Yellowstone National Park
Winter Use Adaptive Management Plan
Wyoming, Montana, Idaho

National Park Service
Department of the Interior

Winter Use Adaptive Management Plan

DECEMBER 2016

Well-prepared and ready to ride - NPS photo

Yellowstone National Park does not endorse the organizations and enterprises listed or appearing in this document. Reference to specific organizations and enterprises are simply for illustrative purposes only in the context of long-term monitoring of resource conditions and visitor experience.

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Winter conditions pose challenges for all - NPS photo

A snowcoach travels through Swan Lake Flats - NPS photo

Executive Summary

A strategy to monitor impacts to park resources, learn from data and new information, and adjust management actions and goals as necessary.

This Yellowstone National Park Winter Use Adaptive Management Plan (AMP) addresses outstanding questions and uncertainties surrounding the implementation of the 2013 Winter Use Plan/Supplemental Environmental Impact Statement (SEIS) and the implementing regulation (final Rule). This plan presents a strategy to monitor impacts to park resources, evaluate and learn from data and new information, and adjust management actions and goals as necessary. It examines six impact topics that may be affected by the implementation of the SEIS.

The SEIS, associated Record of Decision (ROD) (published August 22, 2013), and the final Rule (36 CFR 7.13(l)) on winter use lay the foundation for a collaborative Adaptive Management Program to inform and improve winter use management. The purpose of this plan is to meet the following three goals:

1. To evaluate the impacts of oversnow vehicle (OSV) use and to help managers implement actions that keep impacts within the range predicted under the Selected Alternative.

2. To gather additional data regarding the comparability of impacts from a group of snowmobiles versus a snowcoach.

3. To reduce impacts on park resources after implementation of the Selected Alternative by gathering additional data regarding the overall social and ecological impacts of winter use and using those data to guide future management decisions.

This AMP was developed in collaboration with individuals interested in winter use in Yellowstone National Park (YNP). Working Groups were formed around each impact topic, which were comprised of stakeholders and interested members of the public. The purpose of these Working Groups was not to reach a consensus or to agree on a course of action, but for individual members of each Working Group to provide suggestions, knowledge, technical expertise, and general comments about monitoring objectives and potential mitigation measures.

A draft of this plan was released to the public in May of 2015. Comments were solicited via the Park Planning, Environment, and Public Comment (PEPC) website, and by mail. The public was invited to attend a meeting to discuss suggested metrics contained in the draft document and had the opportunity to comment during the 60-day comment period. Individuals provided input on which of the suggested metrics were most important to them and based on the extent to which they meet the goals of the Adaptive Management Program. A summary of comments received and the NPS response is located in Chapter 8 of this document. The final decision regarding which metrics to monitor rests with the Superintendent.

The Adaptive Management Program, outlined in this plan, is intended to be flexible in that as new information is collected and evaluated, the National Park Service (NPS) and the public will continually re-examine the goals of the program, monitoring strategies, and management actions. The NPS will keep the public updated on new information and any changes to monitoring strategies or winter use management through the YNP website, monitoring reports, and public meetings as needed.

Cold temperatures make even the smallest thermal feature a steamy show in winter - NPS Photo

Chapter 1: Purpose & Need

The who, what, when, and why of the Yellowstone Winter Use Adaptive Management Plan

Introduction

Winter use in Yellowstone National Park (YNP) has been the subject of debate for more than 80 years. At least 12 times since 1930, the National Park Service (NPS) and park stakeholders have discussed winter use in Yellowstone. Interest in accessing the park in the winter began in the early 1930s and grew throughout the years. In the 1970s, 1980s, and early 1990s, snowmobile use in the park grew consistently, with the use of snowcoaches following in popularity. However, the increased use of these vehicles (collectively known as oversnow vehicles or OSVs) to access the park brought unanticipated problems, including air and noise pollution, wildlife harassment, and conflicts with other users, as documented in past planning efforts (NPS 2013c). Planning for the management of OSV use began with the Master Plan in 1974 (NPS 1974). Since then, a series of planning processes have examined Winter Use in Yellowstone (Yochim 2009). A detailed description of these planning processes can be found on the park's winter use website at www.nps.gov/yell/planyourvisit/winteruse.htm.

Purpose and Need

The most recent final Plan/Supplemental Environmental Impact Statement (SEIS) for winter use was released to the public in February 2013, and the corresponding Record of Decision (ROD) officially concluding the National Environmental Policy Act (NEPA) process was signed in September 2013. The Selected Alternative in the ROD called for management of winter use in YNP by transportation events. Under 36 CFR 2.18 (c), the use of snowmobiles is prohibited in parks unless a special regulation allowing such use is promulgated. In October 2013, a final Rule on Winter Use was signed authorizing OSV use and lending regulatory backing to the transportation event paradigm described in the Selected Alternative (36 CFR 7.13(l)). Together, these documents laid a new foundation for winter use management, including the development of a collaborative Adaptive Management Program to inform and improve winter use management.

What is Adaptive Management?

Adaptive management, in general, refers to the process of learning by doing and then adapting or adjusting, and is an important tool for resource management. It is especially useful in a complex environment, where resources are responsive to management interventions but uncertainty exists about the impacts of management actions (Williams and Brown 2012). Adaptive management allows decision-makers to acknowledge the uncertainties surrounding the management of natural systems, and helps natural resource managers respond to resource or system conditions over time through the collection and evaluation of additional information. The knowledge that uncertainties exist provides managers the ability to consider them in their planning and allows for the latitude to modify actions to progress towards desired outcomes. Adaptive management has the potential to improve a manager's understanding of ecological systems to better achieve management objectives.

In 2008, the Department of the Interior codified the definition in regulation, stating that adaptive management is "a system of management practices based on clearly identified outcomes and monitoring to determine whether management actions are meeting desired outcomes; and if not, facilitating management changes that will best ensure that outcomes are met or re-evaluated" (43 CFR 46.30). Additional guidance was provided in 2012 with the publication of Adaptive Management: The U.S. Department of Interior Applications Guide, which provides federal, state, tribal, and other natural resource managers with tools to more effectively address the complexities and uncertainties involved in natural resource management. The Department regulations also direct its agencies to use adaptive management when appropriate (43 CFR 46.145). Adaptive man-

agement is a continuing iterative process where a problem is assessed, potential management actions are designed and implemented, actions and resource responses are monitored over time, data is evaluated, and management actions are adjusted, if necessary, to better achieve desired management outcomes (figure 1).

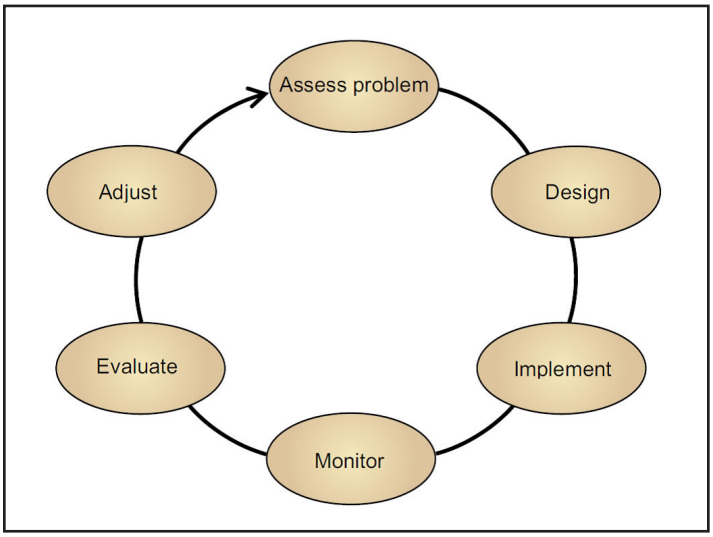


Figure 1: DOI Interior Application Guide Adaptive Management Process Diagram (Williams et al., 2009)

The 2012 U.S. Department of the Interior Applications Guide for Adaptive Management describes two phases of adaptive management (table 1). The first, the set-up phase, involves stakeholder involvement, defining project objectives (e.g., winter use planning objectives), identifying management alternatives, developing predictive models, and creating monitoring protocols. The iterative phase of adaptive management includes decision-making, monitoring, assessment, learning and feedback, and institutional learning (Williams and Brown 2012).

At this stage of the winter use planning process, much of the set-up phase has been completed through the SEIS process. However, this AMP focuses primarily on identifying a suite of possible metrics to monitor and a process for assessment, learning and feedback, and the potential to adjust decision-making. Stakeholder involvement should be an ongoing and integral part of the entire adaptive management process. Institutional learning, or the process of assessing project objectives, management alternatives, and non-technical aspects of this program, is a critical component of true adaptive management and should be ongoing. In the event of the re-evaluation of major objectives or alternatives not analyzed in the scope of the SEIS, further NEPA may be considered.

Table 1. Phases of adaptive management (Williams & Brown 2012)

Phase	Described
Set-up phase of adaptive management	Ongoing: Members of the public were involved to form Working Groups and began meeting in November 2013
	Objectives established for winter use planning in the SEIS (NPS 2013c p. ii-iii)
	Management by transportation event selected as preferred alternative and codified in final Rule (36 CFR 7.13(l))
	Soundscape, air emissions, and socioeconomic (IMPLAN) modeling conducted during SEIS process
	Some exist and were conducted under the SEIS; some to be developed
Iterative phase of adaptive management	Alternatives selected, but there is potential to adjust within parameters of SEIS analysis; metrics prioritized with public input and the NPS will select final metrics
	Monitoring will be conducted each winter season and reports published on the Yellowstone NP website
	Periodic stakeholder meetings to discuss monitoring results
	Ongoing
	Ongoing

The Yellowstone National Park Winter Use Adaptive Management Program

The purpose of the Adaptive Management Program is to provide a structured process, involving the public and interested stakeholders, to continually evaluate the effectiveness of the SEIS and seek to provide information to inform uncertainties and improve management over time. The Adaptive Management Program includes the development, execution, and continual re-evaluation of the AMP.

While most adaptive management plans include developing management actions to address specific goals, developing a monitoring plan, and identifying management triggers, this AMP differs somewhat from that process. Some management actions such as those outlined in the Selected Alternative, and to some extent thresholds, have already been identified in the SEIS, so one of the primary goals of this AMP is to ensure that impacts from the Selected Alternative do not exceed the impacts predicted in the SEIS. Other aspects of the winter use program could include studies or monitoring that don't yet have a specific monitoring plan or triggers. There are three central objectives for the AMP:

1. To evaluate the impacts of OSV use and help managers implement actions that keep impacts within the range predicted under the Selected Alternative.

2. To gather additional data regarding the comparability of impacts from a group of snowmobiles versus a snowcoach.

3. To reduce impacts on park resources after implementation of the Selected Alternative, by gathering additional data regarding the overall social and ecological impacts of winter use and using those data to guide future management decisions.

To meet these objectives, the NPS began a process to collaborate with individual stakeholders to develop this adaptive management and monitoring plan for Yellowstone winter use (table 2). This plan identifies a core set of indicators to address key scientific uncertainties and to measure the park's social and ecological conditions during the winter season going forward. In general, indicators required by the SEIS and pertaining to the first goal of the AMP are the core set of indicators that will be monitored. Several other indicators and

NPS staff discuss snowmobile noise test results with representatives of local snowmobile rental companies - NPS photo

Table 2. Winter use adaptive management plan timeline

Date	Action
23-Oct-13	Final Rule on winter use published
22-Nov-13	Initial public adaptive management meeting in Bozeman, MT
4-Jun-14	Adaptive management public meeting in Jackson, WY
Jul-14	First draft of Working Group chapters due to AMP coordinator
Jan-15	Second draft of Working Group chapters due to AMP coordinator
May-15	Draft Adaptive Management Plan released
Aug-15	Public meeting to discuss draft AMP
Summer 2015	60-day comment period on draft AMP
2016	Final AMP to be published

topics deemed high priorities by the park and the public are currently being monitored, and new indicators may be monitored using the decision-making process outlined in Chapter 8.

Successful adaptive management depends on sustained public and stakeholder engagement. In the adaptive management process, evaluation follows monitoring. In the evaluation stage, managers and stakeholders should continually evaluate goals, problem definitions, decision-making, monitoring strategies, methodologies, and even our most basic assumptions. This is a continual process. If impacts to park resources exceed those predicted in the SEIS or desired levels, the park will consider a range of mitigation measures including those suggested by Working Groups. The park may also revisit monitoring protocols and other elements of this plan, as more is learned about the social and ecological environment in which the park operates. Some plan adaptations may require the approval of the Superintendent, or if beyond the scope of the SEIS, further NEPA analysis. For effective evaluation, the NPS relies on continual public engagement. Protocols, monitoring results, and management actions will be discussed in periodic meetings with stakeholders; individual Working Groups may convene more often as necessary. Each Working Group that publishes annual reports will complete reports each September following a winter season and make this report available online.

Impact Topics and Monitoring Strategies

On November 22, 2013, a public meeting was held in Bozeman, Montana, to invite public input on the content and process of developing the AMP. Stakeholders formed Working Groups around six impact topics: wildlife, soundscape and acoustic resources, air emissions, human dimensions, operations and technology, and the Non-commercially Guided Snowmobile Access Program (NCGSAP). Interested members of the public volunteered to participate in Working Groups of their choosing, and individual members of each Working Group provided background information on their respective impact topics and existing science, suggested monitoring objectives, and proposed a monitoring plan that addresses the plan objectives and metrics for potential inclusion in the monitoring strategy. Working Groups provided comments and input on chapters of this plan surrounding each impact topic. The purpose of these Working Groups was not to reach a consensus on monitoring topics or metrics. Rather, Working Groups provided suggestions, knowl-

Table 3. Working group leaders and links to notes

Working Group	NPS Lead	Contact Information	Link to Notes
Wildlife	Brian Teets	Brian_Teets@nps.gov (307) 344-2653	www.nps.gov/yuell/learn/management/wild.htm
Air quality	Ann Rodman	Ann_Rodman@nps.gov (307) 344-2216	www.nps.gov/yell/learn/management/aqs.htm
Soundscape	Shan Burson	Shan_Burson@nps.gov (307) 739-3584	www.nps.gov/yell/learn/management/aqs.htm
Human Dimensions	Ryan Atwell	Ryan_Atwell@nps.gov (307) 344-2511	www.nps.gov/yell/learn/management/hd.htm
Operations Technology	Christina White	Christinia_Mills@nps.gov (307) 344-2320	www.nps.gov/yell/learn/management/optech.htm
NCGSAP	Ivan Kowski	Ivan_Kowski@nps.gov (307) 344-2165	www.nps.gov/yell/learn/management/ngsap.htm

edge, technical expertise, and general comments. The NPS remains the sole decision-maker. Each Working Group had a leader and met periodically. Working Group leaders and links to meeting notes can be found in table 3.

As an impact topic, climate change was not specifically addressed by the SEIS, "in part because many variables are not fully understood and there may be variables not currently defined" (NPS 2013c, p.25). It is clear that the planet is experiencing a warming trend that affects ocean currents, sea levels, polar sea ice, and global weather patterns; and local data indicate a trend of increasing winter time temperatures in the Greater Yellowstone Ecosystem (visit the National Park Service Climate Change Explorer website for more information –http://www.nps.gov/features/yell/climateexplorer/index.html). These changes will likely affect winter precipitation patterns and amounts in the park (NPS 2013 c, p. 25), which could have implications for winter season opening and closing dates, snow road conditions, and other aspects of winter time operations. While there is not a Working Group dedicated solely to climate change, the Operations and Technology Working Group may address this issue and related concerns in the future, to the extent that the NPS and the public wish to pursue them.

The following sections were developed by Working Group leads with input from individuals in the group. Most include an introduction to the topic, a summary of existing science, a description of the group's process and approach, and monitoring objectives organized by the three goals of this plan. Each Working Group also considered cost to monitor suggested metrics, potential thresholds, and possible mitigation measures. In some cases, Working Groups did not feel it was appropriate to identify thresholds or mitigation measures at this time. The following sections represent discussions about what each Working Group recommended for monitoring. In some cases, it will not be feasible to monitor each of the metrics suggested. Chapter 8 discusses how metrics to be monitored will be considered. Changes between the Draft and Final Plan were based on public comments, and are also discussed in Chapter 8.

Hoar frost covers the trees in Yellowstone's snowy landscape - NPS photo

Bison make their way down a snowy road - NPS photo

Chapter 2: Wildlife

Yellowstone is home to the largest concentration of mammals in the lower 48 states.

Introduction

The extent to which OSVs impact wildlife has been a topic of interest in Yellowstone National Park (YNP) for decades (Borkowski et al. 2006, White et al. 2009). Research has focused on how OSVs might affect the productivity of wildlife populations, influence behavioral responses of individuals, and increase stress levels in animals that are active during winter. The impact analysis in the 2013 SEIS demonstrated that the Selected Alternative would not interfere with the ecology of any wildlife species. Yellowstone National Park will manage OSV use in the park based on transportation events, with one event being equal to one group of snowmobiles (average of 7 snowmobiles per group) or one snowcoach. The Selected Alternative allows for OSV use levels similar to those permitted under the 2009-2013 interim regulations, with an approximated 10% reduction in the number of transportation events. The potential for OSVs to displace wildlife was an important consideration in the evaluation of alternatives analyzed in the SEIS. Under the Selected Alternative, impacts related to the displacement of individual animals are expected to be low because the number of daily transportation events is reduced compared to conditions before 2007 (NPS 2013c).

Summary of Existing Science

Bison and elk are expected to be the two wildlife species most impacted by winter use based on their use of park roads and habitat near roads. However, over 35 years of census data do not reveal any relationship between changing winter use patterns and elk or bison population dynamics (NPS 2013c). Bison and elk have continued to use the same core winter ranges, even when OSV use fluctuated substantially from winter-to-winter (Craighead et al. 1973, Aune 1981, Hardy 2001). Although bison and elk may temporarily avoid areas of OSV use, resulting in short-term displacement, these responses have not caused shifts in core winter habitat use. As such, the adverse impacts on wildlife described within the Selected Alternative are expected to be minor to moderate. As Yellowstone National Park moves forward with the implementation of the Selected Alternative, there is a need to continue monitoring interactions between OSVs and wildlife for the purpose of keeping impacts within the ranges described in the SEIS.

The Selected Alternative proposes that the potential impacts to wildlife from a single snowcoach are comparable to a group of snowmobiles. Data analyses suggest that snowmobiles are more likely to elicit a visible behavioral response from bison or elk; but snowcoaches elicit stronger levels of behavioral responses, such as movement or flight (Borkowski et al. 2006, McClure et al. 2009, White et al. 2009). However, regardless of the type of OSV, movement responses in wildlife occur in less than 10% of encounters. Studies of the behavioral responses of five species (bison, elk, trumpeter swans, wolves, and bald eagles) in YNP indicated these animals rarely exhibit high-intensity responses (movement or alertness for extended periods of time) to approaching OSVs (Borkowski et al. 2006, White et al. 2009). Collectively, all species exhibited non-travel responses (no response, look/resume, or alert response) to human activities at least 90% of the time. Approximately 90% of bison or elk either showed no apparent response or a “look and resume” response when encountered by OSVs. The infrequency with which wildlife demonstrated a movement response to OSVs suggests that a comparison between OSV types may not be a productive use of resources for monitoring. White et al. (2009) reported that human disturbance did not appear to be a primary factor influencing the movement of wildlife species (bison, elk, trumpeter swans, and bald eagles) and

Bison and snowcoaches share the road - NPS Photo

concluded that individual responses that resulted in flight or other active behavior were apparently short-term behavioral responses without lasting influence on species distribution patterns.

At the population level, long-term impacts from winter use could occur if behavioral responses result in the displacement of a substantial portion of a wildlife population. The prevailing evidence suggests that winter snow pack conditions and heterogeneity of the population (i.e., variation in sex and age) are the primary factors influencing winter distribution of elk in central YNP (Messer et al. 2009). Such factors as weather, predators, and plant succession—not winter recreation—are clearly responsible for most variation in vital rates and abundance of bison and elk. OSVs can affect wildlife directly through collisions; however, there have been no known instances of OSV-caused animal mortality since institution of the 100% guiding requirement in December 2004. Based on the data from the managed use era (2004 top resent), there is no reason to suspect that direct mortalities from OSV strikes would occur from either snowmobile or snowcoach transportation events. Data collected and presented in peer reviewed studies between 1999 and 2006, both before and during the managed use era, indicate that there is no evidence to suggest that OSVs have had population-level impacts among studied wildlife species in the park (Borkowski et al. 2006, White et al. 2009). The available data indicate that ecological processes are the dominant influences on the dynamics of wildlife populations.

Summary of key findings from 10 winters of monitoring (Borkowski et al. 2006, White et al. 2009, Teets et al. 2014):

- Monitoring crews sampled more than 10,000 interactions between OSVs and groups of wildlife (i.e., one or more animals) less than 500 meters from the road during 10 winters.
- Human responses to wildlife were few: 52% did not stop; 38% stopped but stayed on their OSV; 4% dismounted their OSV; and 6% approached, impeded, or hastened wildlife.
- As the size of wildlife groups increased, fewer wildlife responses were observed.

• Wildlife groups that were further from the road demonstrated fewer responses.

• Wildlife responded to OSVs more often when in open vs. forested habitats.

• Increased human provocation resulted in increased responses from wildlife.

• Wildlife responded less as cumulative OSV use increased during winter.

• Wildlife responded more as cumulative snow pack (i.e., water equivalent) increased.

• Elk responded more than bison; but responses were typically infrequent, short in duration, and low intensity, with few active responses near roads.

• Wildlife appeared to be tolerant of OSVs.

• There was no evidence that minor energetic costs of movement responses affected the vital rates, distribution, or population dynamics of bison, elk, or swans.

Summary of results from 2014/2015 winter monitoring (Teets et al. 2015):

• Monitoring of interactions between motorized vehicles and wildlife began on December 29, 2014, and continued until February 16, 2015.

• Wildlife monitoring crews conducted 28 surveys on three road segments: Norris to Madison Jct., Madison Jct. to Old Faithful, and West Yellowstone to Madison Jct.

• Observers recorded 132 groups of wildlife, which included 101 groups of bison, 4 groups of elk, 13 groups of swans, 4 groups of bald eagles, 9 groups of coyotes, and 1 group of other species (fox).

• Observers recorded 106 OSV interactions with wildlife (62 snowmobile only, 34 snowcoach only, and 10 mixed interactions).

• The responses of all wildlife species to OSV interactions and associated humans were as follows: 89% categorized as no apparent response, 4% look/resume, 3% travel, less than 1% attention/alarm, and 3% flight/defense.

• Interactions with bison made up 97% of the total OSV/wildlife interactions during the 2014-2015 monitoring season.

• Monitoring efforts ceased on February 16, 2015 due to the plowing of the roads in the primary study area. It was determined that further monitoring of wheeled vehicles was unnecessary and would have been a safety concern due to narrow roads and absence of road shoulder.

Working Group Process and Approach

YNP has monitored the behavioral responses of wildlife to OSVs since 1999 (Borkowski et al. 2006, White et al. 2009). The role of the Wildlife Working Group is to provide comments to the NPS on the design of an updated monitoring strategy that measures and evaluates the impacts of winter use on park wildlife to ensure the winter ecology of wildlife is not disrupted under the implementation of the Selected Alternative.

On February 14, 2014, the Wildlife Working Group held a conference call to solicit insight from each Working Group member on the following topics:

• What basic monitoring is needed to evaluate the impact of OSVs on wildlife and to ensure these impacts stay within the range predicted under the Selected Alternative?

• What research and monitoring is needed to compare impacts that result from a group of snowmobiles versus a snowcoach?

• What additional research is needed to further reduce the social and ecological impacts of winter use on wildlife?

The participants on the call were comprised of eight members of the public, which included concerned citizens, snowmobile guides, and representatives from conservation organizations, as well as two representatives from YNP. Past and present wildlife monitoring efforts were reviewed during the meeting. The Working Group felt that the impacts to wildlife were greater during the period of unmanaged use. The changes made since 2004 have reduced impacts, and the group felt that Yellowstone had done a good job with monitoring since 1997. The following paragraphs summarize comments from the participants to a series of questions.

What are acceptable impact levels for wildlife? Are the levels described in SEIS acceptable?

The Working Group felt that the impact levels described in the SEIS are acceptable. Though no disturbance is ideal, eliminating all disturbances may not be realistic. The group agreed that the level of impacts to wildlife described in the SEIS are accurate and can be used as a baseline for future comparisons. The current study design for wildlife monitoring (located on the park's website at www.nps.gov/yell/learn/management/wild.htm) is appropriate and should be kept for consistency.

Should more areas of the park be monitored?

Areas outside the Firehole-Madison-Gibbon Study Area have less use and less wildlife. The current study design is appropriate because most winter visitation takes place in the current study area. If cost is an important consideration, there is no need to add passive monitoring in less frequently used areas of the park. As an alternative, the monitoring plan should keep the primary survey routes (Firehole-Madison-Gibbon Study Area) as a priority and include secondary routes if needed and as finances are available. Additional routes may be used in the short-term to see if there is a significant number of encounters in other areas of the park; if not, monitoring should focus on the primary routes. (See 2015-2016 Monitoring Modifications).

Should monitoring address behavior of OSV users (e.g., duration and number of visitors approaching wildlife on foot) in more detail?

Current wildlife monitoring protocol documents situations when OSV users depart the OSV and approach wildlife from the groomed road surface (both number of persons approaching as well as distance). At the time of publication, wildlife monitoring crews are not monitoring backcountry visitor/wildlife contacts.

Based on low responses of wildlife to either OSV type, is a rigorous study of comparability necessary? Does the current monitoring program adequately describe wildlife responses to OSV type?

It would be extremely difficult to adequately compare impacts to wildlife that result from encounters with specific types of OSVs, and funding should not be applied for mon-

Wintertime visitors to Yellowstone learn to watch for and respect bison if they encounter them on the roadway - NPS Photo

itoring efforts that attempt to distinguish differences in the intensity of wildlife responses. The comparison of impacts by OSV type is complicated by the fact that interactions with wildlife frequently involve multiple OSV types.

What are potential areas for research?

- Monitoring winter backcountry use by visitors.
- Potential effects of other disturbances (e.g., wildfire, beetles) on how wildlife responds to OSVs.

Are wildlife responses augmented in disturbed habitat?

Current monitoring can address this by including some characteristics/classifications of the habitat where interactions take place. Current habitat classifications documented for each wildlife interaction are Aquatic, Burned Forest, Forest, Meadow/Riparian/Bottomlands, and Thermal.

In summary, the Working Group commented that:

- The impact levels to wildlife described in the SEIS are accurate.
- The current study design for assessing OSV impacts to wildlife is appropriate and should not be changed.
- For monitoring impacts to wildlife, additional studies that specifically compare the impacts from OSV type (snowmobile versus snowcoach) are not necessary.
- The current monitoring program can adequately determine whether OSV impacts are being kept within the ranges described in the SEIS.

Monitoring Objectives

The monitoring objectives regarding human use and its potential adverse effects on wildlife along winter road corridors in Yellowstone National Park will remain as described in Davis et al. (2007) and Teets et al. (2014) (http://www.nps.gov/yell/learn/management/wild.htm). Wildlife monitoring objectives are listed below, organized by the AMP goals.

AMP Goal 1: To evaluate the impacts of OSV use and help managers implement actions that keep impacts within the range predicted under the Selected Alternative

The Wildlife Working Group determined that the current monitoring was sufficient to help managers keep impacts to wildlife within the range predicted under the Selected Alternative. The continuation of the current monitoring program will be used to evaluate whether the following objectives are being met:

1. The avoidance, displacement, or harassment of wildlife from noise, vehicles, or other human activities are comparable to the levels described in the SEIS.
2. Vehicle-caused wildlife deaths or injuries are kept at or near zero.
3. Conflicts with ungulate (e.g., bison, elk) movements on groomed roads are diminished.

AMP Goal 2: To gather additional data regarding the comparability of impacts from a group of snowmobiles versus a snowcoach

While all transportation event types (snowmobile and snowcoach) are documented at each wildlife interaction, no comparative data regarding snowmobile vs. snowcoach as the cause of a given reaction is being pursued. The Wildlife Working Group indicated that additional research on the comparability of impacts from a group of snowmobiles versus a snowcoach was unnecessary. Movement responses in wildlife are too infrequent to justify research into a comparison between the type of transportation event. The group felt that funding could be better applied elsewhere.

AMP Goal 3: To reduce impacts on park resources after implementation of the Selected Alternative by gathering additional data regarding the overall social and ecological impacts of winter use and using those data to guide future management decisions

No novel monitoring or research is recommended to address this objective.

Bull elk can be seen roaming across the landscape - NPS Photo

Additional Recommendations

The Wildlife Working Group and NPS staff suggested the following modifications to further improve the effectiveness of the current monitoring plan. For winter season 2015-2016, it has been decided that Yellowstone keep the core monitoring program with the addition of another monitoring team. It has also been recommended that the Winter Wildlife staff make the previous year's data available by September each year.

2015-2016 Monitoring Modifications

A few minor changes were made to the monitoring for winter 2015-2016. First, the addition of the second monitoring team has been implemented. Two additional technicians based out of Grant Village/South Entrance were added on December 15, 2015. This resulted in North District and South District monitoring teams. Both teams monitored all primary survey routes (Norris Jct. to Madison Jct., Madison Jct. to Old Faithful, and West Entrance to Madison Jct.). The South team worked a Thursday through Sunday schedule, and the North team worked a Monday through Thursday schedule to allow for 7-day a week monitoring. Another benefit of the additional team is an increase in sample size (wildlife/OSV interaction data). Second, it was decided (per Wildlife Working Group comments and NPS staff discussion) to permanently eliminate the additional survey routes (Mammoth to Norris Jct. and Canyon Jct. to Fishing Bridge) that were a pilot project in winter 2013-2014.

Cost, Triggers, and Mitigation Measures

The estimated cost for monitoring would range between $50,000 to $80,000, depending on the number of field staff needed for monitoring. Current operation cost for 2014-2015 fell within the above range.

With regard to triggers, there are numerous factors that affect how wildlife will respond to OSV encounters. These may range from environmental conditions (e.g., snow pack), nutritional condition, group size, or the location and density of predators (e.g., wolves). Therefore, specific triggers should not be used to implement mitigation measures. Rather, significant changes from the baseline response data (cumulative years of wildlife monitoring data) can be used to determine whether mitigation measures are necessary and what specific measures are needed to reduce impacts.

Suggested and current mitigation measures include the following:

- Speed limits for OSVs will continue to be enforced to minimize noise and wildlife disturbance, and to prevent wildlife strikes by OSVs.
- To reduce adverse interaction with wildlife along roads, all OSV use will continue to be either commercially guided, permitted and guided through the NCGSAP, or administrative.
- At periodic intervals when snow depth warrants, routine plowing or grooming operations will include laying back roadside snow banks that could be a barrier to wildlife exiting the road corridor.

- NPS personnel will patrol sensitive resource areas to ensure compliance with area closures.
- The park will continue to support the objectives of the Greater Yellowstone Bald Eagle Management Plan, and the eagle population will continue to be monitored to identify and protect nests.
- Monitoring of wolves will continue.
- Monitoring of grizzly bear populations will continue in accordance with the Interagency Grizzly Bear Management Guidelines and the park's bear management plans.
- Wildlife-proof garbage holding facilities for interior locations (including the Old Faithful Snow Lodge) will be provided as part of regularly-occurring park operations.
- Use of groomed, ungroomed, and plowed surfaces by bison and other ungulates will continue to be monitored.

The monitoring program can be adjusted if there is no significant change in wildlife responses to OSV after several years of monitoring.

Bull elk in deep winter - NPS Photo

Additional Resources

To see the most recent winter wildlife monitoring strategy, visit the Wildlife Working Group website at www.nps.gov/yell/ learn/management/wild.htm.

Technical reports are available at www.nps.gov/yell/learn/man-agement/winter_monitoring.htm.

Some additional resources on winter recreation and wildlife include the following:

Aune, K.E. 1981. Impacts of winter recreationists on wildlife in a portion of Yellowstone National Park, Wyoming. Thesis, Montana State University, Bozeman, Montana, USA.

Borkowski, J.J., P.J. White, R.A. Garrott, T.D. Davis, A.R. Hardy, and D.J. Reinhart. 2006. Behavioral responses of bison and elk in Yellowstone to snowmobiles and snowcoaches. Ecological Applications 16:1911-1925.

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.

Davis, T., P.J. White, D. Reinhart, and C. McClure. 2007. Wildlife responses to motorized winter recreation in Yellowstone: 2007 annual report. Yellowstone National Park, Mammoth, Wyoming, USA.

Jaffe, R., D. Elwood, A. Dimmick, T. Davis, and C. McClure. 2002. Final report: wildlife road survey and human interactions on and off road. Copy available from the West District Resource Management Office, Yellowstone National Park, Mammoth, Wyoming, USA.

McClure, C., D. Reinhart, P.J. White, M. Donovan, and B. Teets. 2009. Wildlife responses to motorized winter recreation in Yellowstone. Draft report. Yellowstone National Park, Mammoth, Wyoming, USA.

Teets, B., J. Roper, P. Perrotti, and D. Reinhart. 2014. Wildlife responses to motorized recreation in Yellowstone: 2014 annual report. Yellowstone National Park, Mammoth, Wyoming, USA.

White, P.J., J.J. Borkowski, T. Davis, R.A. Garrott, D.P. Reinhart, and D.C. McClure. 2009. Wildlife responses to park visitors in winter. Pages 581-601 in R.A. Garrott, P.J. White, and Watson, editors. The ecology of large mammals in central Yellowstone—sixteen years of integrated field studies. Elsevier, San Diego, California, USA.

Short days and a blanket of snow can make Yellowstone feel particularly peaceful in winter - NPS photo

Chapter 3: Soundscapes & Acoustic Resources

The natural soundscape of Yellowstone National Park is a resource that is highly variable, ecologically important, valued by visitors, and protected by policy.

Introduction

The natural soundscape of Yellowstone National Park is a resource that is highly variable, ecologically important, valued by visitors, and protected by policy. Common natural sounds in winter include bird calls, mammal vocalizations, flowing water, wind, and thermal activity. These sounds vary by hour, day, month, and location. The natural soundscape is predominant in the park's backcountry and even in developed areas during the night. The natural soundscape is also predominant along travel corridors for a majority of the time during the day in the winter use season. Environmental conditions, including air temperature and wind, have a substantial effect on how far both natural and non-natural sounds can be heard (NPS 2013c). The common noise (defined as undesirable or extraneous sounds) occurring in the winter include OSVs, aircraft, and utilities associated with developed areas. Parkwide, the primary noise source is from OSVs and is an important management concern in the park (NPS 2013c).

Summary of Existing Science

Since the winter of 2003, the Yellowstone Soundscape Program has collected long-term acoustic data during the winter use season at 47 locations along travel corridors, within developed areas, and in the backcountry. Long-term measurements were collected at the developed areas of Old Faithful, Canyon, and West Yellowstone, and on each of the groomed road segments open to OSVs, except for the Cave Falls Road near Bechler.

Measurements from automated acoustic monitors helped to assess the noise impact of OSVs on the natural soundscape of the park. Noise from both visitor and administrative OSVs were measured. Data collected include digital recordings, continuous sound levels, and wind speed and direction. The park measured the sound levels and the duration and timing when OSVs could be heard (percent time audible and noise-free intervals) along travel corridors, in destination areas, and at backcountry sites. One-second sound levels of OSVs and all other sources were collected 24 hours per day.

The longest monitored sites have been at Old Faithful (since 2003) and along the road near Madison Junction (since 2005), both adjacent to the most heavily-used OSV areas. These and other sites have provided comparisons among locations and years of the noise impact (percent time audible and maximum sound level) of both snowmobiles and snowcoaches (NPS 2013c).

During the day, OSVs can be heard, on average, about half the time at Madison Junction and approximately 62% of the time at Old Faithful, but much less often in areas of the park with lower OSV activity (table 4). The maximum sound levels of groups of snowmobiles measured at 100 feet are generally in the 60s dBA and reach into the 70s dBA for some loud individual snowcoaches (NPS 2013c).

From 2005-2013, an observational study was conducted to identify the type and operators of passing OSVs at many locations within the park. These results along with the associated time audible data have contributed to information about visitor versus administrative use and snowcoach versus snowmobile use. Of all audible groups of snowmobiles, guided visitor groups comprised 36% in developed areas and 65% along travel corridors. Of all audible snowcoaches, guided visitor snowcoaches comprised 87% in developed areas and 94% along travel corridors (Burson 2013).

In support of a new Best Available Technology (BAT) requirement in the SEIS for snowmobiles and snowcoaches, standardized pass-by measurements have been conducted for snowmobiles and snowcoaches. Previous test sites were

Snowcoaches and snowmobiles line up outside of the Madison Warming Hut - NPS photo

at the South Entrance, near Indian Creek between Mammoth and Norris, and near the 7-Mile Bridge between Madison Junction and West Yellowstone. Standardized testing provides data on maximum sound levels of individual OSVs.

In support of the multiple winter use plans, computer modeling was used to evaluate the relative noise impacts of existing and multiple alternatives of OSV use. Noise impacts that were calculated include the area of the park affected, percent time audible among management zones, sound levels at varying distances from OSV activity, peak sound levels, and differences among group size and type. Modeling is described in more detail in Appendix F of the SEIS (NPS 2013c).

The 2013 Supplemental Environmental Impact Statement (NPS 2013c) and the Record of Decision (NPS 2013b) included several acoustic metrics. These included the percent of the travel corridors and backcountry areas affected by OSV percent time audible, the average OSV sound energy (Leq), and the peak OSV sound levels.

Most recently, a brief pilot study was conducted to assess the comparability of noise impacts from snowcoaches and groups of snowmobiles. Acoustic data were collected during the winter of 2014-2015 by autonomous monitoring equipment at the popular visitor destination of Fountain Paint Pots. Analyses of these preliminary data suggested that alternative methodologies (attended onsite data collection) would be necessary to adequately address the comparability of noise from snowcoaches and groups of snowmobiles.

Working Group Process and Approach

A combined Air Quality and Soundscape Working Group was formed and met in person on November 22, 2013, at the Kickoff Meeting of the Winter Use Adaptive Management Program. The group subsequently met by conference calls on February 26, 2014, and April 30, 2014. Shan Burson led discussions of soundscapes, and Ann Rodman led the air quality discussions. Background material, agendas, and questions were distributed by email to the Working Group prior to meetings. These materials were consulted and discussed by the Working Group members during the meetings. All members were encouraged to participate. The Working Group leads developed their chapters (this one and Air Quality) which were then reviewed by individual members of the Working Group.

Table 4. Percent time OSVs were audible by management zone, site, and year in Yellowstone National Park, 2003-2014

	MANAGEMENT ZONES																			
	Developed1		Road Corridor1										Transition2			Backcountry2				
Year	OFWS	CVDA	MJ23	WY31	SPC2	CRPA	GVLL	SERS	MUVO	CLRS	PPRD	SYL3	MMTR	OFUB	LSGY	MM8K	PAYP	SHGB	HLBC	FLBC
4-Mar	61%												32%		3%					
5-Apr	69%			55%										29%	4%	26%				
6-May	67%		55%											35%						
7-Jun	68%		59%		44%				26%											0%
8-Jul	68%		53%				37%									26%		18%		
9-Aug	55%		47%																	
10-Sep	55%		54%																	
11-Oct	61%		51%			44%					22%									
12-Nov	66%	39%	45%							22%										
13-Dec	63%		51%									5%					8%		11%	
13-14	60%		47%					24%												
14-15	49%		30%				28%													
Site average	62%	39%	51%	55%	44%	44%	33%	24%	26%	22%	22%	5%	32%	32%	4%	26%	8%	18%	11%	0%
Mgmt. zone average		50%										32%								13%

[1] Sites ordered from left to right, busiest to less busy
[2] Sites ordered from left to right, closest to motorized route to most distant
[3] Red text indicates only seven days analyzed

KEY			
OFWS	Old Faithful Weather Station	PPRD	Pumice Point Roadside
CVDA	Canyon Village Developed Area	SYL3	Sylvan Pass
MJ23	Madison Junction	MMTR	Mary Mountain Trail
WY31	West Yellowstone	OFUB	Old Faithful Upper Basin
SPC2	Spring Creek	LSGY	Lonestar Geyser Basin
CRPA	Caldera Rim Picnic Area	MM8K	Mary Mountain 8K
GVLL	Grant Village Lewis Lake	PAYP	Paycheck Pass Backcountry
SERS	South Entrance Road	SHGB	Shoshone Geyser Basin
MUVO	Mud Volcano	HLBC	Heart Lake Backcountry
CLRS	Cygnet Lake Roadside	FLBC	Fern Lake Backcountry

Table 5. Number of OSVs in Yellowstone by year

Year	Snowmobiles	Snowcoaches	OSVs including Old Faithful[4]
2003-04	254	23	281
2004-05	206	25	236
2005-06	267	30	302
2006-07	299	30	336
2007-08	290	32	338
2008-09	196	29	234
2009-10	181	28	221
2010-11	214	30	261
2011-12	162	26	204
2012-13	185	28	229
2013-14	195	28	233
2014-15	154	20	188
Average	217	27	255

[4] Number of OSVs originating at Old Faithful prior to 2006-2007 and 2012-2013 were estimated.

To ensure that the noise impact from OSVs does not exceed the values prescribed in the SEIS and the ROD, continued monitoring is necessary. The winter use plan has a staged implementation period over several years until fully implemented. During this time, impacts to the soundscape may continue to vary by year. Once OSV travel patterns stabilize and if OSVs themselves remain acoustically similar, it may be possible to reduce acoustic monitoring. This would be advisable only if the monitoring results indicate static conditions for a number of years. The following section describes the metrics and types of data this Working Group feels are the most important to collect and monitor.

Monitoring Objectives

The following monitoring plan assumes that the conditions of the ROD and the final Rule are followed including speed limits and the travel patterns of OSV use, that only BAT OSVs will be used in Yellowstone, and that the limit on transportation events with their prescribed number and type will be maintained. Two assumptions, that winter use travel patterns do not change substantially and that OSVs comply with speed limits, may need monitoring to assure that they remain valid. Because these assumptions span several impact topic areas, this group does not specify a monitoring plan for them; group members want to emphasize their importance to the extent of noise impacts from OSV use.

AMP Goal 1: To evaluate the impacts of OSV use and help managers implement actions that keep impacts within the range predicted under the Selected Alternative

To meet this goal, the park will continue acoustic monitoring at the two long-term sites near Madison Junction and Old Faithful, following the established protocols (Ambrose and Burson 2004) and intensity of sampling (Burson 2015). The group proposes to add an additional long-term site on the South Entrance Road to monitor the impacts and trends of OSV use originating from the south (the second busiest corridor). The park will continue to analyze percent time audible; noise-free interval; the average, maximum, and median sound levels; and the sound level exceeding 90% of the time, by hour and by winter season. These data and analyses will

A microphone at 7-Mile Bridge captures OSV noise - NPS photo

provide the NPS the ability to evaluate the impact of OSV use and assess trends over time. By comparing future data to previously collected data, the NPS can determine if the noise impacts from OSV use have exceeded that predicted in the SEIS.

AMP Goal 2: To gather additional data regarding the comparability of impacts from a group of snowmobiles versus a snowcoach.

To meet this goal, the group proposes to assess the potential difference between noise impacts of snowcoaches and groups of snowmobiles on visitor experience and the natural soundscape at near-road destinations:

1. Analyze percent time audible, maximum sound levels, and time above 55dBA and time above 10dBA above natural ambient.

2. Conduct visitor surveys at near-road destinations.

These data and analyses will provide the NPS the ability to determine if snowmobiles and snowcoaches have comparable noise impacts on visitors and the natural soundscape in the heavily-visited roadside destination areas. Computer acoustic modeling has concluded that noise impacts from snowcoaches and groups of snowmobiles are comparable when assessed at a distance at which the two types can be considered a point source. Previous analyses from acoustic monitoring concluded that snowcoach and groups of snowmobiles percent time audible are comparable when taken in aggregate, that is, the averages from both types. Near-road area impacts present a different scenario. The noise impact from a snowcoach pass-by event is a single point source, whereas a group of snowmobiles is numerous point sources. The sound levels and audibility at near-road destinations may differ between the two OSV types. The time above metrics will assess the potential for masking natural sounds and speech interference, the maximum sound levels will measure the intensity of the noise impact, and the percent time audible will assess the total available period where visitor perceptions of solitude or being in a natural setting may be influenced.

A visitor survey conducted during the winter at near-road destinations would directly address the comparability of noise from snowcoaches and groups of snowmobiles. A true dose-response analysis is possible by collecting acoustic data at the same locations and times.

AMP Goal 3: To reduce impacts on park resources after implementation of the Selected Alternative by gathering additional data regarding the overall social and ecological impacts of winter use and using those data to guide future management decisions

No novel monitoring or research is recommended to address this objective; however, the following general operational items would result in improvements to the natural soundscape and visitor experience:

1. Purchasing and using the quietest available snowmobile models and snowcoach types.

2. Documenting and subsequently implementing behaviors and other circumstances that mitigate or eliminate noise impacts. Examples would include the following:

- Reducing the distance between individual snowmobiles within groups near visitor destinations to reduce the time audible of a pass-by event, and slowing down to reduce the maximum sound level (also relevant for snowcoaches).
- Turning off motors at wildlife viewing stops.
- Driving behaviors that reduce loud acceleration or deceleration.

Data that could be used for this objective includes the BAT noise certification results from snowmobile manufacturers and NPS snowcoach pass-by testing, acoustic data from on-going monitoring as described above, and staff and other users' anecdotal observations.

Cost, Triggers, and Mitigation Measures

Monitoring objectives under AMP Goal 1 is anticipated to cost approximately $25,000 per year with current staff. If these data indicate a trend of increased noise or audibility of OSVs, the park will closely analyze the cause of the increase and evaluate and consider mitigation measures, such as a reduced speed limit, reduced number of OSVs, or reduced noise emissions from the loudest OSVs (table 6).

NPS Bioacoustic Ecologist Shan Burson measures OSV noise - NPS photo

If monitoring shows a steady-state over three years, and if no changes occur in travel patterns or equipment use, the group recommends that monitoring could be reduced to data collection every other year or every third year. With continued static results, monitoring could further be discontinued until travel patterns or OSV equipment use changes.

Acoustic data collection for AMP Goal 2 with current staff is estimated to be $2,500. Working Group members estimate that a visitor survey would cost approximately $10,000. These data will quantify the difference, if any, between groups of snowmobiles and individual snowcoaches. The potential differences could be maximum sound levels, the time above threshold values, or significant differences in visitor survey responses. A substantial difference between the OSV types could trigger of potential mitigation.

Possible mitigation measures include redistributing and allocating transportation events between snowmobiles and snowcoaches, and reducing noise emissions from the loudest OSVs. This monitoring would be conducted for one or two winter use seasons and could be subsequently phased out if no substantial differences were found between OSV types and the distribution and equipment used for transportation events did not change substantially.

Additional Resources

More information is available in the latest Acoustic Monitoring Report (Burson 2015) available at www.nps.gov/yell/parkmgmt/winter_monitoring.htm. Technical reports from previous years are available at www.nps.gov/yell/learn/management/winter_monitoring.htm; and data on noise emissions of specific vehicles can be found on the park website.

Table 6. Soundscapes and acoustic resources monitoring strategy table of metrics

Unit of Measurement	Frequency	Already Monitoring?	Approximate Cost to Measure/Year	Suggested Trigger	Possible Mitigation Measures	Notes
AMP Goal 1: Evaluate impacts of OSV use and help managers implement actions that keep impacts within the range predicted under the Selected Alternative.						
%TA	**By hour**	**Yes**	**$25,000**	**Upward trend**	**Speed, # of OSVs, Quieter OSVs**	**Percent time audible**
L50	By second	Yes	Included	Same	Same	
Lmax	By second	Yes	Included	Same	Same	Maximum sound level
L90	By second	Yes	Included	Same	Same	10th percentile sound level
NFI	By second	Yes	Included	Same	Same, plus grouping	Noise-free Interval
AMP Goal 2: Gather additional data regarding the comparability of impacts from a group of snowmobiles versus a snowcoach.						
%TA	**By hour**	**Yes**	**$2,500**	**Substantial difference between types**	**Reallocate transportation events, reduce noise of loudest OSVs**	**Percent time audible**
Lmax	By second	Yes	Included	Same	Same	Maximum sound level
TA metrics	By second	Yes	Included	Same	Same	Time above 55 and 10 above natural ambient
Visitor Survey with noise specific questions	Once per winter	No	$10,000	Same	Same	Developed by social scientist
AMP Goal 3: Reduce impacts on park resources after implementation of the Selected Alternative by gathering additional data regarding the overall social and ecological impacts of winter use and using those data to guide future management decisions.						
%TA	**By hour**	**Yes**	**$2,500**	**Substantial difference between types**	**Reallocate transportation events, reduce noise of loudest OSVs**	**Percent time audible**
Operating techniques	Annually	Yes	Negligible	When new quieter approaches are apparent	Implementing new procedures	See text

Drifting snow created beautiful patterns in the deep snow - NPS photo

Trees have a silvery look during winter - NPS photo

Chapter 4: Air Quality

The NPS and the public want to ensure that impacts to air quality remain low and continue to improve when possible.

Introduction

Air quality is a key resource in itself, as well as a highly prized (and expected) element of the park visitor experience. Potential impacts to air quality from winter use in Yellowstone National Park (YNP) include air quality related issues from exhaust as well as visibility (particularly from OSV emissions) (NPS 2013).

The NPS measures a variety of air quality indicators, some of which are specifically related to winter use and the effects of OSVs. In addition to any air quality monitoring specifically outlined in this plan, YNP will continue to monitor visibility, atmospheric deposition, and ozone at Lake and Tower. These sites will provide a general overview of year-round air quality conditions as a backdrop to assessing trends in winter air quality.

Summary of Existing Science

Emissions from OSVs became an issue in the 1990s, as the numbers of vehicles visiting the park began to increase to levels of 80,000 per season. Idling snowmobiles at entrance stations caused unacceptable levels of pollution to the point that the health and safety of employees and visitors was adversely affected (Yochim 2009). In response, the NPS began to monitor winter air quality at two fixed stations, West Entrance and Old Faithful, to cover the high use corridor between Old Faithful, Madison Junction, and West Entrance. The assumption is that the worst pollution will be concentrated in these two locations. In 1998 carbon monoxide (CO) monitoring began at the West Entrance, and particulate matter (PM) monitoring was added in 2002. Monitoring at Old Faithful for CO and PM also began in 2002. Nitrogen dioxide (NO_2) monitoring was added to the West Entrance station in 2009.

In general, the requirements of the managed use era (the 2004-2005 season and beyond) have had a very positive affect on winter air quality (NPS 2013c). This includes Best Available Technology (BAT) requirements for OSVs, a reduction in the time OSVs spend idling, and the requirement that guides accompany groups of OSVs when they tour the park. Analysis of the data shows that levels of CO, PM, and hydrocarbons (HC) have all been reduced since 2002 (figures 2-6). When data is available back to 1998 and the older values are compared to current values the improvement is even more dramatic (figure 3).

Unfortunately, the reductions in most pollutant levels resulting from the BAT implementation occur with a subsequent increase in NO_2 emissions. Monitoring of NO_2 has only occurred since 2009, but so far the data indicates that ambient levels are well below those of the National Ambient Air Quality Standards (NAAQS) for NO_2. Currently, there is not enough data from the NO_2 monitoring to determine if there is any clear trend, i.e. if ambient levels are increasing, decreasing, or staying the same (figure 6).

Moving forward, the NPS and the public want to ensure that impacts to air quality remain low and continue to improve when possible. The 2013 SEIS and the Record of Decision (NPS 2013) included several air quality metrics, and the park is committed to keeping impacts below certain thresholds. The metrics include measurements of CO, $PM_{2.5}$, and NO_2. The thresholds are based on the NAAQS when available, and were determined through a series of modeling exercises that simulated emissions from different combinations of OSVs at different locations throughout the park.

Each figure shows the results of air quality monitoring from the fixed stations at West Entrance and Old Faithful.

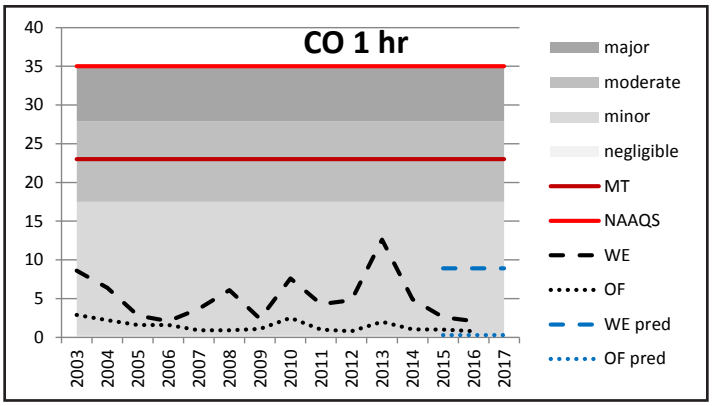


Figure 2: CO Maximum 1-hour (ppm)

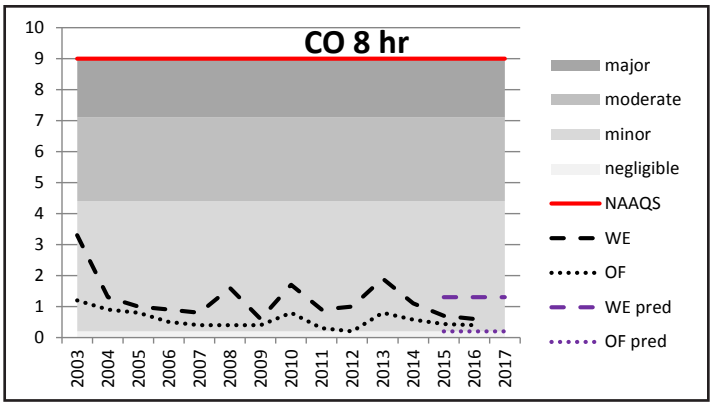


Figure 3: CO Maximum 8-hour (ppm)

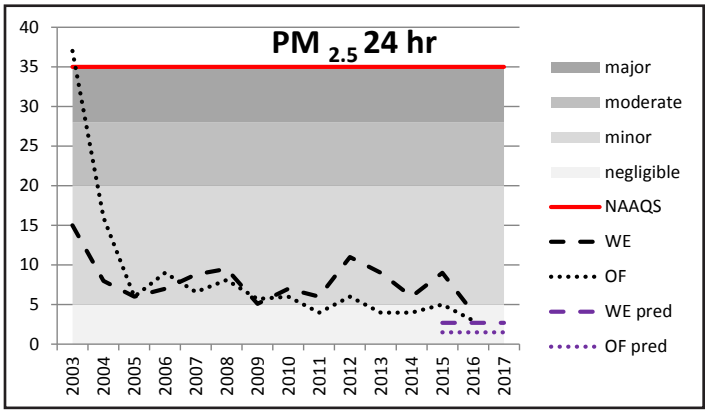


Figure 4: $PM_{2.5}$ Maximum 24-hour ($\mu g/m^3$)

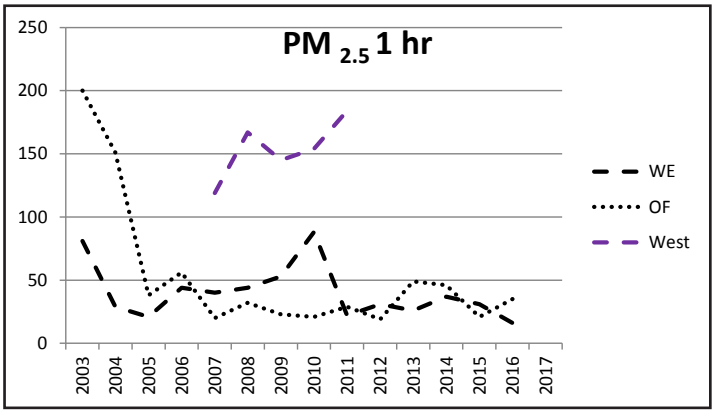


Figure 5: $PM_{2.5}$ Maximum 1-hour ($\mu g/m^3$)

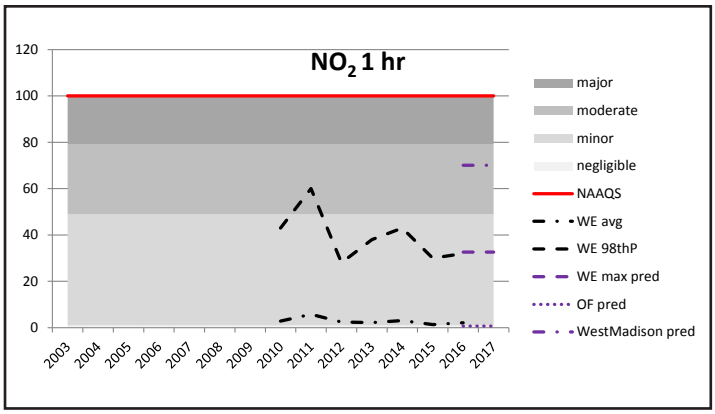


Figure 6: NO_2 98%th percentile 1-hour (ppb)

NOTE: Monitoring results are for CO, $PM_{2.5}$, and NO_2. Model results are shown as predicated values at each location. When applicable, the national (NAAQS) and Montana standards are shown with red lines. Levels of impact are shown with gray shading.

WE=West Entrance, OF=Old Faithful, WestMadison=West Entrance to Madison cooridor, West=West Yellowstone

The NAAQS standard, when available, is shown by a red dashed line. The relevant impact thresholds are also shown, along with the future values predicted through modeling (NPS 2013c).

Working Group Process and Approach

The Air Quality and Soundscape Working Group was formed to address how air quality should be monitored during the implementation of the SEIS. The group met in person on November 22, 2013, at the Kickoff Meeting of the Winter Use Adaptive Management Program, and subsequently met by conference calls on February 26, 2014, and April 30, 2014. Ann Rodman led the Air Quality discussions. Background material, agendas, and questions were distributed by email to the Working Group prior to meetings. The Working Group discussed air quality concerns about exhaust emissions from various types of OSVs, how those emissions impact air quality, possible metrics for monitoring ambient air quality, and the best use of limited resources to answer the most important monitoring questions. The following paragraphs are the result of those discussions.

Continued monitoring is necessary to ensure that air quality impacts from OSVs do not exceed the values prescribed in the 2013 Winter Use Final SEIS and the ROD. There will be a phased implementation period lasting several years, before full implementation of the plan by the winter of 2017-2018 at the latest. Air quality monitoring at West Entrance and Old Faithful will continue during this implementation period and for at least several years after full implementation. During this time, impacts to air quality will be monitored and analyzed annually to assess the effects of the new plan and ensure that CO, $PM_{2.5}$, and NO_2 levels all remain below the impact thresholds listed in the ROD (NPS 2013b). If monitoring results indicate that impacts to air quality are static or decreasing, this plan can be revisited to determine if monitoring at the current level is still warranted.

Monitoring Objectives

The purpose of this monitoring is to ensure that winter use is managed to minimize impacts on resources that may be affected by air pollution. This section is organized according to the three objectives of the AMP.

The following strategy assumes that only BAT OSVs will be used in YNP and that the limit on transportation events with their prescribed number and type will be maintained. Two additional assumptions, that winter use travel patterns do not change substantially and that OSVs comply with speed limits, may need monitoring to assure that assumptions remain valid. Because these assumptions span several impact topic areas, this group did not specify monitoring objectives for them, but emphasizes their importance to the extent of air quality impacts from OSV use.

AMP Goal 1: To evaluate the impacts of OSV use and help managers implement actions that keep impacts within the range predicted under the Selected Alternative

For the foreseeable future, the park will continue air quality monitoring at the two fixed, long-term sites near the West Entrance and Old Faithful following guidance from the Code of Federal Regulations Ambient Air Quality Surveillance (40CFR Part 58). This includes monitoring for carbon monoxide (CO), particulate matter ($PM_{2.5}$), and nitrogen dioxide (NO_2). Data will be available through the park website. Annual summary reports will be available before the start of the next winter season.

The group recommends adding a temporary NO_2 monitoring site along the West (WE)-to-Madison road corridor during a high visitation period. Modeling efforts (NPS 2013a) predicted that this corridor might experience the highest NO_2 levels in the park, and we currently do not monitor this corridor. The group proposes two scenarios for NO_2 monitoring: short-term survey monitoring and seasonal, long-term monitoring. These monitoring efforts will help establish a baseline data set associated with levels of oversnow travel that approximate historical peaks in order to document the effectiveness of the management decisions enacted by the NPS. Additionally, if a portable NO_2 analyzer is used on the West Entrance (WE)-to-Madison corridor, a second portable analyzer will be installed at the WE for consistency and to ensure comparability of the measurements. For longer-term measurements, a portable or regulatory NO_2 analyzer will be deployed.

Short-term survey monitoring (1 week – 1 month)

Measurements will be made over a long weekend (e.g., President's Day Weekend), allowing for the sampling period to coincide with lower- and higher-traffic days in an effort to capture/bracket time periods with low and high OSV emissions. Result from the short-term monitoring will be used to evaluate the need for more comprehensive and longer term monitoring of NO_2. However, one caveat that must be accounted for during short-term survey monitoring is the meteorology; the conditions during the weekend sampling period may or may not be representative of typical conditions (e.g., excessively high winds, etc.). If appropriate meteorological conditions exist, the short-term monitoring data will be used to aid in guiding additional NO_2 monitoring efforts.

Seasonal and/or long-term monitoring (winter season – yearly)

Measurements would be made over the entire winter season or year-round in order to understand the sources, distributions, and ambient levels of NO_2 from OSVs. The longer-term temporal data will provide valuable information to comprehensively assess the NO_2 emissions over the winter season. Moreover, year-round measurements will allow for the identification and quantification of the processes controlling NO_2 levels in the park and are essential for documenting how air quality is changing over time. Longer-term measurements will also allow for an assessment of how changes in emissions and implementation of control strategies ultimately affect the NO2 levels in the WE-to-Madison corridor.

Yellowstone's East Entrance is about 50 miles west of Cody, Wyoming - NPS photo

These data and analyses will provide the NPS the ability to evaluate the impact of OSV use and assess trends over time. By comparing future data to previously collected data, the NPS can determine if the air quality impacts from OSV use have exceeded the impacts predicted in the SEIS.

The group recommends experimenting with different ways of analyzing, summarizing, and reporting results. Although it is important to report maximum 1 hour and 24 hour values to ensure that limits defined in the ROD are not being exceeded, there are other ways of summarizing the data that may do a better job of explaining how the implementation of the plan is affecting overall air quality.

AMP Goal 2: To gather additional data regarding the comparability of impacts from a group of snowmobiles versus a snowcoach.

The Air Quality and Soundscape Working Group decided that ambient air quality monitoring could not determine the difference in air quality impacts between a group of snowmobiles compared to a snowcoach. This type of analysis would have to be done through tail pipe emissions studies.

Monitoring the ambient air quality at the two fixed stations, West Entrance and Old Faithful, will determine whether the new mix of BAT OSVs improves, degrades, or has a neutral effect on air quality.

AMP Goal 3: To reduce impacts on park resources after implementation of the Selected Alternative by gathering additional data regarding the overall social and ecological impacts of winter use, and using those data to guide future management decisions

No novel monitoring or research is recommended to address this objective; however, the following general operational items would result in improvements to the air quality:

- Encourage the purchase and use of the snowmobiles and snowcoaches with the lowest emissions.
- Document and encourage behaviors that reduce air quality impacts. Examples include slowing down to reduce NO2 emissions and turning off motors at wildlife viewing stops to reduce idling.

Cost, Triggers, and Mitigation Methods

The current cost to monitor CO, PM2.5, and NO_2 at the West Entrance and Old Faithful is approximately $65,000. These are metrics that the park is already monitoring. Short-term and seasonal NO_2 monitoring from the West Entrance (WE)-to-Madison Junction would be a new, additional cost.

The Working Group suggests that any upward trend in CO, $PM_{2.5}$, or NO_2 would trigger potential mitigation measures. These could include reducing the number of OSVs in this area or their speed limit (table 7).

Additional Resources

For more information on OSV air quality modeling and data, see:

National Park Service (U.S. Department of the Interior). 2013a. Air Quality Modeling Report Snowmobile and Snowcoach Emissions. Winter Use Plan: Post Supplemental Environmental impact Statement Analysis. Yellowstone National Park Mammoth, Wyoming, USA.

Bishop, G.A., R. Stadtmuller, D.H. Stedman, and J.D. Ray, 2009. Portable emission measurements of snowcoaches and snowmobiles in Yellowstone National Park. Journal of the Air & Waste Management Association. 59:936–942.

Ray, J. D., G. Bishop, B.G. Schuchmann, C. Frey, G. Sandhu, & B. Graver. 2013. Yellowstone over-snow vehicle emissions tests – 2012. Natural Resource Stewardship and Science Division, Denver, Colorado, USA.

Numerous additional reports that provide more details and summarize winter air quality from past years are available here: nps.gov/yell/parkmgmt/winter_monitoring.htm.

For more information on ambient air quality requirements, see 40 CFR Part 58.

Table 7. Air quality monitoring strategy

Unit of Measurement	Frequency	Already Monitoring?	Approximate Cost to Measure/Year	Suggested Trigger	Possible Mitigation Measures	Notes
AMP Goal 1: Evaluate impacts of OSV use and help managers implement actions that keep impacts within the range predicted under the Selected Alternative.						
CO (WE & OF)	Hourly	Yes	$65,000	Upward trend	reduce # of OSVs	Max 1-hr & Max 8-hr
$PM_{2.5}$ (WE & OF)	Hourly	Yes	Included above	Same	Same	Max 1-ht & max 24-hr
NO_2 (WE & OF)	Hourly	Yes	Included above	Same	Same	Max 1-hr
NO_2 (WE – Mad) short-term	Hourly	No	$22,000	>WE	Reduce speed, reduce #OSVs	Max 1-hr
NO2 (WE – Mad) annual	Hourly	No	$31,000	>WE	Reduce speed, reduce #OSVs	Max 1-hr
AMP Goal 2: Gather additional data regarding the comparability of impacts from a group of snowmobiles versus a snowcoach.						
None recommended at this time						
AMP Goal 3: Reduce impacts on park resources after implementation of the Selected Alternative by gathering additional data regarding the overall social and ecological impacts of winter use and using those data to guide future management decisions.						
None recommended at this time						

Yellowstone Lake on a frosty winter morning - NPS photo

Skiers pass through the warm steam of a thermal feature - NPS photo

Chapter 5: Human Dimensions

Human dimensions research can help managers better interpret and respond to emerging social demands on park resources, and address the complex, dynamic, and intersecting social and ecological factors that are shaping the park's future.

Introduction

Visitor use and experience, in addition to resource conservation, is core to the mission of the NPS. Specifically, NPS laws and policy mandate that the agency provide opportunities for use and enjoyment by all possible visitor segments in ways that maximize experience of a park's fundamental resources and values. The human dimensions of resource management help managers and decision makers understand the demographics, values, and experiences of park visitors and stakeholders, as well as other social and economic variables that affect park management.

A substantial amount of human dimensions research has informed past changes in winter use management in Yellowstone National Park (YNP); and the SEIS prioritizes several such objectives and impact topics, including visitor use, experience and accessibility, health and safety, and socioeconomic values. The SEIS and the subsequent final Rule were informed by much of this research.

The Human Dimensions Working Group emphasizes the importance of the monitoring objectives, triggers, and mitigation measures identified in other chapters as foundational to measuring the success of this program. However, monitoring objectives proposed in this chapter are treated differently, here framed as categories of research that are important to informing the future management and decision making of the park and its partners. The Working Group recommends that future human dimensions studies be viewed as "informing" winter use management decisions rather than providing replicable variables that directly trigger mitigation actions or management changes. As such, this chapter is structured differently from others.

The Role of Human Dimensions in Park Management

Human dimensions research plays a broad and important role in natural resource management, explicating the many ways that social, cultural, and economic variables might inform management decisions. This can include highly quantitative variables such as demographic and economic information. It can also include variables such as human values and experiences that require a mix of qualitative, quantitative, and systems approaches. The additional complexity involved in the latter forms of social science should be reflected in the way it is used to inform management decisions. This said, human dimensions research continues to be foundational to the mandate and ongoing management of national parks, including winter use in Yellowstone, where a key objective in the winter use plan is: "providing the opportunity for visitors to experience and be inspired by Yellowstone's unique winter resources and values while ensuring resource protection" (NPS 2013c).

This type of language emphasizing visitor experience, specifically related to a park's "fundamental resources and values" (FRVs), lies at the heart of the legal mandate and management priority of the NPS. The current NPS Management Policies (2006) state:

"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…. 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."

Yellowstone's Foundation Document (2014) describes the FRVs core to the NPS mission as:

"…those features, systems, processes, experiences, stories, scenes, sounds, smells, or other attributes determined to warrant primary consideration during planning and management processes because they are essential to achieving the purpose of the park and maintaining its significance.… Fundamental resources and values help focus planning and management efforts on what is truly significant about the park. One of the most important responsibilities of NPS managers is to ensure the conservation and public enjoyment of those qualities that are essential (fundamental) to achieving the purpose of the park and maintaining its significance."

The document goes on to identify the following fundamental resources and values for YNP:

- geothermal wonders
- dynamic geologic processes and features
- hydrologic systems
- one of the largest, mostly intact temperate ecosystems in the world
- enduring connection to Yellowstone
- a park for the people
- a "wild" experience

Managing for the conservation and public enjoyment of values like "an enduring connection to Yellowstone" or "a wild experience" is more difficult to study than the relatively more concrete and quantifiable resource variables identified as mandatory monitoring objectives in the winter use final Rule, including air quality, wildlife, soundscapes, and health and safety (NPS 2013d). As such, the value laden aspects of human dimensions must be treated with some care in inter-

Visitors scan for wildlife in the Madison Canyon - NPS photo

pretation and should not be seen as quantifiable triggers that would automatically lead to a certain course of management action. However, research to better understand how people can most fully experience and enjoy the resources and values of the park is absolutely essential in informing national park management, including winter use in YNP. Consideration of how past research on the preferences and values of visitors, in relationship to the resources and values of the park, has informed the SEIS and will further illustrate these points.

Summary of Existing Social Science Research

It is widely recognized that changes in Yellowstone's winter use management policies over the last two decades have been informed by many factors including science, politics, and tradeoffs in values among interest groups. In the midst of complex challenges, human dimensions research has been key in providing information that has helped park managers and stakeholder groups develop a path forward that serves the mandate of the NPS and YNP, in part by considering and responding to the values of visitors and stakeholders (NPS 2013c). Much of this research supports the actions outlined in the SEIS and final Rule.

Like many other studies in natural area management, most research on visitors' experience of winter use in YNP (both before and after the managed use era) found that the majority of visitors has been generally satisfied with their experience and prefer future management actions that are similar to the current situation (Davenport et al. 2000, Borrie et al. 2002, Friemund et al. 2008). Prior to the managed use era, research showed that most current visitors were opposed to plowing of roads or elimination of snowmobiles from certain routes or for certain periods of time (Duffield and Neher 2000), but were more favorable towards management strategies that addressed noise and emission standards or created more consistency in speed of OSVs, behavior of visitors, and quality of snow roads (Davenport et al 2000). Prior to managed use, the biggest deficiencies found between values that were important to visitors and their satisfaction with their Yellowstone experience were related to tranquility, peace and quiet, getting away from crowds, and experiencing solitude (Davenport 2000). Other visitor surveys conducted early in the days of managed use found that some restrictions on snowmobiles, while still allowing park access, would likely create the most utility for the most visitors, especially actions that addressed congestion and road conditions (Mansfield et al. 2008).

Perhaps most interestingly and importantly for management, research spanning the pre- and post-managed use eras has consistently demonstrated that the mode of OSV transportation (e.g. snowmobile vs. snowcoach) is not a good predictor of visitors' values or experience preferences (Friemund & Borrie 2001, Davenport et al. 2000, Friemund et al. 2009). The majority of winter visitors accessing Yellowstone's interior via both snowmobiles and snowcoaches display overlapping value sets, are primarily interested in experiences related to the resources and values of the park itself, and are only secondarily invested in the mode of transit that they use to access the park (Davenport et al 2000, Friemund et al. 2009, Kulesza et al. 2012). That said, visitors using both forms of OSV transportation consistently rank the method of travel as a satisfying part of their experience; and many visitors, including disabled visitors, appreciate the greater personal freedom and exposure to the elements offered by snowmobile travel (Davenport & Borrie 2005, Nickerson et al. 2006, Friemund et al. 2009).

Research has affirmed the value of natural soundscapes and wildlife viewing for winter use in Yellowstone (NPS 2013c). The most in-depth study to investigate these areas during the managed era of winter use found that 71 % of visitors experienced the level of sound that they were looking for more than half the time they desired it, but only 15% of visitors were able to find desired levels of sound the whole time they were in the park (Friemund 2009). While interviewees largely accept some presence of mechanical sounds in the park, especially near developed areas, they also generally wanted some time in their experience to be quiet and natural. Respondents were asked about their support for a variety of management actions that protect opportunities to experience natural sounds. Requiring best available technology, continuing to require guides, limiting the total number of snow machines in the park per day, and limiting group sizes to 11 per guide were strongly supported by a minimum of 68% of the respondents. This same study also found that it was very important to 71% of visitors to view bison in their natural habitat, and 87% of visitors were satisfied with this experience.

The SEIS (NPS 2013c) also reviewed and considered other important human dimensions research, including visitor demographics and activities, health and safety, and socio-economic values.

NPS Winter Visitation Data

While the study of visitors' values and preferences can be a complex science, integrating qualitative, quantitative, and systems approaches, an other aspects of human dimensions research can be relatively straightforward and highly quantitative. For instance, Yellowstone collects a variety of visitor access and circulation data that provides important summary statistics on winter visitation that are listed on the NPS Integrated Resource Management Applications (IRMA) website (https://irma.nps.gov/Stats/Reports/Park/YELL).

One nuance of winter visitation numbers that can cause confusion relates to the two different sources of winter visitor numbers collected by Yellowstone and the differences in how visitors access the north gate of the park compared to other gates. In the winter season, the west, south, and east gates of the park are only accessed via over-snow roads. Generally, this is by visitors who are travelling to locations in the interior of the park in guided OSVs, but could also include visitors on skis or snowshoes. Alternatively, visitors pass through the north entrance on plowed roads. They then have the option of touring the north and northeast portion of the park via the plowed road from the North Entrance to Cooke City, or accessing the interior of the park in guided OSVs on over-snow roads starting at Mammoth.

On the IRMA website, the "Detailed and Seasonal" link summarizes data compiled from both gate and concessions offices detailing the number of visitors that access the park's interior in the winter via over-snow roads and via different entrances and modes of transportation (e.g. snowmobiles, snowcoaches). Comparatively, the "Monthly" link provides information on total visits by gate, regardless of whether visitors pass through gates via OSVs on over-snow roads or by wheeled vehicles on the plowed roads of the North Entrance. The "Annual Traffic Counts by Month" link provides numbers of different vehicle types passing through all gates, including a breakdown of snowmobiles and snowcoaches.

The SEIS and the Adaptive Management Plan (AMP) are primarily related to visitation to the interior of the park via travel on over-snow roads. As such, statistics related specifically to OSV use on over-snow roads is most likely to be relevant to informing the AMP.

Working Group Process and Approach

The Human Dimensions Working Group held six conference calls during Winter 2013, Spring 2014, and Winter 2016. The calls brought multiple stakeholders together to collectively frame the human dimensions impact topic and identify monitoring priorities. Several particular areas of interest emerged during a call held on February 22, 2014. Working Group members expressed the importance of better understanding the travel patterns and demographic characteristics of visitors in the park. The value of tracking visitor safety data was also recognized. Members voiced the efficacy of expanding the focus of soundscape research, too. The importance of surveys that looked at economic values, such as willingness to pay, was likewise emphasized. Surveys that investigate what makes the Yellowstone experience special were also seen as worthwhile. Members similarly indicated that they would like to see open-ended survey techniques that asked about visitors' values and preferences, rather than asking solely about preconceived categories. Lastly, the group discussed the importance of understanding not only visitors', but also regional residents', perspectives.

Issues related to the human dimensions impact topic were further clarified in a March 18, 2014, group call. The group, while recognizing links between the over-snow park interior and other areas in the park, decided that the focus of this planning process (unless later modified) would only be on the over-snow interior. Additionally, interest in a better understanding of visitor activities in terms of their travel patterns and use of OSVs to access non-motorized use areas was expressed. The group emphasized that future research on wildlife impacts should consider visitors on foot, skis, and snowshoes, in addition to OSVs. The third and fourth Working Group calls were spent introducing the perspectives of new Working Group leads and reviewing past research related to human dimensions of winter use.

When previous Working Group leads moved onto other positions, Yellowstone's new Social Science Coordinator was asked to compile past information into a revised chapter reflecting a more thorough review of the literature, notes from previous Working Group meetings, and public comments on the Winter Use AMP. This chapter was sent out

to be reviewed by Working Group members in advance of a group call on February 8, 2016. Before, during, and after that call, Working Group members affirmed the overall shape and content of the new chapter, and suggested a number of minor revisions and edits. The most substantial of these were to: a) move discussion of health and safety issues to the purview of the Operations and Technology Working Group, and b) move explicit discussion of fat tire bicycles to the purview of the operations and technology group and here focus more broadly on human dimensions of possible future management changes and emerging technologies. These changes were incorporated, and the chapter was sent back out to Working Group members for final review on May 11, 2016. Working Group members were given until the end of May to review this final draft. Minor revisions were received and incorporated into the final draft.

Future Research Priorities

Monitoring objectives for the human dimensions chapter are structured differently than those in other chapters. As discussed above, human dimensions information can include a variety of data sources. Much of the value of previous work has been to help park managers understand the experiences of visitors in relationship to the fundamental resources and values of the park. This body of literature generally supports the decisions made in the current winter use plan/SEIS and final Rule. Much of this research was conducted under different management scenarios and includes data collected using intensive methods that would not be feasible or reasonable to replicate regularly. For this reason, the Working Group decided that it is not appropriate to use the associated monitoring objectives to measure variables in relationship to certain thresholds that trigger specific mitigation measures. As such, there are no monitoring goals in this chapter that meet the criteria of AMP Goal 1.

Given that past research has showed that mode of transportation is not a good indicator of winter visitors' values and expectations related to park experience, the Working Group also decided that no future human dimension monitoring goals are needed to address AMP Goal 2.

AMP Goal 3: To reduce impacts on park resources after implementation of the Selected Alternative by gathering additional data regarding the overall social and ecological impacts of winter use and using those data to guide future management decisions

However, many future research topics deemed important by the human dimensions Working Group generally fit the criteria of AMP Goal 3. These future research priorities are listed under the following three categories:

Category A: To provide information on various aspects of the current winter use plan / SEIS and final Rule, including:

- visitor access, circulation, and activities
- wildlife viewing satisfaction
- soundscape satisfaction
- air quality satisfaction

Category B: To evaluate human dimensions questions related to specific proposed changes in management, including:

- visitor perception and satisfaction related to low pressure tire snowcoaches
- social or economic dimensions of tradeoffs related to other possible new management practices or technologies, including safety and operational challenges, visitor preference, demand, and economic potential

Category C: Studies to understand visitors' and other stakeholders' values and preferences in ways that inform ongoing and future winter management in Yellowstone National Park, including:

- Investigating values and preferences of current Yellowstone visitors related to winter use, including consideration of how visitors can best experience and enjoy the park's fundamental resources and values. Such research should be developed to answer questions of importance to park managers as well as gateway communities and tour operators, all of whom share an interest in best serving park visitors.

• Exploring the values and preferences of stakeholders who may not currently be able to access, or choose not to access, the park in the winter but who might choose to do so in the future or who appreciate the park from a distance. Associated studies include ways to make access to the park more affordable and feasible to visitor segments who do not currently visit the park in the winter, including but not limited to regional residents.

• Socio-economic studies that help the park and its partners jointly meet the demand for visitor services and experiences in ways that benefit local and regional economies. This includes providing for visitor experience in ways that increase winter and shoulder season visitation to the Greater Yellowstone Area, while conserving park resources, continuing the unique character of the Yellowstone winter experience, and recognizing operational and safety limitations.

Additional Resources

For a more detailed overview of the natural and social science that have informed winter use management decisions in Yellowstone, see:

NPS. 2013. Yellowstone National Park Winter Use Plan / Supplemental Environmental Impact Statement. U.S. Department of the Interior. National Park Service, Yellowstone National Park, Mammoth, Wyoming, USA.

Commercially guided visitors brave a chilly day in the park - NPS photo

Grotto Geyser is enjoyed by a lone skier on a snowy winter morning - NPS photo

NPS staff collect information from snowcoach operators during 2015 noise testing - NPS photo

Chapter 6: Operations & Technology

The final Rule incentivizes advancements in technology and encourages continual improvements of park operations.

Introduction

Management of winter use in Yellowstone National Park (YNP) presents a variety of significant operational and technological challenges to the park's administrative staff, concessioners, and contractors. OSVs can be destructive to the snow road surfaces, which require frequent grooming. The machines must be able to operate in weather well below 0°F (18°C) frequently with limited visibility and drifting snow; many are inefficient in terms of fuel efficiency and are prone to breakdowns.

The final Rule incentivizes advancements in OSV technologies in order to further reduce impacts to park resources and values, and for the benefit of the visitor experience. The Operations and Technology Working Group has addressed six subtopics related to wintertime park operations and technology: speed limits, performance-based air emissions for snowcoaches, OSV noise abatement, avalanche mitigation on Sylvan Pass, rutting of snow roads, the use of large low-pressure tires, and grooming practices.

Working Group Process and Approach

The Operations and Technology Working Group is comprised of approximately 20 individual members, including representatives from snowmobile organizations, local business operators, government, members of the public, and an environmental organization. Following the November 2013 public meeting in Bozeman, MT, the Operations and Technology Working Group held a scoping call on March 10, 2014, to discuss the range of topics that the group would address (table 8). The group identified several subtopics to discuss on further calls, including OSV speed limits, performance-based air emission standards for snowcoaches, rutting of snow roads, low pressure tires, Sylvan Pass, and OSV interior and exterior noise abatement. Later, the subject of grooming practices was added as a subtopic the group wished to address. Group conference calls were held on each subtopic, the dates listed in table 8; and notes from these meetings are available on the park's website (links provided in table 3).

Summary of Existing Science & Working Group Recommendations

For many of the topics addressed by this Working Group, park-specific scientific studies may not exist. Background on some of these topics relevant to monitoring can be found in the final Rule, so regulatory context is included where appropriate.

Table 8: Operations and Technology Working Group meetings

Call	Topic	Date
1	Working group scoping	March 10, 2014
2	Rutting of snowroads	April 3, 2014
3	Speed limits	April 28, 2014
4	Exhaust emissions	May 20, 2014
5	Sylvan Pass and noise abatement	June 17, 2014
6	Low pressure tires	July 1, 2014
7	Grooming	July 28, 2014
8	Monitoring plan	January 14, 2015

Table 9. Approximate travel times between developed areas by speed

Possible Trips*	Miles**	Travel minutes @ 25 mph	Travel minutes @ 35 mph	Travel minutes @ 45 mph
Flagg Ranch to Old Faithful	83	198	142	110
Flagg Ranch to Canyon	123	294	210	163
Flagg Ranch to Lower Loop	145	347	248	193
Mammoth Warming Hut to Old Faithful	98	234	167	130
Mammoth Warming Hut to Canyon	62	148	106	82
Mammoth Warming Hut to Lower Loop	134	321	229	178
Pahaska Tepee to Old Faithful	135	323	231	179
Pahaska Tepee to Canyon	91	217	155	121
Pahaska Tepee to Lower Loop	155	371	265	206
West Entrance to Old Fiathful	60	144	103	80
West Entrance to Canyon	80	192	137	107
West Entrance to Lower Loop	124	298	213	165

* All tours in list return to their point of origin; thus, this mileage includes the round trip.
**Mileages in table are based on the following assumed approximate distances: 21 miles Mammoth to Norris; 12 miles Norris to Canyon; 16 miles Canyon to Lake/Fishing Bridge; 27 miles Lake/Fishing Bridge to East Entrance; 21 miles Lake/Fishing Bridge to West Thumb; 22 miles West Thumb to South Entrance; 17 miles West Thumb to Old Faithful; 16 miles Old Faithful to Madison; 14 miles Madison to West Entrance; 14 miles Madison to Norris. Also assuming that trips out of South actually start at Flagg Ranch (2.3 miles outside of the South Entrance), trips out of East actually start at Pahaska Tepee (2.3 miles outside of the East Entrance), and trips out of Mammoth actually start at the Mammoth Warming Hut (2.2 miles into the park from the Mammoth Area); appropriate mileage was added to trips from East and South and subtracted to trips from Mammoth. Trips out of West are assumed to start at the West Entrance.

Speed Limits

The final Rule specifies that the maximum speed limits within the park will be 35 mph for snowmobiles and 25 mph for snowcoaches (36 CFR 7.13(l)(13)(H-I)). Prior to the implementation of the final Rule, all OSVs were subject to a 45 mph speed limit. Based on observations of NPS personnel, however, most snowmobiles cruise at 30-35 mph; and most snowcoaches cruise at 20-25 mph with the exception of historic Bombardier snowcoaches and some coaches on low pressure tires which have the ability to travel faster than 25 mph. Based on this information and other considerations, the NPS used 35 mph and 25 mph, respectively, as the basis for all air and sound (noise) emission analysis within the SEIS (NPS 2013c). A question raised by Working Group members was the effect speed limits would have on travel times. Table 9 describes approximate travel times between destinations in the park at 25 mph, 35 mph, and 45 mph.

With regard to park speed limits, the Working Group discussed the 25 mph and 35 mph speed limits for snowcoaches and snowmobiles, respectively, outlined in the final Rule. While cognizant of the positive relationship between higher speeds and increased noise emission levels, and generally accepting of the 35 mph limit for snowmobiles, some individuals expressed concern with regard to the distances between destinations in the park and travel times at the reduced speeds. Some group members would like to explore the possibility of some more remote, less congested corridors accommodating higher speeds for snowcoaches or for

Table 10: Snowcoach interior noise levels

Snowcoach	Average dB(A)	Cruising Speed (mph)
2011 Ford F-F550 32 Passenger, Grip Tracks	70	22
2011 Ford Vanterra, Mattracks	74	24
2008 Chevy Express Van, Mattracks	77	24
2011 Ford F-450 Glaval, Mattracks	81	27
1956 Bombardier B-12, V8 Motor, Skis & Tracks	84	26

certain types of snowcoaches. Given that a change in speed limits within the park would require new NEPA analysis, the park is not currently exploring this option but could in future NEPA analyses.

Performance-based Air Emission Specifications for Snowcoaches

The final Rule relies on a technical standard for snowcoach air (exhaust or tailpipe) emissions based on model year, but allows the Superintendent to establish performance-based emission standards for snowcoaches to possibly allow them to operate beyond their 10-year operational window (CFR §7.13(l)(4)(i)). A performance-based specification is defined as one in which a set of parameters for tailpipe pollutants is set under a given operating condition(s), and the vehicle is required to operate within those parameters or be removed from service.

Previous attempts by the NPS to determine a defensible performance-based specification for snowcoach exhaust emissions have proven to be challenging due to varying weather, snow and road conditions, road grades, tracks, and vehicle designs and specifications (Bishop et al., 2009; Ray et al., 2013). In general, the ranges of emission values obtained during oversnow testing of snowcoaches are far beyond those of a similar vehicle equipped with tires in highway operation.

The Working Group's primary concern with performance-based air emission testing remains the wide variety of confounding environmental variables, as well as the wide variability across snowcoaches themselves. The group is interested in pursuing a partnership let the one initiated with Montana State University (MSU) through the CESU program to test multiple vehicles over multiple days in the park, beginning with a small pilot study.

OSV Noise Abatement (Interior and Exterior)

Noise from OSVs can affect visitors and staff as well as park resources, so strategies to attenuate the interior and exterior noise produced by OSVs in the park is of interest to the park and stakeholders.

In 2004, after BAT limits and commercial guiding were in place, occupational exposure to noise was evaluated with the conclusion that exposure did not exceed recommended limits. In 2005, another study at the West Entrance concluded that noise exposures were below the Occupational Safety and Health Administration's (OSHA) permissible limits and other recommended maximum exposure levels.

For snowcoaches, interior noise levels were measured in five different vehicles operating at typical cruising speeds of approximately 20-25 mph on snow-covered groomed roads in the interior of Yellowstone National Park (table 10). These five vehicles ranged from a repowered and retrofitted Bombardier with skis and long tracks to a 32-passenger bus. These vehicles were selected because they represent a cross-section of relatively late-model snowcoaches currently in operation in the park. Noise levels inside snowcoach cabins were measured using a calibrated Larson Davis Type 1 sound level meter and microphone as the snowcoach traveled at typical cruising speed on a snow-covered road. Average dBA was calculated as the logarithmic mean of the front and back seat measurements. Measurements were taken over a three-day period during the week of March 5, 2012 (NPS 2013c).

A profilometer is used to measure the profile of a rut - NPS photo

There is some debate as to the most effective vehicle designs and configurations for abating interior snowcoach noise, although technology likely exists (e.g., in airplane cabins and luxury cars) that could be useful to operators. Working Group members are not interested in the regulation of interior noise, but are interested in exploring interior noise dampening technology in order to improve the visitor experience.

The park has also collected exterior noise data for OSVs that operate in Yellowstone. OSVs are tested in the field using established methodologies (e.g., SAE J1161) to ensure compliance with BAT standards. Vehicle sound levels are recorded in decibels (dBA) and reported to each operator. Additional noise testing has been conducted in collaboration with the Volpe Center in support of the SEIS (NPS 2013c). More information and test results from previous years can be found on the park's website: http://www.nps.gov/yell/learn/management/osvtest.htm.

Several operators are already experimenting with various vehicle designs and modifications to reduce exterior snowcoach noise, including foam mats and wheel well covers. Based on interest from Working Group members, the park explored the viability of conducting noise testing on turf or alternate surfaces to reduce challenges associated with the current testing location, such as variable snow road conditions and conditions that deviate from the SAE J1161 testing methodology. Initial inquires revealed that an alternative test surface, such as sawdust or turf, could interact with various track types differently. This could result in noise levels that are not equally proportionate to the noise levels emitted on snow, and identifying multiple coefficients to understand this difference could be complicated. There are also a variety of practical constraints around locating and/or creating an alternative test track. Instead, the park contracted with the Nevada Automotive Test Center to use their winter facility at the West Yellowstone Airport for noise testing. The use of this carefully groomed test track where conditions are controlled to the greatest extent possible improved the noise testing process. The park intends to continue using this facility in the future and pursuing improvements to the process.

Sylvan Pass

The final Rule designates the East Entrance Road as an OSV route. As with other OSV routes, the Superintendent has the ability to close the route, or portions of it, after taking into

consideration the location of wintering wildlife, appropriate snow cover, public safety, avalanche conditions, park operations, use patterns, or other factors.

Avalanche control has long represented a safety concern to the NPS. Sylvan Pass is situated at an elevation of 8,530 feet (2,600 meters) and receives a great deal of snow in the fall, winter, and spring. There are approximately 20 named avalanche paths that cross the road at Sylvan Pass. Occupational Risk Management Assessments (ORMAs) were conducted in 2007 and 2010, and the SEIS estimated it cost approximately $124,868 to operate Sylvan Pass in FY2011. There has been a general decrease in OSV use over Sylvan Pass since the 1990s, and the East Entrance now averages approximately 1-2 commercial snowmobiles per day during the winter season (NPS 2013c).

While the park currently uses howitzers for avalanche mitigation on Sylvan Pass, group members raised the point that other technologies exist that could eliminate the issue of live rounds left on the mountain. For example, a gas-based pressure release system such as the Gazex could be useful but would also be expensive. The group is also interested in monitoring the number of days and hours that closures are in effect at Sylvan Pass. With regard to helicopters, the group is interested in exploring whether the cost of helicopters, amortized over several years, would be offset by increased non-commercial visitation. Questions were also raised with regard to the quantity of non-work related administrative travel (e.g., residential travel).

Rutting of Snowroads

As snowcoaches operating in Yellowstone have increased in size, curb weight, number, variety of design, and drivetrain configurations, large linear ruts (or troughs) in the snow roads have become a frequent occurrence. These ruts make driving difficult to the detriment of the visitors' safety and experience, as well as that of administrative personnel.

The Working Group invited Jim Knoelke and Randy Baum, who have over 50 years of combined experience with Yellowstone grooming operations, to join the Working Group conference call on snow road rutting. The group discussed the park's current grooming fleet, practices, policies, and grooming conditions unique to Yellowstone National Park (YNP). Isolating vehicular variables that contribute to rutting from weather and snow variations is difficult; yet group members noted that wide variations in environmental factors is an inevitable part of testing, and grooming practices may also have a significant influence. The group would like to better understand how snowcoach characteristics, environmental factors, and grooming practices interact and relate to the issue of rutting.

Research into this topic is ongoing as part of a multi-phase study. Monitoring from January–February 2013 examined changes in road conditions throughout the day and across the winter season with the intent of identifying variables that are highly correlated with the deterioration of snow road conditions. The second phase, initiated in January 2014, attempted to examine relative differences between OSVs in terms of impacts to snow roads. In 2015, Yellowstone initiated a two-year study as part of a Cooperative Ecosystems Study Unit (CESU) agreement with Montana State University to develop a research proposal that examines how snowcoach characteristics, environmental variables, and grooming practices contribute to snow road rutting. The research team has completed an interim report and is preparing for the final season of the study.

Low Pressure Tires

As part of the park's ongoing effort to understand snow road rutting, the park became interested in discovering if various snowcoach configurations differ in terms of their impacts to snow roads, including those fitted with low pressure tires. Park staff and concessioners have speculated on the viability of large footprint, low pressure tires to access the park in winter; however, a systematic approach to assessing the viability of such vehicles has remained largely untested. Based on interest of commercial tour operators and staff members, the park decided to undertake a study beginning in winter 2013-2014 to test the practicality of wheeled snowcoaches using the evaluation criteria described previously. Four criteria were established to guide the evaluation of this pilot study:

1. The vehicle must be safe for both the occupants traveling within it and other users of the snow roads in YNP.

2. The vehicle must be no more impactful to resources (including snow road surfaces, air quality, wildlife, and natural soundscape) than a comparably-equipped snowcoach on tracks.

Several companies operating in the park have experimented with various sizes of low pressure tires - photo Randy Roberson

3. The vehicle needs to preserve the unique look and feel associated with oversnow wintertime travel in YNP.

4. The vehicle must be able to operate safely and effectively in all weather and snow road conditions at a level consistent with or greater than a comparably-equipped snowcoach on tracks.

Working Group members expressed a desire to apply more scientifically rigorous methods to the study of low pressure tires. This group is particularly interested in data on fuel efficiency (mpg) of vehicles equipped with low pressure tires as they compare to other snowcoaches, as well as visitor experience and feedback. Additional information of interest includes experimenting with different tire sizes; pounds per square inch (psi) of vehicles equipped with low pressure tires as it compares to other snowcoaches; and the impact of wheel diameter, rigidity, tread, pinch points, and uniformity of loading on snow roads. The MSU team currently studying the park's snow roads is looking at how tracks and tires impact the park's snow roads differently, including "slip-stick" patterns, snow displacement, surface and subsurface strain, and how vertical force varies between tracks and tires.

Grooming

Each winter, YNP maintains approximately 200 miles of snow roads to support OSV use in the park. The park has been actively grooming the roads of YNP using a wide variety of equipment since the mid- to late 1960s. The park currently uses a combination of large agricultural track-driven tractors, PistenBullys, or Bombardier groomers towing grooming sleds to groom park snow roads. As snowcoaches have increased in number and weight, ruts have become a frequent occurrence, as described in the previous section.

Some Working Group members have noted that different grooming practices in different areas of the park could be contributing to the variance in snow road conditions. As part of the snow road study, MSU researchers are monitoring grooming time, locations, and speeds. Initial findings indicate that slower grooming speeds do not seem to be the primary indicator of road hardness under the 2015-2016 weather and road conditions, but the study is ongoing.

Monitoring Objectives

The Operations and Technology Working Group identified monitoring objectives in the form of research questions based on the conference calls for each subtopic. The research questions below are organized according to the three objectives of the AMP and are based on the eight conference calls conducted with Working Group members. Many of these questions could be addressed through a variety of different methodologies. Some research topics are broad, and the Working Group felt that in some cases it may be appropriate to begin by gathering initial information that could help to formulate more specific metrics in the future.

AMP Goal 1: To evaluate the impacts of OSV use and help managers implement actions that keep impacts within the range predicted under the Selected Alternative

Questions raised by the Working Group pertaining to this goal include the following:

- What is the level of risk associated with avalanche control operations at Sylvan Pass? The SEIS predicts that the risk will remain low (green as defined by Operational Risk Management Assessment) for avalanche mitigation at Sylvan Pass (NPS 2013c).
- Are OSVs meeting noise and air emission standards? Operators must meet BAT standards for both noise and air emissions by the dates specifiedin the final Rule or earlier, if specified in their concessions contract.

AMP Goal 2: To gather additional data regarding the comparability of impacts from a group of snowmobiles versus a snowcoach

The Operations and Technology Working Group did not suggest further monitoring around the comparability of OSV transportation event types.

AMP Goal 3: To reduce impacts on park resources after implementation of the Selected Alternative by gathering additional data regarding the overall social and ecological impacts of winter use and using those data to guide future management decisions

The Operations and Technology Working Group raised the following additional questions that relate to the overall social and ecological impacts of winter use and may help improve winter use management in the park more generally.

- How can snowcoach noise testing be improved?
- Which snowcoach parts and/or design components contribute most to amplifying or reducing interior and exterior noise?
- How do exterior noise levels vary across OSVs and track types?
- How does the fuel efficiency of snowcoaches equipped with low pressure tires compare to that of similarly tracked snowcoaches?
- What are the primary vehicle attributes and conditions that affect differences in snowcoach exhaust emissions?
- How do snowcoach characteristics, environmental variables, and grooming practices contribute to snow road rutting?
- Could other technologies be used in place of the howitzers for avalanche mitigation, while remaining cost-effective and safe?
- For how many hours and days per season are closures in effect at Sylvan Pass?
- How much non-work related administrative travel (e.g., residential travel) occurs over Sylvan Pass?

Cost, Triggers, and Mitigation Measures

Many of the questions discussed by this Working Group are broad and can be addressed in a variety of ways. Therefore, group members felt that it was premature to generate cost estimates and suggested triggers. Some of the research questions that this Working Group is interested in exploring may simply serve to provide additional information that can inform management actions in the future. Other triggers exist more formally as ranges predicted in the SEIS. For example, the final Rule specifies limits for air and noise emissions for OSVs; and if these limits are surpassed during testing, an OSV would not be able to operate in the park.

If triggers specified in the SEIS or desired conditions are exceeded, the park may consider a variety of mitigation measures that could include reducing speed limits, regulating

or advising operators on snowcoach design specifications, allowing low pressure tires as a long-term snowcoach track design option, altering grooming practices, or altering avalanche mitigation techniques. Actions or conditions that were not evaluated under the SEIS, such as higher speed limits, would require additional NEPA analysis.

Additional Resources

More information on OSV noise can be found on the park's website http://www.nps.gov/yell/learn/management/osvtest.htm.

Background on suggested industry grooming practices can be found by consulting Guidelines for Snowmobile Trail Groomer Operator Training: A Resource Guide for Trail Grooming Managers and Equipment Operators, produced in 2005 by the International Association of Snowmobile Administrators. Copies are available from the American Council of Snowmobile Associations (www.snowmobilers.org).

For more information on Sylvan Pass and avalanche mitigation, visit the Sylvan Pass Study Group website www.nps.gov/yell/learn/management/sylvanstudy.htm.

Teton Science Schools tries out new noise-dampening equipment - NPS photo

Buffalo Bus Touring Company's low pressure tire vehicles stand next to mattracks vehicles at Old Faithful.
- Randy Roberson photo

With snowshoes and the right gear, visitors can trek off the main roads on foot - NPS photo

Chapter 7: The Non-Commercially Guided Snowmobile Access Progra

The Non-Commerciallly Guided Snowmobile Access Program is a pilot program that allows groups of snowmobiles to enter the park under the guidance of a member of the public.

Introduction

The National Park Service's 2013 SEIS, Record of Decision, and final Rule establish and set parameters for the development of the Non-commercially Guided Snowmobile Access Program (NCGSAP) as part of the Selected Alternative. This pilot program allows groups of snowmobiles to enter the park under the guidance of a member of the public, rather than a commercial guide.

The final Rule states that "…the Non-commercially Guided Snowmobile Access Program [will result] in impacts to park resources and management that are comparable to those resulting from the use of commercial guides" (36 CFR 7.13 p. 63076). In the event that the impacts from the NCGSAP exceed those predicted in the SEIS, the superintendent can change or eliminate the program at any time (36 CFR 7.13(l) (10)(iv)).

The NCGSAP allows four groups (one per oversnow entrance) of up to five snowmobiles into the park each day. Trip leaders must be at least 18 years old and are determined by a lottery and reservation system on http://www.recreation.gov. All snowmobile operators, including the trip leader, are required to carry state driver's licenses and have completed the on-line Yellowstone Snowmobile Education Certification course. The course focuses on snowmobile safety and resource protection so that riders will be aware of the unique challenges and opportunities that this program offers. All snowmobiles must comply with current BAT standards to ensure that air and noise emissions meet park standards.

Summary of Existing Science

The NCGSAP is a relatively new program; the park has only two years of data specific to non-commercially guided groups (table 11). However, the park has required commercial guiding for all visitor snowmobile trips since the winter of 2004-2005. Data from this period indicate that the guiding requirement has led to a significant decrease in accidents and law enforcement citations (figure 7). This has resulted in better conditions for visitor safety and experience, and the park's natural resources, such as soundscapes, air quality, and wildlife (NPS 2013c).

Working Group Process and Approach

The NCGSAP Working Group has approximately 16 members representing local businesses, environmental interests, snowmobiling and access interests, state government, and an NPS Working Group lead. The group held ten conference calls and identified five categories to monitor using law enforcement citations.

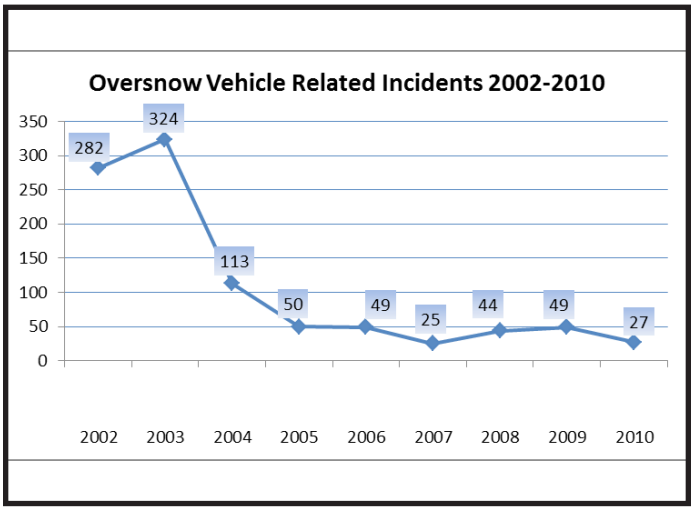


Figure 7: Oversnow vehicle related incidents, 2002-2010 (NPS 2013c)

Table 11. NCGSAP Permits Issued

Year	Permits Issued[1]	Operating Days[2]
2014-2015	89	154
2015-2016	135	254

[1]The total number of available permits is limited by the dates roads are open and closed to oversnow vehicles. Some roads may open late, and some roads may close early. A maximum of 4 permits can be issued on any given calendar day.
[2]An operating day is defined as a day there is an active non-commercially guided snowmobile permit from a specific entrance. A permit issued at each of the four oversnow entrances would equate to four operating days.

Monitoring Objectives

AMP Goal 1: To evaluate the impacts of OSV use and help managers implement actions that keep impacts within the range predicted under the Selected Alternative

The final Rule establishes that impacts from the NCGSAP will be comparable to impacts from commercially guided OSV groups, and the improvements to safety and park resources gained under the commercially guided requirement will remain (36 CFR 7.13 p. 63076). One quantitative way to measure the impacts visitors have on the park is through law enforcement (LE) citations. LE citations can be grouped into five monitoring categories (table 12):

- speeding
- careless operation
- leaving designated roads
- permit violations
- impaired driving

Monitoring began in the winter of 2014-2015, but no citations were issued. During the NCGSAP's first year, NPS managers and rangers emphasized education of participants where possible; for example, counseling at traffic stops replaced the use of citations. In the second year of the program, there were relatively few citations issued to NCGSAP permittees (Table 13).

Impacts are evaluated on a percentage basis since there are potentially 46 commercial trips per day vs. 4 non-commercial trips; a direct comparison would skew results. For example, it is more useful to compare the number of NCGSAP speeding violations per 100 NCGSAP events with the number of commercial speeding violations per 100 commercial events as percentages, instead of directly comparing the number of NCGSAP violations in a season to the number of commercial violations per season. In future years, evaluators can use the averages over the history of the program to determine impacts and trends, ensuring that one year's aberration will not automatically indicate program failure or success. Evaluators will also monitor citations issued to NPS employees and contractors (concessions and contract employees) to ensure that these groups are also adhering to the strict standards set to the public.

Another key aspect of this monitoring strategy is ensuring that citations indicate whether the perpetrator is a commercial user, a non-commercial user, or administrative travel user in order to ensure accurate comparisons. To this end, law enforcement officers are asked to include this information on their citations, and all snowmobiles entering the park will be placarded with the appropriate information (i.e. commercial, non-commercial, administrative).

Table 13. 2015-2016 Citations

Disabled Snowmobile	NPS Employees	1
	Contractors	1
	Commercial Operators	20
Wildlife Harassment	N-CGSAP	1
Motor Vehicle Accident	NPS Employees	3
	Contractors	2
	Commercial Operators	21
	N-CGSAP	2
Snowmobile Off-Road Travel	Contractors	1
	N-CGSAP	4
Permit Violation	NPS Employee	1
	Commercial Operators	1
	N-CGSAP	1
Traffic Violation	Commercial Operators	5
	N-CGSAP	4

In addition to the key indicators derived from historical law enforcement data, the Working Group believes it is important to evaluate how this program impacts the park's wildlife. Law enforcement officers have begun clearly indicating animal-related incidents. To fully understand the impacts that the NCGSAP has on wildlife, the Working Group suggests two strategies:

1. Consistently include an indicator on all citations that identifies whether or not animals were involved in cited offenses. Examples of these types of infractions include chasing bison or feeding wildlife. Park staff is implementing this change to law enforcement documentation and training.

2. Work with the WUAMP Wildlife Working Group to include commercial vs. non-commercial vs. administrative groups in their wildlife impact data collection.

Park staff will analyze data during the spring of each year, after the oversnow roads are closed. Results will be presented to the public through the annual reporting process (by September of each year) and to the Superintendent. The park will work with stakeholders to suggest solutions to problems that arise; but the Superintendent has final authority on any changes made to the NCGSAP, up to and including discontinuing the program.

AMP Goal 2: To gather additional data regarding the comparability of impacts from a group of snowmobiles versus a snowcoach

The NCGSAP involves travel by snowmobile only. Non-commercial groups are not permitted to operate snowcoaches, so metrics related to comparability are not applicable for this impact topic.

AMP Goal 3: To reduce impacts on park resources after implementation of the Selected Alternative by gathering additional data regarding the overall social and ecological impacts of winter use and using those data to guide future management decisions

The monitoring objectives proposed by this Working Group all contribute to ensuring impacts remain within the range predicted under the Selected Alternative. No additional metrics meeting AMP Goal 3 are recommended at this time.

Cost, Triggers, and Mitigation Measures

The cost associated with these metrics is low to negligible. Park staff already record these violations, and the distinction between commercial and non-commercial groups will not add any significant additional cost.

To accurately evaluate this program, the NPS will consider data from multiple seasons, examining trends in citations over time, and compare results against commercially guided groups. If non-commercially guided groups are found to be more impactful than commercial groups, possible mitigation measures include increased education for program participants, reduced number of non-commercially guided groups, or modification of the program by the Superintendent.

Additional Resources

For more information on the NCGSAP, see Appendix C in the SEIS (NPS 2013c).

Table 12. Key indicators for NCGSAP monitoring categories (National Park Service 2013c)

Category	Citation	Average number per year 2004-2010
Speeding	Speeding	180
Careless operation	Motor vehicles - no injury/property damage only	39
	Careless driving	10
	Motor vehicles - injury	3
Leaving designated roads	Snowmobile use in undesignated area	17
	Snowmobile offroad - damage or over 100 feet	1
Permit violations	Operating after permit/license suspension/cancel	5
	Snowmobile - supervising adult/underage operator	2
	No permit/license	2
Impaired driving	Driving under the influence	3

Snow-covered mountains provide a dramatic backdrop to almost any trip to Yellowstone in winter - NPS photo

Chapter 8: Metric Identification, Prioritization, & Selection

The NPS seeks the public's input to help prioritize metrics generated by the Working Groups.

Each Working Group has generated a suite of suggested metrics associated with their respective impact topics for inclusion in the Adaptive Management Program. However, it is not practicable to monitor all suggested metrics, so the park has developed a prioritization tool to guide the process of selecting metrics that, most importantly, align with law and policy, and meet or further the goals of the Adaptive Management Program. Metrics are also evaluated based on the extent to which they are:

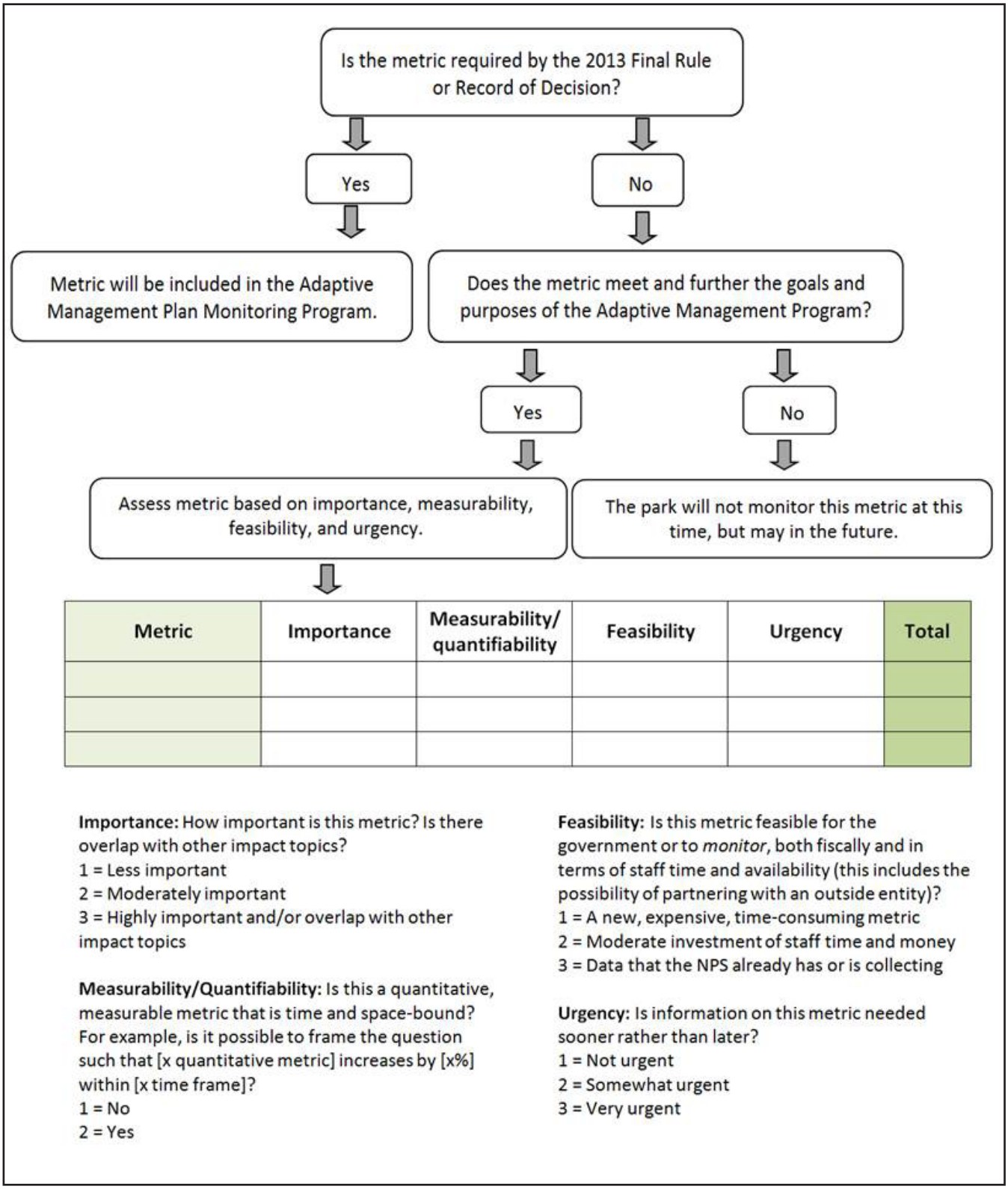
- important
- quantifiable and measurable
- feasible for the government to monitor
- urgent for implementation and continuation of winter use activities (figure 8)

Metrics suggested by Working Groups were prioritized with input from individual Working Group members and other interested members of the public at a public meeting in West Yellowstone in August 2015, and via comment submitted through the PEPC website and by mail. The purpose of this meeting was to seek advice from individual members of the public who may have particular knowledge, expertise, or interest in these topics, but not to reach a consensus. Ultimately, decisions about which metrics to monitor lie with the Superintendent, but this tool is designed to guide conversations with interested stakeholders and lend transparency to the decision-making process.

The prioritization tool is a flow chart (figure 8), beginning with the most important criteria for inclusion in the monitoring program. First, it is most important to consider whether the 2013 final Rule or ROD require that topic to be monitored. If so, that metric is automatically included in the monitoring program. If not, then the park will assess whether monitoring the potential metric furthers one of the three goals of the Adaptive Management Program.

If the metric does not meet these goals, then it will not be included in the Adaptive Management Monitoring Program. However, it may be monitored as part of a different monitoring effort or at a later date. If the metric furthers the goals of the Adaptive Management Program, the prioritization matrix can be used to rate potential metrics according to the extent to which they are deemed important by stakeholders, are quantifiable and measurable, feasible for the government to monitor, and most urgent for implementation and continuation of winter use activities. Definitions of these criteria are located in Figure 8. Scores for each metric can be summed across criteria; metrics with higher scores will receive higher priority than those scoring lower. It's important to recognize that metric priorities may change over time based on public interest, resources, and social and ecological conditions. As such, this strategy identifies the core set of metrics as those required by the SEIS and presents a strategy for continually evaluating other metrics.

The final decision about which metrics to monitor lies with the Superintendent. Metrics evaluated by stakeholders in the August 2015 meeting and the evaluation process are described below. Metrics currently being monitored are described in each chapter, but may be adjusted in the future under the adaptive management process. Significant changes to monitoring will be discussed at NPS stakeholder meetings and published online.



Metric	Importance	Measurability/ quantifiability	Feasibility	Urgency	Total

Importance: How important is this metric? Is there overlap with other impact topics?
1 = Less important
2 = Moderately important
3 = Highly important and/or overlap with other impact topics

Measurability/Quantifiability: Is this a quantitative, measurable metric that is time and space-bound? For example, is it possible to frame the question such that [x quantitative metric] increases by [x%] within [x time frame]?
1 = No
2 = Yes

Feasibility: Is this metric feasible for the government or to *monitor*, both fiscally and in terms of staff time and availability (this includes the possibility of partnering with an outside entity)?
1 = A new, expensive, time-consuming metric
2 = Moderate investment of staff time and money
3 = Data that the NPS already has or is collecting

Urgency: Is information on this metric needed sooner rather than later?
1 = Not urgent
2 = Somewhat urgent
3 = Very urgent

Figure 8: Metric Prioritization Tool

Metric Prioritization Exercise with Working Group Members and Public Comments

During the public meeting held on August 10, 2015, in West Yellowstone, Montana, participants were asked to consider metrics or topics suggested by Working Group members in the Draft Adaptive Management Plan. Participants individually scored suggested metrics/topics based on importance, feasibility, measurability, and urgency; then the participants placed "sticky dots" on a poster next to the top seven metrics/topics that they scored highest. The results are shown below; the metrics/topics most popular among participants have the most sticky dots next to them. This exercise was not a vote but was used as a conversation starter. The prioritization exercise was followed by a group discussion in which individuals were asked to share with the group why they scored various metrics/topics higher than others. The result of the sticky dot exercise is shown below (figure 9), and notes from this meeting can be found on the Yellowstone Winter Use Adaptive Management website (https://www.nps.gov/yell/learn/management/currentmgmt.htm).

In general, participants expressed strong interest in continuing to experiment with low pressure tires and expressed widespread support for the snowroad study currently underway because snowroad conditions affect a variety of impact topics, including safety, emissions, and noise.

The NPS received the most comments on the Human Dimensions chapter of the draft plan. Many thought it should be more focused, more directly address specific questions around winter use, and use more recent literature. The Human Dimensions Working Group held another call, under the leadership of Park Social Scientist Ryan Atwell, to discuss major revisions and restructuring of this chapter, which is reflected in this Final Plan. Other chapters were edited for flow and to reflect any changes in monitoring practices that have occurred since the publication of the Draft Plan.

Another topic that received a significant number of public comments is the use of fat tire bicycles in Yellowstone. The final Rule on Winter Use prohibits fat tire bikes (7.13 (l)(16)(iii)), in part because the scope of this most recent winter use planning process was limited to examining the impacts to the park from motorized oversnow vehicles; and the safety impacts of this emerging activity, particularly the safety implications of fat tire bikes sharing snowroads with large snowcoaches, has not been studied. Changes to the Rule would require new analysis under the National Environmental Policy Act (NEPA), and the NPS is not prepared to begin a new NEPA process at this time. Currently, there are many opportunities to ride fat tire bikes in the areas surrounding Yellowstone National Park, so the NPS is not currently considering the use of these bikes.

This plan presents a strategy to monitor some resources, evaluate potential new metrics, and adapt to new information. Public engagement has been and continues to be critical to the adaptive management process. As resource conditions change or monitoring reveals new information, YNP is committed to continuing these conversations with the public in order to best protect the park's winter resources and experiences.

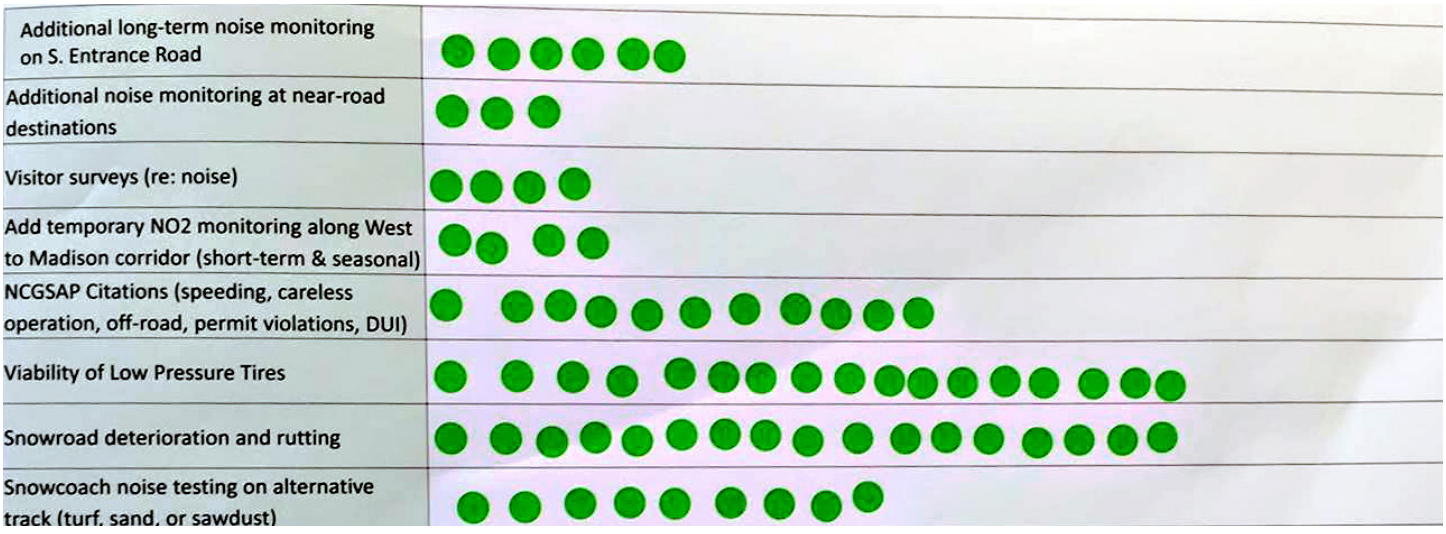


Figure 9: Metric Prioritization

Snowmobilers hiking on a snow-covered boardwalk at Mud Volcano - NPS photo

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Old Faithful is a destination for many winter visitors to the park - NPS photo

Glossary

Adaptive Management – A system of management practices based on clearly identified outcomes, monitoring to determine if management actions are meeting outcomes, and, if not, facilitating management changes that will best ensure that outcomes are met or to re-evaluate the outcomes. Adaptive management recognizes that knowledge about natural resource systems is sometimes uncertain and is the preferred method of management in these cases.

Yellowstone National Park Adaptive Management Program – A program created to provide a structured process, involving the public and interested stakeholders, to continually evaluate the effectiveness of the SEIS and seek to provide information to inform uncertainties and improve management over time. The Adaptive Management Program includes the development, execution, and continual re-evaluation of the Adaptive Management Plan. The three goals of the plan are to 1) evaluate the impacts of OSV use and help managers implement actions that keep impacts within the range predicted under the Selected Alternative, 2) gather additional data regarding the comparability of impacts from a group of snowmobiles versus a snowcoach, and 3) reduce impacts on park resources after implementation of the Selected Alternative by gathering additional data regarding the overall social and ecological impacts of winter use and using those data to guide future management decisions.

Best Available Technology (BAT) – A term applied to regulations on OSV air and noise emissions. See (36 CFR 7.13(l)(4-5)).

dB(A) – Noise levels are measured in decibels, abbreviated dBA. An "A" filter is used to approximate how the human ear hears noise. The resulting "A-weighted sound level" is abbreviated dBA and is a widely used metric for assessing noise impacts on people.

Final Rule – The special regulation for Yellowstone National Park Winter Use published in the Code of Federal Regulations (36 CFR Part 7).

Management Actions – Actions taken by park decision-makers to implement the transportation event paradigm as outlined in the Selected Alternative or future actions that park staff take to manage winter use.

Oversnow Vehicles (OSVs) – OSVs refer to snowmobiles or snowcoach vehicles, defined in more detail in the final Rule (36 CFR 7.13 (l)(2)).

Record of Decision (ROD) – A written public record identifying and explaining the reasoning for the decision on the proposed action, the alternatives considered, mitigation measures, and any monitoring or enforcement programs.

Selected Alternative – The management paradigm chosen by the NPS after analysis of one or more other alternatives.

Soundscape (natural) – The aggregate of all the natural, nonhuman-caused sounds that occur in parks, together with the physical capacity for transmitting sounds.

Supplemental Environmental Impact Statement (SEIS) – Refers to the Yellowstone National Park Winter Use Plan/Supplemental Environmental Impact Statement published in February 2013.

Trigger – A predetermined threshold in an adaptive management plan that identifies when actions are to be taken based on data collected.

A historic bombardier drives up to Old Faithful Visitor Center - NPS Photo

FOR MORE INFORMATION: www.nps.gov/yell/planyourvisit/winteruse.htm