2% – 2.6% of their annual income.

Cumulative Impacts

The following past, present, or reasonably foreseeable actions would affect subsistence use in the TUA:

- The population of the State of Alaska has steadily grown for the last 30 to 40 years, and this trend is likely to continue. Park visitation is also likely to increase over the next 20 years. According to the U.S. Census, the Cantwell population has grown from 17 people in 1939 to 183 people when ANILCA was enacted in 1980 to 222 people in the latest census in 2000. The population is expected to continue increasing.
- The overall number of hunters on general State lands within GMU 13E is increasing. This, combined with tightening of regulations for hunting on these State lands, increases the competition for subsistence opportunities.
- ORV use has been unlimited on State land adjacent to the TUA, and ORVs are likely to continue to be allowed on these lands in the future.

Increases in the Cantwell population and increases in the overall number of hunters would continue to increase competition in the TUA. These past, present, and future actions would have a moderate adverse impact on subsistence use in the TUA. This alternative would be responsible for a substantial portion of the adverse impacts because of the proximity and importance of the TUA to Cantwell NPS qualified subsistence users. The cumulative adverse impact of this alternative plus these past, present, and future actions would therefore be major.

Conclusion

Actions in this alternative would have major negative impacts because subsistence moose hunting, facilitated by unrestricted ORV access, would be above a sustainable level in the TUA. Over the long term NPS qualified subsistence users would have to expend more time and effort hunting moose on non-park lands and could be affected by increasing restrictions as well as declining wildlife populations on those lands.

The level of impacts to subsistence anticipated from this alternative would eventually result in a significant restriction to subsistence resources (moose).

4.9.4 Impacts to Subsistence Opportunities Under Alternative 2

Alternative 2 would result in minor beneficial effects to subsistence resources and opportunities because of extensive ORV access and proactive wildlife management that would provide for sustainable harvest over the next 10-15 years. Enhanced access to subsistence resources and opportunities would result from identifying trails and routes for ORV use and the provision for ORV access for moose and caribou retrieval. The monitoring provisions and recommended management actions in the alternative, including subsistence harvest limits for moose and caribou, would make it possible to have a sustainable harvest level over the long term. The identified ORV trails and routes would be in good moose habitat, so for much of the subsistence hunting season (the last half of August and the month of September) there would be more opportunities to hunt moose near trails. Counteracting these benefits, however, would be the restrictions on ORV use for retrieval and increased competition among hunters in the TUA, especially in and near the access corridors. On balance the beneficial impacts to subsistence use would be minor over the long term.

Subsistence resources

As explained in Section 4.6.4, Impacts to Wildlife under Alternative 2, actions proposed in this alternative would have a moderate adverse impact on wildlife in the TUA because the number of moose harvested each year could increase above the current average of 5 moose/year. Noise from helicopters, airplanes, and ORVs would disturb wildlife. These factors would result in adverse impacts to the availability of subsistence resources (particularly moose). However, this alternative proposes that the NPS work with the Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to establish subsistence harvest limits for moose to maintain natural and healthy populations on park land within the TUA. The harvest limit would counteract the potential threat of over-harvest and decreased resource availability, thus providing a benefit to subsistence hunters.

Access

Under this alternative, off-trail ORV use would be permitted by NPS qualified subsistence users only for retrieval of harvested moose and caribou. In addition, use of ORVs for all subsistence purposes would continue to be allowed on NPS-managed trails and routes: Windy Creek Access Trail, Windy Creek Bowl Trail, Cantwell Airstrip Trail, Pyramid Peak Trail, and Bull River Access Trail (new construction). Both the Bull River and Upper Cantwell Creek Floodplains would be managed by the NPS for continued ORV use by NPS qualified subsistence users for all subsistence purposes.

Construction of the Bull River Access Trail would open more territory (the Bull River Floodplain) to subsistence hunters and the NPS-managed trails would attract more subsistence hunters because they would be in better condition and easier to drive on.

Access patterns under Alternative 2 would include use of ORVs primarily in August and September along the NPS-managed trails and routes. NPS qualified subsistence users would drive ORVs in search of moose and caribou both during the pre-season scoping period and during hunting season. Moose are typically in the headwaters of the draws in August and the early part of September and nearer the lower corridors later in September and October. Alternative 2 would provide access to all of the important lower drainages. The number of moose harvested would continue to depend on where the moose were in any given year.

Alternative 2 would also provide the option of using ORVs for retrieval of harvested moose and caribou, although closures within the TUA may limit any large-scale benefits of this. Management actions would make it more difficult to use an ORV to retrieve a moose far from an NPS-managed trail or route than is currently the case. As a result, subsistence hunters would likely spend more time looking for moose closer to the trails, and off-trail areas could get very little use. However, some hunters would still harvest these animals off-trail even if they could not use an ORV to retrieve them.

The overall effect would be that under this alternative a hunter would realize some limiting factors on access to subsistence hunting while benefiting from improved trails, a new Bull River Access Trail, and improved access to the Bull River and Upper Cantwell Creek Floodplains.

Competition among NPS qualified subsistence users

As under Alternative 1, Alternative 2 would result in increased competition among NPS qualified subsistence users because more subsistence hunters would be expected to use the TUA than in the past, and because use would be focused on a finite number of NPS-managed trails and routes.

In 2000, about 50% of the nearly 100 households attempted to harvest moose, with about 25% successful. It is likely that Cantwell hunters would continue to try hunting in the TUA first because it is closest to them. This means as many as 50 households could use ORVs to scope for moose throughout the TUA (except recovery areas) before and during hunting season.

These factors would result in increased competition for subsistence resources. Increased competition is likely to continue over the long term because the NPS-managed trails and routes are in the most important subsistence hunting areas and because of management actions to provide for sustainable harvests (subsistence harvest limits). This could result in a return to state lands by a small minority of the hunters. Those hunters who harvest game farther from identified trails and routes would benefit from less competition.

Way of Life

Subsistence use would continue to provide a considerable proportion of the rural diet during the life of this plan because the NPS would manage park uses in order to protect natural and healthy wildlife populations. The opportunity for children to learn from elders to identify resources, methods of harvest, and efficient and non-wasteful processing and preparation of moose would continue as it has in the past. While management for sustainable use would protect these subsistence values, successful moose hunts would require more time and effort because of the restrictions on off-trail use of ORVs. There would be no displacement of less-mobile users

because ORVs would be allowed throughout the TUA. Since ORVs would still be allowed off-trail, less-mobile users would generally not be displaced, though they, like everyone else, may prefer to focus on NPS-managed trails instead of dealing with off-trail restrictions.

Economic Analysis

The economic analysis can be determined based on the effect of each alternative on the total annual number of moose harvested by Cantwell subsistence hunters both inside and outside the TUA. Competition for subsistence moose hunting opportunities on general State lands within GMU 13E is increasing, and Cantwell residents have started shifting their hunting effort towards park lands (park lands in Unit 13E Cantwell area and in Unit 20C Kantishna Hills). Given the continuation of this trend, subsistence hunters could depend on hunting on park lands for more than half of the moose the Cantwell community needs in the future (Callaway 2006). In 1999, 27 moose were harvested by the Cantwell community from State and park lands (ADFG 2002). Using this number as a baseline for how many moose harvests would continue to be needed by the community, then 13-14 of those moose would have to come from park lands in the future.

We assume the TUA can't support a harvest of 13-14 moose/year (see Alternative 1 assumptions), but it can support an average of 5 moose harvested from the TUA (or slightly more up to some harvest limit). For this exercise we assume that the limit would be 5 moose. Therefore, subsistence hunters could have to turn to *other* park lands in 13E and 20C to find the remaining 8-9 moose they need. At most, if those 8-9 moose couldn't be harvested, it would be a loss of 8-9 moose for the community per year. If a dressed moose weighs 1,000 pounds, this is a loss of 8,000-9,000 pounds of moose meat to the community per year. At a market basket estimate of \$8/lb, this would be a shortfall in dollars of nearly \$64,000 to \$72,000 – or a loss of \$640 to \$720 per household (assuming 100 subsistence households in Cantwell residence zone).

Though income levels in Cantwell may fluctuate from year to year, the median family income for Cantwell for 2000 was \$39,792 (U.S. Census 2000). An economic loss of \$640 to \$720 for a family would be a loss of 1.6% – 1.8% of their annual income.

Cumulative Impacts

Cumulative impacts on subsistence use resulting from past, present, and reasonably foreseeable future actions are the same as under Alternative 1. Increases in the Cantwell population and increases in the overall number of hunters would continue to increase competition in the TUA. Because of the impacts to subsistence resources and due to the increased competition for hunting in general, these past, present, and future actions would have a moderate adverse impact on subsistence use in the TUA. The actions in Alternative 2 would counteract these effects to some extent because of extensive ORV access and proactive wildlife management. The cumulative adverse impact of this alternative plus these past, present, and future actions would therefore be minor.

Conclusion

Alternative 2 would result in minor beneficial effects to subsistence resources and opportunities because of extensive ORV access and proactive wildlife management that would provide for sustainable harvest over the next 10-15 years. Enhanced access to subsistence resources and opportunities would result from identifying and maintaining trails and routes for ORV use and the provision for ORV access for moose and caribou retrieval. The monitoring provisions and recommended management actions in the alternative, including subsistence harvest limits for

moose and caribou, would make it possible to have a sustainable harvest level over the long term. The identified ORV trails and routes would be in good moose habitat, so for much of the subsistence hunting season (the last half of August and the month of September) there would be improved opportunities to hunt moose near trails. Counteracting these benefits, however, would be the restrictions on ORV use for retrieval and increased competition among hunters in the TUA, especially in and near the access corridors. On balance the beneficial impacts to subsistence use would be minor over the long term.

The level of impacts to subsistence anticipated from this alternative would not result in a significant restriction to subsistence resources or opportunities.

4.9.5 Impacts to Subsistence Opportunities Under Alternative 3

Alternative 3 would result in minor beneficial impacts to subsistence resources and opportunities because of improved access and proactive wildlife management that would provide for sustainable harvest over the next 10-15 years. Greater access to subsistence resources and opportunities would result from improvements to NPS-managed trails and routes, and new access to the Bull River Floodplain. The monitoring provisions and recommended management actions in the alternative, including subsistence harvest limits for moose and caribou, would make it possible to have a sustainable harvest level over the long term and remove uncertainty for NPS qualified subsistence users. The identified ORV trails and routes would be in good moose habitat, so harvests would be likely to increase. There would also be a winter hunt extending as long as possible, which if established would provide additional subsistence opportunities. Counteracting these benefits, however, would be restrictions on off-trail ORV use and increased competition among hunters in the TUA, especially in and near the access corridors. On balance the beneficial impacts to subsistence use would be minor over the long term.

Subsistence resources

Moose harvests in the TUA would at least continue to average 5 moose harvested/year (based on past 15-year average) or could increase up to set harvest limit levels because of the reasons explained in Section 4.6.5, Impacts to Wildlife from Alternative 3. Due to increased mortality, actions proposed in this alternative would have a moderate adverse impact on wildlife, particularly moose and wolves. Noise from helicopters, airplanes, ORVs, and snowmachines would disturb wildlife. These factors would result in adverse impacts to the availability of subsistence resources (particularly moose and wolves). However, this alternative proposes that the NPS work with the Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to establish subsistence harvest limits for moose to maintain natural and healthy populations on park land within the TUA. This alternative also proposes that the NPS monitor the number of wolf harvests and, if necessary, a limit would be proposed to maintain natural and healthy wolf populations.

Since ORVs would be restricted to NPS-managed trails for scouting game, it is likely that more moose would be harvested closer to trails, assuming moose have come down from the headwaters. Greater numbers of moose harvested near trails could affect local moose populations along the Cantwell Creek, Windy Creek, and Bull River Access Trails and routes, though local populations may be replenished with moose from other places that would move into this available habitat.

Access

There would be no off-trail use of ORVs for subsistence, or any other, purposes within the TUA. Instead, the NPS would work with Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to implement a winter subsistence moose hunt, primarily in the area southwest of Cantwell Creek and into the Bull River area. The following trails would be managed by the NPS for continued ORV use by NPS qualified subsistence users for all subsistence purposes: Windy Creek Access Trail, Windy Creek Bowl Trail, Cantwell Airstrip Trail, Pyramid Peak Trail, and Bull River Access Trail (new construction). The Bull River and Upper Cantwell Creek Floodplains would be managed by the NPS for continued ORV use by NPS qualified subsistence users for all subsistence purposes.

NPS qualified subsistence users would drive ORVs in search of moose and caribou both during the pre-season scoping period and during hunting season. Moose are typically in the headwaters of the draws in August and the early part of September and nearer the lower corridors later in September and October. Alternative 3 would provide access to all of the important lower drainages. The number of moose harvested would continue to depend on where the moose were in any given year.

Construction of the Bull River Access Trail would open more territory (the Bull River Floodplain) to subsistence hunters and the NPS-managed trails would attract more subsistence hunters because they would be in better condition and easier to drive on. While greater use would be expected on NPS-managed trails and routes, off-trail areas would be difficult to access during the fall hunting season due to the restrictions proposed in this alternative (no off-trail use of ORVs for any purpose).

An expanded winter subsistence moose hunt would provide additional opportunities to hunt moose. Snowmachine travel during winter would provide much broader access in less time throughout the TUA than is possible during late summer and fall either by ORV or on foot. In addition, cold weather would make it easier to prevent meat spoilage, snow cover would provide an ideal substrate for clean handling of meat, and snowmobiles and sleds would provide an easier way to transport meat. A winter hunt is an important component of the overall long-term beneficial impacts resulting from the management actions in Alternative 3.

The overall effect would be that under this alternative a hunter would realize some limiting factors (no off-trail use allowed) on access to subsistence hunting while benefiting from improved trails (especially being able to count on NPS-managed trails and routes from one season to the next), a new Bull River Access Trail, improved access to the Bull River and Upper Cantwell Creek Floodplains, and additional access to hunting opportunities in winter.

Competition among NPS qualified subsistence users

Alternative 3 would result in increased competition among NPS qualified subsistence users because more subsistence hunters would be expected to use the TUA than in the past, and because use would tend to be concentrated along the NPS-managed trails and routes. ORV use would also increase because the NPS-managed trails would be maintained/improved in better condition, and the Bull River Access Trail would be constructed, making access of the Bull River Floodplain possible/easier. Construction of the Bull River Access Trail would open more territory to subsistence hunters and the maintained identified trails would attract more subsistence hunters because they would be in better condition and easier to drive on.

In 2000, about 50% of the nearly 100 households attempted to harvest moose, with about 25% successful. It is likely that Cantwell hunters would continue to try hunting in the TUA first because it is closest to them. This means as many as 50 households could use ORVs to scope for moose throughout the TUA (except recovery areas) before and during hunting season.

There would be an immediate increase in competition along NPS-managed trails and routes. This increased competition would likely continue over the long term because NPS-managed trails and routes are in important subsistence hunting areas and because of management actions to provide for sustainable harvests (subsistence harvest limits).

The advantages of hunting by snowmobile (extended season, broader access, easier loading, cleaner conditions, and easier storage of meat) would likely result in greater hunter participation, especially over the long term.

These factors could result in a return to state lands by a small minority of the hunters. However, those hunters who harvest game farther from identified trails and routes and who are willing to use non-motorized means of retrieval would benefit from less competition. Over the long term, there would likely be an increase in subsistence activity off trail as more hunters became willing to use alternative methods of game retrieval, including horsepacking.

Way of Life

Subsistence use would continue to provide a considerable proportion of the rural diet during the life of this plan because subsistence use would be managed in order to protect natural and healthy wildlife populations. The opportunity for children to learn from elders to identify resources, methods of harvest, and efficient and non-wasteful processing and preparation of moose would continue as it has in the past. However, some subsistence values may be slightly affected due to restrictions on off-trail ORV use since this would require a slight change in tradition. While management for sustainable use would protect these subsistence values, successful moose hunts would require more time and effort during the fall hunting season because of the restrictions on off-trail use of ORVs. Hunts may require less time and effort during the winter hunt. Since ORVs would not be allowed off-trail, less-mobile users would have to shoot an animal very close to the NPS-managed trails since they would not be allowed to use an ORV for retrieval. This could take more time and effort and possibly displace some users to other areas. The winter hunt would provide an additional opportunity for mobile and less-mobile users; however, a winter hunt would require a change in traditions.

Economic Analysis

The economic analysis can be determined based on the effect of each alternative on the total annual number of moose harvested by Cantwell subsistence hunters both inside and outside the TUA. Competition for subsistence moose hunting opportunities on general State lands within GMU 13E is increasing, and Cantwell residents have started shifting their hunting effort towards park lands (park lands in Unit 13E Cantwell area and in Unit 20C Kantishna Hills). This trend would continue and subsistence hunters could depend on hunting on park lands for more than half of the moose the Cantwell community needs in the future (Callaway 2006). In 1999, 27 moose were harvested by the Cantwell community from State and park lands (ADFG 2002). Using this number as a baseline for how many moose harvests would continue to be needed by the community, then 13-14 of those moose would have to come from park lands in the future.

We assume the TUA can't support a harvest of 13-14 moose/year (see Alternative 1 assumptions), but it can support an average of 5 moose harvested from the TUA (or slightly more up to some harvest limit). For this exercise we assume the limit would be 5 moose. Therefore, subsistence hunters could have to turn to *other* park lands in 13E and 20C to find the remaining 8-9 moose they need. At most, if those 8-9 moose couldn't be harvested, it would be a loss of 8-9 moose for the community per year. If a dressed moose weighs 1,000 pounds, this is a loss of 8,000-9,000 pounds of moose meat to the community per year. At a market basket estimate of \$8/lb, this would be a shortfall in dollars of nearly \$64,000 to \$72,000 – or a loss of \$640 to \$720 per household (assuming 100 subsistence households in Cantwell residence zone).

Though income levels in Cantwell may fluctuate from year to year, the median family income for Cantwell for 2000 was \$39,792 (U.S. Census 2000). An economic loss of \$640 to \$720 for a family would be a loss of 1.6% – 1.8% of their annual income.

Cumulative Impacts

In addition to the cumulative impacts on subsistence use resulting from past, present, and reasonably foreseeable future actions, the following applies under this alternative:

- ANILCA allows snowmachines for subsistence, for traditional activities, and for travel to and from villages and homesites (ANILCA 811 and 1110). During the 1990s, technological improvements in snowmachines enabled a large but unquantified expansion of snowmachine use in Denali. Accurate estimates of snowmachine users are difficult to make, but during March and April of 1999, the NPS estimated that there were between 1,500 and 2,000 snowmobile users along the Parks Highway, primarily in the region from Cantwell to the West Fork of the Chulitna River and the Tokositna River area (NPS 2000a).

Non-subsistence snowmachine use in the TUA could scare wildlife, creating more of a challenge for NPS qualified subsistence users. Increases in the Cantwell population and increases in the overall number of hunters would continue to increase competition in the TUA. Because of the impacts to subsistence resources and due to the increased competition for hunting in general, these past, present, and future actions would have a moderate adverse impact on subsistence use in the TUA. The actions in Alternative 3 would counteract these effects to some extent because of additional ORV access and proactive wildlife management. The cumulative adverse impact of this alternative plus these past, present, and future actions would therefore be minor.

Conclusion

Alternative 3 would result in minor beneficial impacts to subsistence resources and opportunities because of improved access and proactive wildlife management that would provide for sustainable harvest over the next 10-15 years. Greater access to subsistence resources and opportunities would result from improvements to NPS-managed trails and routes, a new Bull River Access Trail, and improved access to the Bull River and Upper Cantwell Creek Floodplains. The monitoring provisions and recommended management actions in the alternative, including subsistence harvest limits for moose and caribou, would make it possible to have a sustainable harvest level over the long term and remove uncertainty for NPS qualified subsistence users. The identified ORV trails and routes would be in good moose habitat, so harvests would be expected to increase. There would also be a winter hunt extending as long as possible, which if established would provide additional subsistence opportunities. Counteracting these benefits, however, would be restrictions on ORV use and increased competition among hunters in the

TUA, especially in and near the access corridors. On balance the beneficial impacts to subsistence use would be minor over the long term.

The level of impacts to subsistence anticipated from this alternative would not result in a significant restriction to subsistence resources or opportunities.

4.9.6 Impacts to Subsistence Opportunities Under Alternative 4

Alternative 4 would result in minor adverse impacts to subsistence resources and opportunities. Access would be more difficult since ORV use would be allowed only on NPS-managed trails, and only beginning one week before the opening of hunting season. Competition among hunters in the TUA would increase, especially in and near the access corridors. However, a winter hunt would provide additional subsistence opportunities, and NPS qualified subsistence users would have the option of using other hunting and retrieval methods such as travel by horseback or on foot. Monitoring and proactive management, including subsistence harvest limits for moose and caribou, would provide for sustainable harvest over the next 10-15 years.

Subsistence resources

Moose harvests in the TUA would remain close to the current average of 5 moose harvested/year (based on past 15-year average). Wolves would be negatively impacted with the addition of a winter hunt. Noise from administrative use of helicopters, airplanes, ORVs, and snowmachines would disturb wildlife. These factors would result in some adverse impacts to the availability of subsistence resources (particularly moose and wolves). However, this alternative proposes that the NPS work with the Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to establish subsistence harvest limits for moose to maintain natural and healthy populations on park land within the TUA. This alternative also proposes that the NPS monitor the number of wolf harvests and, if necessary, a limit would be proposed to maintain natural and healthy wolf populations.

Since ORVs would be restricted to NPS-managed trails for scouting game, it is likely that more moose would be harvested closer to trails, assuming moose have come down from the headwaters. Greater numbers of moose harvested near trails could affect local moose populations along the Cantwell Creek and Windy Creek, though local populations may be replenished with moose from other places that would move into this available habitat.

Access

There would be no off-trail use of ORVs for subsistence, or any other, purposes within the TUA. The following trails would be managed by the NPS for continued ORV use by NPS qualified subsistence users for all subsistence purposes *only* from one week before the beginning of the fall moose and caribou hunting seasons through to the end of these hunting seasons: Windy Creek Access Trail, Windy Creek Bowl Trail, Cantwell Airstrip Trail, and Pyramid Peak Trail. NPS-managed trails would be maintained and would attract more subsistence hunters because they would be in better condition and easier to drive on. However, it would be difficult for NPS qualified subsistence users to access the Bull River and Upper Cantwell Creek Floodplains during fall hunting season. Alternative 4 would provide access to some, but not all, of the important lower drainages.

The NPS would work with Federal Subsistence Board, the Denali Subsistence Resource Commission, and the Regional Advisory Council to implement a winter subsistence moose hunt,

primarily in the area southwest of Cantwell Creek and into the Bull River area. An expanded winter subsistence moose hunt would provide additional opportunities to hunt moose. Snowmachine travel during winter would provide much broader access in less time throughout the TUA than is possible during late summer and fall either by ORV or on foot. In addition, cold weather would make it easier to prevent meat spoilage, snow cover would provide an ideal substrate for clean handling of meat, and snowmobiles and sleds would provide an easier way to transport meat.

The overall effect would be that under this alternative a hunter would realize a number of limiting factors on access to subsistence hunting while benefiting from improved trails (especially being able to count on NPS-managed trails and routes from one season to the next), and additional access to hunting opportunities in winter.

Competition among NPS qualified subsistence users

Alternative 4 would result in increased competition among NPS qualified subsistence users along NPS-managed trails and routes because use would increase and tend to be concentrated in these locations. This increased competition would likely continue over the long term because NPS-managed trails and routes are in important subsistence hunting areas and because of management actions to provide for sustainable harvests (subsistence harvest limits).

In 2000, about 50% of the nearly 100 households attempted to harvest moose, with about 25% successful. It is likely that Cantwell hunters would continue to try hunting in the TUA first because it is closest to them. This means as many as 50 households could use ORVs to scope for moose throughout the TUA (except recovery areas) before and during hunting season.

The advantages of hunting by snowmobile (extended season, broader access, easier loading, cleaner conditions, and easier storage of meat) would likely result in greater hunter participation, especially over the long term.

These factors could result in a return to state lands by a small minority of the hunters. However, those hunters who harvest game farther from identified trails and routes and who are willing to use non-motorized means of retrieval would benefit from less competition. Over the long term, there would likely be an increase in subsistence activity off trail as more hunters became willing to use alternative methods of game retrieval, including horsepacking.

Way of Life

Subsistence use would continue to provide a considerable proportion of the rural diet during the life of this plan because subsistence use would be managed in order to protect natural and healthy wildlife populations. The opportunity for children to learn from elders to identify resources, methods of harvest, and efficient and non-wasteful processing and preparation of moose would be somewhat threatened because subsistence users' traditions would have to change. For example, more people may have to rely on a winter hunt, which while it could be a good opportunity to hunt, share, and learn new skills, it breaks away from the traditional fall hunt. Another break in tradition would be that ORVs would be restricted to NPS-managed trails and ORVs would be allowed only one week prior to hunting season. This would be a change for many hunters.

While management for sustainable use would protect subsistence resources, successful moose hunts would require more time and effort during the fall hunting season because of the restrictions on use of ORVs. Hunts may require less time and effort during the winter hunt. Since

ORVs would not be allowed off-trail, less-mobile users would have to shoot an animal very close to the NPS-managed trails since they would not be allowed to use an ORV for retrieval. This could take more time and effort and possibly displace some users to other areas. The winter hunt would provide an additional opportunity for mobile and less-mobile users; however, a winter hunt would require a change in traditions.

Economic Analysis

The economic analysis can be determined based on the effect of each alternative on the total annual number of moose harvested by Cantwell subsistence hunters both inside and outside the TUA. Competition for subsistence moose hunting opportunities on general State lands within GMU 13E is increasing, and Cantwell residents have started shifting their hunting effort towards park lands (park lands in Unit 13E Cantwell area and in Unit 20C Kantishna Hills). This trend would continue and subsistence hunters could depend on hunting on park lands for more than half of the moose the Cantwell community needs in the future (Callaway 2006). In 1999, 27 moose were harvested by the Cantwell community from State and park lands (ADFG 2002). Using this number as a baseline for how many moose harvests would continue to be needed by the community, then 13-14 of those moose would have to come from park lands in the future.

We assume the TUA can't support a harvest of 13-14 moose/year (see Alternative 1 assumptions), but it can support an average of 5 moose harvested from the TUA (or slightly more up to some harvest limit). For this exercise we assume the the limit would be 5 moose. Therefore, subsistence hunters could have to turn to *other* park lands in 13E and 20C to find the remaining 8-9 moose they need. At most, if those 8-9 moose couldn't be harvested, it would be a loss of 8-9 moose for the community per year. If a dressed moose weighs 1,000 pounds, this is a loss of 8,000-9,000 pounds of moose meat to the community per year. At a market basket estimate of \$8/lb, this would be a shortfall in dollars of nearly \$64,000 to \$72,000 – or a loss of \$640 to \$720 per household (assuming 100 subsistence households in Cantwell residence zone).

Though income levels in Cantwell may fluctuate from year to year, the median family income for Cantwell for 2000 was \$39,792 (U.S. Census 2000). An economic loss of \$640 to \$720 for a family would be a loss of 1.6% – 1.8% of their annual income.

Cumulative Impacts

The cumulative impacts on subsistence use resulting from past, present, and reasonably foreseeable future actions would be the same as for alternative 3. Non-subsistence snowmachine use in the TUA could scare wildlife, creating more of a challenge for NPS qualified subsistence users. Increases in the Cantwell population and increases in the overall number of hunters would continue to increase competition in the TUA. Because of the impacts to subsistence resources and due to the increased competition for hunting in general, these past, present, and future actions would have a moderate adverse impact on subsistence use in the TUA. The actions in Alternative 4 would contribute minor adverse impacts. The cumulative adverse impact of this alternative plus these past, present, and future actions would therefore be moderate.

Conclusion

Alternative 4 would result in minor adverse impacts to subsistence resources and opportunities. Access would be more difficult since ORV use would be allowed only on NPS-managed trails, and only beginning one week before the opening of hunting season. Competition among hunters in the TUA would increase, especially in and near the access corridors. However, a winter hunt

would provide additional subsistence opportunities, and NPS qualified subsistence users would have the option of using other hunting and retrieval methods such as travel by horseback or on foot. Monitoring and proactive management, including subsistence harvest limits for moose and caribou, would provide for sustainable harvest over the next 10-15 years.

The level of impacts to subsistence anticipated from this alternative would not result in a significant restriction to subsistence resources or opportunities.