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Snowmobile Best Management Practices for Forest Service Travel Planning: A Comprehensive Literature Review and Recommendations for Management – *Water Quality, Soils, and Vegetation*

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ABSTRACT: Since the seminal research of Wallace Wanek and his colleagues in the 1970s, it has been well established that snowmobiles can negatively impact water quality, soils, and vegetation. However, while early researchers focused on localized impacts of snowmobiles on groomed trails, today's machines also travel off-trail and into many sensitive habitats such as alpine cirques, meadows, and wetlands. Water quality can also be affected when spring runoff releases pollutants stored in the snowpack – especially at staging areas. Furthermore, as snowmobiles become increasingly powerful, their increased torque and reach creates a potential for greater impact on those resources. Based on this research and existing management strategies, we present best management practices (BMPs) which will help protect water quality, soils, and vegetation.

Keywords: Travel planning, snowmobiles, best management practices, BMPs, water quality, soils, vegetation, USDA Forest Service

Water Quality Research

Protecting and enhancing water supply is a key mandate of the USDA Forest Service (Forest Service), and a number of aquatic species and municipal watersheds depend on National Forests – especially in the West. For example, most National Forest acres west of the Cascade Mountains in Oregon and Washington are municipal watersheds and provide water to local communities (USDA FS 2000). During the winter, snowmobiles release toxins such as ammonium, nitrate, sulfate, benzene, and toluene which accumulate in the snowpack (Ingersol 1999) and increase acidity (Musselman and Kormacher 2007). In the spring runoff, accumulated pollutants are released as a pulse into the soil, groundwater, and surrounding waterbodies.

A recent study found snowmobiles are polluting a tributary of Lake Tahoe, CA. Examining 168 different semi-volatile organic compounds (SVOC), McDaniel (2013) found eight to 20 times greater loadings on snowmobile trails than background levels. He further reported that highly toxic and persistent polycyclic aromatic hydrocarbons (PAHs) had increased two to six times the background level in a nearby stream (McDaniel 2013). Impacts on water quality can be especially pronounced at trailheads and staging areas where snowmobiles congregate (USDA FS 2012). Lakes can also be vulnerable because snow melts directly into the waterbody without any vegetative buffer, and there is a risk of snowmobiles falling through thin ice and spilling toxins directly into the water (USDA FS 2012).

Soils Research

Snowmobiles can directly impact soils in a number of ways including soil compaction, erosion, and contamination. When traveling in areas of low or no snow – such as such as wind-swept ridges, snow-free access points, or during periods of thin snowpack – snowmobiles can be particularly damaging. This may also be an increasingly common situation as climate change leaves low-elevation access points snow-free for longer periods of time. Snowmobiles can also indirectly impact soils through snow compaction (Wanek 1971). Weighing several hundred pounds, snowmobiles easily compact the snow, which can increase snowpack density, reduce soil temperatures, increase soil freezing, and result in a later melt-out (Gage and Cooper 2009).

In areas of low or no snowpack, direct soil compaction can occur from snowmobiles leading to erosion (Gage and Cooper 2009). On steep slopes – especially south facing, or wind-swept slopes – vegetation and snow can be mechanically removed from snowmobile tracks resulting in exposed bare ground (Stagl 1999). Soil compaction impacts nearly all properties and functions of soil including increased bulk density and reduced pore space leading to reduced permeability of water and air (Batey 2009). This results in surface erosion, especially on steep slopes (Batey 2009). Soil erosion when located near streams can also lead to localized stream sedimentation and increased turbidity. As climate change increases the number of snow-free days, erosion from snowmobiles will be an increasing management concern.

Soils can also be contaminated when pollutants enter the soil from a melting snowpack. With inefficient engines, snowmobiles release much of their oil gas mixture into the snow unburned. Several pollutants have been recorded in the snowpack along snowmobile trails including ammonium, nitrate, sulfate, benzene, and toluene (Ingersol 1999). In the spring, these pollutants are released into the soil, creating local contamination and associated impacts.

Vegetation Research

Snowmobiles impact vegetation either through directly crushing and breaking vegetation, or through a number of indirect mechanisms. When traveling off-trail, snowmobiles often run over trees and shrubs causing damage or death – often with minimal snowmobile traffic. Although these impacts may not be environmentally significant when they occur in robust forest environments, they can be very significant when they occur in sensitive forest habit, such as high mountain slopes or meadows.

A recent study on the Gallatin National Forest (MT) found 366 acres of trees damaged by snowmobiles on timber sale units – slowing forest regeneration (WWA 2009, Table 1). Trees such as white-bark pine (*Pinus albicaulis*), found only at high elevations and declining across its range, may be vulnerable to snowmobile damage. Trampling has also been found to result in a reduction in plant productivity, changes in the plant community, and a reduction in plant diversity (Masyk 1973, Wanek 1973, Wanek and Schumacher 1975).

Compaction of the snow reduces the insulating air spaces and conducts cold air to the ground (Wanek 1973). These lower temperatures can reduce plant density and composition (Neumann and Merriam 1972), reduce productivity and growth (Wanek and Potter 1974), delay seed germination and flowering (Rongstad 1980), as well as affect decomposition rates, hummus formation and microbial activity (Neumann & Merriam 1972, Rongstad 1980). These impacts ultimately can change community structure and reduce the availability and duration of spring wildlife foods (Stagl 1999).

to protect the underlying vegetative cover and soil or trail surface; use and enforce closure orders to mitigate effects when adverse effects to soil, water quality, or riparian resources are occurring; use suitable measures to trap and treat pollutants from over-snow vehicle emissions in snowmelt runoff or locate the staging area at a sufficient distance from nearby waterbodies to provide adequate pollutant filtering" (USDA FS 2012, p. 96-97).

Some Forest Service policy has also recommended restricting snowmobile use to protect water quality.

Table 1. Summary of snowmobile damaged trees on the Gallatin National Forest (MT) reported during regeneration transect surveys of previously logged timber stands (reprinted from WWA 2009).

Area name	Year logged	Year inventoried	Acres	Average # damaged trees per acre	Total number of trees damaged
Little Teepee Creek Drainage	1969	1995	122	140	17,080
Horse Butte Road*	1992	1995	15	514*	7710*
Madison Arm	1991	1995	12	5	60
Unknown	1960s	1983	68	23	1564
Unknown*	1960s	1983	100	652*	65,200*
Cream Creek*	1986	1995	60	725*	43,500*
Total damaged trees:					**135,114**

*surveys note the presence of a snowmobile trail in this stand

Water Quality, Soils, and Vegetation Management

The most common strategy for protecting water quality, soils, and vegetation from snowmobile impacts is to ensure that there is adequate snow cover and create a buffer around waterways. For example, the Forest Service has developed best management practices (BMPs) to protect water resources on Forest Service lands from snowmobile pollution (USDA FS 2012). This document recommends, "Allow over-snow vehicle use cross-country or on trails when snow depths are sufficient

The Uinta-Wasatch-Cache National Forest (UT) does not allow recreational snowmobiling in Salt Lake City's municipal watershed (USDA FS 2003). The Inyo, Sequoia, and Sierra National Forests are proposing a minimum of 18" of snowpack before allowing snowmobiling in their revised Forest Plan to protect forest resources (USDA FS 2014). Restricting snowmobile use in sensitive habitats such as riparian areas and wetlands can be helpful in mitigating these impacts as well.

Best Management Practices for Water Quality, Soils, and Vegetation

Designating motorized use

1. Set dates for snowmobile season opening and closure, and adjust based upon adequate snow depth.

2. Require a minimum snow depth of at least 0.3m (12 in), or sufficient depth to protect water quality, soils, and vegetation before a contingency plan and implement emergency closures if snowpack goes below this threshold.

3. Require a minimum snow depth of at least 0.45 m (18 in), or sufficient depth to protect water quality, soils, and vegetation before allowing snowmobiling off-trail. Have a contingency plan and implement emergency closures if snowpack goes below this threshold.

4. Avoid locating snowmobile routes or areas in municipal watersheds.

5. Restrict snowmobile use on wetlands, riparian areas, and sensitive meadows and buffer snowmobile trailheads and routes 45 m (150 ft) from these areas.

Minimizing impacts of motorized use

1. Develop public information, educational programs, and signage about the impacts of snowmobiles on water quality, soils, and vegetation and how to minimize those impacts.

2. Ensure adequate maintenance of bridges and culverts on routes to help prevent erosion during the spring run-off.

3. If roads are only used for snowmobile use, scarify the roadbed to restore hydrology.

4. Encourage or require the use of best available technology (BAT) where necessary to minimize the impacts water quality, soils, and vegetation.

5. Close routes and areas when excessive damage to soils and vegetation has occurred, and/or erosion has been documented.

6. Monitor closed routes and areas to ensure the measures taken are effectively mitigating impacts to water quality, soils, and vegetation.

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

8. Revisit plan decisions as necessary to ensure impacts to water quality, soils, and vegetation are being minimized and motorized impacts are below accepted thresholds.

CONCLUSION

It has been well documented that snowmobiles can impact water quality, soils, and vegetation. Alpine environments are particularly sensitive to disturbance, and snowmobiles can pollute waterways, cause localized soil erosion, and crush and break vegetation. Many of these impacts are compounded by climate change which is leaving many “historic” access points snow-free for much of the winter. Ensuring that there is adequate snow cover and buffered waterways are key mitigation strategies. Restricting use in sensitive habitats such as riparian areas and wetlands is also an important mitigation step. Applying BMPs in the development of a system of snowmobile routes and areas will protect water quality, soils, and vegetation on Forest Service lands.

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