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Snowmobile Best Management Practices for Forest Service Travel Planning: A Comprehensive Literature Review and Recommendations for Management – *Winter Recreational Use Conflict*

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ABSTRACT: Winter wildlands are becoming increasingly crowded, and use conflicts are on the rise. To address use conflict and other resource impacts, the USDA Forest Service has begun Travel Planning in the snow-belt region. To assist in this process, this article presents recent research on how snowmobile use and associated noise and fumes impact non-motorized use. Motorized use often creates annoyance non-motorized users that has been documented to lead to displacement. However, a well-planned and enforced system of routes and areas, as well as improved management tools and technologies, has been shown to help reduce or eliminate conflict. Based on research and existing management strategies, we present a set of best management practices (BMPs) to address winter recreational use conflict and to create a more socially and environmentally sustainable system of motorized and non-motorized designations on National Forest lands.

Keywords: Travel planning, snowmobiles, best management practices, BMPs, winter recreational use conflict, USDA Forest Service

INTRODUCTION

As more people recreate in the backcountry, winter wildlands are becoming increasingly crowded, and conflicts are on the rise. Backcountry skiers and other non-motorized users seek solitude, quiet, and undisturbed natural areas. Desirable terrain, snow conditions and access are also key components of their recreational experience. Snowmobiles change the quality of this experience and create conflict with other winter recreationists (Adams and McCool 2012). Conflict among motorized and non-motorized use is typically "asymmetrical;" skiers experience conflict; snowmobilers do not (Knopp and Tyger 1973, Jackson and Wong 1982, Gibbons and Ruddell 1995). Quiet, non-motorized recreationists can have the quality of their experience dramatically altered by snowmobiles, while motorized users often don't even notice skiers using the same landscape. This article reviews how snowmobile use affects the soundscape, airshed, and viewshed of non-motorized users and presents management strategies for mitigating these impacts.

Soundscape

Protecting quiet soundscapes has become an increasingly important management issue in winter landscapes. Snowmobile noise is one of the biggest sources of use conflict, as an increasing number of winter recreationists seek the peace and quiet found in the backcountry as a way to escape the sounds of modern busy life (Abraham et al. 2010). Noise from motorized recreation is a particular problem in winter because all use becomes restricted to a relatively small number of plowed trailheads, thus significantly reducing access to wilderness for non-motorized users.

Research shows that natural soundscapes assist "in providing a deep connection to nature that is restorative and even spiritual for some visitors" (Freimund et al. 2009, pg. 4). When recreationists have these expectations, the mechanical noise of snowmobiles in otherwise quiet areas can result in a substantial diminution in non-motorized users' recreation experience. This often negatively impacts the experience of the recreationist, creates conflict, and ultimately leads to displacement (Gibbons and Ruddell 1995, Manning and Valliere 2001, Vittersø et al. 2004, Adams and McCool 2010).

In "multiple-use" backcountry areas, snowmobile noise can be difficult to escape. While dependent on speed, type of machine, and direction of wind, snowmobile noise can travel up to 16 km (10 mi; Hastings et al. 2006, Burson 2008) – a distance farther than most non-motorized recreationists travel in a day. Additionally, considering that most forest roads are not plowed in the winter, the ability of skiers to avoid motorized noises is very restricted. Often trails and areas that are considered "front-country" and easily drivable in the summer are much more difficult to access in the winter. Accordingly, the user expectation in these areas is more aligned with a backcountry experience including a quiet soundscape. This strong disconnect between available recreation settings and desired user experience is something the USDA Forest Service (Forest Service) primarily addresses in planning using the Recreation Opportunity Spectrum (ROS). However, ROS is a classification tool that describes physical, social, and managerial attributes – access, remoteness, size, user density, and level of development – in summer, but not winter. Addressing these front-country multiple-use areas, which span a variety of ROS settings and experience high user conflict, is a particularly important priority for travel planning strategies.

Many people also travel in the winter backcountry to view wildlife. However, it has been well established that noise has a widespread and profound impact on wildlife (Barber et al. 2010, Farina 2014), which limits opportunities for viewing and listening to birds and other wildlife. Most fundamentally, snowmobile noise creates annoyance for many non-motorized users that reduces the quality of backcountry experience and may lead to displacement (e.g., Stokowski and LaPointe 2000, Manning and Valliere 2001, Adams and McCool 2010).

Airshed

Motorized and non-motorized winter backcountry recreationists are often confined to the same plowed parking areas to prepare for their trips. However, in these "staging areas" snowmobile emissions can be concentrated and lead to an additional source of conflict and potential health concerns. While technological advances have produced cleaner four-stroke engines (and even zero emission electric snowmobile prototypes), the vast majority of snowmobiles still use highly polluting two-stroke

engine technology. Lubricating oil is mixed with the fuel, and 20 to 30 percent of this mixture is emitted unburned into the air and snowpack (Kado et al. 2001). Also, the combustion process itself is relatively inefficient and results in high emissions of air pollutants (USDI NPS 2000). As a result, two-stroke snowmobiles emit very large amounts of smoke which includes carbon monoxide (CO), unburned hydrocarbons (HC) and other toxins (Zhou et al. 2010).

Concerns over human health related to snowmobile emissions have led to extensive recent research on snowmobile pollution in Yellowstone National Park (e.g., USDI NPS 2000, Bishop et al. 2001, Kado et al. 2001, Bishop et al. 2006, Bishop et al. 2009, Ray 2010, Zhou 2010), and conclusions from these studies have led to a Park ban of 2-stroke engines (USDI NPS 2013). Emissions from snowmobiles release many carcinogens and can pose dangers to human health (Eriksson et al. 2003, Riemann et al. 2009). Several "known" or "probable" carcinogens are emitted including nitrogen oxides, carbon monoxide, ozone, aldehydes, butadiene, benzenes, and polycyclic aromatic hydrocarbons (PAH). While most of the acute toxic effects of snowmobiles are limited to staging areas and parking lots, the smoke and fumes from snowmobiles on trails can dramatically reduce the quality of the experiences of non-motorized users along the trail as well.

Viewshed and other impacts

In addition to the sounds and smells of snowmobiles, the mere presence of snowmobiles on the landscape can degrade the experience of many non-motorized users. In just a few hours, snowmobiles can access almost any basin in the west and disproportionately consume a limited resource, powder snow. Slopes displaying dozens of "high mark" tracks can take away the natural beauty of the landscape for some. The deep tracks of snowmobile can also create a hazard for skiers navigating a downward slope, or the tracks can quickly "track out" a slope, rendering it completely un-skiable. Safety is also a concern, as there is the possibility of collision with a snowmobile, or the risk of a snowmobile triggering an avalanche from above. Alternatively, a snowmobile can diminish the sense of risk or wildness because they effectively reduce the real and perceived distance from safety (Adams and McCool 2010).

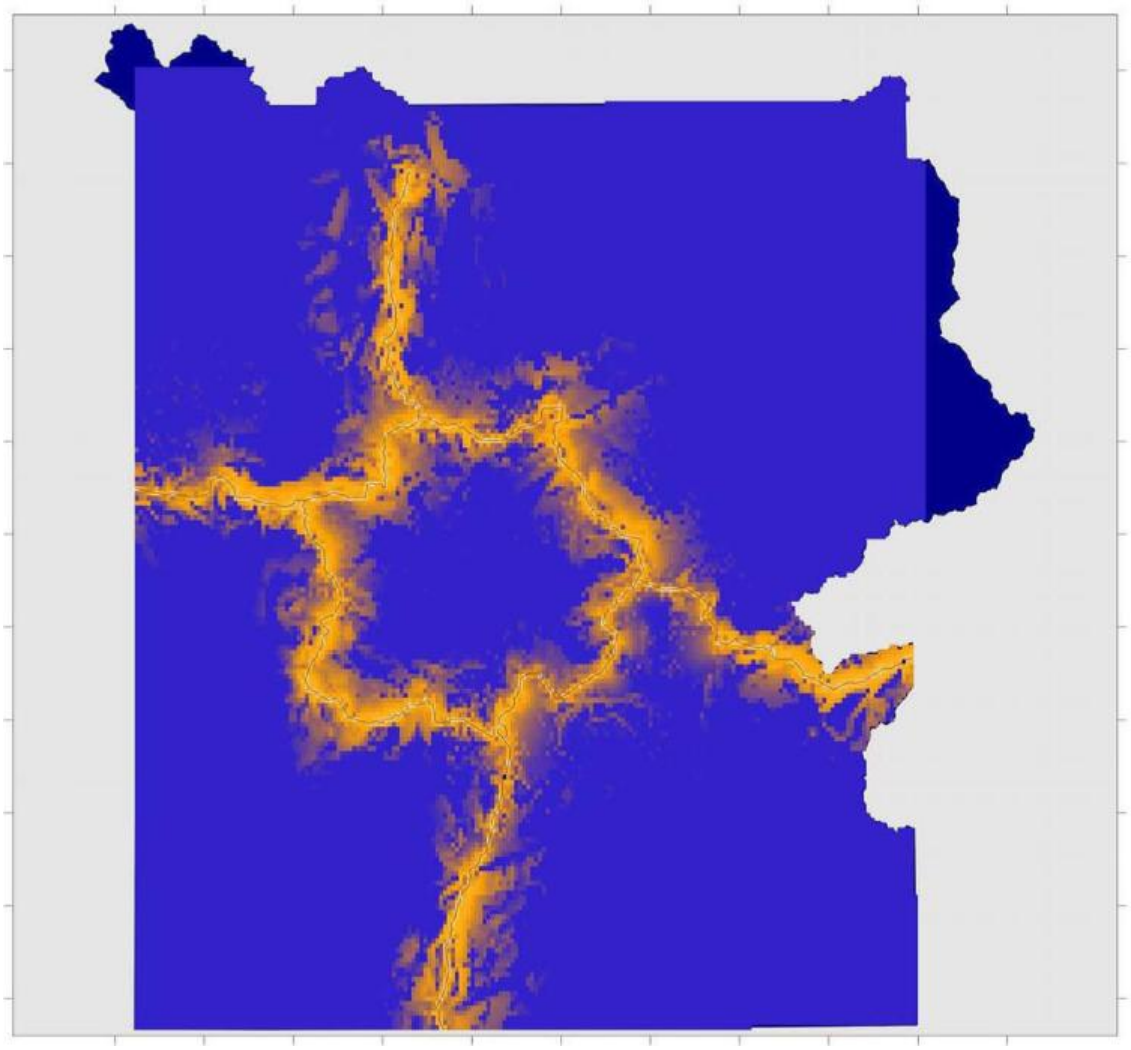
Winter recreational use conflict management

The most effective way to manage winter recreational use conflict is a well-planned and enforced system of routes and areas that separate motorized and non-motorized uses as much as possible (e.g., Andereck et al. 2001, Lindberg et al. 2009, Adams and McCool 2010, USDI NPS 2013). Simply reducing snowmobile noise and smells may not be sufficient to reduce conflict or deter displacement. However, limiting snowmobile use to best available technology (BAT) machines, as has been done at Yellowstone National Park, can substantially reduce use conflict. Closing or separating the non-compatible uses is the most effective way to reduce conflict. For example, an analysis of conflict reduction strategies in Sweden found that closing access to snowmobiles – a change from seeing, hearing, and smelling snowmobiles – led to significant skier welfare gains (Lindberg et al. 2009).

Another strategy employed by the Forest Service is to separate motorized and non-motorized temporally, thereby granting all users some opportunity for use while minimizing conflict. On the Chugach National Forest (AK), for example, one section of the forest is closed to motorized use on alternating years (USDA FS 2007a). On the Humboldt-Toiyabe National Forest (NV, CA), a high-elevation trailhead designated as shared use until lower elevation access receives enough snow for OSV use at which point it becomes non-motorized (USDA FS 2007b). In more popular areas, shorter alternating closure periods, such as biweekly, may be more appropriate.

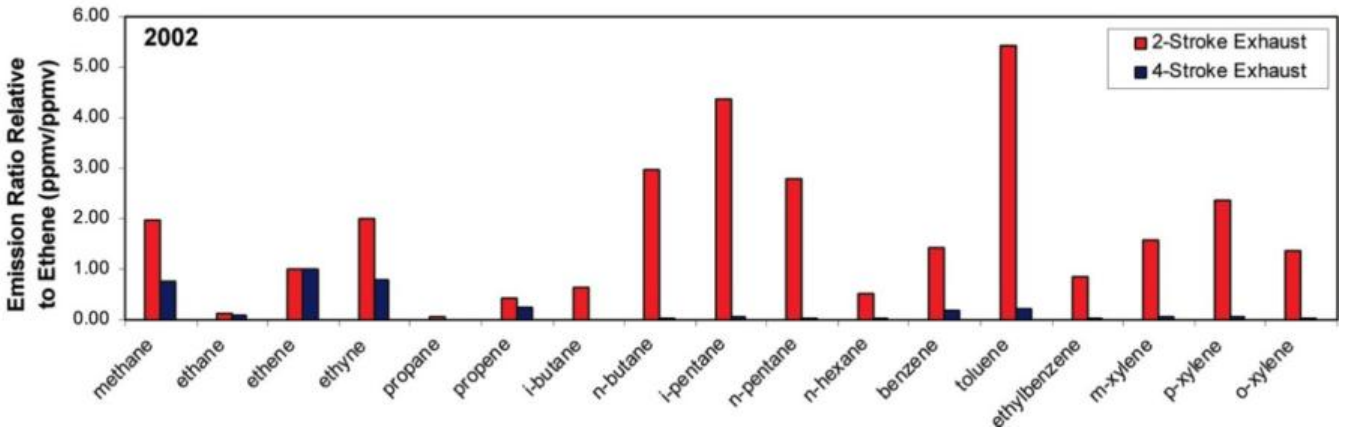
Mitigating snowmobile noise can also help address use conflict. Snowmobile noise can travel long distances in the winter, and noise models have been used to identify areas of recreational use conflict for management planning. For example, noise modeling has been used extensively in Yellowstone National Park to estimate the area affected by noise under a range of management alternatives (Hastings et al. 2006, Hastings et al. 2010, USDI NPS 2013, Figure 1).

Figure 1. Example of noise simulation modeling used in Yellowstone National Park to identify where disturbance and conflict may be a management issue. Orange is the distance snowmobile and snow coach noise travels beyond the groomed roads. Model inputs include temperature, relative humidity, snow cover, and natural ambient sound levels. The modeling also accounts for the acoustic effects of topography, vehicle speeds, and vehicle group size (USDI NPS 2013).



Several studies recommend replacing two-stroke engines with four-stroke engines to significantly reduce emissions and noise (e.g., Miers et al. 2000, Kado et al. 2001, Eriksson et al. 2003). Four-stroke engines are significantly less polluting (Zhau et al. 2010, Figure 2), and have improved fuel efficiency, as well as a reduction in visible exhaust plumes, odor, and noise (Bishop et al. 2006). A study of using best available technology (BAT) machines in Yellowstone has resulted in a 60% reduction in carbon monoxide (CO) and a 96% reduction in hydrocarbon (HC) emissions (Bishop et al. 2006).

Figure 2. Average non-methane hydrocarbons exhaust emission ratios relative to ethene (ppmv/ppmv) for two-stroke and four-stroke engines in 2002 (Reprinted with permission from (Zhou, Y., D. Shively, H. Mao, R.S. Russo, B. Pape, R.N. Mower, R. Talbot, and B.C. Sive. 2010. Air toxic emissions from snowmobiles in Yellowstone National Park. Environmental Science and Technology 44(1): 222-228. Copyright 2010 American Chemical Society).



However, if motorized use of a route or area has been identified as having an unacceptable impact on other user groups, that route or area should be closed (Lindberg et al. 2009, Adams and McCool 2010, and NYSDEC 2011). Furthermore, some National Forest lands have limited non-motorized recreation opportunities, so creating non-motorized areas may be needed. For example, a snowmobile plan for Adirondack Park (NY) calls for closing routes if the "opportunities for quiet, non-motorized use of trails are rare or nonexistent;" (NYSDEC 2011, p.244). Finally, in some areas – regardless of conflict – snowmobiling should not be allowed. For example, Adams and McCool (2010) argue that roadless areas should be protected from motorized use because "roadless areas are exceptional for their wild and quiet recreational opportunities, their habitat for threatened and endangered species, and other values. Their character and values derive from their lack of accessibility by motor vehicles" (p. 109).

To identify routes and areas that are sources of conflict, working groups have been established. However, for this collaboration to be successful, several key aspects have been identified, including: balanced stakeholder representation, clear goals and objectives, information exchange, and shared decision making (Schuett et al. 2001).

Best Management Practices for Winter Recreational Use Conflicts

Designating motorized use

1. When necessary elements for successful collaboration exist, establish a working groupwith motorized and non-motorized users, conservation interests, land managers, and other stakeholders to develop concepts for minimizing recreational conflict.
2. Identify routes and areas where conflict is ongoing among motorized and non-motorized winter recreational use utilizing existing information, surveys, GIS modeling, and community outreach.
3. Identify routes and areas of particularly high value or demand for motorized and non-motorized use.
4. To the degree possible, allocate separate trails, trailheads, and areas.
5. Ensure that non-motorized trails and areas are available:
   a. close to plowed access points, groomed trails, and other access portals.
   b. in contiguous non-motorized blocks.

c. in areas where there are few non-motorized opportunities.

d. in both frontcountry and backcountry settings.

e. in areas with scenic beauty.

f. in areas sheltered from noise emanating from motorized areas.

g. cross a variety of Recreational Opportunity Spectrum (ROS) categories.

6. Ensure that a fair balance of unplowed roads is set aside for non-motorized use.

7. Locate motorized routes and areas:

a. away from popular or historically used backcountry ski areas, or areas of growing use.

b. outside proposed Wilderness Areas, Wilderness Study Areas, and Research Natural Areas.

c. with easily enforceable boundaries using topographic or geographic features. (e.g., a ridge top or highway) - use boundary signage to provide additional clarity, or where unauthorized use is occurring.

d. where they do not bisect non-motorized areas.

8. Consider temporal restrictions in areas of high-use or high-value to both motorized and non-motorized use. This includes both early/late season restrictions, as well as alternating access.

9. Where necessary to designate a motorized route through a non-motorized area, locate and manage such route (such as speed and idling limits) to minimize disturbance to the non-motorized area.

10. In areas of shared use, consider requiring best available technology (BAT) to reduce conflict and impacts between uses.

Minimizing impacts of motorized use

1. Undertake proactive and systematic outreach programs in order to facilitate increased compliance of closures and reduce user conflicts.

2. Provide free digital and paper maps that clearly show routes, areas, and watersheds open and closed to snowmobiles.

3. Encourage or require the use of best available technology (BAT) snowmobiles to reduce noise and local air quality impacts.

4. Implement significant penalties and consequences for violating snowmobile regulations that will dissuade users from such violations.

5. Monitor closed routes and areas to ensure that snowmobile intrusion is not occurring.

6. Establish an adaptive management framework using monitoring to determine efficacy of current management.

7. Revisit plan decisions as necessary to ensure use conflicts are being minimized and motorized impacts are below accepted thresholds. Close snowmobile routes and areas when motorized use is leading to trespass onto non-motorized trails or areas.

CONCLUSION

The growing number of winter backcountry users has increased recreational use conflicts and negative impacts on natural resources. As the Forest Service begins formally addressing winter recreation and determining where motorized use is allowed, restricted, and prohibited, it is essential that managers have the best available science to guide their decisions. Snowmobiles can negatively affect the soundscape, airshed, and viewshed of non-motorized users. The most effective way to mitigate winter recreational use conflict is a well-planned and enforced system of routes and areas. Simply reducing snowmobile noise or smells can limit snowmobile impacts to non-motorized users, but may not be sufficient in reducing conflict. Rather, closing or separating the non-compatible

users is the best way to reduce conflict. Collaboration among user groups can be successful, but there must be a balanced stakeholder representation, clear goals and objectives, information exchange, and shared decision making.

This document presented the best available science on the impacts of snowmobiles. Based upon this research and the recommendations of researchers and managers, and professional experience, we have developed a list of best management practices. These BMPs will help mitigate recreational use conflicts and minimize impacts to natural resources. Once a system of routes and special use areas is established, enforcement and monitoring will be critical to the success of any management plan.

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