CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

Methodology

This chapter analyzes the potential environmental consequences, or impacts, that would occur as a result of implementing the proposed project. Direct, indirect, and cumulative effects, as well as impairment are analyzed for each resource topic carried forward. Potential impacts are described in terms of type, context, duration, and intensity. General definitions are defined as follows, while more specific impact thresholds are given for each resource at the beginning of each resource section.

- **Type** describes the classification of the impact as either beneficial or adverse, direct or indirect:
  - *Beneficial*: A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.
  - *Adverse*: A change that moves the resource away from a desired condition or detracts from its appearance or condition.
  - *Direct*: An effect that is caused by an action and occurs in the same time and place.
  - *Indirect*: An effect that is caused by an action but is later in time or farther removed in distance, but is still reasonably foreseeable.
- **Context** describes the area or location in which the impact will occur. Are the effects site-specific, local, regional, or even broader?
- **Duration** describes the length of time an effect will occur, either short-term or long-term:
  - *Short-term* impacts range from days to three years in duration.
  - *Long-term* impacts extend up to 20 years or longer.
- **Intensity** describes the degree, level, or strength of an impact. For this analysis, intensity has been categorized into negligible, minor, moderate, and major. Because definitions of intensity vary by resource topic, intensity definitions are provided separately for each impact topic analyzed in this environmental assessment.

Cumulative Impact Scenario

The Council on Environmental Quality (CEQ) regulations, which implement the National Environmental Policy Act of 1969 (42 USC 4321 et seq.), require assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts are considered for both the no-action and preferred alternatives.

Cumulative impacts were determined by combining the impacts of the preferred alternative with other past, present, and reasonably foreseeable future actions. In addition to previous winter use analysis and NEPA processes, implementation of either of the alternatives in this EA may influence or be influenced by other planning efforts. No known or potential conflicts between

the proposed action and other plans, policies or controls have been identified. Following are relevant, recent, and ongoing planning efforts.

Broad trends occurring outside the parks which could have cumulative impacts on this analysis include:

- Population growth in the Greater Yellowstone area (GYA). This area has been experiencing rapid population growth for the last twenty years. Such growth can lead to more demand for recreation (especially snowmobiling, cross-country skiing, and snowshoeing), more recreationists in wildlife habitat, and more resulting impacts upon air quality, soundscapes, economics, and wildlife.
- Suburban & rural land subdivision in the Greater Yellowstone area. The area's population growth is accompanied by rapid suburban and exurban subdivision and human structure development (houses, roads, etc.). While this is related to population growth, rural land subdivision can lead to fragmentation of wildlife habitat and changing recreation geography.
- Changing demographics. Americans, and particularly westerners, have expressed an increasing interest in recreation in the last twenty years (all kinds of recreation, but especially bird watching, hiking, and walking (Cordell 2004)). Such changing demographics can affect the demand for different kinds of recreational activities, at times bringing them into conflict with each other.
- Reduction of public land access. Some trailheads or public land access points are privately owned and can become off-limits to the public when sold. While impossible to predict, such occurrences make access to public lands more difficult and can affect demand for recreation in other areas and visitor access and circulation.
- Improving snowmobile technologies. Snowmobile manufacturers have consistently improved the performance of their machines, enabling some of them to reach ever more remote terrain. Usually off-trail, such kind of travel is prohibited in Yellowstone, but can bring snowmobilers elsewhere into conflict with wildlife and non-motorized users.
- Increasing outfitter/guide activity. Visitors are increasingly utilizing outfitters and guides, especially for skilled or knowledge-based activities like kayaking, wildlife viewing, and photography. This trend can affect wildlife habitat, demand for recreation, economic activity, and other aspects of winter recreation.
- Consolidation of checkerboard lands on the Gallatin National Forest. In the last ten years, the Gallatin National Forest has negotiated several land exchanges which have consolidated some previously checkerboarded holdings. While this has generally positive effects for most wildlife (because consolidated lands are less subject to development), it has the negative side effect of private land consolidation (especially in the Big Sky area), which has allowed more land subdivision and rural growth to occur there, with consequent effects on wildlife, air quality, socioeconomics, and visitor access and circulation.
- Forest plan amendments for grizzly bear conservation. The U.S. Forest Service has modified all forest plans in grizzly bear habitat areas to assure conservation of the species after it was removed from the threatened and endangered species list of the Endangered Species Act ("delisted"). Generally, such changes will keep ORV access at or below current levels, making it more difficult for the agency to respond to increasing demand for recreation by building new sites or opening new areas, but assuring grizzly bear preservation.

- Northern Rockies lynx amendment to all USFS Forest Plans. These amendments are intended to conserve this species, listed as threatened on the endangered species list. As with the grizzly bear amendments, these changes would keep recreation at or near current levels in occupied lynx habitats to ensure species survival.
- Noxious weed growth. Noxious weeds are a problem throughout the Greater Yellowstone area, although most counties, states, and federal agencies have programs to keep them in check, with varying levels of success. Noxious weeds can impact forage available to big game.
- Whitebark pine reduction. In many years whitebark pine nuts are the most important food source for grizzly bears, but the tree is increasingly vulnerable to death by insect attack and white pine blister rust. Reduction of this species could harm the grizzly bear's long-term survival.
- Timber harvest on national forest lands. Timber harvest on such lands is an ongoing activity in places, although more and more of it entails fuels reduction efforts with only small-diameter timber being taken. Harvesting can affect wildlife species in various ways (depending on their habitat preferences), along with possible economic effects.
- Grazing and mining on federal lands. Grazing will continue to be similar in extent to current levels on USFS and BLM lands. Mining is more difficult to predict, but will have to undergo NEPA review. Both actions can affect wildlife species and economics.
- Forest and range fires. Both kinds of fires occur regularly on federal lands in the Greater Yellowstone area and can affect wildlife (to differing degrees, depending on wildlife habitat preferences) and air quality.
- Hunting. Big-game hunting occurs throughout the area surrounding the parks, and is likely to continue. While it affects wildlife, the states manage their hunts in such a way as to sustain wildlife populations. Hunting also affects socioeconomics.
- Oil and gas leasing. Parts of Wyoming and Montana are experiencing record amounts of oil and gas leasing. These can affect regional and local air quality and socioeconomics.
- Motorized visitor use on forest and private lands outside the parks. Such use could affect soundscapes within the parks.
- Urban, industrial, and recreational uses. While such uses are more scattered in the Greater Yellowstone area than elsewhere in the U.S., they do exist and generate air quality impacts.

Proposed or recent actions from national parks include the following:

- Administrative Travel in Yellowstone and Grand Teton. NPS and concessions staff must utilize snowcoaches and snowmobiles as part of their regular duties and to obtain necessary supplies (groceries, medicine, etc.). Such travel is not included in the impact determinations for each subject area because this EA covers only visitor travel. Administrative travel can affect wildlife, soundscapes, air quality, and health and safety.
- Construction of Old Faithful Visitor Education Center. Yellowstone is constructing a new visitor center at Old Faithful, on the site of the previous facility, now demolished. This facility could affect socioeconomics, visitor access, and visitor experience.

- Construction of new West Entrance. Yellowstone recently completed a new West Entrance immediately east of the existing facility. This facility could affect socioeconomics, employee and visitor health and safety, and visitor circulation.
- Interagency Bison Management Plan. Completed in 2000, this plan provides management guidance for bison that leave Yellowstone in the winter. This plan affects bison, mainly when they leave Yellowstone.
- Remote vaccine delivery EIS for bison. In progress, this EIS will focus on delivering brucellosis vaccine(s) to bison remotely, and will affect bison management.
- Reconstruction of East Entrance Road (ongoing), Gibbon Canyon (proposed), Dunraven Pass (first half completed, second half proposed), Canyon rim drives (underway), and Mammoth-Norris road (proposed). These Yellowstone road projects are or will upgrade these road segments to modern standards. They may affect socioeconomics, visitor access and circulation, and wildlife.
- Construction of the Craig Thomas Discovery and Visitor Center, Moose, Wyoming. Grand Teton National Park opened the new visitor at Moose to public use in August 2007. This facility could affect socioeconomics and visitor circulation.
- Grand Teton National Park Transportation Plan. The park has begun implementation of portions of the transportation plan, including development of a 43-mile system of multi-use pathways. Several miles of the pathway system were constructed in 2008. Implementation of elements of the plan could affect socioeconomics, wildlife, and visitor access and circulation.
- Laurance S. Rockefeller Preserve. The 1,106-acre property formerly known as the JY Ranch, became part of Grand Teton National Park in November 2007, and a new visitor center opened in June 2008. Visitor use of the Preserve could affect visitor access and circulation, wildlife, and socioeconomics.
- Changing winter use plans in the parks and changing restrictions on winter visitor use between 2000 and 2007. These affected visitor access, visitor experience, socioeconomics, soundscapes, air quality, wildlife, and safety.
- Elk and Bison Management Plan for Grand Teton. This plan guides the management of these two species in Grand Teton National Park. In addition to its affects on these two species, it could affect socioeconomics.

Proposed or recent actions from surrounding lands include the following:

- Shoshone National Forest plan revision. The USFS is in the process of revising this forest's master plan. It could affect a number of aspects of this EIS's analysis.
- At least two businesses with a substantial number of employees have moved their operations out of Cody in the last decade, including Marathon Oil and part of the mail order operation for Sierra Trading Post. These changes affect the town and county's socioeconomics.
- North Fork (Shoshone River) fuel reduction. Through mechanical means and prescribed fires, this project is attempting to reduce hazardous fuels along the North Fork Shoshone River. It could affect wildlife and air quality.
- Bridger-Teton National Forest plan revision. The USFS is in the process of revising this forest's master plan. It could affect all aspects of this EIS's analysis.

- Construction of a natural gas pipeline through Hoback Canyon to serve Jackson. This pipeline will improve natural gas delivery to the Jackson area. It could affect socioeconomics, wildlife, and air quality.
- Reconstruction of Togwotee Pass Highway. The State of Wyoming is rebuilding U.S. 287 over Togwotee Pass. This project could affect wildlife, socioeconomics, and visitor access and circulation.
- Replacement of tram at Jackson Hole Ski Resort. This well-known ski resort recently replaced the tram to the summit of Rendezvous Mountain. This project could affect socioeconomics and visitor access to the backcountry of Grand Teton.
- Teton Pathways Master Plan. Teton County approved this master plan for non-motorized recreational pathways in 2007, with implementation to occur through 2013. This plan could affect air quality, wildlife, socioeconomics, and visitor access and circulation.
- Beaverhead-Deerlodge National Forest travel plan revision. The USFS is in the process of revising this forest's master plan. It could affect a number of aspects of this EIS's analysis.
- Gallatin Travel Plan revision. The USFS recently completed the travel plan for this national forest. It could affect socioeconomics, wildlife, air quality, soundscapes, and visitor access and circulation.
- Proposed reopening of the Sleeping Giant Ski Area near Yellowstone's East Entrance. This project could affect recreation opportunities and socioeconomics.
- Reclamation of historic mines above Cooke City. This ongoing project will reclaim 10-20 mines in the New World Mining district. It could affect wildlife (mainly grizzly bears) and winter recreation (the area is popular with snowmobilers and cross-country skiers).
- Gardiner Basin and Cutler Meadows restoration. The USFS and NPS are implementing long-term projects to restore native plants to these areas. These projects could affect wildlife.
- Rendezvous Ski Trail development plan. The USFS and Rendezvous trail managers are revising their trail plan, which would develop, improve, abandon, and/or maintain the cross-country ski trails there. This could affect socioeconomics and visitor access and circulation.
- Beartooth District of Custer NF travel management plan. The USFS is revising the travel plan for this national forest district. It could affect socioeconomics, wildlife, air quality, and visitor access and circulation.

Unacceptable Impacts

As described in *Purpose and Need*, the NPS must prevent any activities that would impair park resources and values. The impact threshold at which impairment occurs is not always readily apparent. Therefore, the Service will apply a standard that offers greater assurance that impairment will not occur. The Service will do this by avoiding impacts that it determines to be unacceptable. These are impacts that fall short of impairment, but are still not acceptable within a particular park's environment. Park managers must not allow uses that would cause unacceptable impacts; they must evaluate existing or proposed uses and determine whether the associated impacts on park resources and values are acceptable.

Virtually every form of human activity that takes place within a park has some degree of effect on park resources or values, but that does not mean the impact is unacceptable or that a particular use must be disallowed. To determine if unacceptable impact could occur to the resources and values of the parks, the impacts of proposed actions in this environmental assessment were evaluated based on monitoring information, published research, and professional expertise, and compared to the guidance on unacceptable impacts provided in *Management Policies* 1.4.7.1, provided in Appendix A. A determination on unacceptable impacts is made at the end of this chapter.

By preventing unacceptable impacts, park managers also ensure that the proposed use of park resources will not conflict with the conservation of those resources. In this manner, the park managers ensure compliance with the Organic Act's separate mandate to conserve park resources and values.

Effects on Wildlife

Methodology

The area of analysis for wildlife is the three park units. Because there is considerably less OSV travel in Grand Teton and the Parkway and because the species analyzed in this document occur more frequently on the OSV routes in Yellowstone, the analysis primarily focuses on wildlife in Yellowstone. The impacts upon wildlife in Grand Teton and the Parkway would be expected to be similar to, but of a lower intensity than, the impacts upon wildlife in Yellowstone.

The assessment of effects upon wildlife was based primarily upon the following sources:

- Monitoring information from the past five winters.
- Scientific literature on species' life histories, distributions, habitat selection, and responses to human activities. Some of this literature was based on Yellowstone's monitoring data; the remainder is generic to the species found in Yellowstone.
- Site-specific information on wildlife species in the parks, including unpublished information and the professional judgment of biologists familiar with the management concerns related to individual species.

There will always be uncertainty regarding the effects of winter recreation on wildlife in the parks because of the complex interactions of the disparate variables involved. Managers will inevitably need to act without the luxury of complete knowledge, using the best available information to evaluate the range of possible effects. They will also need to weigh the potential benefits and costs of alternate management actions against the risks of inaction. Following is an explanation of some of these uncertainties, associated assumptions used in the subsequent analysis, and the reasons that park managers are able to make informed decisions regarding winter recreation management.

Random weather events (e.g., severe snows, cold temperatures, etc.) during winter in mid- to high-elevation mountain environments interact with animal density to strongly influence population dynamics and how individual animals move and distribute themselves across the landscape. Although the wildlife monitoring of the past several winters in the parks has provided some information on such population dynamics, most of that data have been gathered over a series of relatively mild to moderate winters, with the exception of the winter of 2007-2008. If last winter is an indication, wildlife responses in such winters are more muted than in more moderate winters. Specifically, most animals responded to human recreation either with no

response or a look and resume response; they used more intense responses such as travel, alarm or flight less often (McClure and Davis 2008).

Still, it is difficult to discern whether the reduction in responses was indeed attributable to the severe weather that winter. Visitation remained low relative to the 1990s and early 2000s and was completely guided. The lower responses could be a reflection of wildlife becoming accustomed to the predictability of guided winter recreation [wildlife responses in the winter of 2006-07 were also subdued in intensity, even though it was a more moderate winter (Davis 2007)] or they could reflect better guide enforcement of proper human behaviors. Still other factors could account for the seeming reduction in wildlife response rates, reflecting the complex ecology and behavioral flexibility of Yellowstone's wildlife, as well as the numerous, non-linear interactions between wildlife responses, winter recreation, and other stressors (e.g., snow pack). For this analysis, because severe winters are known to increase energetic costs and chronic under-nutrition in most wildlife species, the NPS assumed that effects of OSVs and associated human activities would be exacerbated during such winters.

Oversnow vehicle activities may cause a wide range of responses from wildlife with effects at differing scales. For example, collisions between OSVs and wildlife can cause direct mortality, while single or repeated interactions between OSVs and wildlife can lead to energy expenditures from flight reactions. Animals can be displaced from important habitats by human activity (Gill et al. 1996), or they can experience less obvious effects like elevated heart rate and metabolism which, in turn, can result in high energy expenditures (Canfield et al. 1999), elevated production of stress hormones (i.e., glucocorticoids), increased susceptibility to predation, decreased reproduction, and diminished nutritional condition (Geist 1978; Aune 1981; Moen et al. 1982; Cassirer et al. 1992; Picton 1999; Hardy et al. 2001; Creel et al. 2002). Thus, this analysis assumes that higher oversnow vehicle traffic would result in more frequent responses by, or stress to, wintering wildlife (Hardy 2001; Creel et al. 2002; Borkowski et al. 2006; White et al. 2006).

This analysis assumes that the likelihood of wildlife species actively responding to snowmobiles or snowcoaches increases with vehicle group size. The estimated odds, based on wildlife monitoring from 2003 to 2006, of observing a movement response compared to no response by bison, swans, and bald eagles were 1.1 (threshold value[1] of 8 snowmobiles), 1.1, and 1.3 (threshold value of 18) times greater, respectively, for each additional snowmobile (White et al. 2006).

Similarly, although existing data does not allow precise quantification or direct comparison of the relative effects to wildlife of actions that increase levels of snowcoach use while decreasing snowmobile use, some comparisons are possible. This analysis assumes that the likelihood of some species actively responding to oversnow vehicles is higher for snowcoaches than for snowmobiles. Snowcoaches present a larger visual profile than snowmobiles, which could elicit greater responses (see especially McClure and Davis 2008). Based on monitoring information from 2003 to 2006, the estimated odds of observing a movement response compared to no response by bison, elk, swans, and bald eagles were 1.5 (threshold value of 3), 1.8, 1.7, and 4.2 times greater, respectively, for each additional coach (White et al. 2006).

Since 2004, the NPS has had a mandatory guide requirement in Yellowstone whereby all visitors to the park must either snowmobile with a commercial guide or tour in a snowcoach, driven by a trained commercial driver. Guided groups are much more likely to pass bison and other animals

[1] Threshold values are the number of coaches or snowmobiles beyond which the animal no longer increasingly responds. In this instance, once eight snowmobiles have been reached, there is no longer an increasing movement response; the animals have reacted as much as they will.

that are on or near park roadways with a minimum of wildlife reaction or harassment. Similarly, guides have the responsibility to enforce proper wildlife viewing behavior, such as limiting interaction times and the distances at which their clients approach wildlife. Guides also enforce proper food storage, preventing their clients from inadvertently allowing wildlife to obtain their food (Taber 2006). Given these behaviors, the NPS assumed in the following analysis that mandatory use of commercial snowmobile guides and snowcoach drivers would reduce adverse wildlife reactions and opportunities for wildlife to obtain human foods.

Despite these assumptions, some uncertainties remain and thereby limit managers' abilities to fully predict the effects of the alternatives. For example, the effects of the alternatives upon habituation of most wildlife are difficult to predict because research findings regarding habituation differ. Additionally, animals that are in poor condition (sick, low energy reserves, etc.) might be less likely or less able to respond visibly to human presence (again, this could account for the lower responses last winter). Animals in these situations could appear to display habituated tolerance levels even if they are disturbed by the activity. Responses can also be also species-specific.

However, enough research and monitoring-based information exists to enable park managers to make reasoned decisions regarding winter recreation management. In general, the results of monitoring data collected over the past five winters of wildlife monitoring indicate that bison, coyotes, eagles, elk, and trumpeter swans in Yellowstone National Park exhibit some individual behavioral responses to oversnow vehicles in association with human activities (White et al. 2005; Borkowski et al. 2006). However, as several wildlife researchers have found, the majority of behavioral responses are low in intensity and do not appear to be adversely affecting the population dynamics or demography of these species (Hardy 2001; White et al. 2006, Borkowski et al. 2006). As discussed in more detail in the relevant sections below, estimates of bison, elk, and bald eagle abundance have increased despite large variations in annual OSV numbers and ongoing levels of minor disturbance to individual animals. Trumpeter swans may be declining in number, but that decline is probably due to other causes, not winter recreation. Grizzly bears are doing so well that they have been removed from the endangered species list. Wolves were doing well enough to be delisted, but have since been placed back on the endangered list for reasons unrelated to winter use in the parks. Research is ongoing regarding the status of wolverines. Coyotes and ravens are abundant throughout the parks and in no danger of population reduction. Finally, the only action alternative analyzed in this document requires all visitors to travel in the company of commercial guides or snowcoach operators, a provision with the potential to continue the reduction in impacts upon wildlife populations seen in the last five years.

Regarding coyotes and ravens in particular, the concern regarding winter recreation is not that they will be displaced, but rather that they will become habituated to human use and will seek out human foods. Both species are widespread throughout Yellowstone and the American West, and neither is in any danger of population-level impacts in Yellowstone. Consequently, the discussion of impacts upon these two species is confined to a section under behavioral responses for Alternative 2.

Impacts of actions proposed in the two alternatives were analyzed on the basis of five major concerns, with the general effects of each summarized below.

- Vehicle-caused mortality to individual animals
- Displacement impacts

- Behavioral responses of wildlife groups to OSVs and associated human activities
- Physiological responses of wildlife groups to OSVs and associated human activities
- Demographic effects at the population level

Impact Threshold Definitions

Although the focus of the impact definitions and associated analysis is predominantly the impact on wildlife populations, the NPS seeks to minimize adverse impacts to individual animals. As discussed extensively in *Affected Environment*, the NPS adheres to the North American Wildlife Conservation Model, which focuses on the health and management of wildlife *populations*. Overall, NPS's goal is to minimize human impacts (including on wildlife individuals) and avoid significant effects from disturbance to abundances, diversities, dynamics, distributions, habitats, and behaviors of wildlife populations and the communities and ecosystems in which they occur, pursuant to 36 CFR § 2.18 and *Management Policies* 4.4.1.

Negligible: An action that may affect a population or individuals of a species, but the effect would be so small that it would not be of any measurable or perceptible consequence to the population.

Minor: An action that may affect a population or individuals of a species, but any measurable effect would be a small and localized consequence to the population.

Moderate: An action that will affect a population or individuals of a species; measurable effects will have a considerable, but localized, consequence to the population.

Major: An action that will noticeably affect a population or individuals of a species; the effect will be measurable and have a substantial and possibly permanent consequence to the population.

Effects of Alternative 1

This alternative would prohibit all visitor use and would consequently have negligible impacts upon wildlife populations or individuals. With no visitor OSV travel occurring, no vehicle-caused mortality would result, wildlife would not be displaced, wildlife would suffer no behavioral or physiological effects, and there would be no demographic effects at the population level. Mitigations would be unnecessary, because visitors would be causing no effects upon wildlife. For cumulative impacts, see the cumulative impacts discussion under Alternative 2 for a listing of potential actions that could affect wildlife, even under this alternative (including administrative travel). Without any visitor effects on the wildlife in the park, though, cumulative impacts would be minimal under this alternative.

In summary, Alternative 1 would result in negligible impacts on wildlife populations or individuals in the parks. Because there would be negligible effects upon wildlife, this alternative would not result in either unacceptable conditions or impairment of wildlife resources.

Effects of Alternative 2

Under this alternative, up to 318 snowmobiles and 78 snowcoaches per day would be allowed into Yellowstone, with another 50 snowmobiles in Grand Teton and the Parkway. Assuming Yellowstone's season would be 90 days long and these limits would be filled to capacity every

day of the winter season, a total of 35,640 vehicles would travel Yellowstone's roads. That number is well below the 50,000 cap recommended by NPS biologists (White et al. 2006).

Note that in the original paper, White et al. recommended that park managers "continue to conduct winter recreational activities in a predictable manner with OSV [over-snow vehicle] traffic levels at or below those observed during the last 3 years of our study (i.e., <50,000 over-snow visitors)." White et al. erred in stating winter use should be limited to 50,000 over-snow *visitors*. Rather, they intended that the phrase read "<50,000 over-snow vehicles" (White 2008). This change is significant, for it allows substantially more visitors to enter the parks; previously, not even the snowcoach-only alternative from the 2007 FEIS would have accommodated fewer than 50,000 visitors.

The following analysis assumes full entrance station utilization per day, using monitoring information from the last several winters as the primary basis of analysis.

Vehicle-caused Mortality (All Animals of Concern)

Based on monitoring data from the last five years, no bison, elk, wolves, bald eagles, swans, lynx, wolverines, or coyotes have been killed by visitor oversnow vehicles. This data suggests that requiring all visitors to tour Yellowstone with either a commercial snowmobile guide or professional snowcoach driver greatly minimizes the possibility of wildlife mortality due to collisions with oversnow vehicles.

Looking further back in Yellowstone's winter use history, the annual number of ungulate deaths caused by snowmobiles from 1989-1999 was estimated as <1% of each species' total abundance in Yellowstone. The possibility of individual bison and elk being killed by OSVs exists, but no population-level impacts to bison and elk have been detected during periods of higher OSV levels. With wolves, out of well over a hundred documented wolf deaths between 1995 and the present, none were from oversnow vehicles, and the total amount of roadkilled wolves (i.e. wolves killed by wheeled vehicles) represented less than 1% of the estimated Yellowstone wolf population. For lynx and wolverines, the low numbers, wide distribution, and secretive nature of the two animals are expected to result in a continuing extremely low incidence of vehicle-caused mortality (the majority of the lynx confirmed by Murphy et al. (2006) were located within 12 km of Yellowstone's East Entrance Road, and preliminary information suggests the same to be true for wolverines, but oversnow vehicles permitted to enter the East Entrance under this alternative would be very low, at 20 or fewer snowmobiles and 2 snowcoaches per day). Finally, there are no records of any vehicle-killed bald eagles or swans from 1989 to 2006. There is documentation of other road-killed birds in Yellowstone, including ravens, typically during the spring and summer months, but these do not include eagles or swans and the small numbers of such road kills are not considered threatening to the species involved.

Despite the small number of road-killed ungulates compared to the size of their populations, the NPS is concerned about these losses and seeks to minimize collisions caused by motorized vehicles of all kinds. The provisions for 100% guided snowmobile travel and snowcoach travel substantially accomplish this objective, because guides are trained in where wildlife tend to occur and are responsible for adhering to safe travel speeds (themselves and their groups).

Based on the monitoring data, mandatory commercial guiding and/or snowcoach touring appears to minimize wildlife mortality. The NPS assumes that increasing OSV traffic through the winter ranges of wildlife relative to current conditions during winter would likely increase the frequency of road-killed wildlife. Because this alternative would maintain snowmobile visitor use at or about existing levels and would require all visitors to utilize commercial guides or

snowcoaches, there would be little, if any increase in ungulate mortality. Consequently, vehicle collision impacts to all wildlife species under this alternative are predicted to be negligible, adverse, short-term, and direct.

Displacement of Animals

Bison, Elk, Eagles, and Swans

As discussed in *Affected Environment*, bison, elk, eagle, and swan displacement seems to be localized, short-term, and existing only for individuals, not the population of the species in question. All four species continue to occupy the same historical winter range in the Madison and Firehole drainages of Yellowstone while exposed to the highest contemporary levels of OSV traffic in the park, minor amounts of short-term displacement, and some visitor use levels higher than those contemplated in this alternative. Regarding swans and eagles in particular, their historical nesting patterns in Yellowstone indicate that they are not likely to experience substantial displacement from OSV traffic or winter recreation. Largely because the winter OSV season lasts less than 90 days, current levels of OSV use are likely to cause only short-term, individual, and localized displacement, but not long-term displacement for individuals or the population. Because this alternative would continue winter use at those same levels (but with a possibility of increased snowcoach use), displacement impacts to these animals under this alternative are predicted to be minor, adverse, short-term, and direct.

As discussed in *Affected Environment* for bison in particular, the NPS is examining the relationship between groomed roads and bison further, based upon the research proposal from Garrott and White (2007), the Gates report, and the bison workshop that occurred in January 2006. These research findings will not be available until after the conclusion of this temporary plan. For the duration of this plan, the NPS will be proceeding with the understanding that bison have not been displaced from important winter range due to oversnow vehicle road grooming.

Wolves, lynx, and wolverines

For wolves, lynx, and wolverines, the discussion of displacement is combined with the discussions for behavioral and physiological response. As discussed in *Affected Environment*, the low incidence of wolves encountered during surveys over four years suggests that wolf interactions with OSVs are rare. The presence of wolves along the busiest OSV route in Yellowstone (West Yellowstone to Old Faithful) and the low number of interactions with OSVs suggest that wolves avoid human activity generally, hence OSVs, in the daytime. Overall displacement events of wolves by OSVs appear to be short in duration, in part because wolves are sometimes active in proximity to roads and developed areas at night. This minimizes the possibility of direct behavioral and physiological impacts to wolves from OSV use. Although displacement of wolves is low overall, this analysis assumes, based on monitoring data from the last five years, that current levels of winter use result in minimal amounts of displacement to wolves and that increased levels of OSV use, and associated human activity, would increase disturbance to, and responses by, wolves.

Generally, according to the best available information, lynx and wolverines appear unlikely to be adversely impacted by expected levels of OSV traffic in the parks. More specifically, the daily level of OSV use on the East Entrance Road is small and likely represents little direct impact to wolverine and lynx. Operations necessary to maintain the road include avalanche control and road grooming. The impacts of avalanche control in the parks on lynx and wolverine are not known, but there have been no direct impacts from these activities recorded upon lynx and

wolverines in the parks, probably resulting from the low density of both species. For these reasons, this analysis assumes that lynx and wolverines would probably not be affected by the levels of OSV traffic proposed in the parks under this alternative.

Based on this monitoring data, the associated assumptions and literature, displacement and behavioral and physiological impacts to wolves, lynx, and wolverines under this alternative are predicted to be negligible to minor, adverse, short-term, and direct.

Behavioral Responses

Ungulates

Wildlife monitoring for the past several winters indicates that 90% or more of bison and elk responses to winter use are either no response or look and resume responses. Less than ten percent of responses are active responses, and they do not have known population-level effects. In many cases, active responses are merely walking away from the threat, a response that causes little overall adverse fitness effects to the animal or population. Other situations, however, are more serious, such as snowmobilers inadvertently or intentionally chasing animals on roadways. These situations are unacceptable, but are largely eliminated by the requirements to utilize commercial guides and/or snowcoaches.

Professional expertise indicates that the use of commercial guides may help to reduce such interactions because guides may be trained to limit their groups' interaction time with animals, to prevent wildlife harassment and chasing, and to limit the distance at which their groups approach animals. Similarly, guides may be trained in recognizing and minimizing those situations where two or more factors may increase wildlife stress. Because this alternative will continue the mandatory guiding practices of the last five winters and will continue human use of the parks at the relatively low levels of the same time period (although snowcoach use could increase), behavioral impacts to ungulates are predicted to be negligible to minor, adverse, short-term, and direct.

Coyotes and Ravens

As previously discussed, there is no concern that coyotes or ravens will suffer adverse effects at the population level due to OSV use and associated recreationist presence. Rather, the concern with both species is that they will actively seek out interactions with people in winter in an effort to obtain food at a time of scarcity. Although coyote and raven behavior cannot be controlled, human behavior can; mandatory guiding substantially reduces the availability of human foods for these two species. Because this alternative retains the mandatory guiding in effect for the past five years, and thus the ability of the NPS to quickly inform guides when a problem is occurring, behavioral impacts of this alternative on coyotes and ravens are predicted to be negligible, direct, short-term, and adverse.

Eagles and Swans

For eagles and swans, the discussions of behavioral and physiological responses are combined.

As with ungulates, behavioral data indicate that use levels similar to those allowed under this alternative have resulted in most eagle and swan reactions to oversnow vehicle use being either no response or look and resume responses. Although there is a small percentage of stronger reactions to human use, these are localized and short-term, affecting individuals but not the populations that have continued to utilize the same winter range for decades.

Additionally, the NPS's experience in the last five years with mandatory guiding assumed that the use of guides helps to reduce such interactions because guides are trained to limit their groups' interaction time with animals, to prevent wildlife harassment and chasing, and to limit the distance at which their groups approach animals. Guides may also be trained in recognizing and minimizing those situations where two or more factors may produce more wildlife stress. Also based on monitoring data, the likelihood of bald eagles and trumpeter swans actively responding to snowmobiles or snowcoaches increases with vehicle group size and with vehicle size (i.e. snowcoaches will produce a greater response than snowmobiles).

There is no current information from the parks that would allow inferences about avian physiological stress in reference to OSV use. Therefore, as with other species and in agreement with behavioral response data, this analysis assumed that higher OSV traffic would result in more frequent physiological responses by, and more stress to, bald eagles and trumpeter swans.

This alternative would allow levels of snowmobile use similar to those seen in the last five years, along with obligatory guiding. Snowcoach use could rise moderately. Based on the monitoring data from the past five years, behavioral and physiological impacts of this alternative on eagles and swans are predicted to be minor to moderate, direct, short-term, and adverse.

Physiological Responses (All Species of Concern)

As monitoring in Yellowstone indicates, the majority of responses by wildlife to OSV use in Yellowstone have been low-intensity vigilance or movements such as travel (Borkowski et al. 2006, White et al. 2006). Just because an animal exhibits no external response, however, does not mean physiological responses are absent. Animals may experience elevated heart rate, blood pressure, breathing rate, and release of adrenaline. Quantifying these physiological responses in wildlife is extremely difficult, though some researchers have attempted to do so with Yellowstone elk and bison. They found that stress hormones in bison showed little relationship to oversnow use but that such levels in elk increased through a winter use season, especially after 7,500 oversnow vehicles had entered the park (Hardy 2001; Creel et al. 2002). However, measuring these physiological responses to recreation by wildlife is challenging due to numerous assumptions and poorly defined parameter estimates. Given these difficulties, it is safest to state that increasing levels of disturbance, including OSV traffic, would likely result in increased stress to wintering wildlife. Hardy and Creel noted, however, that despite the increased stress levels they observed, bison and elk continue to utilize the same winter range year after year and their populations seem unaffected by winter use, even at levels substantially higher than that seen in recent years. Because this alternative would continue winter use at approximately the same levels as seen in those recent years, along with mandatory guiding, the physiological effects of this alternative on all species are predicted to be negligible to minor, adverse, direct, and short-term.

Population-level Impacts/Demographics

Ungulates

As discussed in *Affected Environment*, oversnow vehicle use and winter recreation in Yellowstone and Grand Teton National Parks have not affected bison and elk populations. Any adverse behavioral and energetic effects of OSV recreation to these ungulate populations have apparently been compensated for at the population level. If roads continue to be groomed (as they would under either alternative, though less frequently under Alternative 1 than 2), research strongly suggests that bison populations will continue to be abundant, dominated by natural processes, and healthy. Although individuals will continue to suffer the minor amounts of

disturbance that monitoring has revealed occurs, bison populations are not expected to be adversely affected by winter use.

An unknown number of individual bison and elk will incur adverse effects when exposed to snowmobile and snowcoach traffic and winter recreation under this alternative. Small numbers or groups of bison and elk may be displaced or experience impacts from interactions with oversnow vehicles, for instance. Mitigation measures listed below seek to lessen the frequency and intensity of impacts to individual animals. But again, population level impacts are not expected. Further, the Madison-Norris bison/groomed road experiments may reveal if any changes in bison distribution, survival, and ability to move out of the park have been experienced. Still, based on the research summarized in *Affected Environment*, the forms of winter recreation practiced in the parks may have cumulative effects to individual animals, but such impacts have not risen to the level at which they impact overall wildlife populations in the parks.

Because this alternative would continue winter use at approximately the same levels as seen in the last five years but with the possibility of increased snowcoach use (levels that have not affected bison or elk populations or demographics), the effects of this alternative on ungulate populations and demographics are expected to be negligible, adverse, short-term, and direct.

Wolves

As discussed in *Affected Environment*, wolf populations increased throughout the GYA since their reintroduction, and populations remain healthy throughout the area, including heavily-traveled areas such as Yellowstone's Lamar Valley. Impacts to denning wolves that could cause decreases in reproduction are not expected to occur because wolves den in April, after the closure of the OSV season in the parks.

Significant predictive correlations have been found with park and wilderness lands and wolf presence, as well as negative relationships between roads and wolves. As noted, wolf populations in the GYA are healthy, suggesting that the levels and types of human recreational activity in the parks and road densities therein (pre-existing paved roads are the only OSV routes in Yellowstone and Grand Teton national parks) are generally below the threshold necessary to adversely impact wolf populations. The combined evidence, then, suggests that if existing human winter activity were displacing wolves, the impacts have not been sufficient to significantly increase mortality or decrease reproductive success at the population level.

Because this alternative would only continue winter use at existing levels, the general lack of population or demographic effects on wolves seen since wolf reintroduction is expected to continue. Therefore, the population and demographic effects of this alternative on wolves are expected to be negligible, adverse, short-term, and direct.

Lynx and Wolverines

Of the three lynx identified through DNA in Yellowstone, one was offspring (Murphy et al. 2006). Although detections of offspring do not confirm the presence of a viable, reproductively-stable population in the park or ecosystem, they do suggest resident females. The dynamics of the GYA lynx population are not well understood, making the impacts of the proposed action to a regional lynx population difficult to determine with accuracy. However, impacts to breeding lynx are not expected to occur because the winter recreation season in the parks overlaps the initiation of the lynx breeding season by only a week or two.

Similarly, predicting the effects of any alternative upon wolverines is difficult due to the paucity of information about them anywhere in published literature. However, their preferences for habitat and denning sites mean that they will rarely occur near the road systems of the parks, the majority of which is in habitat that wolverines utilize primarily only as travel corridors between areas of preferential habitat. Further, their wide-ranging nature means that even places like Sylvan Pass, which, although good habitat, may only be rarely frequented by wolverines.

Because this alternative would only continue winter use at existing levels (but with the possibility that snowcoach will increase), because travel over Sylvan Pass would be minimal, and because both wolverines and lynx tend to avoid road corridors anyway, this alternative's population and demographic effects upon the two species are expected to be negligible, direct, adverse, and short-term.

Eagles and Swans

Decreases in reproductive rates have been detected in birds exposed to increased recreational activity. Impacts on large numbers of birds would presumably result in a cumulative, detectable population-level impact. However, nesting success and numbers of fledgling bald eagles in Yellowstone increased during a period of intense OSV use, 1987 to 2005, and were not correlated with cumulative OSV traffic. This suggests that any impacts to individual bald eagles have been compensated for at the population level.

Swan numbers have been declining for several decades, including those in productive areas such as the Centennial Valley of Montana. It is unlikely that poor production across the GYA has resulted from OSV use in Yellowstone or GTNP, because swans in the parks generally return to their breeding territories between February and late May, with young hatching in late June, when OSV traffic is no longer a presence in the parks. Further, swan numbers in the parks decrease as areas of open water diminish with the onset of winter, exposing proportionally fewer trumpeter swans to OSV use in the parks.

Based on this information, those forms of winter recreation practiced in the parks may have cumulative effects to individual birds, but such impacts have not risen to the level at which they impact overall eagle or swan populations in the parks. Because this alternative would only continue winter use at existing levels, because bald eagle and swan breeding periods do not substantially overlap winter use, because the populations of both do not correlate with winter use levels, and because all visitors would continue to be guided, the population and demographic effects of this alternative on bald eagles and swans are predicted to be negligible, adverse, direct, and short-term.

Mitigations

The impacts identified above would be mitigated in several ways under this alternative. First, the daily entry restrictions would limit OSV visitation to a level approximating that seen for the past several seasons. Snowcoach use could increase, and their larger size appears to evoke a higher response rate, but the impacts of that would be mitigated by the fact that snowcoach drivers are trained just like commercial guides in how to pass wildlife safely and observe wildlife responsibly. Because most impacts with the number of visitors seen in the last several years have been minor or negligible, continuing to restrict visitor vehicles and associated human numbers to similar numbers limits wildlife impacts.

Second, monitoring of human-wildlife interactions will continue under either alternative. If this monitoring indicates that human presence or activities are having unacceptable effects on

wildlife that cannot otherwise be mitigated, selected areas of the parks (including sections of roads) may be closed to visitor use.

Third, and as discussed in *Affected Environment*, the requirement to use commercial guides is an effective mitigation for some human impacts upon wildlife. Guides are trained to avoid causing wildlife displacement or stress and are familiar with likely wildlife locations along the road system. Accompanied by guides, OSV users may be less likely to interact improperly with wildlife, causing less mortality, less displacement, and fewer negative behavioral and physiological responses.

Finally, both parks have the authority to enact closures for wildlife purposes, such as to prevent disturbance of denning lynx or wolverines. Should such dens be identified in areas of the parks near human activities (and, therefore, likely to cause disturbance to both individuals, and, because these are rare animals, potentially their populations), the superintendents could implement such closures.

Cumulative Effects

The area of concern for cumulative impact analysis is that which is used by these species for wintering and seasonal migration. This includes all of the three park units plus adjacent lands utilized by affected wildlife, primarily in winter.

Bison that leave Yellowstone are currently subject to brucellosis risk management actions at the park boundary, pursuant to the 2000 Interagency Bison Management Plan (IBMP). Such controls include hazing back into Yellowstone, retaining the animals in holding facilities for eventual release back into Yellowstone, and/or removal from the population. The plan provides the IBMP agencies to emphasize non-lethal management measures when the bison population reaches 2,100. If the bison population reaches 2,100, the agencies are required to increase implementation of non-lethal management measures.

Hunting of both bison and elk is allowed outside the parks and (for elk) in Grand Teton National Park. Hunting seasons and limits are managed by the states (and jointly by the NPS and State of Wyoming within Grand Teton) in such a way as to ensure long-term wildlife viability. Since grizzly bears were removed from the threatened and endangered list in 2007, the surrounding states now managing their populations have not announced hunting seasons for them.

Population growth in the GYA, rural land subdivision, improving snowmobile technologies, and increasing outfitter/guide activity can all influence wildlife populations by introducing more recreationists into big game habitat and/or fragmenting wildlife habitat. Additionally, Grand Teton has recently completed a summer transportation plan, and Teton County has completed the Teton Pathways Master Plan. These actions could have some effect on wildlife, especially those species that are allowed to range outside the parks. Presumably, however, state wildlife management agencies would attempt to minimize significant population declines. Additionally, the large amount of federal land in the GYA and large amounts of elk winter range that have been placed in federal ownership in the last twenty years add some security to elk populations as well as those of most other wildlife species.

The Gallatin National Forest has consolidated much of its checker-boarded holdings in recent years, although that has also been accompanied by the consolidation of private lands, especially in the Big Sky area. It is difficult to predict the net effect of these actions on wildlife, because the consolidated USFS lands are less likely to be developed while the private lands are more likely to be.

Noxious weed growth is a problem throughout the GYA, with potentially adverse effects on wildlife. The federal, state, and county agencies have active noxious weed control programs that attempt to prevent further spread of these plants, limiting their effect on most animal species. Additionally, restoration of some of the Gardiner Basin would have likely benefits for some species, because the native plants preferred by some would be favored by such restoration.

Timber harvest, grazing and mining, fires, and fuels reduction projects will continue to occur on federal and other lands outside the parks. These actions have variable effects on animal species, sometimes stimulating the growth of their preferred forage and sometimes limiting it.

Several national forests in the region are revising their forest plans and/or travel plans. Also, Yellowstone is in the process of writing an EIS on the remote delivery of brucellosis vaccine for bison and Grand Teton has recently completed an elk and bison management plan. These plans will have variable effects on wildlife species, but all such actions would most likely ensure the continued viability of wildlife populations.

Road construction is a recurring event in the region, as are other construction projects. Within the parks, these projects are undertaken in such a way as to minimize their effects on wildlife. On the national forests, this is generally true as well. For example, most facility construction projects within the parks and forests are subject to environmental analysis and are either replacements of existing facilities or are within existing developed areas, therefore minimizing their effects upon wildlife. However, the faster travel speeds resulting from road improvements can result in greater wildlife road kill.

Administrative travel by both the NPS and park concessions will continue in both parks under both alternatives, although it will be somewhat reduced over current levels in Alternative 1 (because there would be no motorized oversnow travel and Old Faithful Snowlodge will be closed). Employees are trained in how to pass wildlife without harassment; such training is ongoing and can be focused on particular problems that monitoring may unveil. Administrative travel can affect wildlife individuals but probably not wildlife populations. For example, one bison was killed by administrative travelers in the last ten years, but such mortality is otherwise very rare. Some displacement and behavioral and physiological effects could be felt on certain wildlife individuals as park employees travel throughout the park to accomplish their duties. However, no population-level effects would be expected from such travel. In general, employee training would serve to minimize such effects on park wildlife, and monitoring would continue to be performed and utilized to minimize any unforeseen effects.

Ranching and cattle grazing will continue to occur outside and adjacent to the parks, and to some extent within Grand Teton. While the majority of wolves prey exclusively on wild game, a small percentage preys upon domestic livestock. When this occurs, the depredating wolves are usually removed from the population. Such control activities will continue. These actions clearly have adverse effects upon wolves, but the state and federal governments are required to maintain viable populations of wolves for perpetuity.

Overall, most of these actions would have either negligible or minor effects on wildlife in the parks, because most such actions have mitigations that limit their effect on wildlife populations. The cumulative effects of these actions, when combined with those incurred by implementation of either Alternative 1 or 2, are expected to be negligible to minor.

Conclusions

Monitoring of winter wildlife reactions to oversnow vehicle use has indicated some small-scale, short-duration, and individual impacts. However, such impacts appear to be compensated for at

the population level, because no wildlife species are experiencing declines in their populations due to winter use.

Alternative 1 would discontinue visitor OSV travel, while Alternative 2 would continue winter use at approximately the same levels as experienced in the past five years, with the possibility of snowcoach travel increasing. Snowcoaches do elicit a larger response than snowmobiles due to their larger profile. However, all winter visitors to Yellowstone would continue to be required to travel in a guided group, whether with a commercial snowmobile guides or in a snowcoach. Effects on wildlife in all three parks under Alternative 2 are expected to be similar to those seen in the last five years: primarily negligible to minor (with possible moderate effects on swans and eagles). Effects are expected to be direct, short-term, and adverse, and are not expected to significantly affect the environment in the parks. The cumulative effects of administrative travel would raise the effects of implementing Alternative 1 to minor, adverse, direct, and occurring over the life of this plan.

Unacceptable Impacts and Impairment

The effects on wildlife seen under either alternative are expected to be acceptable because wildlife populations are expected to remain healthy and abundant. Although monitoring reveals some disturbance to individual animals, no wildlife populations are declining due to winter use (swan populations are declining, but this decline is being experienced regionally, not just in Yellowstone). Few, if any, animals are expected to be killed as a result of vehicle collisions, displacement and behavioral and physiological effects are expected to be minor and of little consequence to wildlife populations (with possible moderate effects on swans and eagles under Alternative 2), and only negligible population effects are expected. Wildlife populations will be abundant and influenced primarily by natural forces; park purposes and values, and desired future conditions will both be attained. Visitors will continue to find wildlife to be both wild and easily viewed; they will all travel with commercial guides or in snowcoaches, learning about and enjoying the abundant wildlife sightings and the safe environment. Because no unacceptable conditions will result, impairment of wildlife resources will also be absent. For the same reasons, NPS will comply with the regulations in 36 CFR 2.18.

Effects on Soundscapes

Methodology

The area of analysis for soundscapes is the three park units. The following analysis of potential adverse effects to soundscapes is limited to the two alternatives for OSV recreation in the parks. The analysis complies with NPS regulations and policies for management of soundscapes.

The natural soundscape of the park units is affected by many non-natural sound sources as described in *Affected Environment* and in this chapter's *Cumulative Impacts*. Administrative oversnow vehicle use is one of those non-natural sound sources that is additive to any visitor use of OSVs. The NPS is engaged in a multifaceted approach to mitigate administrative OSV soundscape impacts as described elsewhere in this document. This chapter's analysis focuses on the soundscape consequences of visitor oversnow vehicle use, with administrative use analyzed as part of the cumulative effects discussion.

Methods are based on monitoring information compiled from the last four years. Estimates of audibility and maximum sound levels for the visitor use levels described under each of the alternatives were computed using this monitoring information. Those levels were then compared to the impact threshold definitions below.

There would be no impacts on the parks' soundscape from Alternative 1 because there would be no motorized visitor use. To determine the impacts of Alternative 2, monitoring information from the past four winters was used to determine the average percent time audible and maximum sound levels for those days with 318 or fewer snowmobiles, plus all snowcoaches that passed the monitoring sites on those same days (see Burson 2008). Snowcoach entry numbers were not tallied separately, but their audibility and maximum sound thresholds were included in the monitoring data. Next, the percent time audible calculated from monitoring data was reduced by the percentage that administrative travel composed, 21% for road corridors and 26% for developed areas (these are the figures for Yellowstone; the contribution of administrative travel to Grand Teton soundscapes is not known, but would be much less than for Yellowstone since most administrative activities do not require the use of snowmobiles). For backcountry zones, the percent time audible was reduced by the percentage that administrative travel composed for road corridors, because road corridor travel is a greater contributor to backcountry soundscapes than is travel within developed areas. Those resulting figures were compared to the impact threshold definitions to determine the level of impact. Analyses were done for three soundscapes management zones: developed areas, roadside corridors, and backcountry zones.

Impact Thresholds

Impact threshold definitions were taken from the 2004 Temporary EA, because the 2007 FEIS definitions were for modeled data and the analysis in this document is based on monitoring data collected in Yellowstone and Grand Teton. Soundscapes science is still fairly new to the national parks, with systematic monitoring data for Yellowstone and Grand Teton only having been collected for the past five winters. Park managers are learning more about park soundscapes with each passing year and continue to reevaluate soundscape thresholds and indicators used to best evaluate the impacts to park soundscapes.

In applying these definitions, if the assessed impact level (i.e., negligible, minor, moderate, or major) for one parameter is higher than for the other, the overall impact is judged to be at the higher level. For example, if an alternative is predicted to have a minor impact for the percent time oversnow vehicles are audible but a moderate impact for the maximum sound level present, the overall impact conclusion is for a moderate impact.

Threshold Definition[a]	**Management Zone**[d]	**Audibility % Time**[b]	**Maximum Sound Level**[c] **dBA**
Negligible: An action that may affect the natural soundscape or potential for its enjoyment by resulting in oversnow vehicle sound that is heard with infrequent occurrence and only for short duration or at a decibel level that may not be noticeable to humans engaged in other activities.	Developed	< 25	< 45
	Travel Corridor	< 15	< 40
	Backcountry	< 5	< 40
Minor: An action that may affect the natural soundscape or potential for its enjoyment by resulting in oversnow vehicle sound heard for a relatively small percent of the time or at a decibel level that would begin to affect conversation.	Developed	25-45	< 60
	Travel Corridor	15-25	< 60
	Backcountry	5-10	< 40

Threshold Definition[a]	Management Zone[d]	Audibility % Time[b]	Maximum Sound Level[c] dBA
Moderate: An action that may affect the natural soundscape or potential for its enjoyment by resulting in oversnow vehicle sound heard for modest amounts of time or at a decibel level that would affect conversation.	Developed	45-75	< 70
	Travel Corridor	25-50	< 70
	Backcountry	10-20	< 45
Major: An action that may affect the natural soundscape or potential for its enjoyment by resulting in oversnow vehicle sound heard for substantial amounts of time or at a decibel level that would make normal conversation difficult.	Developed	> 75	> 70
	Travel Corridor	> 50	> 70
	Backcountry	> 20	> 45

[a] Daily averages are calculated for 8 a.m. to 4 p.m; unit of analysis is the daily average for the winter use season.

[b] Audibility is the ability of humans with normal hearing to hear a sound.

[c] dBA = decibels measured on an A-weighted scale, measured at least 100 feet from the sound source.

[d] The transition zone is not included in the impact definitions.

Effects of Alternative 1

This alternative would have no visitor use of snowcoaches or snowmobiles in Yellowstone or Grand Teton. Oversnow recreational vehicles would not be audible, nor would there be maximum sound levels from them. Without any oversnow vehicle visitor use, the impacts of implementing Alternative 1 on park soundscapes would be negligible, long-term, direct, and neither beneficial nor adverse. Cumulative effects on park soundscapes under this alternative would be the same as those under alternative 2; see that discussion below. No unacceptable conditions or impairment would result, because no visitor oversnow vehicle use would occur.

Effects of Alternative 2

Under alternative 2, up to 318 snowmobiles and 78 snowcoaches would travel Yellowstone's roads per day, plus the associated administrative travel. In addition, 25 snowmobiles per day would be allowed on Jackson Lake on Grand Teton and 25 on the Grassy Lake Road in the Parkway.

Affected Environment, *Soundscapes*, presented the audibility levels associated with this level of use as monitored for the past two winters in Yellowstone. For this analysis, the 8:00 a.m. to 4:00 p.m. period will be used. Monitoring data from four sites represent the soundscapes management zone for developed areas, seven sites represent the travel corridor zone, and two sites represent the backcountry zone. Table 4-1 displays the average audibility at each of these sites.

Table 4-1: Audibility at representative monitoring sites for days with 318 and fewer snowmobiles, winters 2005-08.

1) Location	2) Percent Time OSVs were audible	3) Visitor use contribution to this level	4) Estimated audibility under Alternative 2[b]	5) Impact level
Developed area management zone sites				
Old Faithful	69%	74%	51%	Moderate
West Thumb	56%	74%	41%	Minor
Flagg Ranch	28%	Unknown (Grand Teton/Parkway site)	28%	Minor
Colter Bay	3%	Unknown (Grand Teton/Parkway site)	3%	Negligible
Travel corridor management zone sites				
Madison Jct.	54%	79%	43%	Moderate
Grant Village/Lewis Lake	37%	79%	29%	Moderate
Spring Creek	35%	79%	28%	Moderate
Spring Creek 2[c]	42%	79%	33%	Moderate
West Yellowstone 3.1[d]	35%	79%	28%	Moderate
Mud Volcano	22%	79%	17%	Minor
Grassy Lake Road	6%	Unknown (Grand Teton/Parkway site)	6%	Negligible
Backcountry management zone sites				
Fern Lake	0%	79%	0%	Negligible
Shoshone Geyser Basin	18%[a]	79%	14%	Moderate

[a] Audibility for Shoshone Geyser Basin is computed for the entire 7 days of monitoring there; those days included some with more than 318 snowmobiles.

[b] Computed by multiplying the audibility level (Column 2) by the percentage attributable to visitors and unknown users (Column 3).

[c] The Spring Creek site was moved about ¼ mile between the two winters of its usage.

[d] While all other sites averaged 274 to 305 snowmobiles/day, this site averaged only 225 snowmobiles/day.

Audibility in developed areas is estimated to be negligible to moderate; in the travel corridors, moderate (with one site being minor and another negligible); and in the backcountry, negligible to moderate. Because the highest impact level for audibility is predicted to be moderate, the

overall impact for audibility is predicted to be moderate for Yellowstone and minor for Grand Teton and the Parkway.

Note that for the Old Faithful monitoring site, average audibility for days with less than or equal to 318 snowmobiles was *greater* (69%) than the average including all days over 318 snowmobiles (68%). Similarly, for the West Yellowstone site, average audibility for days between 274 and 318 snowmobiles was slightly less than it was when days with less than 274 snowmobiles were included. These computations reinforce the point made in *Affected Environment*, that audibility is influenced by many factors, with wind being a substantial influence on audibility. Therefore, it is important to include other forms of measuring sound, such as maximum sound levels.

Maximum sound levels were discussed in *Affected Environment*, with Figure 3-7 illustrating the peak sound levels at the Madison Junction 2.3 monitoring site for every day analyzed. Backcountry zones had no values over 40 dBA, and the slower travel speeds in the developed area at Old Faithful resulted in no values over 70 dBA there. Travel corridors had regular occurrences of maximum sound levels over 70 dBA. Ninety-four percent of these there were from high-stack Bombardiers. These are all snowcoaches owned by the NPS and operated under contract by Xanterra. As discussed in *Alternatives*, NPS is working with Xanterra to direct a retrofit or replacement of these vehicles by 2011 so that they meet the same BAT noise requirement as snowmobiles authorized for use in Yellowstone. This will eliminate the highest sound levels over the course of this plan, bringing maximum sound levels to within the moderate range of impacts. Therefore, Alternative 2 is expected to have moderate impacts for maximum sound levels.

Overall, Alternative 2 is predicted to have moderate impacts for both audibility and maximum sound levels in Yellowstone, as based on analyses of monitoring data, coupled with the implementation of snowcoach BAT during the life of this plan. Soundscapes impacts are predicted to be moderate, adverse, direct, and short-term in Yellowstone.

As described in the *Affected Environment, Soundscapes* section, soundscape monitoring in Grand Teton and the Parkway was conducted when snowmobile use levels were well below the daily entry limits allowed under this alternative. Therefore, unlike in Yellowstone where monitoring data exists for use levels consistent with the daily entry limits under this alternative, no such data is available for Grand Teton. The monitoring data that does exist, reflecting actual conditions over several previous winters, would be judged as negligible or minor for any of the management zones. Since it would be reasonable to expect some increase in use of Jackson Lake as more winter anglers acquire BAT snowmobiles, some increase in the audibility levels would also be reasonable to expect. For example, snowmobile use on Jackson Lake totaled 309 for the 2007-2008 winter season, with a peak day of 15, indicating a slight upward trend over the previous three years (although the daily average for the season was only about 3 snowmobiles). It should also be noted that snowmobiles are only used on Jackson Lake for travel to and from fishing locations, rather than for touring, sightseeing, or other activities. Therefore, they are in use only for relatively brief periods of time and shut down for the majority of the day. Based on the very low levels of audibility monitored to date, the very modest growth trend exhibited on Jackson Lake, and the type of use, the NPS does not expect that audibility impacts would exceed minor levels in the foreseeable future, or upon reaching the daily entry limit under this alternative. Likewise, historic use of the Grassy Lake Road, the available monitoring data, and lack of any factors that indicate the potential for substantial increases in use of that route strongly suggest that impacts would not exceed minor in the foreseeable future or upon reaching the daily entry limit.

Overall, the effects of Alternative 2 on natural soundscapes for Grand Teton and the Parkway would be expected to be minor.

Mitigations

The impacts identified above would be mitigated in several ways under this alternative. In addition to the elements fundamental to the alternative that already help to mitigate soundscapes impacts (low snowmobile number limits, BAT requirements for snowmobiles, guided groups), at least three other mitigations would be employed.

First, as discussed in *Alternatives*, BAT requirements for snowcoaches would go into effect in 2011, just after the expiration of this plan. In preparation for the implementation of this requirement, however, snowcoach operators—primarily Xanterra—have already begun taking steps to reduce snowcoach sound levels. Xanterra has already retrofitted three of its high-stack Bombardier snowcoaches to be in compliance with the BAT noise requirement and has plans to retrofit or retire its remaining Bombardiers during the life of this plan. These mitigations should help to ensure that maximum sound levels remain below 70 dBA, and will also cause audibility levels to decrease (quieter vehicles cannot be heard as far as loud vehicles).

Second, changes in snowcoach driver behaviors can also help to reduce both audibility and maximum sound levels. The NPS (and Xanterra) provide annual training to all guides and outfitters. At such sessions the NPS educates drivers on the effects of their driving behaviors on OSV audibility and maximum sound levels. Through educational efforts, the NPS will promote behaviors that are beneficial to the park soundscapes. Those behaviors can also include changes in snowmobile guide behaviors, such as encouraging their clients to shut off their snowmobiles when stopped to view wildlife or scenery and avoiding maximum accelerations.

Third, soundscapes monitoring will continue under this alternative. If this monitoring indicates that OSV use is having unacceptable effects on soundscapes that cannot otherwise be mitigated, the NPS can take steps, including reducing the daily allowable numbers of either snowcoaches or snowmobiles, to protect park soundscapes sufficiently.

Cumulative Effects

The area considered for cumulative impact assessment is natural soundscapes within the boundaries of the three park units. Because individual sources of sound are generally transient and short lived, the potential cumulative impact on the winter soundscape are those sounds occurring during the winter season. Sounds other than those that naturally occur in the park units during the winter include the sound of wheeled vehicular traffic along roads, the sound of oversnow vehicles on groomed routes, aircraft overflights, sounds associated with skiers and snowshoers, and mechanical and electrical sounds coming from facilities in developed areas (see *Affected Environment, Soundscapes*).

Along travel corridors, backcountry areas, and in developed areas, the natural soundscape is affected by non-natural sounds. There are areas in the parks where the total cumulative effect from OSV activities and facilities (buildings, utilities, etc.) is such that it masks the natural soundscape for most of a winter day. Conversely, particularly in transition zones, unoccupied road corridors, and in the backcountry, natural sounds such as wind, bird calls, or thermal activity dominate.

Administrative use of both snowcoaches and snowmobiles by NPS and concessions employees and their researchers, contractors, and guests will continue under either alternative, although such use will be reduced under Alternative 1 relative to current levels because Old Faithful

Snowlodge will be closed. As discussed above, monitoring indicates that such uses constitute 21 to 26% of the percent time OSVs are audible. In developed areas, the contribution of administrative travel is not so high as to raise the impact determinations, but at one travel corridor site, Madison Junction 2.3, it could raise OSV audibility from the predicted 46% (a moderate impact) to 54% (a major impact).

The NPS will mitigate this cumulative impact in several ways. An action common to both alternatives is that NPS will require all park employee guests and all park researchers and contractors to utilize BAT snowmobiles or snowcoaches for their intra-park travel. Park employees will be required to utilize such vehicles for their travel by the end of this plan and will be encouraged to do so before then. NPS will be moving toward implementing BAT sound requirements for snowcoaches during the life of this plan. At the annual guide and outfitter training, NPS will educate guides about the effects of their driving and guiding habits on park soundscapes. NPS will continue its monitoring efforts and will use the adaptive management plan to adjust OSV numbers as needed to protect park soundscapes. NPS will also encourage its employees to take fewer trips or combine multiple trips into single ones. In these ways, NPS seeks to minimize the contribution of administrative travel to OSV audibility and expects that audibility levels will fall within the moderate range of impacts.

Sound sources from outside the park may contribute to the sound environment in the parks, particularly near park boundaries. These influences may include motorized uses on adjacent lands, including the town of West Yellowstone and some USFS lands. Monitoring data about three miles inside the Yellowstone boundary near West Yellowstone indicated that OSVs outside the park boundary were heard as often as visitor OSVs within the park.

In addition, the following may contribute to the cumulative effects on soundscapes in the parks:

The GYA has been experiencing rapid population growth for the last twenty years. Such growth can lead to more demand for recreation (especially snowmobiling, cross-country skiing, and snowshoeing), with more recreationists in and near the parks.

Various planning efforts are under way for the National Forests surrounding the parks. These plan revisions could contribute to or decrease sounds near park boundaries, depending on technology requirements and route designations or area closures:

- Shoshone National Forest master plan revision.
- Bridger-Teton National Forest master plan revision.
- Gallatin National Forest Travel Plan revision. The USFS recently completed the travel plan for this national forest.
- Beartooth District of Custer National Forest travel management plan revision.

During the winter, the Yellowstone natural soundscape is relatively unaffected by sources of non-natural sound other than oversnow vehicles, except for aircraft overflights, which are audible between 3-10% of the average day (NPS unpublished data). Where roads are plowed in the northern portion of the park, most human-caused sound is from wheeled vehicles – but this source lies outside the primary area of concern. Without recreational OSV use (i.e. if Alternative 1 is implemented), other sources of non-natural sound would decrease with the reduced need for administrative travel, grooming, and other support.

In Grand Teton, the sound of oversnow vehicles would be additive to other sources including transient aircraft overflights, activities associated with the Jackson Hole Airport, and highway

traffic along US 191 from Jackson Hole north to Flagg Ranch and US 26 from Moran Junction to the park's east boundary. As a portion of the cumulative human-caused sounds in the park, OSV use would be a smaller component than in Yellowstone. However, in the northern areas of Grand Teton and the JDR, where there are fewer cumulative sound sources, OSV sounds would contribute a higher proportion to the total cumulative impact, for Alternative 2.

Grand Teton is currently preparing an Environmental Impact Statement on extending the Jackson Hole Airport's use agreement for an additional two ten-year terms (for 2033-2053). While the overall trend during the recent years has been increasing numbers of enplanements and aircraft operations, if the agreement is extended, soundscape impacts from the Jackson Hole Airport operation are expected to increase slightly through 2025. In Grand Teton, the cumulative effects of non-natural sounds are likely to have minor effects.

These cumulative soundscape impacts, overall, are likely to have minor effects on Yellowstone soundscapes, with the exception of potential moderate effects within a few miles of the western boundary near the USFS lands with heavy OSV use. The NPS will mitigate the effects of administrative travel in several ways, such that the overall effects of this alternative along with cumulative effects on Yellowstone's soundscape will be moderate.

Conclusions

Monitoring data from the last four winters was used to analyze the effects of implementing the two alternatives. Alternative 1 would result in minor impacts to park soundscapes, because visitor travel would cease but administrative travel would continue and sound from West Yellowstone would continue to affect western portions of Yellowstone. Alternative 2 would result in moderate impacts, due to impacts on audibility and maximum sound levels in Yellowstone, and minor impacts on audibility and maximum sound levels in Grand Teton. Neither alternative is expected to significantly affect the environment in the parks.

Unacceptable Impacts and Impairment

The effects on soundscapes estimated under either alternative will not be unacceptable because winter silence will be predominant away from developed areas and road corridors and present at certain times of day and certain places even in those areas (for example, under Alternative 2, during the midday periods on the West Entrance Road, when most guided groups are at Old Faithful or other park attractions). The soundscapes impacts are also acceptable under Alternative 2 because some non-natural sounds are expected in developed areas and road corridors due to the need for people to use motorized vehicles to reach Yellowstone and Grand Teton's widely spaced wonders, and the levels of such sound under that alternative are at only moderate levels. Finally, maximum sound levels under both alternatives are expected to remain below levels that are acceptable to most visitors as snowcoaches are retrofitted to be BAT. Although some motorized sounds will be evident in developed areas and roadside corridors, winter's silence and the natural soundscapes will generally be readily available to the majority of visitors. Because no unacceptable conditions will result, there will be no impairment of soundscapes (by definition, impairment is worse than unacceptable conditions).

Effects on the Socioeconomic Environment

Methodology

This section analyzes how winter use management alternatives would likely impact recreational use in the Greater Yellowstone Area (GYA) and how impacts to such use would impact economic activity (expenditures and employment) within the area. The economy of the GYA

and the estimated socioeconomic impacts associated with the winter use management alternatives are described in an analysis prepared for the National Park Service (NPS) by Duffield and Neher (2006 and 2007). This section summarizes the methodology and data used in the analyses. Readers are encouraged to refer to those documents for technical details.

Duffield and Neher (2006 and 2007) describe the economy of the GYA at three different levels: a state level (Idaho, Montana, and Wyoming), a county level (Fremont County in Idaho, Gallatin and Park Counties in Montana, and Park and Teton Counties in Wyoming), and a community level (Cody, Jackson, and Wapiti, Wyoming, and West Yellowstone, Montana). Recreational use and visitor expenditure levels were estimated and then the economic impacts associated with each alternative were estimated at the three levels described above.

The economic impacts of Alternative 2 are estimated relative to Alternative 1, the no-action alternative, which would prohibit recreational snowmobile and snowcoach use in the parks and would not allow plowing of interior roads (except the road from Gardiner to Mammoth to Cooke City and U.S. 191 would still be plowed).

An estimate of socioeconomic impacts is presented that is based primarily on the observed visitation resulting from visitation under the 2004 *Temporary Winter Use Plan* (and the winter of 2007-08, covered by the 2007 FEIS).

IMPLAN Modeling

The socioeconomic analysis relies on IMPLAN modeling. IMPLAN is an "input/output" economic model designed by the U.S. Forest Service and is commonly used by state and federal agencies for planning and evaluation purposes. For example, Dean Runyan and Associates used IMPLAN modeling in a report to the State of Wyoming on the economic impact of travel in Wyoming (Dean Runyan 2006). Among other outputs, IMPLAN generates estimates of output and employment. Output is the total business revenue generated by a given activity such as park visitation, and employment is the resulting number of jobs (all jobs – full and part time) associated with that activity.

There are four important caveats that are relevant to the interpretation of the IMPLAN model estimates generated for this analysis. First, the model is static in nature and measures only those effects resulting from a specific activity change at one point in time. Thus, IMPLAN does not account for any subsequent behavioral adjustments that may occur in the economy. For example, a change in the NPS plan for snowmobile management within the parks may encourage local businesses to diversify or modify their operations. These changes could thereby abate potential reductions in output and employment, a change not captured by IMPLAN. Further, IMPLAN does not estimate any potential re-employment of the labor force that may be displaced by management changes (for example the increased employment opportunity provided by guiding). Therefore, the long-run net output and employment impacts resulting from the modeled changes in winter use management would likely be smaller than those estimated by the model. The second caveat to the interpretation of the IMPLAN model estimates generated for this analysis is that they rely on the economic relationships derived from the latest data available, which are from 2003 (Prior analyses relied on earlier IMPLAN data sets and that information is available in those documents—the 2000 EIS, 2003 SEIS, and 2004 EA). Third, IMPLAN information is based on year-round data; winter seasonal information may not be as accurate. Fourth, for small analysis areas (Wapiti, Wyoming, for example) the IMPLAN data may not be an accurate representation of the actual economy due to lack of information. However, the most powerful use for economic modeling is in the comparisons between

alternatives. The impacts of the two alternatives on economic resources can be modeled and compared and the decision maker can understand the effects of the different alternatives.

IMPLAN Model Application

The modeling of the regional economic impacts associated with changes in visitation (and associated visitor spending) on an economic area requires several types of information. In the case of this analysis, the primary driving factor for the IMPLAN model is the changes in the number of visitors from outside an analysis area who decide not to visit the analysis area. For the following analysis, the percentage of visitors to the parks who did not live in each of the economic analysis areas was taken from the results of the 1997-1998 survey of winter park visitors (Duffield and Neher 2000). Specifically, 82.5 percent of visitors lived outside of the five-county area, 65.5 percent lived outside the three-state region, and 99 percent lived outside each of the three communities (Cody, Jackson, and West Yellowstone).

In addition to the change in visitation, the average spending per visitor is required. As noted in *Affected Environment*, per-visit expenditures were estimated using a time series model of West Yellowstone resort tax collections and West Entrance visits. This regression model of winter visitation and tax receipts estimates that for every West Entrance winter visit, $175.33 is spent on taxable goods and services in the community of West Yellowstone. This spending does not represent total trip spending for an individual as he or she may visit the park more than once on a trip or may visit other areas in the vicinity such as national forest lands.

Finally, in order to accurately input the expenditure changes into the IMPLAN model, it is necessary to understand the general distribution of non-resident visitor spending across economic sectors (for instance, lodging, restaurants, rental cars, etc.). The distribution of spending across economic sectors is also drawn from the 1997-1998 winter visitor survey. That survey asked winter park visitors to detail their spending patterns within the GYA. Based on these responses, visitor spending was allocated as 27.5 percent lodging, 24.6 percent automotive and gas stations, 17.1 percent miscellaneous retail expenditures, 14.3 percent eating and drinking establishments, 11.5 percent scenic and recreational transportation, and 5 percent other amusement services. Using these parameters, total estimated direct changes in non-resident visitor spending due to an action alternative, and relative to one of the no-action alternatives, is input into the IMPLAN program.

The IMPLAN program estimates total output and employment impacts, which include indirect and induced impacts arising from the initial direct spending impact, and allocates these impacts across the sectors of the analysis area. Direct impacts reflect the initial spending at local businesses by visitors from outside the GYA. Indirect impacts reflect the subsequent spending by businesses for required inputs such as capital and labor. The induced effects reflect the resulting changes in household income for local residents.

At its most aggregated level, IMPLAN modeling applies output and employment multipliers to the initial visitor spending to arrive at estimated total output and employment impacts. In general, the smaller and less diverse the analysis area is, the closer its expenditure multiplier is to 1.0. Conversely, the larger and more diverse an economy, the larger are its multipliers.

The resulting output and employment impacts are presented below. These impacts represent changes (adverse or beneficial) from the existing economic output and employment levels presented in Table 3-4. The definitions of impact categories below were used to qualitatively describe these impacts.

Current and Historical Use Levels

Recent visitation data and trends are presented in *Affected Environment, Visitor Access*. For the economic impact estimates, use was assumed to be equal to current use levels, as represented by the 2005-2006 winter (a total of 88,718 visits). These are Yellowstone-only numbers because use levels on the Grassy Lake Road, and Jackson Lake are relatively small, and other types of use (wheeled vehicle travel and skiing) are not altered by any alternatives in Grand Teton.

Two different historical use levels are used for comparison: the 1997-1998 winter (or total of 119,274 visits in Yellowstone) and winter 2001-2002 (the most recent high winter and nearly equaling the historical high winters of the early 1990s) or 144,490 visits (Duffield and Neher 2007).

Assumptions for Recreational Use Levels by Alternative

Alternative 1 would have no snowmobile or snowcoach access. Motorized oversnow use in Yellowstone National Park has historically composed over 70 percent of total winter visitation and nearly all visitors entered via the west, south, and east entrances. An analysis of the distribution of recreational use since the winter use management plan changes began in 2001 suggests little evidence of substitution between park entrances. Additionally, an analysis of snowmobile use on national forest land near the West Entrance suggests that snowmobile use in national forests is possibly a complement to snowmobiling in the parks rather than a direct substitute. For these reasons, for the impact estimates, the level of recreational use under this alternative was assumed to be equal to the North Entrance wheeled vehicle entries plus park-wide skiing entries during the 2005-2006 winter (a total of 40,029 visits).

The estimated baseline output and employment for wheeled vehicle and ski/snowshoe use is: Three State area: $9,445,730 and 173 jobs; Five County area: $7,687,891 and 146 jobs; West Yellowstone: $5,782,282 and 125 jobs; Jackson: $1,726,509 and 30 jobs; and Cody: $14,324 and 0 jobs.

Alternative 2 would continue recent use trends. The estimated level of recreational use under this alternative is recent visitation levels, 88,718 visits (2005-2006 visitation).

Impact Threshold Definitions

Negligible: The impact is at the lower levels of detection (< 5% change in either total output or employment)

Minor: The impact is slight, but detectable (5-10% change in either total output or employment)

Moderate: The impact is readily apparent and has the potential to become major (10-20% change in either total output or employment)

Major: The impact is severe, or if beneficial, has exceptional beneficial effects (>20% change in either total output or employment)

Effect of Alternative 1

Under alternative 1, no oversnow motorized recreational access would occur. As noted above, wheeled vehicle access would continue to occur through the North Entrance of Yellowstone as far east as Cooke City, Montana. With no oversnow visitation, the result is that the positive results of "no motorized oversnow access" impact estimates provided in the tables below for alternative 2 would disappear. For example, examining Table 4-2, if Alternative 1 were to be

adopted, the 3-state area would suffer an economic loss of $11,489,249 and West Yellowstone a loss of $7,033,239 (taking the figures in the far right column). With no-motorized oversnow access, the baseline output and employment, as described above, would remain.

The economic impacts presented in the tables below for "no motorized access" are the IMPLAN outputs as compared to the definition of impacts, above. A negligible impact means that the impact is difficult to detect at the state, 5-county, or community level. It does not mean that within any of those three levels adverse (or beneficial) effects are not occurring. They are. For businesses and their employees who are the companies and people behind reduction in output and employment, the adverse impacts are anything but negligible. The results also mask adverse impacts that may be occurring to types of businesses or businesses in a geographic area that is particularly dependent on park visitors. For example, businesses along the North Fork of the Shoshone River state that if the East Entrance is closed under alternative 1, most of them would close in the winter. Further exacerbating their situation is the recent downturn in visitation that has already caused some of the businesses to curtail operations or close entirely in the winter. To these businesses and others similarly situated near other entrances, the impacts of the current conditions are adverse and long-term, and alternative 1 would make the situation far worse. As another example, alternative 1 would result in the closure of the Snowlodge at Old Faithful (and probably the Mammoth Hot Springs Hotel) in the winter because the expected reduction of access would result in these overnight lodging facilities no longer being viable to operate. Also, the yurt camp at Canyon would be closed.

If Alternative 1 were to be implemented, the effects on the socioeconomic environment would be negligible-beneficial to major-adverse and long-term and regional.

Effects of Alternative 2

The economic impact estimates for alternative 2 are presented in absolute terms in Table 4-2, and in relative terms (percentages) in Table 4-3. The absolute impact levels are annual estimates. The impacts are then categorized as to intensity level in Table 4-4.

As described in Alternative 1, the economic impacts presented in the following tables for Alternative 2 are the IMPLAN outputs as compared to the definition of impacts. A negligible impact means that the impact is difficult to detect at the state, 5-county, or community level. It does not mean that within any of those three levels adverse (or beneficial) effects are not occurring. They are. For businesses and their employees who are the companies and people behind reduction in output and employment, the adverse impacts are anything but negligible. The results also mask adverse impacts that may be occurring to types of businesses or businesses in a geographic area that is particularly dependent on park visitors. To these businesses, the impacts of the current conditions are adverse and long-term, and Alternative 2 would continue those impacts into the future.

Table 4-2: Absolute Economic Impact Estimates, Alternative 2

Alternative 2 Absolute Impact Levels		---------- As compared to ----------		
Area/Estimate	Impact[a]	Historical Conditions 1997-1998	Historical Conditions 2001-2002	No Motorized Oversnow Access (and Alternative 1 losses if implemented)
3-State Area				
	Total Output	-7,210,366	-13,160,640	11,489,249
	Total Employment	-134	-245	214
5-County Area				
	Total Output	-5,868,525	-10,711,461	9,351,114
	Total Employment	-109	-198	173
Cody, WY				
	Total Output	-303,488	-414,499	121,114
	Total Employment	-7	-9	3
Jackson, WY				
	Total Output	-1,317,925	-2,405,528	2,100,028
	Total Employment	-23	-41	36
West Yellowstone, MT				
	Total Output	-4,413,885	-8,056,395	7,033,239
	Total Employment	-95	-174	152
Wapiti, WY				
	Total Output	-204,983	-279,963	81,803
	Total Employment	-6	-8	2

[a] Total output is in dollars, and total employment is in full and part-time jobs.

Table 4-3: Relative Economic Impact Estimates, Alternative 2

Alternative 2: Relative Impact Levels		---------- As compared to ----------		
Area/Estimate	Impact [a]	Historical Conditions 1997-1998	Historical Conditions 2001-2002	No Motorized Oversnow Access (and Alternative 1 losses if implemented)
3-State Area				
	Total Output	-0.00%	-0.01%	0.01%
	Total Employment	-0.01%	-0.01%	0.01%
5-County Area				
	Total Output	-0.06%	-0.11%	0.10%
	Total Employment	-0.09%	-0.17%	0.15%
Cody, WY				
	Total Output	-0.03%	-0.05%	0.01%
	Total Employment	-0.06%	-0.09%	0.03%
Jackson, WY				
	Total Output	-0.07%	-0.13%	0.11%
	Total Employment	-0.11%	-0.20%	0.18%
West Yellowstone, MT				
	Total Output	-2.64%	-4.82%	4.21%
	Total Employment	-4.08%	-7.44%	6.49%
Wapiti, WY				
	Total Output	-1.99%	-2.72%	0.79%
	Total Employment	-5.40%	-7.83%	2.16%

[a] Impacts are expressed as percentage changes from the respective existing economic output and employment levels presented in Table 3-1.

Table 4-4 indicates the potential effects of implementing Alternative 2. All effects would be long-term, regional, and both direct and indirect.

Table 4-4: Categorization of Economic Impact Levels for Alternative 2

Alternative 2 Economic Impacts	---------- As compared to ----------		
Area	Historical Conditions 1997-1998	Historical Conditions 2001-2002	No Motorized Oversnow Access
3-State Area	Negligible Adverse	Negligible Adverse	Negligible Beneficial
5-County Area	Negligible Adverse	Negligible Adverse	Negligible Beneficial
Cody, WY	Negligible Adverse	Negligible Adverse	Negligible Beneficial
Jackson, WY	Negligible Adverse	Negligible Adverse	Negligible Beneficial
West Yellowstone, MT	Negligible Adverse	Minor Adverse	Minor Beneficial
Wapiti, WY	Minor Adverse	Minor Adverse	Negligible Beneficial

Cumulative Effects

In *Purpose and Need*, a variety of trends and actions are listed that directly or indirectly influence socioeconomics. Some of these beneficial trends are population growth and suburban and rural land subdivision in the communities and counties of the Greater Yellowstone Area and oil and gas leasing. Some of these beneficial trends are reflected in the 1999-2003 comparisons found in *Affected Environment, Socioeconomics*.

Specific projects in the parks that have (or will have) a generally beneficial bearing on socioeconomics include the new Old Faithful and Canyon visitor centers in Yellowstone, the new Craig Thomas Discovery and Visitor Center and Laurance S. Rockefeller Preserve in Grand Teton, road reconstruction in Yellowstone and Grand Teton, and Grand Teton's summer transportation plan. Some of these longer-term beneficial projects may, in their implementation phase, depress visitation. For example, road construction projects are aggravating to most drivers, some of whom may avoid the portion of the park (and nearby communities) where road work is occurring. Similarly, replacing visitor centers often means a temporary facility is provided (not to mention the disturbance from construction activities). This may also be discouraging to some visitors.

Elsewhere in the region, some of the specific projects that have affected socioeconomics include the relocation of a substantial number of Marathon Oil Company employees from Cody, highway reconstruction over Togwotee Pass, and replacement of the tram at the Jackson Hole Ski Resort. The first had a substantial adverse impact on output and employment in Cody and Park County, Wyoming. The latter two, when completed, could be beneficial to visitation and recreation.

An increase in park visitation would be additive to the existing broad trend of economic growth and employment opportunities. A reduction in park visitation would be somewhat offset by the beneficial regional economic trend related to resource extraction, residential growth, other recreation opportunities, and wildlife and other natural environment attractions. Alternative 2 would allow for levels of use that equal average current use and allow for some growth, particularly through snowcoaches. Therefore, this alternative would likely be additive to all

other current and reasonably foreseeable actions contributing to a beneficial multi-regional economy.

As indicated in *Purpose and Need* and noted in the Alternative 2 cumulative effects, a number of trends and actions inside and outside the parks have the potential to impact the economics of the communities or the region. A reduction in park visitation might be somewhat offset by the beneficial regional economic trend related to resource extraction, residential growth, other recreation opportunities, and wildlife and other natural environment attractions. With the prohibition of motorized oversnow recreational use, Alternative 1 would likely discourage out of state visitors from coming to the area and contributing to local regional economies. It is likely that this alternative would represent an overall adverse impact on regional economic trends.

Conclusions

The direct impacts of implementing Alternative 1 would range from beneficial, negligible to major, adverse impacts resulting from direct and indirect actions and would be long-term and regional. As described earlier, the adverse direct impacts would be most directly felt by communities and businesses near the parks, especially in areas that have a higher proportion of business tied directly to park visitation. The indirect impacts from implementing alternative 1 would be negligible, beneficial (for communities near the North Entrance) to major, adverse, long-term, and regional for the balance of park gateway communities and regions. As individual businesses are adversely affected, they would reduce purchases of other goods and services from suppliers.

In terms of cumulative impacts, some of the communities and areas near the park have already identified adverse impacts, including reduced income and employment, which have occurred over the past few years; implementing Alternative 1 may exacerbate these effects. Implementing Alternative 1 would contribute a negligible, beneficial to major, adverse, long-term, regional impact to past, present, and foreseeable actions and impacts on socioeconomics.

The direct impacts of implementing Alternative 2 would generally range from negligible, beneficial to minor adverse and would be long-term and regional. As described earlier, the adverse, direct impacts would be most directly felt by communities and businesses near the parks, especially in areas that have a higher proportion of business tied directly to park visitation. The indirect impacts from implementing Alternative 2 would be negligible, beneficial to moderate, adverse, long-term, and regional. As individual businesses are adversely affected, they would reduce purchases of other goods and services from suppliers.

In terms of cumulative impacts, some of the communities and areas near the park have already identified adverse impacts, including reduced income and employment, which have occurred over the past few years; implementing alternative 2 may exacerbate these effects. Implementing alternative 2 would contribute a generally negligible-beneficial to negligible-adverse, long-term, regional impact to past, present, and foreseeable actions and impacts on socioeconomics.

Effects on Air Quality and Air Quality-Related Values

Methodology

The area of analysis for air quality and air quality related values is the three park units.

Methods are based on monitoring information compiled from the last five years; both alternatives are compared to periods of time with similar use levels. Air quality monitoring has been year-round, including times in fall and spring when only administrative travel is present in

the park, with no visitors present. These time periods serve as good proxies for Alternative 1, because it would allow administrative travel but no recreational travel. The last two winters have seen visitor use levels similar to those that would be allowed under Alternative 2, so the air quality monitoring information from those two winters serves as good proxies for that alternative.

Impact Threshold Definitions

Using monitoring information as the basis for determination of impacts is not always possible, because the impacts of a given alternative may never have been seen in a given locale. In this case, as discussed above, excellent monitoring information is indeed available. The strength of this analysis, then, lies in the fact that on-the-ground, real-world conditions are being used to assess impacts, not air quality modeling. While air quality modeling is useful in the instances where monitoring information is limited or not available, it is hypothetical and may not be accurate.

Because the impact threshold definitions in this document are based upon monitoring, they must be given in the same terms in which monitoring results are provided. Therefore, stating impact threshold definitions in tons per year of a given pollutant, as the 2007 FEIS did, is not useful here, because it is very difficult to calculate the annual mass of a pollutant when the monitoring provides only the concentration of the pollutant.

The National Park Service has provided some guidance (NPS Natural Resources Program Center 2003) to all parks for establishing air quality impact threshold definitions. Although this guidance is based partly on the tons per year of a given pollutant, it is also based on the current air quality or concentration of that pollutant. Those current concentrations are given in percentage of the National Ambient Air Quality Standards (NAAQS): a negligible impact is <60% of the NAAQS for that pollutant, minor is <80%, and both moderate and major are >80% (with the difference between the two based on the tons per year of the given pollutant). The NAAQS are an objective standard established by the EPA in order to protect air quality and public health. Therefore, they are appropriate levels to use as baseline to ensure that air quality within the park is not impaired or adversely impacted by oversnow vehicle use.

Because the tons per year of any pollutant were not available for this analysis, the following impact threshold definitions are based only upon the current concentration portion of the national guidelines. To confer a higher level of protection on Yellowstone's air quality, the suggested definitions for current air quality were adjusted downwards, to be more conservative (and therefore protective of park resources) as air quality is examined.

Because CO and particulates are the primary pollutants of concern with winter use, the focus of this analysis is on them. Hydrocarbons are also a concern, but more from an employee health and safety perspective; that section of this EA discusses hydrocarbons.

Negligible: The impact on air quality is not measurable or perceptible. Measured emissions concentrations are less than 40% of the NAAQS for CO or PM. No perceptible visibility impacts are likely (no visible smoke, plume, or haze).

Minor: The impact on air quality is measurable, but localized within a relatively small area. Measured emissions concentrations are between 40 and 60% of the NAAQS for CO or PM. No perceptible visibility impacts are likely (no visible smoke, plume, or haze).

Moderate: The impact on air quality is measurable and perceptible, possibly throughout the parks, but could be reversed and generally localized. Measured emissions concentrations are between 60 and 80% of the NAAQS for CO or PM. Perceptible visibility impacts occur, but are only visible from a small area of the park, are of short duration (less than one day) and visible to only a few park visitors on the days that they occur.

Major: The impact is substantial and highly noticeable park-wide. Measured emissions concentrations are more than 80% of the NAAQS for CO and PM. Perceptible visibility impacts occur and are visible from several areas of the park, occur between one and several days, and many park visitors may observe them on the days that they occur. Class I air sheds, or areas within them, are degraded.

Effects of Alternative 1

This alternative would prohibit motorized recreational use of the parks, so the only travel—and therefore emissions—would derive from administrative travel. Currently, Yellowstone's interior roads are closed to public travel from the first weekend of November through mid-December, when they reopen to public oversnow travel. In spring, the oversnow roads close to the public in early to mid-March for spring plowing; they are reopened to the public beginning in mid to late April. These two periods, then (spring and fall), have conditions nearly identical to what would occur if this alternative were implemented.

Table 4-5 displays the air quality monitoring results from spring and fall of 2006 and 2007 from the West Entrance. Note that spring and fall data are not available for Old Faithful.

Table 4-5: Spring and fall emissions concentrations for 2006 and 2007 at Yellowstone's West Entrance (CO in ppm, PM2.5 as ug/m^3).

Statistics	Spring 2006	Fall 2006	Spring 2007	Fall 2007
Max. 1-hr. CO	0.60	0.70	0.90	1.10
Max. 8-hr. CO	0.33	0.41	0.26	0.35
Season average for CO	0.16	0.10	0.15	0.10
90^{th} percentile for CO [a]	0.20	0.20	0.20	0.20
NAAQS for CO: 1-hr. is 35 ppm for National & WY, 23 ppm for MT; 8-hr is 9 ppm for all three.				
Max. 1-hr. PM2.5	15	262	16	275
Max. 24-hr. PM2.5	4.1	37.1	4.4	14.1
Season average	1.8	3.6	4.4	12.2
98^{th} percentile	4.1	37.1	2.3	3.1
NAAQS for PM2.5: 24-hr PM 2.5 98^{th} percentile is 35 for National & MT (15 for MT for annual), 65 for WY				

[a] The 90^{th} percentile is not used by the NAAQS. It is a useful way to track higher concentrations without the points being dominated by possible statistical outliers.

Alternative 1 would probably result in slightly lower emissions concentrations than given in Table 4-5, for three reasons. The data provided in this table come from the West Entrance monitoring station, which is very close to West Yellowstone. Some pollutants could drift in from the town, raising the levels over what would be found elsewhere in Yellowstone, such as at Old Faithful. Second, Alternative 1 could result in even lower administrative travel than currently occurs in spring or fall, because the Old Faithful Snowlodge would be closed, resulting in a

reduction in concessions administrative travel. Third, there is little, if any smoke in winter from wildfires, which accounts for the high readings in fall.

Calculating the percentage of the NAAQS that spring and fall CO values comprise was done by averaging the four 1-hour values and the four 8-hour values. The 1-hour values average 0.825 ppm, which is 2.4% of the NAAQS (using the national standard; the same value is 3.6% of the more conservative MT standard). The 8-hour values average 0.3375 ppm, which is 3.8% of the national standard (and the MT and WY standards). All these values fall well within the negligible category.

For PM2.5, the autumn values were discarded because they are influenced by wildfire smoke (Ray 2008); such smoke is not present in winter. Some smoke from woodstove or fireplace fires would be present, but it is already included in the spring values (spring is easily within the heating season in the Northern Rockies). The average of the two spring 98th percentile values is 3.2 ug/m^3, which is 9.1% of the national standard (21.3% of Montana's annual standard and 4.9% of Wyoming's standard). All of these values fall within the negligible range of impacts.

The NPS is not aware of any visibility impacts from spring or fall at either West Yellowstone or Old Faithful (other than wildfire-related impacts, which are not included in this analysis). Therefore, the NPS expects that implementation of this alternative would not result in any visibility problems.

For CO, PM2.5, and visibility, the effects of implementing Alternative 1 on air quality and air quality related values would be negligible, direct, adverse, and lasting for the duration of this plan.

Effects of Alternative 2

In allowing 318 snowmobiles and 78 snowcoaches per day in Yellowstone, this alternative would have use levels similar to those seen in the last two winters. Last winter, an average of 294 snowmobiles and 35 snowcoaches per day entered the park; two winters ago, 299 snowmobiles and 34 snowcoaches per day was the average. Actual use levels in Grand Teton the last several winters have been far less than the authorized levels (this alternative would permit 25 snowmobiles each on Jackson Lake and the Grassy Lake Road). In 2007-08, Jackson Lake saw an average of less than three snowmobiles per day, and only 165 snowmobiles were recorded on the Grassy Lake Road the entire season.

Air quality monitoring data for the past two winters serves as an excellent proxy for the air quality impacts likely to be experienced under this alternative. For snowmobiles, the averages from the last two winters are within 10% of the limit proposed under this alternative; for snowcoaches, these averages are less than half the number permitted by this alternative. However, the air quality monitoring data from the last two winters include 29 days where more than 396 OSVs (a number equivalent to the combined number of snowmobiles and snowcoaches permitted under this alternative) entered the park (14 days from last winter and 15 from 2006-07), along with 50 days where between 318 and 396 OSVs entered the park (25 days from each winter). The data, therefore, include many days with a number of vehicles traveling through Yellowstone similar to that which would be seen if this alternative would be implemented. These data are presented for both the Old Faithful and West Entrance monitoring sites for both winters in Table 4-6.

Table 4-6: air quality monitoring results from the last two winters (CO in ppm, PM2.5 as ug/m^3).

Statistics	Winter 2006-07, West Entrance	Winter 2006-07, Old Faithful	Winter 2007-08, West Entrance	Winter 2007-08, Old Faithful
Max. 1-hr. CO	3.7	0.9	6.1	0.9
Max. 8-hr. CO	0.8	0.4	1.6	0.4
Season average for CO	0.19	0.27	0.23	0.19
90th percentile for CO [a]	0.27	0.19	0.4	0.24
NAAQS for CO: 1-hr. is 35 ppm for National & WY, 23 ppm for MT; 8-hr is 9 ppm for all three.				
Max. 1-hr. PM2.5	40	20	44	32
Max. 24-hr. PM2.5	8.8	6.6	9.5	8.1
Season average	2.1	3.3	2.6	3.2
98th percentile	8.7	6.4	7.8	5.8
NAAQS for PM2.5: 24-hr PM 2.5 98th percentile is 35 for National & MT (15 for MT for annual), 65 for WY				

[a] The 90th percentile is not used by the NAAQS. It is a useful way to track higher concentrations without the points being dominated by possible statistical outliers.

Table 4-7 displays the percent of the NAAQS that the values in table 4-6 comprise.

Statistic	West Entrance (average of two winters)	Old Faithful (average of two winters)	Average of both West Entrance and Old Faithful
1-hr CO, percent of national NAAQS	14.0%	2.6%	8.3%
1-hr CO, percent of MT NAAQS	21.3%	3.9%	12.6%
8-hr CO, percent of all 3 NAAQS	13.3%	4.4%	3.5%
98th percentile PM 2.5, percent of national NAAQS	23.6%	17.4%	20.5%
98th percentile PM 2.5, percent of MT annual NAAQS	55%	40.7%	47.8%
98th percentile PM 2.5, percent of WY NAAQS	12.7%	9.4%	11.0%

The NPS is not aware of any visibility impacts the last two winters at either West Yellowstone or Old Faithful. Therefore, the NPS expects that implementation of this alternative would not result in any visibility problems.

All of the comparisons to the national NAAQS (from 2.6 to 23.6% of the NAAQS—the highlighted rows in Table 4-7) fall within the negligible range of impacts identified in the impact threshold definitions. Therefore, Alternative 2's effects on air quality in Yellowstone are expected to be negligible, direct, adverse, and lasting for the duration of this plan.

In Grand Teton, both the actual use levels over the previous few winters, as well as use levels authorized under Alternative 2, are far lower than use levels in Yellowstone. Therefore, impacts on air quality for Grand Teton and the Parkway would be less than in Yellowstone; overall, they would be negligible, direct, adverse, and long-term.

Note that modeling was done in the 2004 EA for an alternative with a level of snowmobiles and coaches similar to Alternative 2 in this EA. That modeling suggested that 318 snowmobiles and 87 snowcoaches would produce 123 tons/season of CO and 4 tons/season of particulates. Comparing these to the impact threshold definitions in the 2007 FEIS, Alternative 2 would have a moderate impact on air quality (moderate was defined to be between 100 and 250 tons per year of a pollutant). As noted previously, however, using the monitoring results as the primary basis of comparison is generally more credible, since those are based on real-world conditions. For purposes of this EA, therefore, Alternative 2 is assessed as having negligible impacts as indicated.

Mitigations

Given that neither alternative will have even minor impacts upon the parks' air quality, the continued use of BAT for snowmobiles, the continued conversion of snowcoaches to BAT during the term of this plan, and the numerical restrictions on both kinds of oversnow vehicles will serve as sufficient mitigations to protect Yellowstone's pristine air quality.

Cumulative Impacts

The area of concern includes the airshed described by all three park units and by adjacent Class I areas on national forests. Although ambient air pollution generated at great distances beyond the park boundaries is of concern compared to air quality in the parks, it is unreasonable to consider all of the western United States as an area of concern.

Levels of nitrates found in Yellowstone's snowpack can be related to regional industry (Ingersoll et al. 1997) confirming the fact that additional air pollution in the parks comes from regional industry within 150 km of the park (including oil and gas drilling and processing, power plants, and industrial combustion), urban uses, and recreational uses outside the parks. In addition to these known sources, other trends, plans, and actions that may affect air quality in the parks include population growth (such as that in Big Sky and Jackson) and the construction of a natural gas pipeline in Hoback Canyon, both of which may further degrade air quality, although to an unknown extent. Countering these effects (or improving air quality) may be the forest plan and/or travel plan revisions being undertaken by the national forests in the GYA and the Teton Pathways & Grand Teton Summer Transportation Plan, which may promote alternative transportation.

Background concentrations of air pollutants, along with pollutants from all other sources both within and outside of the parks, are already included in the monitored results. Therefore, the monitored results provide an excellent indication of what air quality conditions would be like under either alternative, including impacts from cumulative sources.

Conclusions and Unacceptable Impacts and Impairment

Under either alternative, air quality in the parks is expected to remain pristine, at less than 24% of the federal NAAQS. This small a percentage indicates how clean the winter air in the parks is

expected to be under either alternative in this EA: in a word, excellent. Unacceptable impacts would be levels of pollutants that are considerably closer to violations of the federal NAAQS, with impairment being even worse (perhaps violations of the NAAQS). With the conservative use limits and Best Available Technology restrictions for snowmobiles and the move towards cleaner snowcoaches, the NPS expects implementation of either alternative to preserve excellent air quality in the parks, air that is far removed from being unacceptable in quality or being impaired. Neither alternative is expected to significantly affect the environment in the parks.

Effects on Public and Employee Health and Safety

Methodology

The area of analysis is the parks. To assess the level of impact to employee and public health and safety for each alternative, the following types of information were used:

- Safety policies and guidelines
- Results of air monitoring near the West Entrance in Yellowstone
- Results of personal exposure and sound monitoring
- Reports from employees and commercial guides
- Past and current avalanche analyses.

Overall impacts to health and safety, including impacts for avalanche control in the Sylvan Pass area of Yellowstone, are defined below. Because personal and occupational exposure to air quality and noise contaminants has been monitored in Yellowstone, the alternatives are compared qualitatively, using the monitored data (See Jensen and Meyer, 2006; Spear et al., 2006).

Impact Threshold Definitions

Negligible: No noticeable or perceptible impact; no mitigation needed. 8-hour time-weighted noise exposure levels are below 60 dBA; peak sound pressure levels (SPL) are below 75 dBA.

Minor: Measurable or perceptible impact if ATSDR Minimum Risk Levels (MRLs)* or other established limits are rarely exceeded. If mitigation were needed, it would be relatively simple and would likely be successful. 8-hour time-weighted noise exposure levels are below 70 dBA; peak noise levels are below 80 dBA.

Moderate: Impact could cause a permanent change; ATSDR MRLs or other established limits are exceeded daily. Mitigation measures would probably be necessary and would likely be successful. 8-hour time-weighted noise exposure levels are below 85 dBA; peak noise levels are below 90 dBA.

Major: Substantial impact to employee or public health and safety; ATSDR MRLs or other established limits are exceeded more than once per day. Extensive mitigation measures would be needed, and their success would not be guaranteed. High potential exists for serious accidents or hazards. 8-hour time-weighted noise exposure levels exceed 85 dBA; peak noise levels routinely exceed 90 dBA. Maximum one second Leq levels exceed 130 dBA.

*From the Agency for Toxic Substances & Disease Registry at http://www.atsdr.cdc.gov/mrls/index.html

Effects of Alternative 1

Under this alternative, all oversnow motorized visitor use in the parks would cease, so effects on visitors would be negligible. Administrative use of the parks would continue, with road grooming done on a reduced (as-needed) basis. Sylvan Pass would be closed to such travel, with no avalanche control operations occurring (other than those necessary for search and rescue operations and spring opening procedures). Employee exposure to high noise levels would exist only when using a snowmobile. Therefore, the effects of implementing this alternative on employee health and safety would be moderate, adverse, short to long-term, and direct.

Effects of Alternative 2

This alternative would allow snowmobiles and snowcoaches to continue in Yellowstone, although all snowmobiles would have to be BAT and guided (and coaches would be guided and moving towards BAT). Administrative uses would continue, exposing visitors and employees to high noise levels. Road grooming would be done regularly, so travel conditions would generally be good, with few rough road conditions. However, continued snowcoach use could expose all travelers to snowcoach-caused ruts and bumps.

Exposure to low amounts of benzene and formaldehyde would continue under this alternative. As explained in *Affected Environment,* exposure to benzene has not exceeded any federal standards. Exposure to formaldehyde has exceeded the most conservative such standard. For both of these air toxics, monitoring will continue and adaptive management will be utilized should concerns be present.

Snowmobile use would be allowed in Grand Teton on Jackson Lake, and in the Parkway on the Grassy Lake Road. Such use levels would be relatively low, and the locations where that use would occur would be limited. The amount of associated administrative use, such as for law enforcement, would also be relatively small. Therefore, the exposure to high noise levels or other adverse conditions would be limited.

As described in *Affected Environment*, avalanche work is inherently dangerous and risks to employees may be greater than those generally posed to visitors because 1) employees conducting avalanche hazard mitigation spend more time in the pass, and 2) avalanche control work, by its very nature, is hazardous. Under alternative 2, the risk would be addressed through implementation of a strict safety-based, risk reduction program. The pass would not be open unless safety criteria are met and, in the professional judgment of park managers, operations can be conducted within acceptable levels of risk.

Significant closures of the pass may result and avalanche operations will not occur if safety criteria cannot be met. A combination of avalanche mitigation techniques may be used, including risk assessment analyses as well as forecasting and helicopter and howitzer dispensed explosives. Area staff may use whichever tool is the safest and most appropriate for a given situation, with the full understanding that safety of employees and visitors comes first. Employees in the field make the operational determination when safety criteria have been met, and operations can be conducted with acceptable levels of risk. The NPS will not take unacceptable risks. When safety criteria have been met, the pass will be open; when they have not been met, the pass will remain closed. As with past winters, extended closures of the pass may occur. Also, during the winter season, the pass will not be open for administrative travel unless it is also open to public travel, further reducing employee exposure to risk.

The results of previous safety evaluations of Sylvan Pass by the Occupational Health and Safety Administration and an Operational Risk Management Assessment will be reviewed and updated, and the NPS will evaluate additional avalanche mitigation techniques and risk assessment tools in order to further improve safety and visitor access.

Because exposure to high noise levels will continue, because exposure to avalanche risk will continue, and because the NPS will strictly adhere to safety and risk reduction measures, Alternative 2 will result in moderate, adverse, direct, and long-term impacts to employee and visitor health and safety in Yellowstone. During the duration of the temporary plan, the risk management and safety concerns will continue to be reviewed and assessed. Because the use levels and risk factors in Grand Teton and the Parkway are substantially less than in Yellowstone, the impacts on visitor and employee health and safety would also be less, and are considered to be minor, direct, adverse, and long-term.

Mitigations

For both alternatives, current mitigation measures such as the wearing of appropriate winter clothing, helmets, and earplugs would continue as needed. Other personal protective equipment would be made available for employee use as appropriate.

For Alternative 2, guiding is an effective mitigation for visitor and employee health and safety, because guides are effective at enforcing proper touring behaviors, such as staying within speed limits and on the groomed road surfaces. Requirements for BAT on snowmobiles and snowcoaches have dramatically reduced exposure to air toxics and mitigated exposure to noise. Snowcoach size limits would mitigate the effects of large vehicles upon the road surfaces. The use of hearing protection is an effective mitigation against noise exposure; the NPS recommends such protection for all OSV users, including visitors. Monitoring of air toxics and exposure to noise will continue and adaptive management utilized as needed to protect employee and visitor health and safety.

For Alternative 2, exposure to avalanche hazards would be mitigated by area-specific forecasting, control methods such as helicopter dispensed explosives, howitzer operations, grooming and/or other appropriate control methods and mitigation measures. Other mitigation includes closure of the pass when necessary to protect human health and safety (as determined by NPS personnel). During the winter season, administrative travel will only be allowed when the pass is open to the public. Closures may occur frequently for unlimited periods of time and are likely to inconvenience planned employee and visitor travel.

Cumulative Impacts

The area of concern is the parks. Few if any actions or trends from outside the parks would influence public and employee health and safety in the parks. For example, the trend toward increasing guide and outfitter activity extends to the parks, but the NPS strictly regulates the provision of guided services within the parks. As well, although changing demographics means an increasing interest in outdoor activities, all snowmobiling in Yellowstone is guided, reducing the occurrence of unsafe snowmobile behaviors.

For employees exposed to noise and rough roads, health effects may accumulate over the course of a season. Additionally, there is the potential for synergistic effects. However, under alternative 2, the provisions for BAT, limited entries, and guided groups substantially mitigate these effects. A variety of other hazards associated with winter travel may also be experienced while traveling in the parks during the winter, all of which are common to winter travel in the intermountain west. These hazards may include avalanches, rock fall, hypothermia, blowing

snow, traffic accidents and poor driving conditions. To some extent these hazards are mitigated by management action such as the cold weather advisory system and temporary road closures.

Overall, the moderate, short-term, and adverse impacts resulting from direct and indirect actions described in both alternatives would contribute a minor to moderate, adverse, short-term impact to past, present, and foreseeable actions and impacts on employee health and safety.

Conclusions

For both alternatives, continued use of snowmobiles would expose employees and/or visitors to potentially high noise levels, although the wearing of earplugs can mitigate this to a large degree. Road grooming would be less frequent under Alternative 1, while snowcoach use could affect road quality under Alternative 2, so the effects of road surface quality from either alternative on employee and visitor health and safety would be about the same. Alternative 2's provision to keep Sylvan Pass open would result in major impacts if it were not for the fact that NPS will strictly adhere to a safety-based risk reduction program. Consequently, the effects of implementing either alternative on visitor and employee health and safety in Yellowstone will be moderate, long-term, direct, and adverse, and minor, direct, long-term, and adverse in Grand Teton and the Parkway.

Effects on Visitor Access and Circulation

Methodology

Although NPS policies for Yellowstone and Grand Teton have tended to emphasize visitor experiences based on the quality of park resources rather than the mode of transport used to access them, the mode of travel that a visitor prefers is not necessarily related to intrinsic park values. The modes of travel include snowmobile and snowcoach access. This section therefore addresses the impact of changes in mode of access and the places in the parks that are accessible separately from impacts relating specifically to visitor experience.

Impact Threshold Definitions

Negligible: Changes in the modes of transportation (snowmobile and snowcoach) and in the areas accessible (as compared to current conditions) affect small areas of the parks and are imperceptible to most visitors.

Minor: Changes in the modes of transportation and in the areas accessible (as compared to current conditions) affect a few areas of the parks and are noticeable to many visitors.

Moderate: Changes in the mode of transportation and in the areas accessible (as compared to current conditions) affect a number of areas of the parks and are evident to most visitors.

Major: Changes in the mode of transportation and in the areas accessible (as compared to current conditions) affect a majority of the parks and are evident to virtually all visitors.

Impacts Common to Both Alternatives

Wheeled vehicle access from Yellowstone's North Entrance to Mammoth Hot Springs and to the Northeast Entrance and Cooke City would occur under both alternatives, as would wheeled

vehicle access in Grand Teton National Park from the South Entrance to Moran Junction and to Flagg Ranch.

Effects of Alternative 1

Under this alternative, all oversnow roads in Yellowstone would be closed to public oversnow vehicle access, although non-motorized access would be allowed. This alternative would have a major adverse impact on visitors wishing to access the parks via oversnow vehicles in the winter because changes in the modes of transport would affect most of the park and would displace nearly all visitors from the interior portions of Yellowstone where oversnow vehicle access has been the predominant means of access for several decades.

Some of those desiring non-motorized experiences would benefit, because the parks would remain open for these activities. However, accessing non-motorized trails within Yellowstone's interior would be difficult for most skiers and snowshoers. Also, for visitors who prefer to visit the park without snowmobiles present, the impact of this alternative would be beneficial.

In Yellowstone, the effects of alternative 1 on visitor access and circulation would be long-term, direct, major, and adverse because of the highly restricted nature of the access, although effects on the minority of the public desiring to see oversnow access terminated would be beneficial.

For Grand Teton and the Parkway, snowmobile access to the large expanse of Jackson Lake would no longer be available for anglers that enjoy the ice fishing opportunities. While it is possible to access some areas of the lake that are close to shore, the vast majority of the lake would be inaccessible due to the large distances involved. Lack of access to the lake would be a considerable adverse affect for the subset of park visitors for whom ice fishing is important, but this group of visitors represents only a very small fraction of the park's overall winter visitation.

Similarly, snowmobile prohibition on the Grassy Lake Road between Flagg Ranch and the Targhee National Forest would deny some visitors the opportunity to complete a long-distance snowmobile tour, or to simply access the national forest from the Flagg Ranch area. While the closure of the Grassy Lake Road within the Parkway would have important adverse effects for those visitors that wished to use it, the number of visitors affected would be very small in proportion to the overall amount of winter visitation.

Overall, the effects of Alternative 1 on visitor access and circulation for Grand Teton and the Parkway would be long-term, direct, minor, and adverse.

Effects of Alternative 2

All usual oversnow roads, including the East Entrance Road/Sylvan Pass, would remain open under alternative 2. Visitors would continue to have access to the park's major features, and visitor circulation through the parks would remain largely unchanged from current conditions. The Cave Falls Road would also be designated open for snowmobile use, making the Cave Falls feature accessible.

This alternative offers visitors several choices in experiencing the parks: guided snowmobile, guided snowcoach, cross-country skiing, and snowshoeing.

Some people for whom the experience of traveling independently (that is, without a guide) on a snowmobile is important may choose not to visit the parks because the type of access and experience they prefer is not available. The impact of this alternative would be adverse for these potential visitors.

Some visitors who would prefer to visit by snowmobile but are unable to do so because of the low daily snowmobile entry limits may choose instead to visit by snowcoach. Although these people would still have access to the park, they may be adversely affected because the snowcoach tour was not their preference. Some people may opt instead to visit the park on a less busy day, travel to a different entrance where the daily snowmobile limit has not been reached (although the driving distance between the park entrances in the winter would make this impractical in most cases), or decide not to visit the park at all. For these visitors, the effects of implementing this alternative would be adverse.

Because of the lower daily limit on snowmobiles (318 per day), visitors who desire fewer snowmobiles might find this alternative attractive. Others may still be dissatisfied that any snowmobiles are present, so the number of snowmobiles permitted under alternative 2 may be a deterrent to their visit, and the impact of this alternative on those visitors' access would be adverse.

A winter visit to Yellowstone has always been expensive; in recent years, with the advent of restrictions on use to address the concerns related to historic snowmobile use, the cost has risen further. This has been especially true for residents near the parks who previously brought their private snowmobiles in the parks and for park employees who do not live in the park's interior. With the BAT restrictions imposed in the last four winters, residents and others who do not own BAT machines can no longer bring their own sleds into Yellowstone. The guiding requirements are an additional burden for some, both financially and logistically. Further, some guides and outfitters have chosen not to operate during the Temporary Plan implementation, limiting use more. The uncertainties brought on by court decisions and the short duration of the temporary plan have prevented the NPS from offering a business opportunity to other companies who might be interested in operating and providing guide services in the winter. If and when a long-term and sustainable decision is reached, business opportunities commensurate with the decision of that plan can be offered, and businesses will be chosen though a competitive process.

In Yellowstone, the effects of alternative 2 on visitor access and circulation would be long-term, direct, minor, and adverse because the lower visitation limit could impact some visitors who would prefer to tour via snowmobile. The effects on the minority of the public desiring to see oversnow access terminated (and/or snowmobile use specifically) would be adverse, minor, direct, andlong-term.

For Grand Teton and the Parkway, visitors would continue to have the opportunity to access Jackson Lake and the Grassy Lake Road by snowmobile. This would allow anglers to access the large expanse of Jackson Lake to enjoy ice fishing opportunities, and would also allow snowmobile touring opportunities that involved the Targhee National Forest and other public lands. The opportunities provided under Alternative 2 would be important to the visitors for whom those activities are important, but that would be a very small portion of the park's overall winter visitation.

Overall, the effects of Alternative 2 on visitor access and circulation for Grand Teton and the Parkway would be long-term, direct, minor, and beneficial.

Cumulative Effects

The parks are one component of the GYA, which includes several national forests, wildlife refuges, and communities such as Jackson and Cody, Wyoming; West Yellowstone and Gardiner, Montana; and Island Park and Ashton, Idaho. Visits to the parks are often combined with visits to a wide variety of destinations elsewhere in the region and the three-state area.

Opportunities to snowmobile abound on the public lands around the parks, with both on-and off-trail access available at a variety of skill levels. Forest and/or travel planning are underway in some of the national forests around the park, but these plans are in process and it cannot be predicted how they may affect oversnow travel in the region. The USFS has begun implementation of the Gallatin National Forest Travel Plan, with varying effects around Yellowstone. Although some motorized trails will be lost, others are being formalized, and non-motorized opportunities are being strengthened as well. Opportunities to ride a snowcoach are generally limited to the parks, because snowcoaches are, for the most part, restricted from using forest trails.

The effects of these actions on visitor access and circulation in the parks, or effects in the reverse direction, are difficult to predict. As indicated in the *Environmental Consequences, Socioeconomics* discussion, use of the parks and surrounding lands does not always correlate. Some outside areas have observed decreases in use in recent years, but not at the same rate or magnitude as the parks.

Population growth through the GYA, rural land subdivision and reduction of public land access, changing demographics, improving snowmobile technologies, and increasing outfitter/guide activity may all influence visitor access and circulation in various ways. It is very difficult to predict how any one of these trends, or the interactive effects of more than one or all of them together, will influence visitor access and circulation. In general, though, the effects of these trends on park access and circulation will be indirect, at least as compared to the actual guidance provided under the two alternatives in this EA.

New or rehabilitated visitor centers with greatly improved exhibits and interpretation are underway (Canyon opened August 2005, the Craig Thomas Discovery and Visitor Center and the Laurance S. Rockefeller Plan Preserve in Grand Teton both recently opened, and Old Faithful is under construction). A new West Entrance Station and improved facilities at the West Yellowstone Interagency Visitor Center were recently completed in Yellowstone. Road improvements may eventually widen the underlying snow roads from Norris to Mammoth and Grant Village to South Entrance in Yellowstone. The Togwotee Pass Highway is also being improved and widened. Completion of the Grand Teton Transportation and Teton Pathways plans may improve non-motorized access in the Jackson/Grand Teton area, as will Rendezvous Ski Trail planning in West Yellowstone. These projects will improve access in the parks through enhanced interpretation and better facilities.

The cumulative effects of no snowmobile and snowcoach access may displace all variety of winter users to the surrounding lands, creating substantial effects there. Fewer visitors might travel to the Greater Yellowstone Area in the absence of oversnow vehicle access opportunities in the parks. Conversely, the lack of snowmobiles may attract other visitors who will recreate in other ways on the surrounding lands as part of their visit. For those who prefer to visit the parks with snowmobiles eliminated entirely, Alternative 1 may encourage these visitors to visit the GYA.

Past, present, and foreseeable actions occurring within and around the parks that could affect visitor access and circulation are the same for alternative 2 as those for alternative 1. The cumulative effects of alternative 2 may be higher than alternative 1 due to the allowance of recreational snowmobile and snowcoach use in the parks, which may result in increased use of the surrounding lands as more snowmobile-oriented visitors may travel to the Greater Yellowstone Area. For those who prefer to visit with snowmobile numbers reduced or

snowmobiles eliminated entirely, the lower number of allowed snowmobiles may encourage these visitors to visit the GYA.

Conclusions

The effects of alternative 1 on visitor access and circulation would be long-term, major, adverse (or beneficial for those visitors who don't want snowmobiles in the parks and would visit the parks only if and/or more often if no snowmobiles were present), and direct in Yellowstone and minor, adverse, long-term, and direct in Grand Teton and the Parkway because all current routes would be closed to oversnow vehicle travel.

In terms of cumulative effects, the long-term, major, adverse (or beneficial for those desiring no snowmobiles in the parks) impacts resulting from direct and indirect actions described for alternative 1 would contribute a major, long-term, adverse impact to past, present, and foreseeable actions and impacts on visitor access and circulation.

The effects of alternative 2 on visitor access and circulation would be long-term, minor, adverse (or beneficial for those who don't like as many snowmobiles in the parks), and direct because all current routes would be open to oversnow (both snowmobiles and snowcoaches) vehicle travel, including the East Entrance road/Sylvan Pass. The number of snowmobiles allowed in the parks would be similar to current conditions; therefore, on busy days, due to the daily limit of 318 snowmobiles, some visitors desiring to snowmobile would not be able to access the parks.

In terms of cumulative effects, the long-term, minor, adverse (or beneficial for those who want snowmobiles eliminated), and park-wide impacts resulting from direct and indirect actions described in Alternative 2 would contribute a long-term, minor, adverse impact to past, present, and foreseeable actions and impacts on visitor access and circulation.

Effects on Visitor Experience

Methodology

The area of analysis for visitor experience is the three parks. This section includes an analysis of quality opportunities to view and experience park resources in a minimally affected environment. Resources considered in the analysis include: opportunities to view wildlife and scenery, the safe behavior of others, quality of road surfaces, availability of information, quiet and solitude, clean air, and stakeholder values. Visitor access was separately analyzed in the foregoing section.

To evaluate the level of impact to the visitor experience for each alternative, the following types of information were used:

- Visitor surveys
- Assessment of visitation patterns
- Assessment of opportunities historically available

Impact Threshold Definitions

Negligible: Visitors have quality opportunities to view and experience the parks in a minimally-affected environment, with safe and comfortable touring conditions, ready availability to information, good opportunities to view wildlife and scenery, and easy access to quiet, solitude, and clean air.

Minor: The impact to visitor experience is slight, without appreciably limiting or enhancing critical characteristics of the experience. Although visitors may have slight difficulties finding safe and comfortable touring conditions, ready availability to information, good opportunities to view wildlife and scenery, and/or easy access to quiet, solitude, and clean air, their visits remain high quality with a high degree of satisfaction.

Moderate: The impact to visitor experience is noticeable and may be measurable, changing critical characteristics of the desired experience, or reducing or increasing the number of visitors. Visitors will occasionally have some difficulty finding safe and comfortable touring conditions, ready availability to information, good opportunities to view wildlife and scenery, and/or easy access to quiet, solitude, and clean air. Their visits are good quality with generally good degrees of satisfaction.

Major: The impact to visitor experience is substantial and measurable, eliminating, detracting from, or greatly enhancing multiple critical characteristics of the desired experience, or greatly reducing or increasing visitation. Visitors will frequently have substantial difficulty finding safe and comfortable touring conditions, ready availability to information, good opportunities to view wildlife and scenery, and/or easy access to quiet, solitude, and clean air. Their visits are fair quality with fair degrees of satisfaction.

Effects of Alternative 1

For visitors travelling in wheeled vehicles to visit the northern tier of Yellowstone, visitor access and experiences would remain unchanged. The restriction for the rest of the park to ski and snowshoe access only, however, would have substantial effects upon the visitor experience. Only a handful of visitors capable of skiing or snowshoeing many miles would be able to enjoy the wildlife, scenery, silence, solitude, and clean air in the park interior. Guides would no longer be needed and the Visitor Center at Old Faithful would be closed; both changes would diminish information availability in Yellowstone.

Compared to current conditions, this alternative's effects upon the visitor experience in Yellowstone would be adverse and substantial. Most of the park would be closed, eliminating any possible experience for most visitors (skiers and snowshoers could still use the park). In Yellowstone, the effects of Alternative 1 on visitor experience would be major, adverse, direct, and long-term.

In Grand Teton and the Parkway, there would generally be no change in terms of roads that have traditionally been plowed for wheeled vehicles, nor to the facilities that have traditionally been available to park visitors. Opportunities for a wide variety of winter activities would remain, and most visitors would be unaffected by the prohibition on the use of snowmobiles on either Jackson Lake or the Grassy Lake Road. The absence of noise associated with snowmobiles might enhance the experience of some visitors by improving opportunities for quiet and solitude. Outstanding opportunities for cross-country skiing, snowshoeing, mountaineering, wildlife viewing, and enjoyment of the scenery would continue to be available throughout the park. The experience of visitors for whom snowmobile access to Jackson Lake or the Grassy Lake Road is important would be diminished, although these visitors represent only a small portion of the park's visitation.

Overall, the effects of Alternative 1 on visitor experience for Grand Teton and the Parkway would be direct, long-term, minor, and adverse, although some visitors might characterize the effect as beneficial due to the absence of snowmobiles.

Regarding values-based responses of visitors to the rules under this alternative, adherents to recreation and tourism resource values would likely find these rules to be quite burdensome because most of the parks would have limited, non-motorized access. Some adherents to natural values would likely be encouraged by the elimination of snowmobiles and snowcoaches from the parks and other adherents to this view would likely be pleased at the clean air, quiet conditions, which would prevail under this alternative. However, some adherents to natural values would regret the lack of access possible and reduced information availability under this alternative.

Effects of Alternative 2

As summarized in *Affected Environment,* the 2008 visitor surveys indicate widespread visitor satisfaction with soundscape conditions found in the park last winter, as well as bison viewing opportunities. The continued ability to tour the parks by OSV would offer good opportunities to have an enjoyable visitor experience, especially in Yellowstone where many park attractions would not otherwise be accessible to most visitors. The requirements to use commercial guides and BAT snowmobiles under this alternative would enable good opportunities to view wildlife and scenery, generally safe touring conditions, ready availability of information, good opportunities for quiet and solitude, and clean air, similar to the conditions that have prevailed in the parks in the last four winters. Guides are familiar with typical wildlife viewing locations and routinely make impromptu stops to view wildlife and park scenery. They enforce proper touring behavior and usually provide informative commentary to their clients; other information would continue to be available at warming huts, contact stations, visitor centers and entrance stations. Because guided groups travel together and because most such groups adhere to schedules that leave large periods of time free from OSV noise, periods of quiet and opportunities for solitude will remain. Additionally, the requirement to use BAT technology will continue to mean the parks will have pristine air quality. Finally, although OSV travel may somewhat degrade the quality of groomed surfaces, most visitors would experience the parks on roads that are well-groomed on a regular basis.

The limits on snowmobile numbers will be restrictive, especially on holidays and weekends and some visitors may not be able to have the experience they desire. Although some capacity is available on snowcoaches, if visitors are willing and able to shift modes of transportation, snowcoaches could also reach capacity on traditionally busier periods.

For visitors travelling in wheeled vehicles to visit the northern tier of Yellowstone, visitor access and experiences would remain unchanged.

Compared to the no-action alternative, this alternative would offer a significantly better visitor experience (except for the small minority who could ski the long distances between park attractions under the no-action alternative) since it would allow motorized access to the parks to continue. Effects of implementing this alternative in Yellowstone would be minor, adverse, long-term, and direct because the low visitation limits under this alternative could preclude trips into Yellowstone for some visitors.

For Grand Teton and the Parkway, visitors would have the opportunity to enjoy ice fishing on Jackson Lake, and have access to snowmobiling opportunities along the Grassy Lake Road and in the Targhee National Forest. Opportunities for ice fishing on Jackson Lake would be

enhanced since snowmobiles would make the entire lake available, rather than only those areas within walking distance of the shore. Visitors would continue to enjoy outstanding opportunities for cross-country skiing, snowshoeing, mountaineering, wildlife viewing, and enjoyment of the scenery throughout the park. The snowmobile access on Jackson Lake would benefit only a small percentage of the park's overall winter visitation, although the sounds of snowmobiles could also be viewed as an adverse effect on other visitors.

Overall, the effects of Alternative 2 on visitor use and experience for Grand Teton and the Parkway would be long-term, direct, beneficial, and minor, however, some visitors might characterize the effect as adverse.

Some generalizations regarding the values-based responses of visitors to the rules under this alternative are possible. Using the characterizations of the two main values groups provided by Borrie, Freimund, and Davenport (2002), adherents to "recreation and tourism resource values" may find the guiding requirement to be burdensome, although other adherents to this perspective will be satisfied that basic motorized park access is available. Adherents to "natural values" may be discouraged at the continued use of snowmobiles in the parks, although other adherents to this view will be pleased at the clean air, quiet conditions, orderly and safe visitor behavior, and information availability that would prevail under this alternative.

Mitigating Measures

No measureable impacts on sound, wildlife, air quality and other natural resources would be expected to occur under alternative 1. The monitoring and adaptive management program would be implemented to ensure that ski and snowshoe use does not create concerns. The closure of much of the parks to visitor access would have substantial impacts upon the visitor experience, impacts not easily mitigated.

Monitoring of many aspects of the visitor experience will continue (such as air quality, sound, and wildlife) under alternative 2. The NPS will use the adaptive management plan presented in the appendices to remedy any impacts that would arise under this plan. The use of guides and BAT technology are also mitigations for the visitor experience. As discussed above, these provisions significantly improve the visitor experience for many visitors.

Cumulative Effects

The area considered for cumulative impact assessment is that within the boundaries of the three park units along with those trends, projects, and actions in the region that may influence a visitor's experience.

The parks are one component of the GYA, which includes several national forests, wildlife refuges, and communities such as Jackson and Cody, Wyoming; West Yellowstone and Gardiner, Montana; and Island Park and Ashton, Idaho. Visits to the parks are often combined with visits to a wide variety of destinations elsewhere in the region and the three-state area. Opportunities to snowmobile abound on the public lands around the parks, with both on-and off-trail access available at a variety of skill levels. As indicated in the *Environmental Consequences, Socioeconomics* discussion, use of the parks and surrounding lands does not always correlate. Some areas have observed decreases in use in recent years, but the relationship of such declines to park visitation is unclear.

Completion of the NPS visitor centers at Old Faithful, Canyon, and Moose, and the Laurance S. Rockefeller Preserve will improve (or are already improving) the visitor experience for many.

Similarly, further reclamation of the abandoned mines above Cooke City would improve the experience for visitors, some of whom snowmobile or ski in that area.

Actions taken by the U.S. Forest Service on national forest lands outside the parks may alter opportunities for snow-based recreation. The increase or decrease in these opportunities may add to or diminish the quality of the visitor experience that park visitors may have. Changes in current activities outside the park may be included in revisions to the forest plans and/or travel plans being contemplated by many of the surrounding national forests. Although most of those changes are unknown at this time, with uncertain effects on visitor experience, the national forests have all amended their forest plans for grizzly bear and lynx conservation. These amendments may affect visitor experience indirectly, because the forests may be less able to respond to changing recreation trends than they would otherwise be.

Regional population growth, rural land subdivision/reduction of public land access, changing demographics, and increasing outfitter/guide activity may also affect visitor experience. Population growth and changing demographics may lead to increased demand for recreation in finite areas, with rural land subdivision also possibly limiting the availability of public land. Some visitors may enjoy the increased outfitter and guide activity (particularly the ability to learn from knowledgeable guides).

When added to the potential actions of other agencies adjacent to Yellowstone or within the park which would act to restrict access, Alternative 1 could have the effect of dramatically and adversely affecting the visitor experience. Alternative 2 would have only minor effects, because visitors would still have motorized access to the parks and would not be displaced (to the degree that Alternative 1 would cause) to other national parks.

Conclusions

Closure of Yellowstone park roads, Jackson Lake, and the Grassy Lake Road to OSV travel would mean that most visitors would not be able to enjoy the wildlife, scenery, silence, solitude, clean air, or information on those roads. Therefore, the effects of implementing alternative 1 on the visitor experience would be major, adverse, long-term, and direct in Yellowstone and minor, adverse, direct, and long-term in Grand Teton and the Parkway. However, visitors could ski or snowshoe in the parks and this alternative would result in no unacceptable impacts to the visitor experience (many other national parks have major portions limited to non-motorized access in the winter).

In terms of cumulative effects, the major, adverse, long-term impacts resulting from direct and indirect actions described in alternative 1 would contribute a moderate, adverse, long-term impact to past, present, and foreseeable actions and impacts on visitor experience in Yellowstone. In Grand Teton and the Parkway, the minor, adverse, long-term impacts resulting from direct and indirect actions described in alternative 1 would contribute a minor, adverse, long-term impact to past, present, and foreseeable actions and impacts on visitor experience.

Under Alternative 2, visitors will continue to be able to view and experience the parks in a natural setting, enjoying good access to park attractions through their guides and the new and existing visitor centers. The current high level of satisfaction (as indicated by the 2008 visitor surveys discussed in *Affected Environment*) would continue. Visitor numbers will be limited, so that especially on holidays and some weekend days, people will not be able to access the park via snowmobiles. Some snowmobilers may choose to ride snowcoaches instead, although on holidays, coach capacity may also be reached. Opportunities to view wildlife and scenery will abound and access to quiet, solitude, and clean air will be abundant. However, OSV roads could

be rough at times under this alternative, so the overall effects of this alternative on the visitor experience in Yellowstone would be minor, adverse, long-term, and direct. In Grand Teton and the Parkway, the overall effects of Alternative 2 would be minor, beneficial, long-term and direct. This alternative would result in no unacceptable impacts to the visitor experience.

In terms of cumulative effects, the minor, adverse (for Yellowstone) and beneficial (for Grand Teton and the Parkway), short-term impacts resulting from direct and indirect actions described in this alternative would contribute a minor, adverse, short-term impact to past, present, and foreseeable actions and impacts on visitor experience.

Unacceptable Impacts and Impairment

As previously described, unacceptable impacts are those that fall short of impairment, but are still not acceptable within a particular park's environment. As defined in §8.2 of 2006 *Management Policies,* unacceptable impacts are those that would:

- Be inconsistent with a park's purposes or values, or
- Impede the attainment of a park's desired future conditions for natural and cultural resources as identified through the park's planning process, or
- Create an unsafe or unhealthful environment for visitors or employees, or
- Diminish opportunities for current or future generations to enjoy, learn about, or be inspired by park resources or values, or
- Unreasonably interfere with
    - Park programs or activities, or
    - An appropriate use, or
    - The atmosphere of peace and tranquility, or the natural soundscape maintained in wilderness and natural, historic, or commemorative locations within the park.
    - NPS concessioner or contractor operations or services.

Neither alternative is inconsistent with either Yellowstone nor Grand Teton's purposes and values. Both parks were established for resource protection and visitor enjoyment and both alternatives protect resources and provide opportunities for visitor enjoyment. Neither alternative impedes the attainment of the parks' desired future conditions; in fact the desired conditions from previous park planning documents are reproduced as objectives and desired conditions for this temporary plan.

The analysis of effects on employee and visitor health and safety indicated that there are no major adverse effects under either alternative; effects were analyzed as minor to moderate.

Under either alternative, visitors continue to have opportunities to enjoy, learn about, or be inspired by park resources and values.

Implementation of alternative 1 would have adverse effects on the NPS concessioner, but there is no unreasonable interference.

Regarding soundscapes, implementation of Alternative 1 would result in negligible impacts to natural soundscapes because no oversnow motorized visitor use would be permitted. Under Alternative 2, impacts to natural soundscapes were identified and resulted in negligible to

moderate direct, short-term, and adverse impacts, due to audibility and maximum sound levels. Because there are no major adverse effects to natural soundscapes, implementation of either alternative would not unreasonably interfere with the natural soundscape. The effects on soundscapes estimated under either alternative will not be unacceptable because winter silence will be predominant away from developed areas and road corridors and present at certain times of day and in certain places even in those areas. The soundscapes impacts are also acceptable because some non-natural sounds are expected in developed areas and road corridors (people use motorized vehicles to access Yellowstone and Grand Teton's widely spaced wonders), and the levels of such sound under that alternative are at only moderate levels. Finally, maximum sound levels under both alternatives are expected to remain below levels that are acceptable to most visitors as snowcoaches are retrofitted to be BAT.

The effects on wildlife are expected to be acceptable because wildlife populations are expected to remain healthy and abundant. Although monitoring reveals some disturbance to individual animals, no wildlife populations are declining due to winter use (swan populations are declining, but this decline is being experienced regionally, not just in Yellowstone). Few, if any, animals are expected to be killed as a result of vehicle collisions, displacement and behavioral and physiological effects are expected to be minor and of little consequence to wildlife populations (with potential moderate effects on swans and eagles), and only negligible population effects are expected. Visitors will continue to find wildlife to be both wild and easily viewed; they will all travel with commercial guides or in snowcoaches, learning about and enjoying the abundant wildlife sightings.

Under either alternative, air quality in the parks is expected to remain pristine, at less than 24% of the federal NAAQS. This small a percentage indicates how clean the winter air in the parks is at either alternative in this EA: in a word, excellent. Unacceptable impacts would be levels of pollutants that are considerably closer to violations of the federal NAAQS. With the conservative use limits and Best Available Technology restrictions for snowmobiles and the move towards cleaner snowcoaches, the NPS expects implementation of either alternative to preserve excellent air quality in the parks, air that is far removed from being unacceptable in quality or being impaired.

As described in *Purpose and Need*, the NPS's threshold for considering whether there could be an impairment is based on *major* (or significant) effects. This EA identifies less than major effects on wildlife, natural soundscapes, and air quality for Alternatives 1 and 2. Guided by this analysis and the Superintendent's professional judgment, there would be no impairment of park resources and values from implementation of Alternative 1 or 2.

CHAPTER 5: CONSULTATION, COORDINATION, AND BIBLIOGRAPHY

Public Involvement

As described in Chapter 1, due to the extensive public involvement and public comment received over the past decade on the winter issue, scoping was not conducted on this EA.

This EA will be posted for public review on the NPS Planning, Environment and Public Involvement (PEPC) web site (http://parkplanning.nps.gov) and on the Yellowstone winter web site (http://www.nps.gov/yell/planyourvisit/winteruse.htm). A news release will be issued, and an email notification will be sent to an extensive (400+) list of agencies and individuals notifying them that the EA is available for review and comment.

Preparers

Name	Title or Role	Agency or Affiliation
Preparers		
Mike Yochim	Outdoor Recreation Planner	Yellowstone National Park
John Sacklin	Management Assistant	Yellowstone National Park
Christine Turk	Environmental Quality Coordinator	Intermountain Region – NPS
Laurie Domler	Environmental Protection Specialist	Intermountain Region – NPS
Kevin Franken	Planning Assistant	Yellowstone National Park
Technical Expertise		
Shan Burson	Ecologist	Yellowstone National Park
Bruce Peacock	Economist	National Park Service
John D. Ray	Atmospheric Chemist	National Park Service
Gary Pollock	Management Assistant	Grand Teton National Park
P.J. White	Wildlife Biologist	Yellowstone National Park
Consultants		
Wayne Freimund	Professor	University of Montana
Chris Neher	Economist	University of Montana
John Duffield	Economist	University of Montana

Name	Title or Role	Agency or Affiliation
Management Support		
Colin Campbell	Deputy Superintendent	Yellowstone National Park
Chris Lehnertz	Deputy Superintendent	Yellowstone National Park
Suzanne Lewis	Superintendent	Yellowstone National Park
Al Nash	Chief of Public Affairs	Yellowstone National Park
Mary Gibson Scott	Superintendent	Grand Teton National Park
Michael Snyder	Intermountain Regional Director	National Park Service
Bob Vogel	Deputy Superintendent	Grand Teton National Park

Bibliography and List of Cited References

Ables, E. D. and C. D. Ables. 1987. "Behavioral Comparisons of Elk in Yellowstone National Park." Journal of Idaho Academy of Science 23(2): 40-48.

Alger, Russ, Scott Gruenberg, and Geoff Gwaltney. 2002. "Snowmobile Trail Bump Formation Analysis, Prediction, and Modeling. Final Report for National Park Service - Yellowstone National Park." Keweenaw Research Center, Michigan Technological University.

Alt, K. L. 1980. "Ecology of the Breeding Bald Eagle and Osprey in the Grand Teton-Yellowstone National Parks Complex." Master's Thesis, University of Montana, Missoula, Montana.

Ambrose, Skip, Chris Florian, and Shan Burson. 2006. "Low-Level Soundscape Measurements, Yellowstone National Park, Feb. 7-9, 2006." National Park Service, Yellowstone National Park, Wyoming.

Apps, C. D. 2000. "Space-Use, Diet, Demographics, and Topographic Associations of Lynx in the Southern Canadian Rocky Mountains: A Study." Pages 356–376 *in* Ecology and Conservation of Lynx in the United States, L. F. Ruggiero, K. B. Aubry, S. W. Buskirk, G. M. Koehler, C. J. Krebs, K. S. McKelvey, and J. R. Squires, eds. U.S.D.A. Forest Service, General Technical Report RMRS-GTR-30WWW.

Aune, K. E. 1981. "Impacts of Winter Recreationists on Wildlife in a Portion of Yellowstone National Park, Wyoming." Master's Thesis, Montana State University, Bozeman, Montana.

Banci, V. A. and A. S. Harestad. 1990. "Home Range and Habitat Use of Wolverines (*Gulo gulo*) in Yukon." Holarctic Ecology 13: 195-200.

Banci, V. A. and A. S. Harestad. 1988. "Reproduction and Natality of Wolverine (*Gulo gulo*) in Yukon." Ann. Zool. Fenn. 25: 265-270.

Barber, S. M., L. D. Mech, and P. J. White. 2005. "Bears Remain Top Summer Predators." Yellowstone Science 13(3): 37-44.

Big Sky Institute. 2006. "A Stakeholder Workshop to Identify Potential Winter use Management Effects Studies for the Road Corridor from Madison Junction to Mammoth Hot Springs, January 18-19, 2006." National Park Service files, Yellowstone National Park, Wyoming.

Bishop, Gary A., Daniel A. Burgard, Thomas R. Dalton, and Donald H. Stedman. 2006. "In-Use Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park." Unpublished report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Bishop, Gary A., Ryan Stadtmuller, and Donald H. Stedman. 2007. "Portable Emission Measurements of Snowcoaches and Snowmobiles in Yellowstone National Park." Unpublished report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Bjornlie, D. D. 2000. "Ecological Effects of Winter Road Grooming on Bison in Yellowstone National Park." Master's Thesis, Montana State University, Bozeman, Montana.

Bjornlie, D. D. and R. A. Garrott. 2001. "Ecological Effects of Winter Road Grooming on Bison in Yellowstone National Park." Journal of Wildlife Management 65: 560-572.

Bomar, Mary. 2007a. Memorandum to All Employees, June 5, 2007. National Park Service, Yellowstone National Park, Wyoming.

Bomar, Mary. 2007b. Memorandum to All Employees, July 10, 2007. National Park Service, Yellowstone National Park, Wyoming.

Borkowski, J. J. 2006. "Evaluating Wildlife Responses to Winter Human Use in Yellowstone National Park – Statistical Analyses of Four Years (2003-2006) of Winter-Use Wildlife Road Survey Data for Bison, Elk, Trumpeter Swans, Bald Eagles, and Coyotes." Unpublished report, National Park Service, Yellowstone National Park, Wyoming.

Borkowski, J. J., P. J. White, R. A. Garrott, T. Davis, A. R. Hardy, and D. J. Reinhart. 2006. "Behavioral Responses of Bison and Elk in Yellowstone to Snowmobiles and Snow Coaches." Ecological Applications 16 (5): 1911-1925.

Borrie, William T., Wayne A. Freimund, and Mae A. Davenport. 2002. "Winter Visitors to Yellowstone National Park: Their Value Orientations and Support for Management Actions." Human Ecology Review 9(2): 41-48.

Bruggeman, J.E., P.J. White, R.A. Garrott, F.G.R. Watson. 2008a. "Partial migration in central Yellowstone bison." Chapter 12 in R.A. Garrott, P.J. White, and F.G.R. Watson, eds. Large mammal ecology in central Yellowstone: a synthesis of 16 years of integrated field studies. Elsevier, Academic Press Terrestrial Ecology Series, San Diego, California.

Bruggeman, J.E., R.A. Garrott, P.J. White, D.D. Bjornlie, F.G.R. Watson, and J.J. Borkowski. 2008b. Bison winter road travel: facilitated by road grooming or a manifestation of natural trends? Chapter 27 in R.A. Garrott, P.J. White, and F.G.R. Watson, eds. Large mammal ecology in central Yellowstone: a synthesis of 16 years of integrated field studies. Elsevier, Academic Press Terrestrial Ecology Series, San Diego, California.

Bruggeman, J.E., R.A. Garrott, P.J. White, F.G.R. Watson, and R.W. Wallen. 2008c. Effects of snow and landscape attributes on bison winter travel patterns and habitat use. Chapter 28 in R.A. Garrott, P.J. White, and F.G.R. Watson, eds. Large mammal ecology in central

Yellowstone: a synthesis of 16 years of integrated field studies. Elsevier, Academic Press Terrestrial Ecology Series, San Diego, California.

Bruggeman, J. E., R. A. Garrott, P. J. White, F. G. R. Watson, and R. W. Wallen. 2007. "Covariates Affecting Spatial Variability in Bison Travel Behavior in Yellowstone National Park." Ecological Applications 17:1411-1423.

Bruggeman, J. E. 2006. "Spatio-Temporal Dynamics of the Central Bison Herd in Yellowstone National Park." Ph.D. Dissertation, Montana State University, Bozeman, Montana.

Bruggeman, J. E., R. A. Garrott, D. D. Bjornlie, P. J. White, F. G. R. Watson, and J. J. Borkowski. 2006. "Temporal Variability in Winter Travel Patterns of Yellowstone Bison: The Effects of Road Grooming." Ecological Applications 16: 1539-1554.

BRW, Inc. 1994. Alternative Transportation Modes Feasibility Study. [Denver]: Denver Service Center.

Burson, Shan. 2008a. "Natural Soundscape Monitoring in Yellowstone National Park, December 2007-March 2008." Unpublished, draft report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Burson, Shan. 2008b. "Natural Soundscapes of Grand Teton National Park, October 2002-June 2008," Working Draft, July 1, 2008, Grand Teton National Park files.

Burson, Shan. 2007. "Natural Soundscape Monitoring in Yellowstone National Park, December 2006-March 2007." Unpublished, draft report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Burson, Shan. 2006. "Natural Soundscape Monitoring in Yellowstone National Park, December 2005-March 2006." Unpublished report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Burson, Shan. 2005. "Natural Soundscape Monitoring in Yellowstone National Park, December 2004-March 2005." Unpublished report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Burson, Shan. 2004. "Natural Soundscape Monitoring in Yellowstone National Park, December 2003-March 2004." Unpublished report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Canfield, J. E., L. J. Lyon, J. M. Hillis, and M. J. Thompson. 1999. "Ungulates." In Effects of Recreation on Rocky Mountain Wildlife: A Review for Montana, coordinated by G. Joslin and H. Youmans. Committee on Effects of Recreation on Wildlife, Montana Chapter of the Wildlife Society.

Cassirer, E. F., D. J. Freddy, and E. D. Ables. 1992. "Elk Responses to Disturbance by Cross-Country Skiers in Yellowstone National Park." Wildlife Society Bulletin 20: 375-381.

Cheville, N. F., D. R. McCullough, L. R. Paulson, N. Grossblatt, K. Iverson, and S. Parker. 1998. "Brucellosis in the Greater Yellowstone Area." Washington D.C.: National Academy Press.

Clark, T. W., A. H. Harvey, R. D. Dorn, D. L. Gentor, and C. Graves, eds. 1989. "Rare, Sensitive and Threatened Species in the Greater Yellowstone Ecosystem." Jackson, Wyoming: Northern Rockies Conservation Cooperative, Montana Natural Heritage Program, The Nature Conservancy, and Mountain West Environmental Services.

Clark, W. 1999. "The Effects of Winter Recreation on Elk." In The Effects of Winter Recreation on Wildlife of the Greater Yellowstone Area: A Literature Review and Assessment, edited by T. Olliff, K. Legg, and B. Kaeding. Report to the Greater Yellowstone Coordinating Committee. Yellowstone National Park, Wyoming.

Comey, Bob. 2007. Avalanche Hazard Assessment and Mitigation Report, Sylvan Pass, Yellowstone National Park. National Park Service files, Yellowstone National Park.

Coefield, J. 2002. "Carbon Monoxide Monitoring in West Yellowstone, Montana, 1998-2001." Unpublished report, National Park Service, Yellowstone National Park, Wyoming.

Copeland, J. P. 1996. "Biology of the Wolverine in Central Idaho." Master's Thesis, University of Alaska, Fairbanks, Alaska.

Copeland, J. and K. Murphy. 2005. "Ecological Assessment of Wolverines (*Gulo gulo*) in the Absaroka-Beartooth Mountain Range: Answering Mission-Critical Questions about our Most Mysterious Carnivore." Unpublished study plan, National Park Service, Yellowstone National Park, Wyoming.

Coughenour, M.B. 2005. "Spatial-dynamic Modeling of Bison Carrying Capacity in the Greater Yellowstone Ecosystem: a Synthesis of Bison Movements, Population Dynamics, and Interactions with Vegetation." Natural Resource Ecology Laboratory, Colorado State University.

Crabtree, R.L. and J. W. Sheldon. 1999. "The Ecological Role of Coyotes on Yellowstone's Northern Range." Yellowstone Science 7: 15-22.

Craighead, J. J., F. C. Craighead, R. L. Ruff, and B. W. O'Gara. 1973. "Home Ranges and Activity Patterns of Nonmigratory Elk of the Madison Drainage Herd as Determined by Biotelemetry." Wildlife Monograph No. 33, Washington, D.C.: The Wildlife Society.

Creel, S., J. E. Fox, A. Hardy, J. Sands, B. Garrott, and R. O. Peterson. 2002. "Snowmobile Activity and Glucocorticoid Stress Responses in Wolves and Elk." Conservation Biology 16: 809-814.

Davis, Troy. 2007. "Wildlife Responses to Motorized Winter Recreation in Yellowstone: 2007 Annual Report (December 18, 2006 through March 29, 2007). Unpublished report, National Park Service and available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Davis, D., R. Jenkins and R. Angell. 2006. "2005-2006 Annual Winter Monitoring Report." Ashton/Island Park Ranger District, Caribou-Targhee National Forest, Idaho.

Davis, T., P.J. White, J. Borkowski, D. Reinhart, C. McClure, and P. Perrotti. 2004. "Wildlife Responses to Motorized Winter Recreation in Yellowstone National Park: 2003 Annual Report." Unpublished report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Dean Runyan and Associates. 2006. "The Economic Impact of Travel on Wyoming, 1997-2005 Detailed State and County Estimates." Prepared for the State Office of Travel and Tourism, Wyoming Business Council. Dean Runyan and Associates. Portland, Oregon.

Despain, Don. 1990. Yellowstone Vegetation: Consequences of Environment and History in a Natural Setting. Boulder, Colorado: Roberts Rinehart, Inc.

Dimmick, Curt R. 2002. "2001-2002 Winter Use Final Report." National Par Service, Yellowstone National Park, Wyoming.

Dimmick, Curt R. 2003. "Winter 2002-2003 Final Report." National Park Service files, Yellowstone National Park, Wyoming.

Dorrance, M. J., P. J. Savage, and D. E. Huff. 1975. "Effects of Snowmobiles on White-Tailed Deer." Journal of Wildlife Management 39: 563-569.

Duffield, J. and C. Neher. 2007. "Draft Supplemental Technical Memorandum, Regional Economic Impact Analysis of Options for Yellowstone and Grand Teton National Parks and John D. Rockefeller, Jr. Memorial Parkway Winter Use Management." Unpublished report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Duffield, J., C. Neher, and D. Patterson. 2006. "Wolves and People in Yellowstone: Impacts on the Regional Economy." Unpublished report prepared for Yellowstone Park Foundation available at http://www.defenders.org/resources/publications/programs_and_policy/wildlife_conservation/imperiled_species/wolf/northern_rockies_wolf/wolves_and_people_in_yellowstone.pdf, accessed on October 11, 2008.

Duffield, J. and C. Neher. 2006. "Final Technical Report, Regional Economic Impact Analysis for Yellowstone and Grand Teton National Parks and John D. Rockefeller, Jr., Memorial Parkway Winter Use Draft Environmental Impact Statement." Unpublished report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Duffield, J. and C. Neher. 2000. "Final Report, Winter 1998-99 Visitor Survey: Yellowstone National Park, Grand Teton National Park and the Greater Yellowstone Area." Unpublished report, National Park Service, Yellowstone National Park, Wyoming.

Eberhardt, L.L., P.J. White, R.A. Garrott, and D.B. Houston. 2007. "A Seventy-Year History of Trends in Yellowstone's Northern Elk Herd." Journal of Wildlife Management 71(2): 594–602.

Ecosystem Research Group. 2006. "Review Regional Economic Impact Analysis Greater Yellowstone Area Winter Use DEIS." Unpublished report prepared for State of Wyoming Office of Planning, available in National Park Service files, Yellowstone National Park, Wyoming.

Eibl-Eibesfeldt, I. 1970. Ethology: The Biology of Behavior. Holt, Rinehart, and Winston, New York, New York.

Ellard, J. A., N. P. Nickerson, and K. McMahon. 1999. "Recreation Participation Patterns by Montana Residents." Research Report 68 prepared by the Institute for Tourism and Recreation Research, University of Montana, Missoula, Montana.

Farnes, Phillip E., and Katherine Hansen. 2005. "Historical Snow Water Equivalent and Temperature Data for Oversnow Vehicle Travel Areas in Grand Teton and Yellowstone National Parks." Unpublished report, National Park Service, Yellowstone National Park, Wyoming.

Felicetti, L.A., C. Schwartz, R.O. Rye, M.A. Haroldson, K.A. Gunther, D.L. Phillips, and C.T. Robbins. 2003. "Use of Sulfur and Nitrogen Stable Isotopes to Determine the Importance of Whitebark Pine Nuts to Yellowstone Grizzly Bears." Canadian Journal of Zoology 81:763-770.

Fuller, J. A., R. A. Garrott, and P. J. White. 2007*a*. "Emigration and Density Dependence in Yellowstone Bison." Journal of Wildlife Management 71:1924-1933.

Fuller, J. A., R. A. Garrott, P. J. White, K. E. Aune, T. J. Roffe, and J. C. Rhyan. 2007*b*. "Reproduction and Survival of Yellowstone Bison." Journal of Wildlife Management 71:2365-2372.

Fuller, J.A. 2006. "Population Demography of the Yellowstone National Park Bison Herds." Master's Thesis, Montana State University, Bozeman, April 2006.

Gardner, C. L., W. B. Ballard, R. H. Jessup. 1986. "Long Distance Movement by an Adult Wolverine." Journal of Mammalogy 67: 603.

Garrott, R.A., and P.J. White. 2007. "Evaluating Key Uncertainties Regarding Road Grooming and Bison Movements." Draft research proposal submitted to the National Park Service and available at http://www.nps.gov/yell/parkmgmt/upload/keyuncertaintiesdraft_expert.pdf, accessed on October 11, 2008.

Garrott, R. A., L. L. Eberhardt, P. J. White, and J. Rotella. 2003. "Climate-induced Variation in Vital Rates of an Unharvested Large-Herbivore Population." Canadian Journal of Zoology 81:33-45.

Gates, C. C., B. Stelfox, T. Muhly, T. Chowns, and R. J. Hudson. 2005. "The Ecology of Bison Movements and Distribution in and beyond Yellowstone National Park." Available at http://www.nps.gov/yell/parkmgmt/gates.htm, accessed on October 11, 2008.

Gehman, S., Crabtree, R., Robinson, E., Harter, M., and S. Consolo-Murphy. 1997. "Comparison of Three Methods for Detecting Mammalian Carnivores." Unpublished report, National Park Service, Yellowstone National Park, Wyoming.

Geist, V. 1978. "Behavior." In Big Game of North America, Ecology and Management, edited by J. L. Schmidt and D. L. Gilbert. Harrisburg, PA: Stackpole Books.

Geremia, C., P.J. White, R.A. Garrott, R. Wallen, K.E. Aune, J. Treanor, and J.A. Cunningham. 2008. "Demography of central Yellowstone bison: effects of climate, density and disease." Chapter 14 in R.A. Garrott, P.J. White, and F.G.R. Watson, eds. Large mammal ecology in central Yellowstone: a synthesis of 16 years of integrated field studies. Elsevier, Academic Press Terrestrial Ecology Series, San Diego, California.

Gibeau, M. and K. Heuer. 1996. "Effects of Transportation Corridors on Large Carnivores in the Bow River Valley, Alberta." In Proceedings Florida Department of Transportation/Federal Highway Administration: Transportation-Related Wildlife Mortality Seminar. Orlando, Florida.

Gill, J. A., W. J. Sutherland, and A. R. Watkinson. 1996. "A Method to Quantify the Effects of Human Disturbance on Animal Populations." Journal of Applied Ecology 33: 786-792.

Global Insight. 2005. "The Economic Impact of Travel and Tourism in Idaho." Report prepared for the Idaho Division of Tourism Development, available at http://commerce.idaho.gov/assets/content/docs/2004%20economic%20impact%20of%20tourisminidahoInsightStudy.pdf, accessed on October 11, 2008.

Gonza´lez, L. M., B. E. Arroyo, A. Margalida, R. Sa´nchez, and J. Oria. 2006. "Effect of Human Activities on the Behaviour of Breeding Spanish Imperial Eagles (*Aquila adalberti*): Management Implications for the Conservation of a Threatened Species." Animal Conservation 9: 85-93.

Green, G. I., D. J. Mattson, and J. M. Peek. 1997. "Spring Feeding on Ungulate Carcasses by Grizzly Bears in Yellowstone National Park." Journal of Wildlife Management 61: 1040-1055.

Halfpenny, J.C., K. Murphy, and D. P. Reinhart. 1999. "Lynx: Their Ecology and Biology and how Winter Recreation Affects Them." In Effects of Winter Recreation on Wildlife of the Greater Yellowstone Area: A Literature Review and Assessment. T. Olliff, K. Legg, and B. Kaeding, eds. Report to the Greater Yellowstone Coordinating Committee.

Hardy, A. 2001. "Bison and Elk Responses to Winter Recreation in Yellowstone National Park." Master's Thesis, Montana State University, Bozeman, Montana.

Haroldson, M. A., M. A. Ternent, K. A. Gunther, and C. C. Schwartz. 2002. "Grizzly Bear Denning Chronology and Movements in the Greater Yellowstone Ecosystem." Ursus 13: 29-37.

Hobbs, N. T., and R. Hilborn. 2006. "Alternative to Statistical Hypothesis Testing in Ecology: a Guide to Self Teaching." Ecological Applications 16:5-19.

Hornocker, M. G. and H. S. Hash. 1981. "Ecology of the Wolverine in Northwestern Montana." Canadian Journal of Zoology 59: 1286-1301.

Idaho State Tax Commission. 2006. Lodging Sales - Monthly (92-Present). Available at http://commerce.idaho.gov/travel/research.aspx, accessed October 11, 2008.

IHI Environmental. 2004. "Personnel Air and Noise Monitoring Survey, Yellowstone National Park." Unpublished report, National Park Service, Yellowstone National Park, Wyoming.

Industrial Hygienist. 2008. Memorandum to Safety Manager, Yellowstone National Park, May 30, 2008. National Park Service files, Yellowstone National Park.

Ingersoll, G.P., D. Campbell, and C. McClure. 2005. Rocky Mountain Snowpack Chemistry Monitoring. Unpublished report, National Park Service, Yellowstone National Park, Wyoming.

Inman, K. H., R. M. Inman, R. R. Wigglesworth, A. J. McCue, B. L. Brock, J. D. Rieck, and W. Harrower. 2003. "Greater Yellowstone Wolverine Study, Cumulative Progress Report, December 2003," Wildlife Conservation Society General Technical Report.

Institute for Tourism and Recreation Research. 2003. "Niche News: Winter Outdoor Enthusiasts." Available at http://www.itrr.umt.edu/nichenews/winter.pdf, accessed on October 11, 2008.

Jaffe, R., D. Elwood, C. Dimmick, T. Davis and C. McClure. 2002. "Final Report: Wildlife Road Survey & Human Interactions On and Off Road." Unpublished report, National Park Service, Yellowstone National Park, Wyoming.

Jensen, Lea, and Ken Meyer. 2006. "Summer West Entrance Employee Air Monitoring." National Park Service, Yellowstone National Park, Wyoming.

Judd, S. L., R. Knight, and B. Blanchard. 1986. "Denning of Grizzly Bears in the Yellowstone National Park Area." International Conference Bear Research and Management 6:111-117.

Kado, Norman Y., Paul A. Kuzmicky, and Robert A. Okamoto. 2001. "Environmental and Occupational Exposure to Toxic Air Pollutants from Winter Snowmobile Use in Yellowstone National Park." Unpublished report, National Park Service, Yellowstone National Park, Wyoming.

Koch, E.D. and C.R. Peterson. 1995. The Amphibians and Reptiles of Yellowstone and Grand Teton National Parks. Salt Lake City, Utah: University of Utah Press.

Koehler, G.M., and K.B. Aubry. 1994. Chapter 4: "Lynx." Pages 74-98 *in* American Marten, Fisher, Lynx, and Wolverine in the Western United States, L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, W.J. Zielinski, eds. U.S. Forest Service, General Technical Report RM-251.

Kurz, G., E. Reinertson, and D. Reinhart. 2000. "Winter Bison Monitoring: Final Report." Unpublished report, National Park Service, Yellowstone National Park, Wyoming.

Landa, A., O. Strand, J. D. C. Linnell, and T. Skogland. 1998. "Home-Range Sizes and Altitude Selection for Arctic Foxes and Wolverines in an Alpine Environment." Canadian Journal of Zoology 76: 448-457.

Larter, N. C. and C. C. Gates. 1990. "Home Ranges of Wood Bison in an Expanding Population." Journal of Mammalogy 71(4): 604-607.

Layzer, Judith A. 2006. The Environmental Case: Translating Values into Policy. Washington, D.C.: CQ Press.

Legg, Kristin. 1998. "The Effects of Winter Recreation on Bighorn Sheep." In Effects of Winter Recreation on Wildlife of the Greater Yellowstone Area: A Literature Review and Assessment. T. Olliff, K. Legg, and B. Kaeding, eds. Report to the Greater Yellowstone Coordinating Committee. National Park Service files, Yellowstone National Park, Wyoming.

Magoun, A. J. and J. P. Copeland. 1998. "Characteristics of Wolverine Reproductive Den Sites." Journal of Wildlife Management 62: 1313-1320.

Magoun, A. J. and P. Valkenburg. 1983. "Breeding Behavior of Free-Ranging Wolverines (*Gulo gulo*)." Acta Zoologica Fennica 174: 175-177.

Maret, Terry. 1995. "Water Quality Assessment of the Upper Snake River Basin, Idaho and Western Wyoming – Summary of Aquatic Biological data for Surface Water through 1992." Water Resources Investigations Report 95, U.S. Geological Survey.

Mattson, D. J., B. M. Blanchard, and R. R. Knight. 1992. "Yellowstone Grizzly Bear Mortality, Human Habituation, and Whitebark Pine Seed Crops." Journal of Wildlife Management 56: 432-442.

Mattson, D. J., B. M. Blanchard, and R.R. Knight. 1991. "Food Habits of Yellowstone Grizzly Bears, 1977-1987." Canadian Journal of Zoology 69: 1619-1629.

McClure, Craig, and Troy Davis. 2008. "Wildlife Responses to Motorized Winter Recreation in Yellowstone." Draft report to the National Park Service and available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on Nov. 1, 2008.

McEneaney, T. 2006. "Yellowstone Bird Report, 2005." Report YCR-2006-2, Yellowstone Center for Resources, National Park Service, Yellowstone National Park, Wyoming.

McManus, C., R. Coupal, and D. Taylor. 2001. "2000-2001 Wyoming Snowmobile Survey." Report prepared for the Wyoming Department of State Parks and Historic Sites, the University of Wyoming, and the Wyoming State Snowmobile Association.

McNamee, T. 1984. The Grizzly Bear. New York, New York: Alfred A. Knopf.

Meagher, M. M. 1998. "Recent Changes in Yellowstone Bison Numbers and Distribution." In International Symposium on Bison Ecology and Management, edited by L. Irby and J. Knight, Bozeman, Montana.

Meagher, M. M. 1993. "Winter Recreation-Induced Changes on Bison Numbers and Distribution in Yellowstone National Park." Unpublished report, Yellowstone National Park, Wyoming.

Meagher, M. M. 1989. "Range Expansion by Bison of Yellowstone National Park." Journal of Mammalogy 70(3): 670- 675.

Messer, M. A. 2003. "Identifying Large Herbivore Distribution Mechanisms Through Application of Fine-Scale Snow Modeling." Master's Thesis, Montana State University, Bozeman, Montana.

Moen, A. N., S. Whittmore, and B. Buxton. 1982. "Effects of Disturbance by Snowmobiles on the Heart Rate of Captive White-Tailed Deer." New York Fish and Game Journal. 29(2): 176-183.

Murphy, K. M., T. M. Potter, J. C. Halfpenny, K. A. Gunther, M. T. Jones, P. A. Lundberg, and N. D. Berg. 2006. "Distribution of Canada Lynx in Yellowstone National Park." Northwest Science 80: 199-206.

Murphy, K., T. Potter, J. Halfpenny, K. Gunther, T. Jones, and P. Lundberg. 2005. "The Elusive Canada Lynx: Surveying for Yellowstone's Most Secretive Threatened Carnivore." Yellowstone Science 13(2): 7-15.

Myberget, S. 1968. "Jervens ynglehi (The Breeding Den of the Wolverine, *Gulo gulo*)." Fauna (Oslo) 21: 108-115.

National Park Service. 2007a. Winter Use Plans Final Environmental Impact Statement: Yellowstone and Grand Teton National Parks; John D. Rockefeller, Jr. Memorial Parkway. Yellowstone National Park, Wyoming.

National Park Service. 2007b. "Bison and Elk Management Plan and Environmental Impact Statement." Grand Teton National Park, Wyoming.

National Park Service 2007c. Sylvan Pass Operational Risk Management Assessment. National Park Service files, Yellowstone National Park.

National Park Service. 2006. Management Policies 2006. Washington, D.C.: U.S. Government Printing Office.

National Park Service. 2004a. Employee Safety & Health Implementation Plan. National Park Service files, Yellowstone National Park, Wyoming.

National Park Service. 2004b. "Temporary Winter Use Plans Environmental Assessment and Finding of No Significant Impact for Grand Teton/Yellowstone National Parks and John D. Rockefeller, Jr., Memorial Parkway." U.S. Department of the Interior.

National Park Service. 2003. Winter Use Plans Final Supplemental Environmental Impact Statement and Record of Decision: Yellowstone and Grand Teton National Parks and the John D. Rockefeller, Jr., Memorial Parkway. U.S. Department of the Interior.

National Park Service. 2000a. "Air Quality Concerns Related to Snowmobile Usage in National Parks." Unpublished report, National Park Service Air Resources Division, Yellowstone National Park, Wyoming.

National Park Service. 2000b. Winter Use Plans Final Environmental Impact Statement and Record of Decision for the Yellowstone and Grand Teton National Parks and John D. Rockefeller, Jr., Memorial Parkway. U.S. Department of Interior.

National Park Service. 1998. "Yellowstone National Park Resource Management Plan." Yellowstone National Park, Wyoming.

National Park Service. 1997. "Environmental Assessment and Finding of No Significant Impact: Temporary Closure of a Winter Road." Yellowstone National Park, Wyoming.

National Park Service. 1995. Grand Teton National Park Resource Management Plan. Grand Teton National Park, Wyoming.

National Park Service. 1990. "Winter Use Plan Environmental Assessment, Yellowstone and Grand Teton National Parks and John D. Rockefeller, Jr., Memorial Parkway." Denver Service Center, Denver, Colorado.

National Park Service Natural Resources Program Center. 2003. Interim Technical Guidance on Assessing Impacts and Impairment to Natural Resources.

Office of the Secretary [of the Interior]. 2007. "Kempthorne: No Longer 'Business as Usual,'" and associated remarks. Press release, Yellowstone National Park, Wyoming.

Olliff, T., K. Legg, and B. Kaeding, eds. 1999. "Effects of Winter Recreation on Wildlife of the Greater Yellowstone Area: A Literature Review and Assessment." Report to the Greater Yellowstone Coordinating Committee. Unpublished report, National Park Service, Yellowstone National Park, Wyoming.

Otter, C.L. 2007. Letter from Governor, State of Idaho to Superintendents, Yellowstone and Grand Teton National Parks commenting on Preliminary Draft EIS. January 4, 2007.

Parker, K. L., C. T. Robbins, and T. A. Hanley. 1984. "Energy Expenditures for Locomotion by Mule Deer and Elk." Journal of Wildlife Management 48: 474-488.

Picton, H. D. 1999. "Energetic Cost of Displacement to Wildlife by Winter Recreation." In The Effects of Winter Recreation on Wildlife: A Literature Review and Assessment. T. Olliff, K. Legg, and B. Kaeding, eds. National Park Service, Yellowstone National Park, Wyoming.

Podruzny, S. R., S. Cherry, C. C. Schwartz, and L. A. Landenderger. 2002. "Grizzly Bear Denning and Potential Conflict Areas in the Greater Yellowstone Ecosystem." Ursus 13: 19-28.

Preisler, H. K., A. A. Ager, and M. J. Wisdom. 2006. "Statistical Methods for Analyzing Responses of Wildlife to Human Disturbance." Journal of Applied Ecology 43: 164-172.

Pullianinen, E. 1968. "Breeding Biology of the Wolverine (*Gulo gulo*) in Finland." Annales Zoologici Fennici 5: 338-344.

Pyare, S. 2001. "Conservation, Survey, and Monitoring of Canada Lynx in Jackson Hole." Unpublished report available from Wildlife Conservation Society/Denver Zoological Foundation, Kelly, Wyoming.

Radtke, Tim. 1997. "Industrial Hygiene Consultation Report." Unpublished report, National Park Service, Yellowstone National Park, Wyoming.

Ray, John D. "Winter Air Quality in Yellowstone National Park, 2007-2008." Unpublished draft report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on Nov. 3, 2008.

Ray, John D. 2007. "Winter Air Quality in Yellowstone National Park, 2006-2007." Unpublished report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Ray, John D. 2006. "Winter Air Quality in Yellowstone National Park, 2005-2006." Unpublished report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Ray, John D. 2005. "Winter Air Quality Study, 2004-2005." Unpublished report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Reinhart, D. P. and D. B. Tyers. 1999. "The Effects of Winter Recreation on Grizzly Bears." In The Effects of Winter Recreation on Wildlife: A Literature Review and Assessment. T. Olliff, K. Legg, and B. Kaeding, eds. National Park Service, Yellowstone National Park, Wyoming.

Richens, V. B. and G. R. Lavigne. 1978. "Response of White-Tailed Deer to Snowmobiles and Snowmobile Trails in Maine." Canadian Field Naturalist 92: 334-344.

RTI International. 2004. "Economic Analysis of Temporary Regulations on Snowmobile Use in the Greater Yellowstone Area - Final Report." Available at http://www.nps.gov/yell/parkmgmt/upload/econ_analysis-04.pdf, accessed on October 11, 2008.

Ruediger, B., J. Claar, S. Gniadek, B. Holt, L. Lewis, S. Mighton, B. Naney, G. Patton, T. Rinaldi, J. Trick, A. Vandehey, F. Wahl, N. Warren, D. Wenger, and A. Williamson. 2000. Canada Lynx Conservation Assessment and Strategy. U.S.D.A. Forest Service, U.S.D.I. Fish and Wildlife Service, U.S.D.I. Bureau of Land Management, and U.S.D.I. National Park Service. Forest Service Publication Number R1-00-53, Missoula, Montana.

Schultz, R. D. and J. A. Bailey. 1978. "Responses of National Park Elk to Human Activity." Journal of Wildlife Management 42: 91-100.

Smith, D. W., K. M. Murphy, and D. S. Guernsey. 1998. "Yellowstone Wolf Project: Annual Report 1998." National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming.

Spear, Terry M. and Dale J. Stephenson. 2005. "Yellowstone Winter Use Personal Exposure Monitoring." Unpublished report, National Park Service, Yellowstone National Park, Wyoming.

Spear, Terry M., Julie Hart, and Dale J. Stephenson. 2006. "Yellowstone Winter Use Personal Exposure Monitoring." Unpublished draft report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Stalmaster, M. V. and J. L. Kaiser. 1998. "Effects of Recreational Activity on Wintering Bald Eagles." Wildlife Monographs 137 (April).

Stangl, J. T. 1999. "The Effects of Winter Recreation on Bald Eagles." In The Effects of Winter Recreation on Wildlife: A Literature Review and Assessment. T. Olliff, K. Legg, and B. Kaeding, eds. National Park Service, Yellowstone National Park, Wyoming.

Staples, W.R. 1995. "Lynx and Coyote Diet and Habitat Relationships During a Low Hare Population on the Kenai Peninsula, Alaska." Master's Thesis, University of Alaska, Fairbanks, Alaska.

Steidl, R. J. and R. G. Anthony. 2000. "Experimental Effects of Human Activity on Breeding Bald Eagles." Ecological Applications 10: 258-268.

Sunquist, M. E. and F. Sunquist. 2002. Wild Cats of the World. University of Chicago Press, Chicago, Illinois.

Swanson, Larry. 2006. "The Park County Economy – Restructuring and Change in a Growing Region." Unpublished report prepared for Greater Yellowstone Coalition available at http://greateryellowstone.org/media/pdf/ParkCountyEconReport.pdf, accessed on October 11, 2008.

Swensen, J. E., K. L. Alt, and R. L. Eng. 1986. "The Ecology of the Bald Eagle in the Greater Yellowstone Ecosystem." Wildlife Monograph 95.

Switalski, T. 2003. "Coyote Foraging Ecology and Vigilance in Response to Gray Wolf Reintroduction Yellowstone National Park." Canadian Journal of Zoology 81: 985-993.

Sylvester, J. T. 2002. "Snowmobiling in Montana." Report prepared for the Montana Department of Fish, Wildlife, and Parks, and the Montana Snowmobiling Association.

Taber, Mary. 2006. "In Praise of Guides." Unpublished paper, National Park Service, Yellowstone National Park, Wyoming.

Taper, M. L., M. L. Meagher, and C. L. Jerde. 2000. "The Phenology of Space: Spatial Aspects of Bison Density Dependence in Yellowstone National Park." Unpublished report available at http://www.nrmsc.usgs.gov/files/norock/products/YNP_bison_density.pdf, accessed on October 11, 2008.

Taylor, David. 2007. "Economic Trends in the Winter Season for Park County, Wyoming." Department of Agriculture and Applied Economics, University of Wyoming, Laramie, Wyoming.

Thompson, M. J. and R. E. Henderson. 1998. "Elk Habituation as a Credibility Challenge for Wildlife Professionals." Wildlife Society Bulletin 26: 477-483.

Tyers, D. B. and L. Irby. 1995. Shiras Moose Winter Habitat Use in the Upper Yellowstone River Valley prior to and after the 1988 Fires." Alces 31: 35-43.

Tyers, D. B. 1999. "The Effects of Winter Recreation on Moose." In The Effects of Winter Recreation on Wildlife: A Literature Review and Assessment. T. Olliff, K. Legg, and B. Kaeding, eds. National Park Service, Yellowstone National Park, Wyoming.

U.S. Department of the Interior. 2000. Occupational Safety and Health Strategic Plan. National Park Service files, Yellowstone National Park, Wyoming.

U.S. Department of the Interior. 1995. The Secretary of the Interior's Standards for the Treatment of Historic Properties with Illustrated Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings. Kay D. Weeks and Anne E. Grimmer. U.S. Department of the Interior, National Park Service, Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Labor. 2007. "Bureau of Labor Statistics, Consumer Price Indices." Available at http://www.bls.gov/cpi/home.htm, accessed on October 11, 2008.

U.S. Environmental Protection Agency. 1998. Final Guidance For Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses. Accessed October 30, 2008 at http://www.epa.gov/compliance/resources/policies/ej/ej_guidance_nepa_epa0498.pdf.

U.S. Fish and Wildlife Service. 1994. The Reintroduction of Gray Wolves to Yellowstone National Park and Central Idaho. Final Environmental Impact Statement. Helena, Montana.

Van De Polder, Craig. 2006. "Feedback on Preliminary Alternatives." National Park Service files, Yellowstone National Park, Wyoming.

Varley, Nathan. 1999. "The Effects of Winter Recreation on Mountain Goats." In The Effects of Winter Recreation on Wildlife: A Literature Review and Assessment. T. Olliff, K. Legg, and B. Kaeding, eds. National Park Service, Yellowstone National Park, Wyoming.

Vucetich, J. A., D. W. Smith, and D. R. Stahler. 2005. "Influence of Harvest, Climate, and Wolf Predation on Yellowstone Elk, 1961-2004." Oikos 111:259-270.

Wagner, F. 2006. Yellowstone's Destabilized Ecosystem: Elk Effects, Science, and Policy Conflict. New York, Oxford University Press.

White, P.J. 2008. Memorandum to Tom Olliff, October 6, 2008. National Park Service files, Yellowstone National Park, Wyoming.

White, P.J., and R. A. Garrott. 2005. "Northern Yellowstone Elk after Wolf Restoration." Wildlife Society Bulletin 33:942-955.

White, P. J., T. Davis, J. Borkowski, R. Garrott, D. Reinhart, and D. McClure. 2006. "Behavioral Responses of Wildlife to Snowmobiles and Coaches in Yellowstone." Unpublished report, Yellowstone Center for Resources, Yellowstone National Park, Wyoming. Available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

White, P. J., T. Davis, J. Borkowski, D. Reinhart, C. McClure, and P. Perrotti. 2005. "Wildlife Responses to Motorized Winter Recreation in Yellowstone: 2005 Annual Report."

Unpublished report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

White, P. J., T. Davis, J. Borkowski, D. Reinhart, C. McClure, and P. Perrotti. 2004. "Wildlife Responses to Motorized Winter Recreation in Yellowstone National Park: 2004 Annual Report." Unpublished report available at http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm, accessed on October 11, 2008.

Wildlife Resource Consultants. 2004. "Winter Recreation Effects on the Subnivean Environment of Five Sierra Nevada Meadows." National Park Service files, Yellowstone National Park, Wyoming.

Wyoming Travel and Tourism. 2003. Wyoming Travel Industry 2003 Impact Report.

Yellowstone Business Partnership. 2007. "Turning On the Off-Season, Opportunities for Progress in the Yellowstone-Teton Region" Yellowstone Business Partnership, Bozeman, Montana.

Yellowstone Center for Resources. 2007. "Yellowstone Center for Resources Annual Report, 2006." YCR-2007-03, National Park Service, Yellowstone National Park, Wyoming.

Yellowstone National Park. 2005. Two Year Safety Strategic Plan. National Park Service files, Yellowstone National Park, Wyoming.

Yochim, Michael J. In press. Yellowstone and the Snowmobile: Locking Horns over National Park Use (Lawrence: University Press of Kansas, 2009 (estimated)).

Yochim, Michael J. 2004. "Compromising Yellowstone: The Interest Group-National Park Service Relationship in Modern Policy-making." Ph.D. Dissertation, University of Wisconsin-Madison.

This page intentionally left blank.

APPENDICES

This page intentionally left blank

APPENDIX A. POLICIES AND MANDATES

The Organic Act

The NPS gets its basic mandate from the NPS Organic Act (16 USC 1, 2–4) and the General Authorities Act (16 USC 1a–1 through 1a–8). The NPS Organic Act provides:

"The Service thus established shall promote and regulate the use of the Federal areas known as National Parks…by such means and measures as to conform to the fundamental purposes of the said Parks…which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

The direction provided by the Organic Act was the subject of many comments on the 1999 Draft Environmental Impact Statement (Draft EIS) and these are discussed in the 2000 Final EIS (NPS 2000b:3).

The General Authorities Act

The General Authorities Act, as amended by the Redwood Act (March 27, 1978, P.L. 95–250, 92 Stat. 163, 16 USC 1a–1) affirms the basic tenets of the Organic Act and provides additional guidance on National Park System management:

"The authorization of activities shall be construed, and the protection, management and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established…."

The restatement of these principles of park management in the Redwood Act is intended to serve as the basis for any judicial resolution of competing private and public values and interests in the National Park System (Senate Report No. 95–528 on S. 1976 pg. 7). The Senate committee report stated that under the Redwood amendment:

"The Secretary of the Interior has an absolute duty, which is not to be compromised, to fulfill the mandate of the 1916 Act to take whatever actions and seek whatever relief as will safeguard the units of the National Park System."

Consideration of these principles gives rise to the concept of "impairment" discussed on page 3 of the Final EIS, and below under Management Policies 2006.

Park-Specific Legislation

The Yellowstone National Park Act (16 USC 21, et seq.), the Grand Teton National Park Act (16 USC 406d–1 et seq.), and the John D. Rockefeller, Jr., Memorial Parkway Act (P.L. 92-404) provide authority and direction for management of each park. The establishment legislation is included in Appendix C of the 2000 EIS.

Other Laws

Because one of the primary issues about snowmobile use is that of air quality, the Clean Air Act (as amended, P.L. Chapter 360, 69 Stat. 322, 42 U.S.C. 7401 et seq.) is a primary focus in both the

2000 Final EIS and in the 2003 Final SEIS. Other laws that are generally pertinent to national park management are listed on page 3 of the 2000 Final EIS.

The Clean Air Act

The Clean Air Act provides both for the prevention of significant deterioration of areas where air is cleaner than National Ambient Air Quality Standards (NAAQS), and for an affirmative responsibility by the federal land manager to protect air quality-related values, including visibility. The federal land manager, in this case the NPS, has an affirmative responsibility to protect these resources, which is a separate issue from air quality vis-à-vis the NAAQS.

The Prevention of Significant Deterioration (PSD) provisions of the Clean Air Act are intended, in part, to preserve, protect, and enhance the air quality in national parks. The legislative history of the PSD provisions (S. Rep 95–127, 95th Cong., 1st Sess., 1977) indicates that federal land managers are to "assume an aggressive role in protecting the air quality values of land areas under his jurisdiction" and to "err on the side of protecting the air quality-related values for future generations." The Act also requires the prevention of any future impairment and the remedying of any existing impairment in Class I federal areas, which includes Yellowstone and Grand Teton National Parks. Additionally, the John D. Rockefeller, Jr., Memorial Parkway (a Class II area) abuts Class I federal areas, including the two national parks and the Jedediah Smith and Teton Wilderness Areas.

Executive Orders

EO 11644, Use of Off-Road Vehicles on the Public Lands, issued by President Nixon in 1972, states, "The widespread use of such vehicles on the public lands—often for legitimate purposes but also in frequent conflict with wise land and resource management practices, environmental values, and other types of recreational activity—has demonstrated the need for a unified federal policy…that will ensure that the use of off-road vehicles on public lands will be controlled and directed so as to protect the resources of these lands, to promote the safety of all users of those lands, and to minimize conflicts among the various users of those lands." Further, the order directs federal land managers that "[a]reas and trails shall be located to minimize harassment of wildlife or significant disruption of wildlife habitats" and "areas and trails shall be located to minimize conflicts between off-road vehicle use and other existing or proposed recreational uses of the same or neighboring public lands…." Additionally, "Areas and trails shall be located in areas of the National Park System…only if the respective agency head determines that off-road vehicle use in such locations will not adversely affect their natural, aesthetic, or scenic values." Finally, "The respective agency head shall monitor the effects of the use of off-road vehicles on lands under their jurisdictions. On the basis of the information gathered, they shall from time to time amend or rescind designation of areas or other actions taken pursuant to this order as necessary to further the policy of this order."

Under the Executive Orders, the term "off-road vehicle" specifically excludes "any vehicle whose use is expressly authorized by the respective agency head under a permit, lease, license, or contract." Executive Order No. 11644 § 2(3(C).

This order is amended by EO 11989, issued by President Carter in 1978, which adds:

"…the respective agency head shall, whenever he determines that the use of off-road vehicles will cause or is causing considerable adverse effects on the soil, vegetation, wildlife, wildlife habitat or cultural or historic resources of particular areas or trails of the public lands, immediately close such areas or trails to the type of off-road vehicle causing such effects, until

such time as he determines that such adverse effects have been eliminated and that measures have been implemented to prevent future recurrence."

EO 13266, Activities to Promote Personal Fitness, issued by President George W. Bush in 2002, promotes health and personal fitness opportunities of the general public. Opportunities for non-motorized recreation in the parks are appropriate; many of these opportunities are only accessible via motorized access.

Regulations

36 CFR 2.18 Snowmobiles

General provisions in NPS regulations address snowmobile use (36 CFR 2.18). Snowmobiling is generally prohibited except on designated routes and water surfaces available for motorized use at other times. In addition, snowmobiles are prohibited except where designated and "only when their use is consistent with the park's natural, cultural, scenic and aesthetic values, safety considerations, park management objectives, and will not disturb wildlife or damage park resources" (36 CFR 2.18 (c)). Section (d) of this regulation lists additional limitations and prohibitions that apply where snowmobiles are allowed, including noise limits, speed limits, operator requirements, and machine appurtenances.

36 CFR 1.2 Applicability and Scope

"(c) The regulations contained in part 7 and part 13 of this chapter are special regulations prescribed for specific park areas. Those regulations may amend, modify, relax or make more stringent the regulations contained in parts 1 through 5 and part 12 of this chapter.

36 CFR 1.5 Closures and public use limits

"(a) Consistent with applicable legislation and Federal administrative policies, and based upon a determination that such action is necessary for the maintenance of public health and safety, protection of environmental or scenic values, protection of natural or cultural resources, aid to scientific research, implementation of management responsibilities, equitable allocation and use of facilities, or the avoidance of conflict among visitor use activities, the superintendent may:

(1) Establish, for all or a portion of a park area, a reasonable schedule of visiting hours, impose public use limits, or close all or a portion of a park area to all public use or to a specific use or activity.

(2) Designate areas for a specific use or activity, or impose conditions or restrictions on a use or activity.

(3) Terminate a restriction, limit, closure, designation, condition, or visiting hour restriction imposed under paragraph (a)(1) or (2) of this section.

(b) Except in emergency situations, a closure, designation, use or activity restriction or condition, or the termination or relaxation of such, which is of a nature, magnitude and duration that will result in a significant alteration in the public use pattern of the park area, adversely affect the park's natural, aesthetic, scenic or cultural values, require a long-term or significant modification in the resource management objectives of the unit, or is of a highly controversial nature, shall be published as rulemaking in the Federal Register."

36 CFR 1.7 Public Notice

"(a) Whenever the authority of §1.5(a) is invoked to restrict or control a public use or activity, to relax or revoke an existing restriction or control, to designate all or a portion of a park area as open or closed, or to require a permit to implement a public use limit, the public shall be notified by one or more . . .methods. . ."

NPS Management Policies

Current policy guidance for the NPS is published in Management Policies 2006 (August 31, 2006; available on the Internet at www.nps.gov/policy/mp/policies.html). The policies interpret the laws, regulations, and Executive Orders governing management of National Park System units. The policies most applicable to this EIS are summarized or abstracted here. The parenthetical numbers below refer to the portions of the Management Policies 2006 that are the sources for the text.

The NPS Obligation to Conserve and Provide for Enjoyment of Park Resources and Values (1.4.3)

"The fundamental purpose of the national park system, established by the Organic Act and reaffirmed by the General Authorities Act, as amended, begins with a mandate to conserve park resources and values. This mandate is independent of the separate prohibition on impairment and applies all the time with respect to all park resources and values, even when there is no risk that any park resources or values may be impaired. NPS managers must always seek ways to avoid, or to minimize to the greatest extent practicable, adverse impacts on park resources and values. However, the laws do give the Service the management discretion to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park, so long as the impact does not constitute impairment of the affected resources and values.

"The fundamental purpose of all parks also includes providing for the enjoyment of park resources and values by the people of the United States. The enjoyment that is contemplated by the statute is broad; it is the enjoyment of all the people of the United States and includes enjoyment both by people who visit parks and by those who appreciate them from afar. It also includes deriving benefit (including scientific knowledge) and inspiration from parks, as well as other forms of enjoyment and inspiration. Congress, recognizing that the enjoyment by future generations of the national parks can be ensured only if the superb quality of park resources and values is left unimpaired, has provided that when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to be predominant. This is how courts have consistently interpreted the Organic Act."

The Prohibition on Impairment of Park Resources and Values (1.4.4)

"While Congress has given the Service the management discretion to allow impacts within parks, that discretion is limited by the statutory requirement (generally enforceable by the federal courts) that the Park Service must leave park resources and values unimpaired unless a particular law directly and specifically provides otherwise. This, the cornerstone of the Organic Act, establishes the primary responsibility of the National Park Service. It ensures that park resources and values will continue to exist in a condition that will allow the American people to have present and future opportunities for enjoyment of them.

"The impairment of park resources and values may not be allowed by the Service unless directly and specifically provided for by legislation or by the proclamation establishing the park. The relevant legislation or proclamation must provide explicitly (not by implication or inference) for

the activity, in terms that keep the Service from having the authority to manage the activity so as to avoid the impairment."

What Constitutes Impairment of Park Resources and Values (1.4.5)

"The impairment that is prohibited by the Organic Act and the General Authorities Act is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values. Whether an impact meets this definition depends on the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts.

"An impact to any park resource or value may, but does not necessarily, constitute an impairment. An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is:

- necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park, or
- key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park, or
- identified in the park's general management plan or other relevant NPS planning documents as being of significance.

"An impact would be less likely to constitute an impairment if it is an unavoidable result of an action necessary to preserve or restore the integrity of park resources or values and it cannot be further mitigated.

"An impact that may, but would not necessarily, lead to impairment may result from visitor activities; NPS administrative activities; or activities undertaken by concessioners, contractors, and others operating in the park. Impairment may also result from sources or activities outside the park."

What Constitutes Park Resources and Values (1.4.6)

"The 'park resources and values' that are subject to the no-impairment standard include:

- the park's scenery, natural and historic objects, and wildlife, and the processes and conditions that sustain them, including, to the extent present in the park: the ecological, biological, and physical processes that created the park and continue to act upon it; scenic features; natural visibility, both in daytime and at night; natural landscapes; natural soundscapes and smells; water and air resources; soils; geological resources; paleontological resources; archeological resources; cultural landscapes; ethnographic resources; historic and prehistoric sites, structures, and objects; museum collections; and native plants and animals;
- appropriate opportunities to experience enjoyment of the above resources, to the extent that can be done without impairing them;
- the park's role in contributing to the national dignity, the high public value and integrity, and the superlative environmental quality of the national park system, and the benefit and inspiration provided to the American people by the national park system; and
- any additional attributes encompassed by the specific values and purposes for which the park was established."

Decision-making Requirements to Avoid Impairments (1.4.7)

"Before approving a proposed action that could lead to an impairment of park resources and values, an NPS decision-maker must consider the impacts of the proposed action and determine, in writing, that the activity will not lead to an impairment of park resources and values. If there would be an impairment, the action must not be approved.

"In making a determination of whether there would be an impairment, an NPS decision-maker must use his or her professional judgment. This means that the decision-maker must consider any environmental assessments or environmental impact statements required by the National Environmental Policy Act of 1969 (NEPA); consultations required under section 106 of the National Historic Preservation Act (NHPA), relevant scientific and scholarly studies; advice or insights offered by subject matter experts and others who have relevant knowledge or experience; and the results of civic engagement and public involvement activities relating to the decision. The same application of professional judgment applies when reaching conclusions about "unacceptable impacts."

"When an NPS decision-maker becomes aware that an ongoing activity might have led or might be leading to an impairment of park resources or values, he or she must investigate and determine if there is or will be an impairment. This investigation and determination may be made independent of, or as part of, a park planning process undertaken for other purposes. If it is determined that there is, or will be, an impairment, the decision-maker must take appropriate action, to the extent possible within the Service's authorities and available resources, to eliminate the impairment. The action must eliminate the impairment as soon as reasonably possible, taking into consideration the nature, duration, magnitude, and other characteristics of the impacts on park resources and values, as well as the requirements of the National Environmental Policy Act, National Historic Preservation Act, the Administrative Procedure Act, and other applicable laws."

Unacceptable Impacts (1.4.7.1)

"The impact threshold at which impairment occurs is not always readily apparent. Therefore, the Service will apply a standard that offers greater assurance that impairment will not occur. The Service will do this by avoiding impacts that it determines to be unacceptable. These are impacts that fall short of impairment, but are still not acceptable within a particular park's environment. Park managers must not allow uses that would cause unacceptable impacts; they must evaluate existing or proposed uses and determine whether the associated impacts on park resources and values are acceptable.

"Virtually every form of human activity that takes place within a park has some degree of effect on park resources or values, but that does not mean the impact is unacceptable or that a particular use must be disallowed. Therefore, for the purposes of these policies, unacceptable impacts are impacts that, individually or cumulatively, would:

- be inconsistent with a park's purposes or values, or
- impede the attainment of a park's desired future conditions for natural and cultural resources as identified through the park's planning process, or
- create an unsafe or unhealthful environment for visitors or employees, or
- diminish opportunities for current or future generations to enjoy, learn about, or be inspired by park resources or values, or unreasonably interfere with

- park programs or activities, or
- an appropriate use, or
- the atmosphere of peace and tranquility, or the natural soundscape maintained in wilderness and natural, historic, or commemorative locations within the park.
- NPS concessioner or contractor operations or services."

Air Quality (4.7.1)

"The National Park Service has a responsibility to protect air quality under both the 1916 Organic Act and the Clean Air Act (CAA). Accordingly, the Service will seek to perpetuate the best possible air quality in parks to (1) preserve natural resources and systems; (2) preserve cultural resources; and (3) sustain visitor enjoyment, human health, and scenic vistas. Vegetation, visibility, water quality, wildlife, historic and prehistoric structures and objects, cultural landscapes, and most other elements of a park environment are sensitive to air pollution and are referred to as "air quality-related values." The Service will actively promote and pursue measures to protect these values from the adverse impacts of air pollution. In cases of doubt as to the impacts of existing or potential air pollution on park resources, the Service will err on the side of protecting air quality and related values for future generations.

"Superintendents will take actions consistent with their affirmative responsibilities under the Clean Air Act to protect air quality-related values in Class I areas. Class I areas are national parks over 6, 000 acres and national wilderness areas over 5,000 acres that were in existence on August 7, 1977. The act establishes a national goal of preventing any future and remedying any existing human-made visibility impairment in Class I areas. The Service supports that goal and will take advantage of opportunities created by the act to help achieve it. The federal land manager shares the responsibility to protect air quality-related values in Class I areas. As the federal land manager for the department, the Secretary of the Interior has delegated this responsibility to the Assistant Secretary for Fish and Wildlife and Parks.

"The Clean Air Act also recognizes the importance of integral vistas, which are those views perceived from within Class I areas of a specific landmark or panorama located outside the boundary of the Class I area. Integral vistas have been identified by the Service and are listed in Natural Resources Reference Manual 77. There are no regulations requiring special protection of these integral vistas, but the Service will strive to protect these park-related resources through cooperative means.

"Although the Clean Air Act gives the highest level of air quality protection to Class I areas, it provides many opportunities for the Service to participate in the development of pollution control programs to preserve, protect, and enhance the air quality of all units of the national park system. Regardless of Class I designation, the Service will take advantage of these opportunities.

"Air resource management requirements will be integrated into NPS operations and planning, and all air pollution sources within parks—including prescribed fire management and visitor use activities—will comply with all federal, state, and local air quality regulations and permitting requirements. Superintendents will make reasonable efforts to notify visitors and employees when air pollution concentrations within an area exceed the national or state air quality standards established to protect public health. Furthermore, because the current and future quality of park air resources depends heavily on the actions of others, the Service will acquire

the information needed to effectively participate in decision-making that affects park air quality. The Service will:

- inventory the air quality-related values associated with each park;
- monitor and document the condition of air quality and related values;
- evaluate air pollution impacts and identify causes;
- minimize air quality pollution emissions associated with park operations, including the use of prescribed fire and visitor use activities; and
- ensure healthful indoor air quality in NPS facilities.

"External programs needed to remedy existing and prevent future impacts on park resources and values from human-caused air pollution will be aggressively pursued by NPS participation in the development of federal, state, and local air pollution control plans and regulations. Permit applications for major new air pollution sources will be reviewed, and potential impacts will be assessed. If it is determined that any such new source might cause or contribute to an adverse impact on air quality-related values, the Park Service will recommend to the permitting authority that the construction permit be denied or modified to eliminate adverse impacts.

"The public's understanding of park air quality issues and the positive role and efforts of the Service toward improving the air quality in parks will be promoted through educational and interpretive programs."

Soundscape Management (4.9)

"Park natural soundscape resources encompass all the natural sounds that occur in parks, including the physical capacity for transmitting those natural sounds and the interrelationships among park natural sounds of different frequencies and volumes. Natural sounds occur within and beyond the range of sounds that humans can perceive, and they can be transmitted through air, water, or solid materials. The National Park Service will preserve, to the greatest extent possible, the natural soundscapes of parks.

"Some natural sounds in the natural soundscape are also part of the biological or other physical resource components of the park. Examples of such natural sounds include:

- sounds produced by birds, frogs, or katydids to define territories or aid in attracting mates
- sounds produced by bats or porpoises to locate prey or navigate
- sounds received by mice or deer to detect and avoid predators or other danger
- sounds produced by physical processes, such as wind in the trees, claps of thunder, or falling water.

"The Service will restore to the natural condition wherever possible those park soundscapes that have become degraded by unnatural sounds (noise), and will protect natural soundscapes from unacceptable impacts.

"Using appropriate management planning, superintendents will identify what levels and types of unnatural sound constitute acceptable impacts on park natural soundscapes. The frequencies, magnitudes, and durations of acceptable levels of unnatural sound will vary throughout a park, being generally greater in developed areas. In and adjacent to parks, the Service will monitor human activities that generate noise that adversely affects park soundscapes, including noise caused by mechanical or electronic devices. The Service will take action to prevent or minimize

all noise that through frequency, magnitude, or duration adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified through monitoring as being acceptable to or appropriate for visitor uses at the sites being monitored."

Visitor Use (8.2)

"Enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all parks. The Service is committed to providing appropriate, high quality opportunities for visitors to enjoy the parks, and the Service will maintain within the parks an atmosphere that is open, inviting, and accessible to every segment of American society. However, many forms of recreation enjoyed by the public do not require a national park setting and are more appropriate to other venues. The Service will therefore:

provide opportunities for forms of enjoyment that are uniquely suited and appropriate to the superlative natural and cultural resources found in the parks;

defer to local, state, tribal, and other federal agencies; private industry; and non-governmental organizations to meet the broader spectrum of recreational needs and demands.

"To provide for enjoyment of the parks, the National Park Service will encourage visitor activities that:

are appropriate to the purpose for which the park was established; and

are inspirational, educational, or healthful, and otherwise appropriate to the park

environment; and

will foster an understanding of and appreciation for park resources and values, or will

promote enjoyment through a direct association with, interaction with, or relation to park resources; and

can be sustained without causing unacceptable impacts to park resources or values.

"The primary means by which the Service will actively foster and provide activities that meet these criteria will be through its interpretive and educational programs, which are described in detail in chapter 7. The Service will also welcome the efforts of nongovernmental organizations, tour companies, guides, outfitters, and other private sector entities to provide structured activities that meet these criteria. In addition to structured activities, the Service will, to the extent practicable, afford visitors ample opportunity for inspiration, appreciation, and enjoyment through their own personalized experiences—without the formality of program or structure.

"The Service may allow other visitor uses that do not meet all the above criteria if they are appropriate to the purpose for which the park was established and they can be sustained without causing unacceptable impacts to park resources or values. For the purposes of these policies, unacceptable impacts are impacts that, individually or cumulatively, would:

be inconsistent with a park's purposes or values, or

impede the attainment of a park's desired conditions for natural and cultural resources as identified through the park's planning process, or

create an unsafe or unhealthy environment for visitors or employees, or

diminish opportunities for current or future generations to enjoy, learn about, or be inspired by park resources or values, or unreasonably interfere with:

park programs or activities, or

an appropriate use, or

the atmosphere of peace and tranquility, or the natural soundscape maintained in wilderness and natural, historic, or commemorative locations within the park, or NPS concessioner or contractor operations or services.

"Management controls and conditions must be established for all park uses to ensure that park resources and values are preserved and protected for the future. If and when a superintendent has a reasonable basis for believing that an ongoing or proposed public use would cause unacceptable impacts to park resources or values, the superintendent must make adjustments to the way the activity is conducted to eliminate the unacceptable impacts. If the adjustments do not succeed in eliminating the unacceptable impacts, the superintendent may (1) temporarily or permanently close a specific area, or (2) place limitations on the use, or (3) prohibit the use. Restrictions placed on recreational uses that have otherwise been found to be appropriate will be limited to the minimum necessary to protect park resources and values and promote visitor safety and enjoyment. Any closures or restrictions—other than those imposed by law—must be consistent with applicable laws, regulations, and policies, and (except in emergency situations) require a written determination by the superintendent that such measures are needed to:

protect public health and safety;

prevent unacceptable impacts to park resources or values;

carry out scientific research;

minimize visitor use conflicts; or

otherwise implement management responsibilities.

"When practicable, restrictions will be based on the results of study or research, including (when appropriate) research in the social sciences. Any restrictions imposed will be fully explained to visitors and the public. Visitors will be given appropriate information on how to keep adverse impacts to a minimum, and how to enjoy the safe and lawful use of the parks."

Use of Motorized Equipment (8.2.3)

"The variety of motorized equipment—including visitor vehicles, concessioner equipment, and NPS administrative or staff vehicles and equipment—that operates in national parks could adversely impact park resources, including the park's natural soundscape and the flow of natural chemical information and odors that are important to many living organisms. In addition to their natural values, natural sounds (such as waves breaking on the shore, the roar of a river, and the call of a loon), form a valued part of the visitor experience. Conversely, the sounds of motor vehicle traffic, an electric generator, or loud music can greatly diminish the solemnity of a visit to a national memorial, the effectiveness of a park interpretive program, or the ability of a visitor to hear a bird singing its territorial song. Many parks that appear as they did in historical context no longer sound the way they once did.

"The Service will strive to preserve or restore the natural quiet and natural sounds associated with the physical and biological resources of parks. To do this, superintendents will carefully evaluate and manage how, when, and where motorized equipment is used by all who operate

equipment in the parks, including park staff. Uses and impacts associated with the use of motorized equipment will be addressed in park planning processes. Where such use is necessary and appropriate, the least impacting equipment, vehicles, and transportation systems should be used, consistent with public and employee safety. The natural ambient sound level—that is, the environment of sound that exists in the absence of human-caused noise—is the baseline condition, and the standard against which current conditions in a soundscape will be measured and evaluated.

"To meet its responsibilities under Executive Order 13149 (Greening the Government through Federal Fleet and Transportation Efficiency), the Service will develop and implement a strategy to reduce its vehicle fleet's annual petroleum consumption."

Motorized Off-road Vehicle Use (8.2.3.1)

"Off-road motor vehicle use in national park units is governed by Executive Order 11644 (Use of Off-road Vehicles on Public Lands, as amended by Executive Order 11989), which defines off-road vehicles as "any motorized vehicle designed for or capable of cross-country travel on or immediately over land, water, sand, snow, ice, marsh, swampland, or other natural terrain" (except any registered motorboat or any vehicle used for emergency purposes). Unless otherwise provided by statute, any time there is a proposal to allow a motor vehicle meeting this description to be used in a park, the provisions of the executive order must be applied.

"In accordance with 36 CFR 4.10(b), routes and areas may be designated only in national recreation areas, national seashores, national lakeshores, and national preserves, and only by special regulation. In accordance with the executive order, they may be allowed only in locations where there will be no adverse impacts on the area's natural, cultural, scenic, and esthetic values, and in consideration of other existing or proposed recreational uses. The criteria for new uses, appropriate uses, and unacceptable impacts listed in sections 8.1 and 8.2 must also be applied to determine whether off-road vehicle use may be allowed. As required by the executive order and the Organic Act, superintendents must immediately close a designated off-road vehicle route whenever the use is causing or will cause unacceptable impacts on the soil, vegetation, wildlife, wildlife habitat, or cultural and historic resources.

"NPS administrative off-road motor vehicle use will be limited to what is necessary to manage the public use of designated off-road vehicle routes and areas; to conduct emergency operations; and to accomplish essential maintenance, construction, and resource protection activities that cannot be accomplished reasonably by other means."

Snowmobiles (8.2.3.2)

"Snowmobile use is a form of off-road vehicle use governed by Executive Order 11644 (Use of Off-road Vehicles on Public Lands, as amended by Executive Order 11989), and in Alaska also by provisions of the Alaska National Interest Lands Conservation Act (16 USC 3121 and 3170). Implementing regulations are published at 36 CFR 2.18, 36 CFR Part 13, and 43 CFR Part 36. Outside Alaska, routes and areas may be designated for snowmobile and oversnow vehicle use only by special regulation after it has first been determined through park planning to be an appropriate use that will meet the requirements of 36 CFR 2.18 and not otherwise result in unacceptable impacts. Such designations can occur only on routes and water surfaces that are used by motor vehicles or motorboats during other seasons. In Alaska, the Alaska National Interest Lands Conservation Act provides additional authorities and requirements governing snowmobile use.

"NPS administrative use of snowmobiles will be limited to what is necessary (1) to manage public use of snowmobile or oversnow vehicles routes and areas; (2) to conduct emergency operations; and (3) to accomplish essential maintenance, construction, and resource protection activities that cannot be accomplished reasonably by other means."

Director's Orders

Director's Order #75A: Civic Engagement And Public Involvement:

"The purpose of this Director's Order (DO) is to articulate our commitment to civic engagement, and to have all National Park Service units and offices embrace civic engagement as the essential foundation and framework for creating plans and developing programs. Civic engagement is a continuous, dynamic conversation with the public on many levels that reinforces public commitment to the preservation of heritage resources, both cultural and natural, and strengthens public understanding of the full meaning and contemporary relevance of these resources. The foundation of civic engagement is a commitment to building and sustaining relationships with neighbors and communities of interest.

The remainder of the Director's Order may be viewed at http://www.nps.gov/policy/DOrders/75A.htm.

U.S. Department of Interior Memorandum

February 17, 2004, memorandum from Assistant Secretary, Fish and Wildlife and Parks, to Director, National Park Service, addressing snowmobile use in national parks service wide:

"…it has become clear that a service-wide directive to prohibit all forms of recreational snowmobile use in the National Park System is no longer warranted and that, with requirements for monitoring and increased use of newer technology snowmobiles, recreational uses can continue to be a part of the NPS winter experience. This will also allow decisions to be made on a park-by-park basis, relying on the professional judgment of each parks' staff. They will be able to consider the lessons from Yellowstone, such as the use of Best Available Technology requirements, guiding requirements, and adaptive management, as well as overall technological improvements and any other new information, and will then be able to determine whether any review or revision of their special regulations is needed."

"Existing road grooming serves an important and sometimes essential role in guaranteeing winter access for both visitors and park staff. It is necessary not only for the operation of recreational snowmobiles, but also for snowcoaches and for snowmobile use by park staff. In some parks, eliminating road grooming would eliminate motorized access to many popular and developed areas. It would not necessarily serve the needs of most visitors or park staff, if it becomes necessary to walk, snowshoes, or cross-country ski over dozens of miles of ungroomed snow-covered roads or trails to reach such areas. Park staff needs to retain the flexibility to address these issues in their parks and make decisions regarding park resources, visitor needs, and administrative access needs."

"NPS also needs to lead by example when purchasing and operating snowmobiles for administrative purposes. Only snowmobiles that meet the BAT standards as outlined in the Winter Use SEIS should be used by the NPS for administrative purposes. All purchases of snowmobiles by NPS units must be limited to BAT-compliant models unless a justification for an exception based on operational needs is approved by the respective Regional Director. No approval of a non-BAT machine may be made on the grounds of cost. Parks with employees

who reside in the park during the winter months and use snowmobiles as a means of travel on and off duty should also develop a policy that promotes the use of BAT-compliant snowmobiles for these types of uses. Superintendents should encourage their employees, especially new hires, to use BAT-compliant personal snowmobiles as well. Through a deliberate process of converting to cleaner and quieter snowmobiles, the NPS can be the leader in reducing impacts to our national parks."

"Park superintendents with continued snowmobile use need to do some form of monitoring as outlined in Executive Orders 11644 and 11989. This kind of use must continue to be a part of an active monitoring program and impacts of the use must be assessed from time to time. The appropriate level of monitoring must be tailored to the actual level of use in a park, as determined by the superintendent and park staff. Park officials should use their best professional judgment in determining the level of monitoring that is required."

Secretarial Order

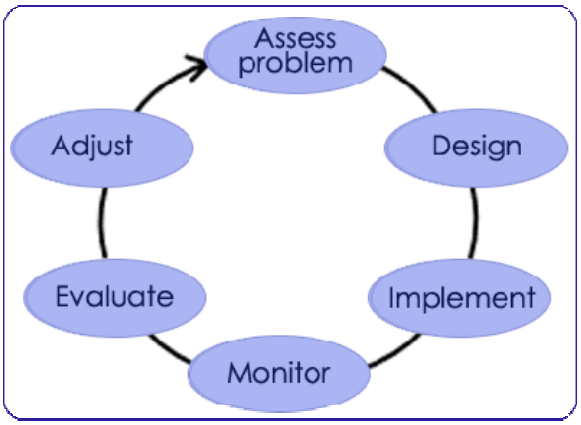
March 9, 2007 Order 3270 provides policy guidance and procedures for implementing adaptive management and transmits *Adaptive Management: The U.S. Department of the Interior Technical Guide* and website http://www.doi.gov/initiatives/AdaptiveManagement/.

APPENDIX B. MONITORING AND ADAPTIVE MANAGEMENT PROGRAM

Adaptive management helps science managers maintain flexibility in their decisions, knowing that uncertainties exist and provides managers the latitude to change direction. Adaptive management will improve understanding of ecological systems to achieve management objectives and is about taking action to improve progress towards desired outcomes.

The emphasis in an adaptive approach is first and foremost on resource management. The value of understanding, and the monitoring and analysis that produce understanding, is inherited from their contributions to the objectives of resource management. Although the focus is on learning, the ultimate goal of the effort is smart management. It is important to recognize that adaptive management is a complex endeavor that includes much more than simply following a sequence of steps. Properly executed, the process involves ongoing, real-time learning, both in a technical sense and in terms of process itself. Stakeholders need to be engaged at the stage of initial problem formulation and remain engaged throughout implementation (Williams et al. 2007). Williams identifies nine steps in adaptive management:

1. Stakeholder involvement
2. Objectives
3. Management actions
4. Models
5. Monitoring Plans
6. Decision making
7. Follow-up monitoring
8. Assessment, and
9. Iteration.



Through this and previous winter planning processes, steps 1-5 have been completed. The Finding of No Significant Impact is step 6.

Both alternatives include adaptive management provisions. An adaptive management plan is different from a monitoring plan in that it allows park managers to act when some information exists about a specific resource but conclusive data is currently unavailable. A key step in adaptive management is to develop and implement a management scenario based on the best available information. For example, in this document Alternative 2 proposes a specific limit on the number of winter visitors that can enter the park daily via snowmobile. The next step is to implement an evaluation program to assess the success of the management scenario relative to defined resource thresholds. This evaluation is critical within the framework of adaptive management because of the uncertain results of the initial predictions. Managers then review the results of the evaluation program and may adjust activities or use limits to mitigate unplanned or undesirable outcomes. For example, if the visitor limits set for a park entrance have a greater or lesser effect on resource thresholds than predicted, then the number of visitors allowed to enter the parks could be raised or lowered accordingly.

Monitoring is also a component of both alternatives. General resource monitoring applies when adequate information exists to make informed management decisions based on discrete and accepted thresholds. It is the process of collecting information to evaluate if the objectives of a management plan are being realized. Appropriate monitoring techniques will be used to assess impacts to air quality, natural soundscapes, public and employee health and safety; water quality and snowpack, geothermal features; wildlife; and some aspects of the visitor experience. The table in this appendix describes monitoring and adaptive management indicators, locations/zones, preliminary thresholds, methods, and monitoring intensity. The table also identifies possible management actions that will be implemented if thresholds are violated. Some non-emergency actions, such as the construction of a new facility, may require additional site-specific NEPA analysis, which includes public involvement. Other actions might be administrative in nature or could be implemented through application of a categorical exclusion under NEPA.

The preliminary thresholds are established to help a manager understand the results of monitoring programs and be one of many guides for possibly taking action if a problem is perceived. Exceeding a threshold does not mean that such a level would be unacceptable or result in impairment, but it does provide managers an early warning when conditions may be moving away from those that are desirable long before they reach an unacceptable level. Monitoring and adaptive management, and management action if these thresholds are violated, will ensure the parks' obligation to preserve resources and values in an unimpaired and acceptable condition is achieved, while allowing for winter use of the parks. Many of these thresholds were derived partly from the results of computational models, and they are preliminary in nature. Therefore, they could be adjusted depending on data resulting from monitoring programs.

These thresholds are the same as those found in the 2007 FEIS, with the exception of corrections to mistakes in the earlier thresholds. In gathering monitoring information, it may become necessary to examine adaptive management thresholds critically. Occasionally, the information gleaned from monitoring (as well as new research) may indicate that a threshold is actually inappropriate and should be adjusted upwards or downwards. For this reason, these thresholds could be adjusted in the future, based on monitoring information, research, and professional judgment.

Monitoring and Adaptive Management Indicators, Thresholds, and Methods

Resource or Value	Indicator	Location/ Management Zone	Preliminary Threshold	Preliminary Method	Initial Monitoring Intensity[1]	Possible Management Options if Threshold is Violated
Air Quality	Park employees and visitors exposure to CO, particulate matter, and volatile organic compounds. For comparison purposes, monitoring data for air quality may be found in Chapter 3 of this EA.	Developed Area	1-hr maximum CO (w/bkgd): 8 ppm 8-hr maximum CO (w/bkgd): 3 ppm 24-hr maximum PM_{10} (w/bkgd): 23 $\mu g/m^3$ No observed employee health problems due to air quality ATSDR (Agency for Toxic Substances and Disease Registry) Minimal Risk Levels	Fixed site monitoring or personal sampling for PM and CO Personal samples, cartridges, or canisters for VOCs (air toxics)	High	Require new technologies Adjust number of daily vehicle entries permitted Establish timed-entry requirements Medically monitor employees if necessary
		Road corridor	1-hr maximum CO (w/bkgd): 1 ppm 8-hr maximum CO (w/bkgd): 1 ppm 24-hr maximum PM_{10} (w/bkgd): 6 $\mu g/m^3$ No observed employee health problems due to air quality ATSDR (Agency for Toxic Substances and Disease Registry) Minimal Risk Levels	Fixed site monitoring or personal sampling for PM and CO Personal samples, cartridges, or canisters for VOCs (air toxics)	Moderate	

[1] High = daily to weekly or in accordance with standard protocol for parameter in question; Moderate = monthly to seasonally and during peak days or use periods; Low = annually during peak use periods or at the end of the season.

Resource or Value	Indicator	Location/ Management Zone	Preliminary Threshold	Preliminary Method	Initial Monitoring Intensity[1]	Possible Management Options if Threshold is Violated
		Transition and Backcountry	1-hr maximum CO (w/bkgd): 1 ppm 8-hr maximum CO (w/bkgd): 1 ppm 24-hr maximum PM_{10}: 5 µg/m^3	Fixed site monitoring or personal sampling for PM and CO	Low	
	Visibility	Development Area and Road corridor	No perceptible localized visibility impacts	Photo Survey, time lapse video and nephelometer	High	
		Transition and Backcountry	No perceptible localized visibility impacts		Low	
	Odor	Developed Area and Road Corridor	Area free of any noticeable odor resulting from motorized recreation at least 90% of the daytime hours of park operation (8 A.M. – 4 P.M.)	Park visitor survey	High	
		Transition and Backcountry	Area free of any noticeable odor resulting from motorized recreation		Low	

Resource or Value	Indicator(s)	Location/ Management Zone	Preliminary Threshold	Preliminary Method	Initial Monitoring Intensity[1]	Possible Management Options if Threshold is Violated
Natural Soundscapes	Distance and time OSV sound is audible; maximum sound level (dBA) Note: A rare event that exceeds these thresholds may not trigger management action. For comparison purposes, monitoring data for sound may be found in Chapter 3 of this EA.	Developed Area	Measured during daytime hours of park operation (8 A.M.– 4 P.M.) and 100 feet from sound sources: Audibility[2]: not to exceed (NTE) 75% OSV sound: NTE 70 dB(A)	Audibility logging, digital recordings, and sound pressure level measurement	High	Require new technologies Adjust number of daily vehicle entries permitted Establish timed-entry requirements
		Road Corridor	Measured during daytime hours of park operation (8 A.M.– 4 P.M.) and 100 feet from sound sources: Audibility: NTE 50% OSV sound: NTE 70 dB(A)		High	
		Transition Zone	Measured during daytime hours of park operation (8 A.M. – 4 P.M.) at selected index sites for the zone. Audibility: NTE 25% OSV sound: NTE 65 dB(A)		Moderate	

[2]Audibility is the percent of time OSV are audible to a person with normal hearing. A NTE 50% threshold means that OSV will not be audible more than 50% of the time during daytime hours of park operation.

Resource or Value	Indicator(s)	Location/ Management Zone	Preliminary Threshold	Preliminary Method	Initial Monitoring Intensity[1]	Possible Management Options if Threshold is Violated
		Backcountry	Measured during daytime hours of park operation (8 A.M. – 4 P.M.) at selected index sites for the zone. Audibility: NTE 10% OSV sound: NTE Lnat (natural ambient sound levels) Note: Vehicle noise, even at 6 dB(A) less than natural ambient, is usually audible due to the lower frequencies of OSV sound. Additionally, since natural and non-natural sounds tend to be in different frequencies, both can be audible at the same time, even at very low levels.		Moderate	

Resource or Value	Indicator(s)	Location/ Management Zone	Preliminary Threshold	Preliminary Method	Initial Monitoring Intensity[1]	Possible Management Options if Threshold is Violated
Public and Employee Health and Safety	Motor vehicle accidents Exposure to noise For comparison purposes, monitoring data for noise exposure may be found in Chapter 3 of this EA.	Developed Area and Road Corridor	Continual improvement of three-year moving average 8-hour time-weighted noise levels exceed 85 dBA and peak noise levels exceed 90 dBA. [See Air Quality for other health and safety thresholds.]	Incident descriptions and GIS mapping Personal exposure monitoring	High	Alter or implement commercial and non-commercial guiding requirements and/or ratio Increase signage and reduce speed limits in areas of recurring incidents Increase law enforcement and educational information Adjust number of daily vehicle entries permitted Require use of personal protection equipment; issue PPE; improve PPE

Resource or Value	Indicator	Location/ Management Zone	Preliminary Threshold	Preliminary Method	Initial Monitoring Intensity[1]	Possible Management Options if Threshold is Violated
Water/Snowpack	Water quality: VOCs, pH, hydrogen, ammonium, calcium, sulfate, nitrate, and NOx	Developed Area and Road Corridor	Ref: Ingersoll (1999) compared his water quality findings for snowmelt runoff to drinking water standards. Benzene: EPA maximum limit for drinking water 0.005 mg/L. OSHA permissible exposure in workplace (8-hour day, 40-hour weeks) 1 ppm Toluene: EPA maximum limit for drinking water 1 mg/L. OSHA permissible exposure in workplace 200 ppm Ethylbenzene: EPA maximum limit for drinking water .7 mg/L. OSHA permissible exposure in workplace 100 ppm Xylene: EPA maximum limit for drinking water 10 ppm. OSHA permissible exposure in workplace 100 ppm	Snowpack sampling, snowmelt runoff, stream runoff, snowmelt/rain event	Low or as needed by changing conditions	Require new technologies Determination and application of best management practices Adjust number of daily vehicle entries permitted

Resource or Value	Indicator	Location/ Management Zone	Preliminary Threshold	Preliminary Method	Initial Monitoring Intensity[1]	Possible Management Options if Threshold is Violated
		Backcountry	Benzene: EPA maximum limit for drinking water 0.005 mg/L. OSHA permissible exposure in workplace (8-hour day, 40-hour weeks) 1 ppm Toluene: EPA maximum limit for drinking water 1 mg/L. OSHA permissible exposure in workplace 200 ppm Ethylbenzene: EPA maximum limit for drinking water .7 mg/L. OSHA permissible exposure in workplace 100 ppm Xylene: EPA maximum limit for drinking water 10 ppm. OSHA permissible exposure in workplace 100 ppm	Snowpack sampling, snowmelt runoff, stream runoff, snowmelt/rain event	Low	
Geothermal Features	Human-caused damage to geothermal areas	Developed Area	No degradation of geothermal resources	Remote sensing and visual observation	High	Increase law enforcement and educational information Restrict travel

Resource or Value	Indicator	Location/ Management Zone	Preliminary Threshold	Preliminary Method	Initial Monitoring Intensity[1]	Possible Management Options if Threshold is Violated
Visitor Experience	Smoothness of the groomed surface	Travel Corridor	No worse than fair 20% of the daytime hours of park operation (8 A.M. – 4 P.M.)	Visual observation	High	Increase grooming Adjust vehicle numbers when threshold temperature and/or snow conditions are forecasted or reached
	Visitor satisfaction levels with opportunities to experience and view wildlife, scenery, and clean air and solitude.	Developed Area, Road Corridor, Transition, and Backcountry	Visitors are highly satisfied (+90%) with their park experience	Visitor Survey	High	Establish carrying capacity/adjust visitor numbers Determine unsatisfactory conditions and rectify
	Visitor perception and assessment of important park resources and values	Developed Area, Road Corridor, Transition, and Backcountry	Visitors are able to see, smell, and hear the natural environment at roadside pullouts and interpretive trails 90% of daytime hours during park operation (8 A.M. – 4 P.M.)	Visitor survey Encounter rates Time lapse photos Travel simulation models Observations	High	Establish carrying capacity/adjust visitor numbers Require new technologies

Resource or Value	Indicator	Location/ Management Zone	Preliminary Threshold	Preliminary Method	Initial Monitoring Intensity[1]	Possible Management Options if Threshold is Violated
Wildlife	Bird and mammal habituation and effectiveness of garbage facilities	Developed Area	Garbage, human food and other attractants unavailable to wildlife	Observations and monitoring	High	Improve or redesign facilities Alter or implement commercial guiding requirements and allocations
	Ungulate (e.g., bison and elk) movements on plowed roads	Travel Corridor	No unacceptable adverse effects. Unacceptable effects are those considered greater than "adverse moderate."	Continue bison monitoring and flights	High	Evaluate alternative transportation systems Close roads (by road segment or seasonally) Lower speed limits and increase enforcement
	Vehicle caused wildlife mortality	Travel Corridor	No unacceptable adverse effects	Incident reports, roadside surveys, GIS, and visual observations	High	Alter or implement commercial guiding requirements and allocations Evaluate alternative transportation systems Increase law enforcement and educational information Reduce speed limits

Resource or Value	Indicator	Location/ Management Zone	Preliminary Threshold	Preliminary Method	Initial Monitoring Intensity[1]	Possible Management Options if Threshold is Violated
	Wildlife harassment or displacement due to vehicle sounds or movements	Travel Corridor	No unacceptable adverse effects	Incident reports and visual observations	High	Increase law enforcement and educational information Require new technologies Adjust number of daily vehicle entries permitted Alter or implement commercial guiding requirements and allocations Establish additional no-stopping zones Adjust group size requirements Establish timed-entry requirements Close roads (by road segment or seasonally)
	Wildlife trapped by snow berms in road corridor	Travel Corridor	No unacceptable adverse effects	Incident reports, roadside surveys, and visual observations	High	Increase number of exit berms and re-evaluate location of existing exits Evaluate alternative transportation systems

Resource or Value	Indicator	Location/ Management Zone	Preliminary Threshold	Preliminary Method	Initial Monitoring Intensity[1]	Possible Management Options if Threshold is Violated
	Ungulate (e.g., bison and elk) use of groomed surfaces	Travel Corridor	No unacceptable adverse effects	Visual observations, air surveys, and telemetry. Continue bison monitoring	High	Close roads or eliminate grooming operations (by road segment or seasonally) Adjust grooming intensity
	Carnivore (e.g., wolves and lynx) displacement and habitat effectiveness	Transition and Backcountry	Insignificant, discountable, or beneficial effects only	Monitoring and air surveys	High	Mitigate effects or close area Increase law enforcement and educational information Require new technologies Adjust number of daily vehicle entries permitted Alter or implement commercial guiding requirements and allocations Establish additional no-stopping zones Adjust group size requirements Establish timed-entry requirements Consult with USFWS for appropriate mitigation strategies

Resource or Value	Indicator	Location/ Management Zone	Preliminary Threshold	Preliminary Method	Initial Monitoring Intensity[1]	Possible Management Options if Threshold is Violated
	Wildlife harassment or displacement as a result of visitor activities	Transition and Backcountry	No unacceptable adverse effects	Incident reports and visual observations	High	Increase law enforcement and educational information Require use of designated trails only Close areas to use seasonally
	Human-bear conflicts during pre- and post-denning periods	Transition and Backcountry	No unacceptable adverse effects	Mapping of denning areas and visitor use patterns and trends. Incident Reports	Moderate	

Appendix C. SUMMARY OF RECENT BISON AND ELK STUDIES

Borkowski et al. 2006: This study utilized multinomial logits models in more than 6500 interactions of bison and elk with groups of OSVs during five recent winters in YNP to identify conditions leading to behavioral responses. Borkowski et al. found that elk responded three times as often (52%) as bison (19%) during interactions with OSVs due to increased vigilance responses. However, the frequency of higher-intensity movement responses by bison and elk were similar (6–7%, travel; 1–2%, flight; 1%, defense) and relatively low compared to other studies of ungulates and snowmobile disturbance. The likelihood of active responses by bison and elk increased if animals were on or near roads, groups of animals were smaller, or humans approached. The likelihood of an active response by bison decreased within winters having the largest visitation, suggesting some habituation to snowmobiles and snowcoaches. Also, using data from the past 35 years, the authors found no evidence that snowmobile use has affected the population dynamics or demography of bison or elk. They suggest that the regulations restricting levels and travel routes of OSVs have been effective at reducing disturbances to bison and elk below a level that would cause measurable fitness effects and further recommend that park managers consider maintaining OSV traffic levels at or below those observed during the study. Borkowski and his colleagues suggest that differing interpretations of the behavioral and physiological response data will continue to exist because of the diverse social values of the various constituencies concerned with YNP.

Bruggeman et al. 2008a: The authors used aerial and ground data collected during 1970-71 through 2005-06 to quantify annual variations in the magnitude and timing of migration by central herd bison, identify potential factors driving this variation, and evaluate the "domino effect" hypothesis (Meagher 1998) that (a) significant migration to the Madison headwaters area did not occur until bison had fully occupied the Hayden and Pelican valleys, and (b) more animals migrated earlier as numbers increasingly exceeded this limit. Bison from the central herd in Yellowstone National Park were partially migratory, with a portion of the animals migrating to the lower-elevation Madison headwaters area during winter while some remained year-round in or near the Hayden and Pelican valleys. Contrary to the "domino effect" hypothesis, there was significant bison migration to the Madison headwaters area before the Hayden and Pelican valleys were fully occupied and abundance approached the food-limiting carrying capacity of these valleys. However, after the central herd exceeded 2350 animals the number of bison wintering in the Hayden and Pelican valleys appeared to stabilize, while bison continued to migrate to the Madison headwaters area. Also, more bison migrated earlier as density increased (as hypothesized by Meagher 1998). The results suggest some bison migrated outside the west-central portion of the park between the summer and winter counts each year when the central herd exceeded 2350 bison, perhaps relocating to northern range as hypothesized by Meagher (1998) and Fuller et al. (2007). Some of the annual variability in the proportion of bison migrating each winter was explained by density-independent climate covariates. The timing and magnitude of bison migration were accentuated during years of severe snow pack that limited access to food.

Bruggeman et al. 2008b: The effects of road grooming on bison distribution and movements in Yellowstone National Park have been debated since the early 1990s. Opponents claim energy saved by bison traveling on packed snow, in combination with better access to foraging habitat, results in enhanced population growth and increased movements to

boundary areas. We collected spatial and temporal data on bison travel on and off roads during the winters of 1997-98 through 2005-06 to evaluate if road travel was facilitated by road grooming or a manifestation of general bison travel patterns throughout the landscape. Road travel was negatively correlated with road grooming, suggesting grooming did not facilitate bison travel during winter. Temporal trends in road travel were likely a manifestation of general travel patterns because travel on and off roads was driven by factors affecting resource availability, including bison density, snow pack heterogeneity, and cohesion of snow-free patches. Bison use of roads varied depending on habitat attributes and topography surrounding road segments, with certain segments acting as travel corridors. Topography and distances to streams, forested habitats, and foraging areas were significant influences on the amount of bison road travel, with more travel occurring on road segments closer to streams and unburned forest, farther from foraging areas, and passing through canyons. Foraging was the most time-intensive activity (67%) by bison during winter. Traveling comprised a small amount (11%) of bison activity, with the majority (79%) of travel occurring off road. Thirty-one percent of foraging bison displaced snow, compared to only 7% of traveling animals. The ecological effects of road grooming on current bison travel patterns appear minimal, with no evidence that grooming facilitates bison movements beyond park boundaries.

Bruggeman et al. 2008c: The influence of winter road grooming on bison travel patterns in Yellowstone National Park has been debated for more than two decades. The authors radio collared 30 adult, female bison from the central herd during three winters to quantify how snow, topography, habitat attributes, and roads influenced bison travel patterns and non-traveling activities (i.e., foraging, resting). Bison were less likely to use a point on the landscape for traveling or feeding as snow pack increased. However, bison used local areas with deeper snow as the overall snow pack increased on the landscape. Distance to stream was the most influential habitat covariate, with the spatial travel network of bison being largely defined by streams connecting foraging areas. Distances to foraging areas and streams also significantly influenced non-traveling activities, being negatively correlated with the odds of bison foraging or resting. Topography significantly affected bison travel patterns, with the probability of travel being higher in areas of variable topography that constrained movements (e.g., canyons). Distance to road had a significant, negative effect on bison travel, but was nine times less influential compared to the impact of streams. Road grooming has a minimal influence on bison travel and habitat use given the importance of natural dynamic and static landscape characteristics such as snow pack, topography, and habitat attributes on bison choice of travel routes and habitat use for foraging and resting.

Bruggeman, J. E. 2006, Bruggeman et al. 2006, and Bruggeman et al. 2007: Based on data gathered from 1997-2005 using field methods, Bruggeman used statistical modeling and information theoretic techniques to examine spatial and temporal patterns in bison migration, road and off-road travel, and foraging behavior in relation to abiotic and biotic factors. Numbers of bison migrating were related to density and drought severity, while snow, drought, and density affected timing of migration. The probability of bison travel and spatial distribution of travel corridors were affected by topographic and habitat attributes including slope, landscape roughness, habitat, and distances to streams, foraging areas, and forested habitats. Streams were the most influential landscape feature affecting travel and results suggest the bison travel network is defined largely by the presence of streams. Probability of travel was higher in regions of variable topography (i.e., canyons). Pronounced travel corridors existed both in close association with roads and distant from any roads, and

results indicate roads may facilitate bison travel in areas. Multiple effects influenced temporal bison travel patterns. Road travel was negatively correlated with road grooming and Bruggeman found no evidence that bison preferentially used groomed roads during winter. Snowpack, density, and springtime melt were correlated with bison road and off-road travel. Bison foraging area residence times were affected by the ratio of local to landscape scale snowpack, previous foraging experiences, and local and landscape scale competition. Bison patch scale foraging behavior was predominantly affected by snowpack, with biomass and competition having minimal influence. The results indicated that bison spatio-temporal dynamics are affected by multiple, interacting, scale-dependent mechanisms. Overall, factors influencing resource availability provide the primary impetus for variability in bison distribution, movements, and foraging behavior.

Coughenour 2005: Michael Coughenour at Colorado State University evaluated if Yellowstone bison had reached a food-limited carrying capacity by using a spatially-explicit ecosystem simulation model for the Yellowstone ecosystem that integrated data from site water balance, plant biomass production, plant population dynamics, litter decomposition and nitrogen cycling, ungulate herbivory, ungulate spatial distribution, ungulate energy balance, ungulate population dynamics, predation, and predator population dynamics submodels. The overarching model simulated the two Yellowstone bison herds, two resident wintering elk herds, and the summer immigrant elk, and included GIS data for soils, vegetation, topography, and other variables. The model was driven by weather data from 29 different climatological and SNOTEL sites located in and near the park. Precipitation and temperature maps were generated using elevation-corrected spatial interpolation, and a validated snow model simulated the accumulation and melting of snow. When the model was run for 50 years without removals or migrations outside the park, the northern herd increased to a mean of 2417 bison (range = 1820-3530) over 8 simulations using stochastic weather. The central herd increased to a mean of 3776 bison (range = 2430-5630). Maximum counts of Yellowstone bison were 3531 bison in the central herd and 1484 bison in the northern herd during summer 2005. According to this model, neither the central or northern bison herds have yet reached their theoretical food-limited carrying capacities in the park.

After culling in the park ceased (1968), the central bison herd grew to a density where nutritional stress elicited increased competition for key resources and subsequent behavioral responses to search for additional range. Carrying capacity increased once new ranges were found, which resulted in a positive feedback cycle of increased bison numbers, nutritional stress, and further range expansion. Grooming snow-covered roads for snowmobiles may have contributed to the rate at which this process occurred because an increased proportion of travel on packed snow could provide minor energetic savings that, cumulatively over the course of many winters, could compound to accelerate population growth. In addition, there could be an effect on instantaneous decision-making by bison because individual animals decide to travel or not based upon the immediate stress imposed by deep snow conditions. However, bison also reached levels of increased nutritional stress when they were limited to their historical Hayden and Pelican valley winter ranges within the interior of the park. This intolerable nutritional stress, combined with their nomadic nature and ability to travel through deep snow, makes it likely that migration to the upper Madison drainage and beyond was an inevitable outcome whether roads were groomed for OSVs or not.

Fuller et al. 2007a: Fuller and her co-authors examined a 99-year time series of annual counts and removals for 2 bison (*Bison bison*) herds occupying northern and central Yellowstone National Park in the western United States. Yellowstone's aggressive

management intervention effectively recovered bison from 46 animals in 1902 to >1,500 animals in 1954. Supplemental feeding of the northern herd facilitated rapid growth during 1902 to 1952. Augmentation of the central herd with 71 animals also led to rapid growth over 1936 to 1954. In 1969, manipulative management ceased in the park, and the authors detected evidence of density-dependent changes in population growth rates for both herds during 1970 to 2000 as numbers increased to 3,000 animals. The central herd showed evidence of a constant density-dependent response over 1970 to 2000. In contrast, density dependence had a stronger effect on the northern herd's growth rate during 1970 to 1981 than during 1982 to 2000. The authors found evidence to suggest that these trends resulted from pulses of emigration from the central herd to the northern range beginning in 1982 in response to resource limitation generated by an interaction between density and severe snow pack. Corroborative evidence supporting this interpretation included 1) the annual growth of the central herd was negatively correlated with snow pack but that of the northern herd was not, 2) growth rates of the central and northern herds were uncorrelated during 1970 to 1981 but significantly and negatively correlated during 1982 to 2000, and 3) the northern herd could not have sustained the high removals experienced during 1984 to 2000 without immigration. Density-related emigration from the central herd to the northern range may be fueling bison emigration onto private and public lands where large-scale removals occur.

Fuller et al. 2007b: The conservation of bison (*Bison bison*) from near extinction to >4,000 animals in Yellowstone National Park has led to conflict regarding overabundance and potential transmission of brucellosis (*Brucella abortus*) to cattle. We estimated survival and birth rates from 53 radiocollared adult female bison during 1995–2001, and we used calf:adult (C:A) ratios to estimate reproduction with the combined effects of pregnancy, fetal loss, and neonatal mortality during 1970–1997. Annual survival of adult females was high and constant. Birth rates differed by brucellosis status and age. Birth rates were 0.40 calves per female for brucellosis-positive 3 year olds, 0.63 for individuals testing negative, and 0.10 for individuals contracting brucellosis that birth year (sero-converters). Birth rates were 0.64 for brucellosis-positive individuals $\geq$4 years old, 0.81 for brucellosis-negative individuals, and 0.22 for sero-converters. Spring C:A ratios were negatively correlated with snow pack. Growth rate was highly elastic to adult survival (0.51), and juvenile survival (0.36) was 3 times more elastic than fecundity (0.12). Simulations suggested brucellosis eradication via vaccination would result in increased birth rates and a 29% increase in population growth, possibly leading to more bison movements outside the park. Our results will help park managers evaluate bison population dynamics and explore consequences of management actions and disease control programs.

Geremia et al. 2008: The authors monitored 80 adult female bison from the central herd in Yellowstone National Park during 1995-2006 to estimate vital rates that incorporated the effects of brucellosis and could be used to formulate appropriate management strategies (e.g., vaccination, culling). Animals testing positive for exposure to brucellosis had significantly lower pregnancy rates across all age classes compared to seronegative bison. The authors do not understand the causal mechanism for this finding, which is difficult to ascertain since shedding through reproductive events is believed to be the primary route of brucellosis transmission. Birth rates were high and consistent for seronegative animals, but lower for younger, seropositive bison. Seronegative bison that converted to seropositive while pregnant were likely to abort their first and second pregnancies. Thus, naïve seronegative adult bison may be highly susceptible compared to animals exposed before they were reproductively mature. The authors detected pronounced senescence in survival for animals

>12 years old. Also, brucellosis exposure indirectly lowered bison survival because more bison were culled over concerns about transmission to cattle when bison attempted to move to lower-elevation areas outside the park. The authors detected a significant decrease in adult female survival when the number of bison in the central herd exceeded 2000-2500 animals, which was exacerbated during winters with severe snow pack because more bison moved outside the park. Except during 1996-97, the vast majority of radio-collared bison culled at the northern and western boundaries during 1995-2006 came from the central herd. The findings suggest the combined effect of brucellosis on survival, pregnancy, and birth rates lowered the growth rate in the central herd. Thus, population growth rates will likely increase by more than 15% if vaccination plans are implemented and successful. Wildlife managers would then be challenged with greater numbers of disease-free bison dispersing or migrating outside of the park in response to density and climate effects.

Wagner (2006): This analysis of bison count data found no evidence supporting the prediction that road grooming contributed to increased survival or decreased energy expenditure. Wagner stated his agreement with similar conclusions from the National Research Council (Cheville et al. 1998): "the available evidence indicates there has not been such an effect" of groomed roadways upon bison populations and distribution (2006:157).

White et al. (2006): In a statistical analysis similar to Borkowski et al. (2006—the separate study summarized above), this study examined over 5500 records of interactions between OSVs and wildlife collected by the NPS during the last four winters (2002-2003 through 2005-2006) for bison, elk, trumpeter swans, bald eagles, and coyotes. Utilizing this data, multinominal logits models were evaluated to determine if variables related to winter recreation (for example, snowpack characteristics, levels of OSV traffic, distance of the wildlife group from the road, the number of animals in the group, habitat type, etc.) were associated with changes in the behavior of wildlife. This analysis is of particular value because of its robust statistical methodology, the consistent sampling methodology over those years, and the recognition of year-to-year variability. White et al. found that these animals exhibited varying behavioral responses to OSVs in association with human activities. Specifically, animals exhibited an increased vigilance response (in which they focused their attention on the human activities) or a movement response (in which they moved away from the human activity) when they were in close proximity to or on roads, and when groups of wildlife were smaller. White et al. found the same result for bison, elk, and swan groups when they were approached by humans and when their movements were impeded or hastened by vehicles. Overall, the intensity of wildlife group responses differed across the five species in this study, with the percentage of observing a response (either movement or vigilance) being 83.3% for bald eagles, 60.5% for coyote, 52.4% for elk, 42.5% for swans, and only 19.6% for bison. As stated previously, the variability in these percentages is fairly well correlated with the varying vigilance responses of each animal to human disturbance: eagle 72.8% (meaning that 72.8% of eagle responses to human presence were vigilance), coyote 36.7% elk 44.3%, swan 32.5%, and bison 12.5%.

In the original paper, White et al. recommended that park managers "continue to conduct winter recreational activities in a in predictable manner with OSV [over-snow vehicle] traffic levels at or below those observed during the last 3 years of our study (i.e., <50,000 over-snow visitors)." White et al. erred in stating winter use should be limited to 50,000 over-snow *visitors*. Rather, they intended that the phrase read "<50,000 over-snow vehicles" (White 2008). This change is significant, for it allows substantially more visitors to enter the parks;

previously, not even the snowcoach-only alternative from the 2007 FEIS would have accommodated fewer than 50,000 visitors.

Cormack Gates Study

In 2004, the NPS commissioned an interdisciplinary study to assess the science and literature of bison movement and dispersal in the Yellowstone ecosystem. This report, the Gates Report, was the result of a collaborative agreement between the University of Calgary, Faculty of Environmental Design and the Rocky Mountains Cooperative Ecosystems Studies Unit (RM-CESU) at the University of Montana, commissioned by the NPS. Led by Dr. Cormack Gates of the University of Calgary, Canada, the team included Brad Stelfox, Tyler Muhly, Tom Chowns, and Robert J. Hudson, all members of the Faculty of Environmental Design there. The team issued their report in April 2005, entitled "The Ecology of Bison Movements and Distribution in and Beyond Yellowstone National Park: A Critical Review with Implications for Winter Use and Transboundary Population Management." The report is available at: http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm under the heading, **Bison/Groomed Road Research**.

The goal of the report was to provide a thorough, independent assessment of the state of knowledge of the ecology of bison movements and distribution within the context of current published concepts and theories. Another important goal was to provide recommendations for adaptive management of uncertainties and gaps in reliable knowledge within an adaptive environmental assessment and management framework, which involves organizing people to link science to management.

The report drew exhaustively upon all known bison literature (including those of Mary Meagher), over 30 bison "informants" (including Mary Meagher, Robert Garrott, Mark Taper, and Dan Bjornlie, and almost 30 others), and extensive modeling efforts. The report began by summarizing the bison management history of YNP. In 1968, the park moved from a 33-year (1934-1967) period of culling ungulate populations to achieve predetermined stocking levels, to a regime of ecological management. Under this regime, populations of bison and other ungulates are allowed to fluctuate in the park without human intervention. Bison populations have grown continuously under this regime. With growing numbers of bison, management has become dominated by two major linked controversies:

- the perceived risk to livestock from brucellosis infection when bison move beyond the park boundary, a concern since the 1920's; and
- the debate over the effects of winter recreation (specifically, grooming roads for oversnow vehicle traffic) on bison ecology, including range expansion, transboundary movements, bison condition, and population dynamics.

The report entailed review of 1) literature on ungulate distribution, including YNP publications and planning documents, 2) key informant interviews for gaining rapid understanding of the system and unpublished knowledge, 3) development of a strategic level bison population and winter distribution model, and 4) key informant technical workshops to refine the model. In addition, a workshop was held with non-governmental organizations to review the concepts and knowledge upon which the assessment and model are based.

The report gives key findings derived from 1) informant knowledge and interpretation of empirical data on population and spatial ecology, and 2) a systems model. Additionally, the report outlines key uncertainties and data gaps that may be addressed through monitoring and basic research.

Key Findings Based on Interviews, Empirical Data, and Historical Records

History

Bison populations have been affected by widely varying influences in recent history including hunting and captive breeding. They are part of a larger system that is best understood at long time scales and at a spatial scale larger than YNP.

Ranges and Movement Corridors

Bison occupy five winter ranges in YNP. The Central herd uses Pelican Valley, Mary Mountain (e.g. Hayden/Madison-Firehole), and West Yellowstone. The Northern herd occupies Lamar Valley and Gardiner Basin. As defined by key informants, these ranges are interconnected by five primary movement corridors including Firehole to Mammoth, Firehole to West Yellowstone, Gardiner Basin to Lamar, Mirror Plateau, and Pelican to Hayden.

Range Expansion

In a finding highly applicable to the winter use debate, the Gates report stated that all YNP bison ranges provide environmental conditions supporting long term growth and persistence of bison populations. Furthermore, there was no evidence to suggest that groomed roads have changed population growth rates relative to what may have happened in the absence of road grooming.

As the number of bison increased, the area they utilized expanded and distributions eventually coalesced. Presently, the authors recognize that the Yellowstone population is composed of two subpopulations, the Central and Northern herds. These herds are defined by differences in ecological conditions and use of space between ranges, genetic differences, fetal growth rates, and tooth wear patterns. For both the Northern and Central bison ranges, mid-winter survey data and history provide strong evidence that range expansion is density driven; more bison require more resources.

It was suggested that groomed roads could promote energy savings and exploratory routes that caused the bison population to increase 'unnaturally.' The authors, however, suggest that bison distribute themselves in an attempt to maintain a certain level of resources per individual. Range expansion, then, is driven by an interaction between population size, forage production, and forage availability. Exploratory movements and knowledge of productive destinations also influence range expansion.

Population Ecology

Generally, YNP is a forage-limited system. Bison in YNP attempt to compensate for declining per capita food resources by range expansion, thus maintaining a relatively stable instantaneous density. However, compensation is not exact; population growth rate declines with density because high quality foraging patches are limited in overall area, are patchily distributed and depleted first, forcing bison to shift to poorer quality patches as density increases. Bison in different areas of YNP experience different ecological conditions, including but not limited to forage, climate, refugia, topography, and predation.

Key Findings Based On Systems Modeling

The Gates report clearly states that bison population and spatial dynamics are expressions of complex interactions best understood using a systems approach. Based on the systems

dynamics paradigm, a strategic-level model was developed to facilitate collaborative learning about bison population, range use dynamics, and management alternatives. Key informants were asked to rank the importance of the system model variables. Using the resulting stakeholder contributions, the model was refined into a 'majority average model' and used to model bison population change over time with varying inputs, including the inputs of winter road grooming and no winter road grooming. The model was also run using the inputs of "Key Informant Group #4," which included Mary Meagher and Mark Taper.

The model identifies key knowledge gaps and easily accommodates new empirical data and relationships emerging from existing and future research. Forage availability was a sensitive driver of bison movements in the model. In turn, the three key variables determining winter forage availability were previous summer precipitation, snowpack characteristics, and elk and bison density (i.e., forage demand).

Bison Road Use

The model indicated that inter-range movements of bison were generally not constrained by winter snowpack in non-road grooming scenarios during most winters. The notable exception to this rule was the Firehole-Mammoth corridor that was a barrier during all non-road grooming scenarios.

According to the modeling, road grooming had a greater influence on movement of bison between interior ranges (Lamar-Mary Mountain, Mary Mountain-Pelican) than to the boundary ranges (West Yellowstone, Gardiner Basin).

Modeling scenarios of bison movement between winter ranges projected from 100 to 4,000 animals, influenced most by per capita forage availability. An average movement of ~1,000 bison occurred in non-road grooming scenarios, and 1,200 in road-grooming scenarios.

Modeling found that cumulative culls during ten 100-year stochastic runs ranged between annual average culls of 50-90 bison for the non-grooming scenario and 60-100 for road grooming scenarios. On average, 75 bison would be culled each year from boundary ranges with or without road grooming. The model predicted maximum cull under current boundary management would periodically exceed 500 animals and rarely exceed 750 animals.

Of note was the finding that increasing bison habitat exterior to YNP is an effective strategy to increase the total regional population, but such a strategy would not reduce the number of bison that would need to be culled annually in the regional landscape surrounding the park. Unless the landscape is completely permeable to bison, management culling will always occur at the margins of bison ranges. In fact, more habitat would allow for bison population growth, which would eventually drive more bison range expansion. While the percentage of the bison population affected would likely decrease, the number of individual animals removed would increase with more habitat.

The issue of how frequently bison use groomed roads and how that use affects their population dynamics and distribution has been contentious. The Gates report, using historical records, interviews and systems modeling, strongly indicates that population growth and range expansion in the Central herd is driven primarily by biotic factors as opposed to the groomed roads. Specifically, the authors state that groomed road segments facilitate movements within the Central Range during winter, but the authors found that such movements would likely have developed in the absence of road grooming as the density of bison increased, because road segments are aligned with natural movement pathways.

However, the Gates report did draw attention to one groomed route that may not be aligned with natural movement pathways. Since the early 1990s Central Range bison have migrated in increasing numbers north to Blacktail Deer Plateau and the Gardiner basin in winter using the road between Madison Junction and Mammoth. The authors suggest that this migration of Central Range bison to the Northern Range might not have developed in the absence of the groomed road between Madison Junction and Mammoth. The suggestion was that snow conditions (depth, SWE, etc.), topography (particularly in the Gibbon Canyon) and other factors might prevent bison from moving from Madison to Mammoth if the groomed road surface was unavailable to them. Given the unique importance of this road corridor in the park's road system, the authors suggested that management manipulations on the Madison to Mammoth road could be used as a de facto experiment to test hypotheses about bison road use.

Key Uncertainties

The authors state that bison population and spatial dynamics are sensitive to variation in several key variables and interactions between variables. Among them is a subset for which the least amount of empirical data is available. They identified 'Key Uncertainties' deserving further research.

One such uncertainty is the extent of the interchange between the Northern and Central bison herds. This information is important for understanding how to conserve the spatial and genetic structuring of this population and maintenance of bison on the Northern Range under current boundary management.

Recommendations from the Gates Report

Monitoring and Science

Yellowstone National Park should implement an internally funded bison population monitoring program that collects and manages data on population size, vital rates, and winter distribution in the long-term. (Such bison monitoring is underway.)

Yellowstone National Park should define a minimum viable bison population for the Northern Range.

Yellowstone National Park should encourage and coordinate research focused on reducing key uncertainties over a full range of densities as the population fluctuates in response to environmental stochasticity or management actions (the workshop and research proposal by Garrott and White, discussed below, provided the foundation for this work).

An adaptive management experiment should be designed to test permeability of the Firehole to Mammoth corridor under variable snow conditions with a specific focus on the road section between the Madison Administrative Area and Norris Junction. (see discussion below).

Yellowstone National Park should install a SNOTEL or snow-course station in the Pelican Valley, monitor snow conditions in the Pelican-Hayden Corridor, and re-evaluate the two existing snow models. (These steps are underway.)

Yellowstone National Park should continue to utilize GPS collars to gather data concerning key questions about movement ecology to be addressed, including the timing and extent of movements in relation to plant phenology, snow conditions, forage production and utilization. (This is part of the monitoring being done as part of the first bullet above.)

Adaptive and Collaborative Management Structures and Processes

The NPS should engage the U.S. Institute for Environmental Conflict Resolution in an independent situation assessment that includes advice on designing an integrated agency and public planning strategy to represent the common interest. (The NPS did engage this group and used the services of Cadence, Inc., to foster and facilitate public engagement on the 2007 EIS.)

The Yellowstone Center for Resources should play a lead role among agencies and researchers in coordinating data sharing, research, and monitoring of bison and other research relevant to bison ecology and management by developing a stable collaborative science and management framework.

The NPS should develop or refine appropriate systems models and other decision support tools to help agencies and other stakeholders to understand key uncertainties and system properties and to evaluate outcomes of management scenarios defined through value-based decision processes. (This research is underway, partly through the adaptive management experiment discussed above.)

The NPS should increase its support for the appropriate agencies to secure agreements for key winter range for bison and other wildlife adjacent to the park in the Northern Range.

Responses to Gates' Study

Acting upon Gates' suggestion, the NPS invited the Big Sky Institute at Montana State University to organize a workshop to evaluate the assertion that the Madison to Norris groomed road would serve as a barrier to bison movements between the Central and Northern winter ranges if grooming on that road were to cease. Held in January 2006, the group discussed an adaptive management experiment to evaluate that assertion: discontinuing road grooming on the road from Madison to Norris (and possibly from there to Mammoth as well) and measuring bison responses and predictor variables. However, the group noted that the proposed adaptive management experiment does not have a control area against which observational data could be compared. Consequently, the temporal change of terminating grooming can only provide observational data of a weak inferential nature on whether the advent of road grooming in the early 1970s has indeed altered bison distributions and migrations in YNP. Indeed, it is impossible to retrospectively determine if groomed roads initially facilitated increased abundance and range expansion by bison because no data on bison travel patterns existed prior to road grooming and bison are now familiar with destination ranges in their expanded range (Big Sky Institute 2006; Garrott and White 2007; see also Fuller 2006). While the workshop group suggested this and other experiments, it did not develop detailed experimental designs that would be necessary to fully implement a meaningful adaptive management experiment. Indeed, some believed that a scientific experiment is impossible because of the extreme number of variables (Big Sky Institute 2006).

Nevertheless, in spring 2007, the NPS contracted with Dr. Robert Garrott at Montana State University-Bozeman to develop a range of studies that could be used to test the key uncertainties identified at the Big Sky Institute workshop. Garrott, in combination with Dr. P.J. White, an NPS wildlife biologist at Yellowstone National Park, submitted "Evaluating Key Uncertainties Regarding Road Grooming and Bison Movements" to the NPS on May 15, 2007. The NPS sought peer review of the proposal from up to twelve wildlife experts, with two agreeing to perform the review. The NPS also posted the draft proposal on its website for

cooperators, stakeholders (including potential litigants) and other interested parties to review (the website is http://www.nps.gov/yell/parkmgmt/winterusetechnicaldocuments.htm). Peer review is now complete, with the final proposal, the peer reviews, and the author's response available at the same website. NPS anticipates further participation with stakeholders as it develops objectives, design, and analyses of a potential road closure experiment.

In their proposal, Garrott and White (2007) considered various types of study designs and statistical approaches to evaluate three overriding uncertainties regarding road grooming and bison movements in Yellowstone: 1) what is the influence of snow and terrain on bison movements; 2) what are the drivers of bison migration, re-distribution, and demography; and 3) what are the effects of road grooming on bison use of travel corridors? They developed testable predictions, proposed study designs and statistical analyses, and identified strengths of inference and potential pitfalls. They recommended a tiered approach to gain reliable knowledge regarding the effects of road grooming on bison movements. To evaluate the influence of snow and terrain on bison movements, they recommended using data from Global Positioning System (GPS) collars deployed on more than 30 bison during 2003-2007 to evaluate their odds of occupancy or movement given certain snow pack levels. To determine the drivers of bison spatial dynamics and population vital rates, they recommended integrating available data sets and formulating response variables describing variation in bison migration, foraging movements, adult survival, and calf survival with potential drivers of the variation evaluated within a multiple regression framework. To evaluate the effects of road grooming on bison travel, they recommended that a progression of studies be implemented during a succession of winters (these would be increasingly intrusive to park operations and visitors): 1) maintain a sample of 50-60 bison with GPS collars distributed between the central and northern breeding herds for at least five years to gain insights into the spatial and temporal factors influencing bison movements across the landscape; 2) deploy camera systems along the Firehole Canyon, Gibbon Canyon, and Mary Mountain trail to collect baseline data on the direction, frequency, magnitude, and timing of movement through major travel corridors; 3) perform experimental manipulations of bison movements through the Firehole Canyon by using metal gates or temporary cattle-guard bridges and fencing to deny bison access to the main groomed road and evaluate their use of alternate ungroomed routes; 4) manipulate bison movements through the Gibbon Canyon using gates/bridges and fencing to deny bison access to the new bridge and road (once construction is completed), while evaluating their use of an alternate ungroomed route; and 5) close the road between Madison and Norris junctions with no grooming of the roadway. The NPS has begun implementation of the research proposal by initiating the development and testing of a prototype camera system and placing radio collars on 30-40 bison (2008-09).

This study is intended to provide insights regarding key uncertainties about the bison-groomed road issue. The fact that the numerous studies into this concern have provided partial support for competing views, rather than the unambiguous rejection of one over another, is not surprising because ecological interactions are complex at the landscape scale (Hobbs and Hilborn 2006). The best available evidence now suggests that the observed changes in bison distribution over time were consequences of natural population growth and range expansion in a population recovering from near extirpation that would have occurred with or without access to snow-packed roads, though perhaps not at the same rate (Coughenour 2005, Gates et al. 2005, Bruggeman 2006) (see *Affected Environment: Wildlife)*.

Appendix D: SOCIOECONOMIC DATA

Comparison of Results to Other Studies

A number of other studies and documents were evaluated as a basis for alternative estimates or economic parameters for purposes of this analysis. These include: "Snowmobiling in Montana 2002" (Sylvester 2002); "2000-2001 Wyoming Snowmobile Survey" (McManus et al. 2001); "The Economic Impact of Travel & Tourism in Idaho" (Global Insight 2005); "Recreation Participation Patterns by Montana Residents" (Ellard et al. 1999); "Niche News: Winter Outdoor Enthusiasts" (Institute for Tourism and Recreation Research, 2003); "The Montana Trail Users Study" (McCool and Harris 1994); "Wyoming Travel Industry 2003 Impact Report" (Wyoming Travel and Tourism 2003), "Economic Trends in the Winter Season for Park County, Wyoming" (David T. Taylor 2007), "Wolves and People in Yellowstone: Impacts on the Regional Economy" (John Duffield, Chris Neher, and David Patterson 2006), "Turning On the Off-Season, Opportunities for Progress in the Yellowstone-Teton Region (Yellowstone Business Partnership 2007), and "The Park County Economy – Restructuring and Change in a Growing Region" (Swanson 2006). With the exception of Sylvester (2002) and McManus et al. (2001), the studies are too general to provide parameters or estimates for application in this analysis. Most of the studies are at the state level, for the entire year, and for all types of recreation. These studies are discussed below.

The Bureau of Business and Economic Research at The University of Montana prepared the report "Snowmobiling in Montana 2002" for the Montana Department of Fish, Wildlife, and Parks and the Montana Snowmobile Association (Sylvester 2002). The report updated previous evaluations of the economic contribution of snowmobiling in the State of Montana. This report concentrated on snowmobile expenditures in the West Yellowstone area. The authors estimated that nonresident snowmobilers spend about $225 per activity day, including food, lodging, and often, snowmobile rental costs.

The main focus of the Sylvester (2002) study is on a statewide overview of snowmobiling in Montana. However, Sylvester explored the reaction to the NPS proposal to limit snowmobiles in Yellowstone National Park. The study asked West Yellowstone respondents if they would return to the area even if they could not snowmobile in the park. Over 56% said they would return. Sylvester estimated that about $33 million of the total nonresident expenditures from snowmobiling occur in West Yellowstone. He also estimated that restricting the number of individuals in Yellowstone National Park may result in a decline of nonresident expenditures of between $10 million and $15 million in West Yellowstone. This decline assumed that some of the snowmobilers may be replaced by other winter users. Sylvester estimated that these expenditure estimates translate into losses of between $2 million and $4 million in labor income, affecting winter employment opportunities in West Yellowstone, that some full-time jobs may become part-time jobs, and that some part-time jobs may cease to exist. Based on this study, as many as 150 jobs in West Yellowstone could be affected if the NPS were to limit snowmobiling in the park. These results are comparable to some of the estimates reported above in this EA.

The results from the 2000-2001 Wyoming Snowmobile Survey provide information on trail usage, expenditure information and user satisfaction for snowmobiling in the State of Wyoming. The results represent resident, nonresident, and outfitter client snowmobile use of Wyoming

State trails during the season of 2000-2001. Trips to Yellowstone and Grand Teton National Parks trails accounted for 3.1% of resident, 4.6% of nonresident, and 33.2% of outfitter client snowmobile trips during the season. Daily per person trip expenditures in Wyoming ranged from $180.27 for outfitter clients to $98.99 for nonresidents and $68.50 for residents. Annual equipment expenditures in Wyoming ranged from $2,306.13 for residents to $329.94 for nonresidents, and $64.11 for outfitter clients (McManus et al. 2001). However, statewide information contained in the Wyoming survey is not directly comparable to survey data specific to the GYA.

In the 2000-2001 Wyoming Snowmobile Survey, the majority of residents (nearly 70%) preferred that there would be no ban on snowmobiles. Half of these preferred a requirement for cleaner and quieter machines and half wanted no additional requirements. About 20% of resident snowmobilers preferred a solution that limited snowmobile access by day or by season. Over 37% of nonresident respondents preferred no ban and no additional requirements. As a solution, 28% favored cleaner and quieter machines and almost 30% favored either a partial ban in highly sensitive areas or more limited access by day or by season. Half of resident Wyoming snowmobilers did not see a need for cleaner and quieter snowmobiles but 50% also said they would pay more to use them if these vehicles were available. A minority of nonresidents (28.2%) thought there was a need for cleaner and quieter snowmobiles, but 50.5% of all respondents said they would pay more to use them if these vehicles were available. A majority of outfitter clients (56%) thought there was a need for cleaner and quieter snowmobiles and over 64% said they would be willing to pay a higher price to use them (McManus et al. 2001).

The 2000-2001 Wyoming Snowmobile Survey also asked respondents (statewide) about behaviors that would result from a ban on snowmobile use in the parks. The study found that over 78% of outfitter clients, 89% of residents, and 97.3% of nonresidents indicated that snowmobiling was their primary purpose for traveling to Wyoming during their most recent visit. Trips to Yellowstone and Grand Teton national parks accounted for 3.1% of resident, 4.6% of nonresident, and 33.2% of outfitter client snowmobile trips during the 2000-2001 season. Outfitter clients would make the most changes of all Wyoming trail users if the parks were closed to snowmobile access; nonresidents and residents would also be affected but to a lesser degree. Resident, nonresident, and outfitter clients indicated they would decrease their annual overall total number of snowmobiling trips by 2.5%, 11.4%, and 34% respectively. Resident, nonresident, and outfitter clients indicated they would decrease their annual snowmobiling trips to Wyoming trails by 5%, 10.4%, and 52.3% respectively. However, the survey results do indicate some substitution to other trails within the region (Montana, Idaho, Colorado, South Dakota, and Utah) with the number of resident trips increasing by 52.1% and outfitter client trips increasing by 20.6%. Nonresident snowmobilers indicated their use of other regional trails would decrease by 10.4%. The majority of Wyoming snowmobile trail users (84.6% of outfitter clients, 91.2% of residents, and 93.2% of nonresidents) would not consider going to Yellowstone if their only mechanized access were by snowcoach tours (McManus et al. 2001).

The Wyoming study concludes from these data that there could be a loss of up to 938 jobs, $11.8 million in labor income, and $1.3 million in government revenue in the state if the NPS implemented a snowmobile ban in the parks. The estimated job losses in the McManus et al. study just for Wyoming are higher (938 jobs lost) than the estimated job losses for Wyoming, Montana, and Idaho, combined, in the results reported in this EIS (747 jobs). Additionally, the

community level analysis in this EIS indicates a much larger loss at West Yellowstone for a snowmobile ban (378 jobs) than at Jackson (144 jobs) and Cody (9 jobs) (McManus et al. 2001). This is consistent with the distribution of snowmobile visitors at the west, east, and south entrances. The Wyoming estimates may be high because snowmobilers were surveyed statewide and not all respondents actually would be reducing their use in the GYA in response to a ban.

The Global Insights (2005) study of the tourism industry in Idaho provides county by county estimates of the annual impacts of tourism for all types of activities. There is no specific analysis of winter use or snowmobiling.

The Ellard, Nickerson, and McMahon (1999) study is an analysis of participation patterns by Montana residents for all recreation activities and on an annual basis. The study shows that relative to other activities, snowmobiling has relatively low participation, at seven percent. However, there is no specific analysis of snowmobiling in any specific area (such as Yellowstone), expenditure analysis, or policy analysis for this sport.

The Niche News document (ITTR 2003) summarizes some facts about winter recreation in Montana. The reported data specific to snowmobiling are that 16 percent of nonresident visitors are attracted to this activity, compared to 59 percent for downhill skiing and 27 percent for Yellowstone.

McCool and Harris (1994) examined participation in Montana resident trail use for all kinds of activities including walking for pleasure, backpacking, ATV use, etc. Findings specific to snowmobiling are that 15 percent reported going snowmobiling in the fall through winter survey period, and that there is a slight preference for groomed trails.

The Wyoming Travel and Tourism report (2003) includes an overview of the economic impact of all types of tourism on an annual basis in Wyoming. One finding is that hiking creates 32 percent of "marketable trips," compared to 3 percent for snowmobiling.

The Economic Trends for Park County, Wyoming (Taylor 2007) summarized park visitation, lodging sales and lodging tax revenue, and accommodation and food service sector employment for the county. The report applies an inflation factor so that the reader can see the effect of rising lodging rates on tax revenue.

Wolves and People (Duffield, Neher and Patterson 2006) is a specific look at the role of wolf watching in Yellowstone on the economy of the Greater Yellowstone region.

The report "Turning On the Off Season" (Yellowstone Business Partnership 2007) presents the results of a research project to look at some of the characteristics and indicators that are relevant to understanding how the Greater Yellowstone region operates, especially in the fall, winter, and spring seasons.

Finally, the report "The Park County Economy – Restructuring and Change in a Growing Region" (Swanson 2006) is a focused look at the Park County, Wyoming economy and how it has changed in the last 15 years in comparison with similar counties in the West.