EVALUATION OF ATV USE ON GROOMED SNOWMOBILE TRAILS

Produced by the
International Association of Snowmobile Administrators

iasa
International Association of Snowmobile Administrators

2006

Evaluation of ATV Use On Groomed Snowmobile Trails

Project Manager:

Kim Raap – Trails Work Consulting
TrailsWork@aol.com
4015 S. Brady Court
Sioux Falls, SD 57103
(605) 371-9799

Copies available from:

International Association of Snowmobile Administrators (IASA)
www.snowiasa.org

or

American Council of Snowmobile Associations (ACSA)
www.snowmobilers.org
271 Woodland Pass, Suite 216
East Lansing, MI 48823
(517) 351-4362

ACKNOWLEDGEMENTS and DISCLAIMERS

This evaluation project has been produced with financial assistance from the Recreational Trails Program administered by the U.S. Federal Highway Administration (FHWA).

The International Association of Snowmobile Administrators (IASA) and the American Council of Snowmobile Associations (ACSA), as well as the individuals within those organizations and others are recognized for their input, project coordination, support, and suggestions in the development of this evaluation project. Project management, field testing, evaluation and analysis, writing, and photography were provided by Trails Work Consulting.

Special recognition and a very special thank you are given to Polaris Industries and MidAmerica Moto Plex in Sioux Falls, SD for providing the two ATVs and two snowmobiles used as control vehicles for this project. This assistance was extremely vital to the successful completion of field testing which evaluated side-by-side impacts of snowmobiles and ATVs on groomed snowmobile trails.

A special thank you also to the many staff and volunteers in the states of Idaho, Minnesota, South Dakota, Wisconsin, and Wyoming who helped make the field tests possible and successful and to staff in the state of Maine who diligently made arrangements for an additional testing site, only to have Mother Nature not cooperate with adequate snowfall. Additionally, thank you to the 66 trail managers in the United States and Canada who responded to the Survey of Trail Managers.

The objective of this project was to collect information to help local decision makers: 1) identify potential impacts to the groomed and compacted snow surface from ATV use in varying conditions during the winter season and provide Best Management Practices (BMPs) to help minimize or mitigate potential conditions that could affect trail user safety and the quality of groomed snow trails, 2) identify potential safety issues that may result from mixing snowmobile and ATV vehicle traffic on the same groomed trail during the winter season and provide BMPs to help minimize or mitigate any potential effects, and 3) identify potential off-season impacts to snowmobile trail routes from unauthorized ATV use and provide BMPs to help minimize and mitigate any potential effects. The project's scope was limited to evaluation of use during the winter season when trails are compacted and did not include funding to evaluate potential shoulder season ATV management issues.

The decision as to how to use this information and whether to allow concurrent ATV and snowmobile use on trails groomed for snowmobiles must be made at the local level by landowners, trail providers, and political jurisdictions. The intent of publishing this document is not to either encourage or discourage concurrent use but rather to provide entities with information to help them with their local decisions. All decisions regarding ATV use on groomed snowmobile trails are reserved for implementation by local jurisdictions and local trail grooming managers consistent with local priorities and resources.

The sole purpose of this publication is educational only, with no other intent but to help expand trail managers' and local decision makers' knowledge base. It should not be assumed by the reader that all contributors agree with every written word, but are opinions only. The authors, contributors, FHWA, Trails Work Consulting, IASA, ACSA and their members accept no liability resulting from the compliance or noncompliance with the findings or recommendations given herein, or for the accuracy or completeness of the information contained herein.

Sponsors of this project do not endorse products or manufacturers. Trade and manufacturer's names appear in this document only because they are considered essential to the object of the document.

TABLE OF CONTENTS

Part 1 – Summary of Findings and Management Practices

Part 2: APPENDIXES A – D

LIST of EXHIBITS and TABLES

LIST of PHOTOS with credits

100 Photo 153: Fresh snowfall on the side trails, *Kim Raap*
Photo 154: The vehicle in fresh snow (MN 2, 700 Polaris ATV), *Kim Raap*
101 Photo 155: Tracks in the fresh snow (MN 2, 700 Polaris ATV), *Kim Raap*
Photo 156: Tire impression in fresh snow (MN 2, 700 Polaris ATV), *Kim Raap*
Photo 157: Downhill on a side trail (MN 2, 700 Polaris ATV), *Kim Raap*
Photo 158: Around a curve on a side trail (MN 2, 700 Polaris ATV), *Kim Raap*
102 Photo 159: Tire impression on the railroad grade trail (MN 2, 500 Polaris ATV), *Kim Raap*
Photo 160: Tracks on a side trail (MN 2, 500 Polaris ATV), *Kim Raap*
103 Photo 161: Snow is almost as deep as vehicle's suspension (MN 2, 500 Polaris ATV), *Kim Raap*
Photo 162: Tire impression in new snow (MN 2, 500 Polaris ATV), *Kim Raap*
104 Photo 163: ID 1 field test site, *Kim Raap*
Photo 164: Impressions from a fast pass-by (ID 1, 700 Polaris ATV), *Kim Raap*
105 Photo 165: An aggressive start (ID 1, 700 Polaris ATV), *Kim Raap*
Photo 166: Impressions from an aggressive stop (ID 1, 700 Polaris ATV), *Kim Raap*
Photo 167: Surface chew from a slow pass (ID 1, 500 Polaris ATV), *Kim Raap*
Photo 168: Impressions from an aggressive start (ID 1, 500 Polaris ATV), *Kim Raap*
Photo 169: Impressions from an aggressive stop (ID 1, 500 Polaris ATV), *Kim Raap*
106 Photos 170 and 171: The vehicle got off the edge of the compacted base and got stuck (ID 1, 500 Polaris ATV), *Kim Raap*
107 Photo 172: An aggressive start (ID 1, 500 Suzuki ATV), *Kim Raap*
Photo 173: An aggressive stop (ID 1, 500 Suzuki ATV), *Kim Raap*
Photo 174: An aggressive start (ID 1, 500 Polaris Scrambler ATV), *Kim Raap*
Photo 175: An aggressive stop (ID 1, 500 Polaris Scrambler ATV), *Kim Raap*
108 Photo 176: An aggressive start (ID 1, 900 Polaris snowmobile), *Kim Raap*
Photo 177, An aggressive stop (ID 1, 900 Polaris snowmobile), *Kim Raap*
Photo 178: Surface chew from a slow pass-by (ID 1, 700 Polaris snowmobile), *Kim Raap*
109 Photo 179: An aggressive start (ID 1, 700 Polaris snowmobile), *Kim Raap*
Photo 180: Impressions from an aggressive stop (ID 1, 700 Polaris snowmobile), *Kim Raap*

INTRODUCTION and SUMMARY OF FINDINGS

Background

This project was driven by the fact that the number of all-terrain vehicles (ATVs) has increased dramatically over the past 20 years. In Canada, ATV sales have more than tripled in just the past few years. While there were around a half million ATVs in the United States in the mid 1980s, there are an estimated 8 million units in the United States today. Comparatively, there are about 1.75 million registered snowmobiles in the United States, 605,000 in Canada and a total of only 2.6 million registered snowmobiles worldwide. The numbers of ATVs will likely continue to rise (currently at a rate of over 700,000 units per year in the U.S.) while simultaneously the sale of new snowmobiles has declined by 45% in the United States and by 36% in Canada over the past ten years. This is a trend that trail managers and recreationists cannot ignore and must proactively address.

The growth in ATV numbers has driven a desire for more places to operate them recreationally on trails. In some areas of the Snowbelt this has led to a growing interest for ATV operation on groomed snowmobile trails during the winter season. This can be a challenge for land and trail managers. Some snowmobilers do not embrace this new use of "their trails" since, typically, snowmobile trails were created and are maintained by their fees, their volunteer construction and maintenance efforts, and their work with landowners who often don't want ATVs on their property during the summer season for a multitude of reasons. It is also a challenge because of a perception that ATVs rut the snowmobile trails and cause safety issues. While there are often strong opinions on both sides of this discussion, there has generally been a lack of good information on the subject.

The intent of this project was not to either encourage or discourage concurrent ATV use but rather to provide landowners, recreationists, trail providers, and political jurisdictions with better information to help them make objective local decisions. This report was produced to help expand trail managers' and local decision makers' knowledge about the effects of ATV use on groomed snowmobile trails during the winter season. All decisions regarding ATV use on groomed snowmobile trails are clearly reserved for implementation by local jurisdictions and local trail grooming managers consistent with their local priorities, conditions, and resources.

Information Provided

Information provided in this publication relates to the three components of this project:

1. A survey of trail managers across the United States and Canada that collected information regarding current laws, rules, regulations, and policies related to the allowance or prohibition of concurrent ATV use on groomed snowmobiles trails; statistical information regarding crashes, social conflicts, policies, case studies, guidelines, and other data related to the management of joint snowmobile and ATV use; and information about off-season impacts from unauthorized ATV use on snowmobile trail routes during the spring, summer, and fall.
2. Field studies that identified the depth of both ATV and snowmobile impressions on the groomed snowmobile trail surface, to gauge if they could potentially affect trail user safety and the quality of the trail, and also evaluated the difference in operational speeds, maneuverability, and stopping distances between snowmobiles and ATVs while also comparing ATV stopping distances on non-snow surfaces.
3. Development of suggested management practices that include examples of laws and regulations that both allow and prohibit concurrent use, Best Management Practices (BMPs) to help minimize or mitigate potential conditions that could affect trail user safety or the quality of groomed snow trails if local jurisdictions decide to allow concurrent winter ATV use, and BMPs to help minimize or mitigate impacts from unauthorized off-season ATV use on snowmobile trail routes.

Summary of Findings

The Executive Summaries that follow provide a synopsis of information collected by the Manager Survey and from field tests conducted for this project. A complete report on the Survey can be found in Chapter 2. Chapter 3 presents a summary of field test results. Readers are urged to review this report and Appendix A in their entirety to properly understand findings in their correct specific context. However <u>if you choose to only cherry-pick information from this report, refer to Exhibit 1 on page 13 and the 'Twelve Factors to Consider' on pages 17-22.</u>

SURVEY OF TRAIL MANAGERS – EXECUTIVE SUMMARY

This is a summary of results from the Survey of Trail Managers conducted between November 1, 2005 and January 30, 2006 in regard to Evaluation of ATV Use on Groomed Snowmobile Trails. 100% of all U.S. and Canadian jurisdictions with groomed snowmobile trails responded. The reader should consult the complete survey Results report in Chapter 2 for a comprehensive discussion about specific topics and issues.

Where Is Concurrent Snowmobile/ATV Use Allowed

Twenty-three jurisdictions (63.9%) allow (or cannot prevent) some level of concurrent ATV use on groomed snowmobile trails, while 13 jurisdictions (36.1%) do not. This includes 16 of 25 states (64%) and 7 of 11 Canadian jurisdictions (63.6%). A total of 53,147 miles/85,531 kilometers (26.9% of all groomed snowmobile trails in the United States and Canada) are classified as "open" to concurrent use. This includes 22% of all U.S. groomed trails and 35% of all Canadian trails, although such ATV use in Canada is by and large discouraged since there is generally no funding in place to provide trail operation to support ATV use – winter or summer.

Levels of concurrent use range from "100% of all groomed trails" in three U.S. and five Canadian jurisdictions to "less than 1%" of the groomed trails in three states. In the U.S., a total of 27,012 miles of trail are open to concurrent use which represents 28.1% of the groomed trails in those 16 states. In Canada, 42,060 kilometers of trail are technically open to concurrent use which represents 42.8% of the groomed trails in those six provinces and one territory. 100% of western states and 75% of western Canadian jurisdictions allow some level of concurrent use, while about 40% of Midwestern and eastern states/provinces allow some level of concurrent use.

The most common method by which concurrent ATV use on groomed snowmobile trails is allowed is that there is "No Formal Action to Prohibit" (60.9%). The most common method by which concurrent ATV use is prohibited is by "Agency Rule or Regulation" (53.8%). There are typically few or no restrictions or special conditions applied to ATVs when concurrent use is allowed and the season of use is typically the same as the jurisdiction's "snowmobile season." Concurrent ATV use on groomed snowmobile trails is typically very light where it is open and generally ranges from "1% to 2%" up to "5% to 10%" of total winter trail use. Only one area reported ATV use as high as "30% to 35%" of total winter use.

Crash and Incident Rates on Concurrent Use Trails

There is generally very little data available from trail managers regarding ATV related crash and social conflict incident rates on concurrent use trails. Nearly 85% of the survey's participants skipped these questions while another 50% to 64% of the few that did respond indicated "Unknown." Only one person indicated that ATV crash/incident rates were higher on their trails while two people indicated that ATV crash/incident rates were generally lower. Additionally, one person indicated that vehicle crash rates were generally the same while two persons indicated that social conflict incident rates were generally the same as on "snowmobile-only" trails.

Off-Season Impacts from ATV Use on Snowmobile Trail Routes

Nearly 60% of the survey's participants indicated they experience off-season impacts from unauthorized ATV use on snowmobile trail routes. This represents eighteen states, nine provinces (72% and 82% respectively of the U.S. and Canadian jurisdictions with groomed trails), and six U.S. Forest Service areas. The top issues ranked in the range of being a "major to slight" problem and included the following (listed from most to least impacts):

1. Private Property Trespass – landowner permission is only for the winter season
2. Public Land Issues – agency permission is only for winter use of the trail route
3. Severe, Moderate, and/or Slight Resource Damage from ATV use of the route in the off-season
4. Social Conflicts with Heavy Nonmotorized Use of the trail route during the off-season
5. Conflicts with Exclusive Nonmotorized Use of the trail route during the off-season

The following issues ranked in the range of being a "very slight problem" to "not a problem": Conflicts with Livestock Grazing, Conflicts with Wildlife Production, Harassment of Wildlife, and Harassment of Livestock.

FIELD TESTING – EXECUTIVE SUMMARY

This is a summary of observations from field tests conducted at fifteen sites in five different states (South Dakota, Wyoming, Wisconsin, Minnesota, and Idaho) between January 9 and February 21, 2006. While these tests were conducted during the middle of the "snowmobiling season," the variety of conditions recorded at these sites is representative of conditions that may also occur earlier or later in the winter season. These tests, purposely, did not look at impacts to the snow surface before trails had been compacted by trail grooming or after trail grooming would typically cease at the end of winter, hence the title *Evaluation of ATV Use on <u>Groomed</u> Snowmobile Trails.* Without doubt, impacts from both ATVs and snowmobiles will be different on uncompacted snow and when temperatures are warmer, as compared to the results of this field study on compacted trails where the temperatures were at or below freezing. While other management issues could potentially arise from ATV operation prior to the start of or after the end of the snowmobile trail grooming season, they were outside the scope of this project and could potentially be the topic of a future study to augment information collected by project.

These particular field tests looked at "worst-case" results in regard to the depth and width of impressions caused by the operation of both ATVs and snowmobiles on actual groomed snowmobile trails. The reader should consult Chapter 3 – Field Study Results and Appendix A – Summary of Daily Field Testing Journals with Photo Documentation for a comprehensive discussion regarding specific test results in varying temperature and snow conditions at each locale and then apply specifics similar to their local conditions to their decision making versus applying general/average results from this study to local decisions.

It should be noted that these results represent a "snapshot" of impacts observed at the particular point in time, and under the very specific conditions, documented for each test site. They are not intended to represent a comprehensive look at every potential issue under all possible scenarios in the universe. It should also be recognized that these results are subject to change under other snow and weather conditions, with different or more vehicles, and/or with different vehicle operators. Nonetheless, these "snapshots" provide new information that can further more informed decision making regarding concurrent ATV/snowmobile use and management. Also keep in mind that a primary factor of any groomed snow surface's durability is the cumulative number of vehicles that use it (snowmobiles or ATVs) between grooming repetitions and how well the trail surface is able to refreeze/set up prior to traffic resuming on the surface. Irrespective as to whether the vehicles are snowmobiles or ATVs, the results from these field tests, coupled with numbers and types of vehicles, can be used to approximate cumulative impacts from single or concurrent use since impressions will potentially get deeper and deeper until an ice layer, the ground, or a road base is reached from repetitive traffic patterns.

The Field Tests' "Settings" and Range of Conditions

First, the air temperature during these tests ranged from 11.0 F (-11.7 C) to 31.9 F (-0.1 C). Second, the field tests were conducted only on actual groomed trails with regular snowmobile traffic versus using test tracks compacted only for this study. Third, compacted snow depth on the trails ranged from 15 to 60 centimeters (5.9 to 23.6 inches) in depth. The exception was the Wisconsin curve test (Site Wisconsin 2) where there were only 4 to 9 centimeters (1.6 to 3.5 inches) of snow on top of an ice layer. The uncompacted depth of snow along side the groomed trails ranged from 30 to 76 centimeters (12 to 30 inches) in depth, although uncompacted snow adjacent to the trail at Site Wisconsin 2 was only 20 centimeters (8 inches) deep. Fourth, while this testing was done during what could be considered the middle of the snowmobiling season (January-February), some sites had been groomed for only three weeks or less (Sites South Dakota 1, 2, and 3 and Wyoming 2) even though the testing occurred in January and, therefore, were somewhat representative of earlier season conditions than what the January dates might suggest. Finally, most trails used for this field testing had a very well compacted trail base – consistent with what would generally be considered "good" snowmobile trails. Trails that had been regularly groomed with a multi-blade drag were generally very firm (irrespective as to whether they had been groomed for three weeks or up to eight weeks) and showed minimal impressions from either vehicle type. The exceptions to having 'very firm trails' were Site Wyoming 2, which had been groomed only three times with a single blade drag and was very soft underneath the surface crust, and Site Idaho 1 which was a bit soft due to recent tilling and also had a sub-base which was less dense than the trails groomed with multi-blade drags.

Summary of Results

Exhibit 1: Summary of Field Testing General Observations

It must be kept in mind that the scope of this project dealt only with the evaluation of impacts on snowmobile trails that were groomed and compacted during the winter season. It did not involve the evaluation of impacts from ATVs during shoulder seasons (immediately before and after) the winter snowmobiling season, which will be different. In respect to observations from vehicle operation on compacted snowmobile trail surfaces:

Vehicle Impressions on Trail: 1) All vehicles (ATVs and snowmobiles) leave some impression on a groomed snowmobile trail surface since the very top layer of the compacted snow surface is typically less dense than an ATV’s tires or a snowmobile’s track and ski skags. 2) Overall, when operated on the generally well compacted trails and under the conditions where these tests were conducted (at or below freezing), there were no substantive differences observed between the impressions left by ATVs or snowmobiles operated on groomed snowmobile trails. This was particularly true on flat, straight sections of trail, such as what is typical of railroad grade trails. As curves and/or grades were evaluated, the depth of impressions left on the trails by ATVs increased slightly more than what the depth of impressions from snowmobiles did, particularly as the grades increased. Consequently, as grades on a trail increase it is likely that the suitability for concurrent ATV operation will most likely decrease. Likewise, as either the level of trail compaction decreases or sustained air temperatures increase substantially above the freezing point, the compatibility of concurrent ATV use will most likely decrease. 3) As new, uncompacted snow was introduced on top of the compacted trail base, either from fresh snowfall or from wind drifting, ATV tires tended to penetrate and compress the new snow versus having any degree of flotation on top of the snow like what a snowmobile has. This is likely a limiting factor if new snowfall is not regularly compacted on concurrent use trails.

ATV Operational Characteristics: 1) ATVs generally stopped quicker and in a shorter distance than what snowmobiles did on the snowmobile trails. The only exception was a snowmobile equipped with picks in its track. 2) Whenever the tires of an ATV got off a well compacted base, whether entirely off the trail or at the edge of some trails where the compaction at the outside edge was significantly less than in the middle of the trail, the vehicle typically became stuck. A partial solution may be restricting ATVs to designated routes and trails in concurrent use areas. 3) ATVs had a difficult time negotiating sections of trail with deep and heavy moguling since the vehicles’ shorter length caused them to bob up and down when traversing the moguls. This stresses the importance of regular trail grooming (or low snowfall conditions when moguls can’t get very deep) to help keep concurrent use trails fairly smooth as well as compacted. 4) New, uncompacted snow on top of compacted trails changed the operational characteristics of ATVs considerably, particularly 2-wheel drive models. As uncompacted snow depth on the trails increased, the vehicles became more “squirrelly” to operate and harder to control. As snow depth began to exceed the vehicles’ clearance, the likelihood of their becoming stuck quickly increased. This again stresses the importance of trail grooming and compaction for successful concurrent ATV use. 5) There was a noticeable difference between the handling of 2-wheel drive versus 4-wheel drive ATVs on both compacted and uncompacted snow. The additional “pulling” assistance from the front tires on 4-wheel drive units provided a feeling of being better in control of the vehicle, particularly as operating speeds increased, as compared to the tendency on the 2-wheel drive units to feel like the front end was constantly “skating.” Perhaps concurrent use areas should consider allowing winter use by only 4-wheel/All-Wheel Drive units.

A summary of more specific observations is as follows:

Observations from ‘Slow’ Vehicle Operation

There were no observed adverse impacts from either ATVs or snowmobiles operated at ‘slow/normal’ speeds of 15 mph/24 kph or less. The deepest impressions on the groomed trail surface from both ATV and snowmobile operations at slow speeds were 3 centimeters/1.2 inches deep, consistent with what would generally be considered normal “surface chew” from wheeled or tracked vehicle operation on a compacted snow surface. Comparatively, the deepest impressions on the trail from footprints were 5 centimeters/2.0 inches deep.

Observations from ‘Aggressive’ Vehicle Operation

Aggressive Starts: the worst-case observation was that “aggressive starts” by ATVs created tire impressions that were only a bit deeper (2 centimeters/0.8 inch) than the deepest snowmobile track impressions. The deepest impressions from ATVs during aggressive starts ranged from 2 to 12 centimeters/0.8 to 4.7 inches in depth, while the deepest snowmobile track impressions ranged from 2 to 10 centimeters/0.8 to 3.9 inches in depth.

Fast (35 mph/56 kph) Pass-Bys: there were no observed adverse impacts such as rutting or trenching of the trail surface from either ATVs or snowmobiles. Tire and track impressions on the groomed trail surface were generally what is considered normal “surface chew.” The worst-case observation was that ATVs created tire impressions that were just a bit deeper (1 centimeters/0.4 inch) than the deepest snowmobile track impression. The deepest impressions from ATVs during fast pass-bys ranged from 1.5 to 5 centimeters/0.6 to 2 inches, while the deepest snowmobile track impressions ranged from 1 to 4 centimeters/0.4 to 1.6 inches. Comparatively, footprints on the same trail surfaces ranged from 2 to 5 centimeters/0.8 to 2 inches in depth.

Aggressive Stops: the worst-case observation was that ATVs created tire impressions that were slightly deeper (7 centimeters/2.8 inches) than the deepest snowmobile track impressions. The deepest impressions from ATVs during aggressive starts ranged from 2.5 to 13 centimeters/1 to 5.1 inches in depth, while the deepest snowmobile track impressions ranged from 2 to 6 centimeters/0.8 to 2.4 inches in depth. This is the only area where there was a small yet noticeable difference between ATV and snowmobile impressions while operated on the fast/aggressive track.

Observations from Vehicle Operation on Curves

Curve Pass-Bys: the worst-case observation was that ATVs created tire impressions that were slightly deeper (5 centimeters/2 inches) than the deepest snowmobile track impressions. The deepest impressions from ATVs during curve pass-bys ranged from 7 to 14 centimeters/2.8 to 5.5 inches in depth, while the deepest snowmobile track impressions ranged from 4 to 9 centimeters/1.6 to 3.5 inches in depth. Overall, the ATVs’ tires tended to push a more pronounced berm of snow up on the outside edge of the trail as the vehicle negotiated curves, as compared to the snowmobiles’ track which tended to slide or “plane on top” more around the curves.

Observations from Vehicle Operation on Hills

Hill Pass-Bys: the worst-case observation was that ATVs created tire impressions that were slightly deeper (7 centimeters/2.8 inches) than the deepest snowmobile track impressions and, in general, struggled on the steepest grades. The deepest impressions from ATVs during uphill pass-bys were 12 centimeters/4.7 inches in depth, while the deepest snowmobile track impressions ranged from 2 to 5 centimeters/0.8 to 2 inches in depth. Downhill pass-bys resulted in tire and track impressions that were primarily “surface chew” consistent with results from fast pass-bys. At higher speeds, the ATVs were often viewed by the test drivers as “squirrelly” and hard to control. Of note, snowmobile pass-bys on the hills typically redistributed snow on the trail surface and, in essence, re-leveled tire impressions or ruts left by prior ATV pass-bys.

Comparison of Stopping Distances at 35 mph/56 kph

The overall average stopping distance of all ATVs was shorter than all snowmobiles except the Arctic Cat F7 which had 153 1-½ inch picks in its track. The maximum average stopping distance for ATVs ranged from 13.7 meters/45.1 feet to 27.7 meters/90.7 feet, while the maximum average snowmobile stopping distance ranged from 17.3 meters/56.8 feet to 27.4 meters/89.9 feet. The overall average snowmobile stopping distance was 28.8% greater than the overall average ATV stopping distance. The average stopping distance for ATVs on snow was also typically less than when they were tested on grass, dirt, and gravel trail surfaces.

ATV Operation on New, Ungroomed Snowfall and in Drifted Snow

The ATVs’ tires typically compressed new snow to a depth of 1 to 3 centimeters/0.4 to 1.2 inches, which means they had little flotation as compared to a snowmobile. The 4-wheel drive model with higher clearance negotiated new snow on top of the compacted trail surface relatively well, while the 2-wheel drive model with lower clearance struggled with operation in uncompacted snow, particularly as snow depth increased. Because of this compression versus flotation factor, the depth of new snowfall, particularly as it increases above the clearance of an ATV and irrespective of 2-wheel versus 4-wheel drive, is and important and a potentially limiting factor for winter ATV operation.

“New” snowfall can also be the result of new snow deposited on the trail by wind drifting. The ATVs typically became stuck whenever they encountered long stretches of fresh, deep drifted snow on the trail. This is an important factor since wind drifting can change the characteristics of the trail surface from compacted to uncompacted over a relatively short period of time. This highlights the importance of regular and frequent trail grooming to keep the trail base compacted if winter ATV use on snowmobile trails is allowed.

ATVs Became Stuck When Off-Trail or On the Outside Edge of the Groomed Trail
The ATVs nearly always became stuck whenever they got off the compacted trail base. This was almost predictable whenever, on purpose, the operator attempted to turn around by driving into uncompacted snow off the trail rather than doing a 3-point turn or spin-around on the compacted trail base. But unpredictably, the ATVs also became stuck numerous times as they were going down the trail and their outside tires were sucked into softer snow at the edge of the trail or off the side of the trail. Sometimes this occurred when the operator pulled to the side of the trail when meeting traffic or to let another vehicle pass when going down the trail between test sites. At other times it occurred when the groomer marks gave the appearance of a wide, compacted trail, when in fact the last grooming repetition had widened the trail and meant the far outside edges of the trail were only slightly compacted.

Wind drifting that obliterated a clear definition of the groomed trail surface also contributed to this situation. The worst occurrence resulted in an ATV flipping end-over-end when its outside front tire was sucked into soft snow off the compacted trail base on a wind swept curve. These instances highlight the fact that appearances can be deceiving – that groomer marks don’t necessarily mean the trails are compacted well enough to support ATV traffic, and that wind blown snow will not necessarily support ATV traffic. This stresses the point that it is critical for ATVs to stay on the compacted trail base and that trails must be regularly and consistently groomed at the same width to keep them compacted if the goal is to manage any trail for concurrent ATV use.

In some instances, this may lead to ATV riders crowding the middle of the trail if they are uncomfortable with potentially soft snow at the outside edge of the trail. This may be a concern in some areas, particularly those with narrow winding and hilly trails, although it is not an issue particularly unique to ATV riders since snowmobilers also often crowd the middle of the trail in similar circumstances.

Snowmobile Ski Skag Grooves on the Trail
Snowmobile ski skags (carbides or other runners on the bottom side of the skis) left grooves in the trail that were consistently present and varied from 2.5 to 6 centimeters (1 to 2.4 inches) in width and 1 to 4 centimeters (0.4 to 1.6 inches) deep. It is common when riding a snowmobile to have ski skag grooves on the trail from previous snowmobile traffic sometimes “hook” or grab the snowmobile’s ski and cause a sudden and unexpected pull to the right or left as the sled’s ski is pulled into and often trapped in the pre-existing skag groove.

Some have expressed a concern that impressions left on a snowmobile trail from ATV tires could cause a similar hooking or trapping of a snowmobile’s ski. That was not the observation during this field testing. Tire impressions are typically 20 to 30 centimeters (7.9 to 11.8 inches) wide and therefore substantially wider than the ski skag grooves, so there was no similar “trapping” of the ski within the tire impression observed. While there could certainly be a ridge in the trail due to a tire impression, the wider width of the depression allows some movement of the ski within the depression, to allow changing the angle of the ski while turning, versus when a ski is trapped in a skag groove which often requires a strong steering effort to power the ski loose from the skag groove. One must also keep in mind that, if there are tire impressions on the trail deep enough to cause steering problems, then most likely there are also going to be similar impressions from snowmobile tracks. Either way, there is room to begin maneuvering a snowmobile’s skis within tire or track impressions.

ATV Operation on Heavily Moguled Trails
ATVs had a difficult time negotiating and maintaining much speed on sections of trail with deep and heavy moguls. Their shorter length caused them to bob up and down when traversing the moguls much more than the snowmobiles did when traversing the same moguls. Consequently, snowmobiles were able to stay more under control and also operate at much higher speeds across rough, heavily moguled trails.

These Results as Compared to the 1984 Idaho Study
The only other formal field evaluation of ATV use on groomed snowmobile trails that has ever been done was conducted in 1984 by the Idaho Department of Parks and Recreation. That study looked at snowmobile and ATV operation in an area north of Boise, Idaho from February 7 through March 4, 1984 and concluded that, "It is very evident that most of the impacts created by ATVs on groomed snowmobile trails are similar to the impacts created by snowmobiles under the same conditions, and it would be hard to say objectively that ATVs and snowmobiles have a significant difference in the impacts they create on a groomed snowmobile trail."

Even though ATVs and snowmobiles have both changed substantively since 1984, the results of this study would generally concur with the 1984 conclusion – the impacts created by ATVs and snowmobiles operated on groomed snowmobile trails under the same conditions are very similar.

CHAPTER ONE: SUGGESTED MANAGEMENT PRACTICES AND DECISION FACTORS

The intent of this publication is not to influence local jurisdictions to either encourage or discourage concurrent ATV use, but rather to provide them with better information to help them make objective local decisions. The bottom line is that both ATV and snowmobile use should be actively managed (versus just letting it occur without any level of management) to have successful recreation experiences that are also sustainable over the long term. In that vein, this chapter provides examples of laws and regulations that both allow and prohibit concurrent use, suggested management practices to help minimize or mitigate potential conditions that could affect trail user safety or the quality of groomed snow trails if local jurisdictions decide to allow concurrent use, and suggested management practices to help minimize or mitigate impacts from unauthorized off-season ATV use on snowmobile trail routes. The key is that ATV use, year-round, requires active management and it must be planned for in the local decision-making process.

'TWELVE FACTORS TO CONSIDER' REGARDING ATV MANAGEMENT AND CONCURRENT WINTER USE

There are several factors and management practices that local jurisdictions should consider before making a decision to either allow or disallow concurrent ATV use on groomed snowmobile trails. While the importance of each factor may vary by locale, the following issues (but not necessarily limited to this list) should be considered for informed and objective decision making. Based upon information gathered from the Trail Manager Survey, learned from field testing, and gleaned from various other sources through this project, it is suggested that decision makers and trail managers consider the following factors:

1. Funding – First and foremost, it is essential that funding from ATV riders accompany any decision to allow concurrent ATV use on groomed snowmobile trails. Winter trail grooming is expensive and any increase in use will also necessitate more trail grooming – and not because ATVs cause more damage but because traffic by all vehicles wears snow out. Snow trails must be regularly groomed to be "restored" to a condition where they are safe and pleasurable to ride. Since snowmobile trails are funded solely by the registration fees, user fees, and/or gas taxes that snowmobilers pay, ATV riders must also contribute their fair share toward on-going trail maintenance costs. Additionally, many snowmobile trails were developed by volunteers or are operated by a volunteer organization which further necessitates sensitivity to their ownership in "their" trails. There is no such thing as a free lunch in the world of snowmobile trails – so all users need to pay to help support the cost of winter trail management.

2. Shoulder Season Regulation and Management – It is important that the trail have a firmly compacted snow base for concurrent use to be successful. Therefore, it is important that regulation of the "shoulder season" (the beginning and end of the snowmobile trail grooming season when temperatures are likely to occasionally or regularly be above freezing) be considered based upon local factors and conditions and that ATV use on the trail corridor be managed accordingly.

First and foremost, the trail base must properly harden before it will withstand wheeled traffic from ATVs. This requires "setup" time so the groomed snow has time to re-freeze and harden properly. Since ATVs typically have a higher pounds per square inch (psi) of pressure in contact with the trail (the weight of the vehicle and rider is spread over just the surface area of the tires that are in contact with the trail surface) than the psi exerted upon the trail by a snowmobile (the weight of the vehicle and rider is spread over the surface area of the track and skis that are in contact with the trail surface), the snow surface must be harder than what is required for snowmobile-only use. This makes proper setup at the start of the season critical to prevent on-going issues with rutted trails as the season progresses.

Second, many areas go from snow season to “mud season” immediately after the snowmobile season. In such cases, continued ATV use can potentially cause damage to the resource and to the underlying trail base. Consideration should be given to a “drying out period” before ATV use is allowed to continue (if the route is open to summer ATV use).

The Trail Manager Survey found that some counties in Wisconsin provide one example as to how shoulder seasons can potentially be managed. They stipulate that concurrent ATV use may not start on the snow trail until a week to ten days *after* the first day the snowmobile trail is groomed. This allows a chance for the trail to build base in terms of snow depth and, most importantly, an opportunity for the trail base to setup and harden properly. Additionally, some trails close to wheeled vehicle use when the air temperature is above a set threshold (28 to 32 degrees F for example). Likewise, several areas also stipulate that ATV use must end on the snow trail when the “snowmobile season” ends, or that the trail closes to all use on a specific date such as March 31 or April 1. The trail may or may not open again after the “mud season” to ATVs, dependant upon what summer uses are allowed on that specific trail corridor. If the snow trail route is very rocky or has been hardened with a gravel or similar surface, this may not be an issue. But if the route is subject to being soft and muddy, this may be an important consideration.

3. Liability Insurance – Risk management is a critical part of managing any recreational activity. Trail providers must ensure that their liability insurance will cover concurrent ATV use on their trail system. If the ultimate liability rests with a government entity, this may or may not be an issue. But if the responsible entity is ultimately a snowmobile club or an association, their insurance most likely may not provide coverage for any trail use other than snowmobiles. This issue should be carefully researched for clear answers prior to any decision that will change the status quo.

4. Landowner Permission – Landowners must be involved in any decision to allow concurrent use. If the trail crosses private property, this is critical since non-winter use of the surrounding lands, particularly if it is in an agricultural area, may not allow use of the route as a summer trail corridor. If the route has been for “winter-only” snowmobile use, then trail managers must ensure they take steps to ensure non-winter recreation use does not occur on the corridor outside of their permission for the snowmobile season. Otherwise they risk losing the route for their snowmobile trail route.

There may also be potential for conflict on public lands. If the snowmobile trail route is also a motorized road or trail during the non-winter season, this may be easy and winter concurrent ATV use may simply round out a year-round multiple use trail plan. But if the winter route is designated as a nonmotorized trail in the summer, there will likely be issues to address as to how that nonmotorized designation is protected in the non-winter season. Likewise, if the snowmobile trail follows a cross-country route not open to motorized travel during the summer, there most likely will be issues that must be considered and addressed. The bottom line is that, if winter concurrent ATV use is added on a route not open to motorized use in the non-winter season, trail providers must proactively work to ensure off-season trespass or conflicts do not result in the loss of winter trail routes for the snowmobile trail. While this can be accomplished with on-the-ground education and enforcement, it cannot be done without conscious and concerted efforts.

5. Geography of the Trail System – The geographic characteristics of the trail system can be an important indicator as to the suitability of concurrent use for that particular area. Field testing showed very little substantive difference between the impressions left on the trail by ATVs and snowmobiles when the trail was straight and relatively flat. Therefore trail corridors such as abandoned railroad grades are generally good candidates for concurrent use trails since they are typically straight, relatively wide, and normally have a grade that does not exceed 3%. Other non-railroad grade trail corridors with similar characteristics could also be candidates for concurrent use consideration.

Field testing also showed that as curves, and particularly hills, are added to the topography, tire impressions from ATVs started to get a bit deeper than the impressions left by snowmobiles on the groomed trail surface. While curves do not necessarily rule out a trail’s candidacy for concurrent use, their presence should be a signal to trail managers that more grooming will be necessary if there is heavy use on the trail. But this is also true on snowmobile-only trails – the presence of lots of curves necessitates more grooming than if the trail is straight.

Hills and steep grades can definitely be a limiting factor in the viability of concurrent use by ATVs, particularly if the trail is not firmly compacted or if there is much new, uncompacted snow on top of the compacted trail base. Field testing showed that ATVs clearly struggled on a compacted trail with a 19% grade, as well as on a grade of only 8% that was covered by fresh snowdrifts. This would suggest that close consideration should be given to the suitability of encouraging winter ATV operation as trail grades begin to exceed 15% to 20% on compacted trails. And if the area has frequent heavy snowfalls or drifting, the maximum desirable grade may be as low as 8% to 10%.

6. Trail Compaction and Grooming – A well compacted trail base is the key to trail durability and the most essential ingredient for successful concurrent use. This means the area needs a good trail grooming program that provides regular grooming commensurate with both the overall volume of traffic on the trail and the amount and frequency of new snowfall in the area. Heavy traffic and/or frequent big snowfalls will require a very frequent and aggressive grooming schedule. Without good and consistent trail compaction, concurrent use will likely not be successful.

The type of grooming equipment in the area may also play a role in the viability of concurrent use. Field testing showed that the trails groomed with multi-blade drags were generally very well compacted and held up well to traffic from both ATVs and snowmobiles. Conversely, the one area (Wyoming 2) tested that had been groomed with a single blade drag, and very infrequently, had poor compaction and did not hold up well to ATV traffic. While this may or may not be an isolated case, it is nonetheless an indicator that should be considered. Additionally, the trail base in the area (Idaho 1) that had been groomed with a tiller the morning of the test was also generally less dense than the trails groomed with multi-blade drags. While this trail base held up okay during the field testing, it was noticeably softer. And while this tilled trail likely could have been firmer with more setup time, this is potentially something that should be considered.

It is important to know beforehand if an area's trails are well compacted, which requires monitoring them to gauge their actual level of compaction. A simple way to do this is to periodically dig a snow pit in the middle of the trail and look closely at the layers of snow from the top of the trail surface down to either the ground or the ice layer that sometimes forms. A drain spade can be used to easily dig a 5 to 6 inch (12 to 15 centimeters) diameter hole. Once the hole has been cleaned out with your gloved hand, press your bare fingers against the sidewall and rub them up and down a few times. If the sidewall remains intact, or better yet gets a bit glazed or icy, it's an indicator that the trail's compaction is good. But if the sidewall hollows out or crumbles away even slightly, it's an indicator that the trail's compaction is likely not good. If this is the case, irrespective of the concurrent use question, trail grooming techniques, equipment, and frequency should be reevaluated. Always refill the hole with the snow that was removed and compress it with your foot so as to not create a safety hazard in the middle of the trail. While this technique is not overly scientific, it is a very simple yet telling exercise that can help trail managers better understand the compaction of their trails.

7. Snow Characteristics – The characteristics of snowfall in the local area can be important factors to consider and can include the typical moisture content, general snow depths, and the frequency of new snowfall. However, to a great extent, all of these factors can be managed or mitigated by good grooming programs that, in particular, regularly target grooming after fresh snowfalls since the key to concurrent ATV use is maintaining a firmly compacted trail base.

The depth of uncompacted snow along the edge of the trail can become an issue for safe ATV operation. There were numerous incidents during field testing where just one tire of the ATV dropping off the outside edge of the compacted trail caused the ATV to get stuck or even flip over. Therefore, it is critical that the area's grooming efforts routinely compact the trail to its full intended width to prevent "soft spots" from forming along the outside edge of the trail.

The depth of uncompacted snow, from freshly fallen snow or new snow deposited by wind drifting, on top of the compacted trail can also be a limiting issue for ATV operation. While snowmobiles generally “float” on top or toward the top of uncompacted snow, ATVs do not. Field testing showed that their tires generally compressed new snow to a depth of 1 to 3 centimeters (0.4 to 1.2 inches), an indication that they have virtually no flotation. Additionally, since an ATV’s clearance is typically only about 18 to 25 centimeters (7 to 10 inches), the vehicles struggle to negotiate deep snowfall. Therefore it is critical that concurrent use trails be regularly groomed soon after new snowfalls to restore a compacted surface on the trail.

8. Local Weather Patterns – Frequent warm temperatures, frequent winds, and/or winter rainfall can all affect the condition of groomed trails and are factors that should be considered. Warm temperatures are a possibility early and late in the season most anywhere, as well as in the middle of the season in some areas, so this is not an ‘absolute’ factor since a few days of warm temperatures can rarely be avoided entirely during the span of a winter season. Field testing showed there were no substantive impacts to trails from either ATV or snowmobile operation at air temperatures up to 32 degrees F/0 degrees C, the highest temperature recorded during field testing. While some counties in Wisconsin prohibit ATV operation on the trails when the temperature on the trail “at a point four feet above the trail surface is 28 degrees Fahrenheit (-2.2 C) or higher,” this threshold may be lower than what is necessary, as well as hard to enforce. “Four feet above the trail” is also likely not the best location to assess temperature as a factor that may influence trail conditions. Instead, it is more likely that the temperature *of the snow at the trail’s surface* is the best indicator. Most likely it will require *sustained* air temperatures above freezing (32 F/0 C), and perhaps as high as 40 degrees Fahrenheit (+4.4 C), before the trail’s surface temperature causes the trail’s surface to begin to soften. This can also be further influenced by the aspect of the trail, i.e. whether the trail (or a part of the trail) is located in the shade or in the sun.

As mentioned in Snow Characteristics, frequent high winds can create a challenge to keeping a groomed surface consistently compacted. If it is a low snowfall area with frequent winds, this will be less of a factor than if it is a high snowfall area with lots of wind. Frequent warm winds can also accelerate softening of the trail’s surface compaction.

Rainfall during the winter season can be a destroyer of any groomed trail surface. While any area can have a rain event during the heart of the winter (that is not necessarily catastrophic as long as the temperatures cool down again fairly quickly), areas with frequent winter rain events will typically have softer trails and may not be good candidates for concurrent use.

9. Potential Use Patterns – Use patterns and the potential mixture and volume of uses on the trail are important factors to consider. The Trail Manager Survey showed that existing ATV use on concurrent use trail systems is what would be considered as “very light,” varying from 1-2% up to 5-10% with isolated cases in low snow areas of up to 30-35% of total winter use. Additionally, many trail managers commented that most ATV use is “local,” meaning riders typically venture only a few miles from parking areas and/or communities as contrasted with snowmobilers who routinely venture long distances in a day of riding while trail touring.

One reason for this difference in use (typically local ATV riding versus more long distances via snowmobile) is that riding an ATV during winter conditions can be very cold when compared to a snowmobile, as was experienced during field testing. Whereas a snowmobile has hand warmers, a windshield, and a cowling that directs some heat back toward the driver, a stock ATV typically offers nothing in regards to similar protection for the operator from the winter elements. While hand warmers and a windshield can be easily added to an ATV, the issue of no protection and heat from a cowling remains. Additionally, safe “touring speeds” on an ATV operating on a groomed snowmobile trail surface were judged during field testing to typically be at least 10 to 20 miles per hour (16 to 32 kph) lower than when on a snowmobile.

The volume of winter ATV use will potentially be higher in low to marginal snow areas, in low snowfall years, and during periods of warmer (not frigid) temperatures. The ability to operate an ATV during low or marginal snow conditions is one factor that is driving some snowmobilers to switch to an ATV in addition to, or instead of, their historic use of a snowmobile for recreation. This familiarity with the snowmobile trail systems can however be a double-edged sword: it is good in respect to the fact these users are accustomed to paying fees and volunteering to support their trails, but can be bad since oftentimes they do not understand that these snowmobile trails may not be open to ATV use, winter or summer. This cross-over segment of ATV riders is important to the future of continued trail access and should not be discounted nor summarily dismissed as unimportant, or worse, a nuisance.

The volume of use, by snowmobilers and/or ATV riders, will drive the needs of the local grooming program. One observation from the field testing was that, when snowmobile use was equal to or greater than ATV use on the trail, snowmobile traffic actually helped to re-level impressions left on the trail by ATV tires. But cumulative effects from single or multiple uses from numerous vehicles are always a factor that must be considered since any groomed snow surface can be eventually worn out from too much traffic between grooming repetitions, irrespective as to whether the vehicles are snowmobiles or ATVs. This observation would tend to also suggest that single-use by ATVs on a groomed winter trail would likely be less desirable and have greater cumulative impacts on the trail surface than what single-use snowmobile traffic has.

One additional observation from field testing was that ATVs had a difficult time staying under control or operating at much speed on heavily (deep) moguled trails since the shorter vehicle length of an ATV doesn't allow it to get into a rhythm to easily traverse moguls. Comparatively, the longer length and the suspension of a snowmobile allows it to span some moguls and traverse rough trails much easier, smoother, and faster than the up-and-down "bobbing" motion experienced when ATVs negotiate deep moguls.

10. 2WD versus 4WD ATVs – While the Trail Manager Survey did not identify areas that currently regulate winter season ATV use based upon whether the units are 2-wheel drive (2WD) versus 4-wheel drive or all-wheel drive (4WD), it may be a factor to consider. Field testing showed there was a noticeable difference in the handling of 2WD ATVs as compared to 4WD units, particularly when there was fresh uncompacted snow on the trail. The 2WD units were often described as "squirrelly" and hard to control in these conditions since the front tires were being "pushed" through the new snow versus the noticeable "pulling" assistance from the front tires when operating units in all-wheel drive. This difference in operational characteristics could be more of a factor in areas that receive frequent, deep snowfalls or in areas where there may be a considerable amount of time between grooming repetitions than it may be in low snowfall areas or areas with aggressive grooming schedules.

11. Off-Season Trail Maintenance – A groomed snowmobile trail can only be as good as the quality of the trail base beneath the compacted snow layer. Ideally, the trail base beneath the snow should be even like a smooth road surface and free of ruts, holes, and depressions. If the sub-base has tire ruts and holes, trail grooming will produce pockets where the snow compaction is less dense in the ruts than it is on the smoother surface above/beside the ruts. Even as more snow accumulates and is groomed on the trail over the winter season, the "memory" of this less densely compacted area remains in the snow trail throughout the season. This means that off-season maintenance and trail grading to restore evenness to the trail surface, along with water drainage control, are crucial to having an evenly compacted trail that will withstand snowmobile and/or ATV traffic.

Oftentimes the ground on and along snowmobile trails become rutted from spring, summer, and fall wheeled vehicle traffic, particularly during hunting seasons which are typically just prior to the beginning of snowmobiling season. While this timing often makes late-fall repair difficult, it is important that an effort is made to restore an even subsurface for the snowmobile trail if the goal is to have smooth snow trails. Therefore, a good year-round trail maintenance program is an important part of having successful concurrent use in an area.

12. Potential for Partnerships – The potential for partnerships that may help further the objectives of snowmobile, ATV, and/or multiple use trail management in the area should be considered as an important factor when weighing the pros and cons of concurrent use. Where common ground can be found, coalitions working together to protect and enhance motorized recreation can help strengthen and improve opportunities for both snowmobiles and ATVs. While concurrent use is not appropriate for every local condition and situation, there are at the same time likely many appropriate opportunities that could successfully be implemented at the local level.

Beyond the local level, in respect to considering the "big picture," there are many good reasons to objectively consider partnerships between snowmobile and ATV users. One must keep in mind that there are over 8 million ATVs in the United States alone (and the number continues to grow exponentially in both the U.S. and Canada), while at the same time there are only 1.75 million registered snowmobiles in the United States, 605,000 in Canada, and only a total of 2.6 million worldwide (and snowmobile numbers continue to decline). The potential clout of both user groups working together is immense. And in the U.S., those 8 million ATVs are scattered across all 50 states while snowmobiling states cover only half of the nation.

At the national level, despite the fact that, year-round, ATVs typically have more resource management issues than what snowmobiles do, there is potentially more for snowmobilers to gain than there is for them to lose if they look for ways to work together. But success starts at the grassroots level, so the future is dependant upon local users and trail managers pursuing a fresh and objective look at the potential for new and creative partnerships in their areas. "Divide and Conquer" is a common tactic used by groups who often oppose motorized recreation, so the old adage "United we stand, divided we fall." is extremely relevant for the future of motorized recreation access. Getting both groups working together through successful partnerships can make a positive difference for the future of motorized access for trails and riding opportunities.

MANAGEMENT PRACTICE EXAMPLES

Examples of Laws/Regulations that Prohibit Concurrent ATV Use
The following represent examples of language used by jurisdictions to prohibit ATV use on groomed snowmobile trails:

- **Illinois**: "It shall be unlawful for any person to operate any motor driven bicycle, mini-bike, motorcycle or off-road vehicle unless it is on a roadway designated for vehicular use or on a designated area established by the Department for off-road vehicular use…" [17 Illinois Administrative Code, Chapter 1, Section 110.160 (a) (2)]
- **Indiana**: Rule 1 – Snowmobile Trails: "Use of wheeled vehicles prohibited." [312 IAC 7-1-3]
- **Massachusetts** forests and parks: "Riding Season – ORV use is permitted only during the riding season (as conditions allow) beginning no earlier than May 1 and ending no later than the last Sunday in November each year." [304 CMR 12.29(4)(c)]
- **New Brunswick**: "You can not operate any motor vehicle other than a snowmobile on the managed snowmobile trail from December 1 to April 15 inclusive." [Off-Road Vehicle Act, Section 7.1 (3)]
- **North Dakota**: State Park roads, trails & vehicle use. "Unless specifically designated, all-terrain vehicles are not permitted within state parks or on state snowmobile trails." [North Dakota Code 58-02-08-07 (5)]
- **South Dakota** – combination of three statutes: (1) Definition of snowmobile: "Any engine-driven vehicle of a type which uses sled type runners, wheels, or skis with an endless belt tread or similar means of contact with the surface upon which it is operated [SDCL 32-20A-1 (8)]; (2) Operation on state snowmobile trail or area: "No person may operate a snowmobile on a state snowmobile trail or area established pursuant to the provisions of chapter 41-19 unless the snowmobile has a curb weight of less than fourteen hundred pounds, is driven by track in contact with the snow, and is steered by ski in contact with the snow. [SDCL 32-20A-24]; and (3) Use of trails and areas restricted to licensed snowmobiles: "The use of state snowmobile trails and areas acquired, leased, developed, or improved by the department under the provisions of this chapter by any person operating any snowmobile other than a licensed snowmobile as defined by § 32-20A-1, is a Class 2 misdemeanor." [SDCL 41-19-4]
- **U.S. Forest Service**: ATV use on Forest Service lands is typically guided by local Forest Management Plans and Forest Travel Management Plans. There are examples of both allowing and not allowing concurrent winter ATV use on groomed snowmobile trails on Forest Service lands across the United States. It is ultimately a local decision based upon a public planning process tiered to one of these types of management plans, which can result in some areas of a forest being open while other areas of the same

forest unit may not be open. While these management plans typically closely mirror applicable state and county regulations, they may also prescribe different management prescriptions at local levels. If snowmobile trails are closed to ATV use on a national forest, it is typically done with language in a "Forest Supervisor's Order." The following is language typical of an Order that governs Winter Travel Restrictions – "Pursuant to 36 CFR 261.50(a) and (b), and to protect natural resources and public safety, the following acts are prohibited… (1) When there is snow on the ground, using any rubber-tired vehicle on a National Forest System road that has been designated as a marked or groomed snowmobile route on the attached map. [36 CFR 261.54(a)] and (2) When there is snow on the ground, using any rubber-tired vehicle on a National Forest System trail that has been designated as a marked or groomed snowmobile route on the attached map." [36 CFR 261.55(b)]

Examples of Shared Operation Agreements
Some areas in Canada have addressed concurrent ATV/snowmobile use management through a "Shared Operation Agreement" signed by both the provincial snowmobile federation/association and the provincial ATV federation/association. Since all Crown lands are technically open for multiple uses, this provides somewhat of a 'gentlemen's agreement' approach to segmenting use. Primary elements contained in two examples include:

- **New Brunswick**: The two federations agree that snowmobiles and ATVs must not use the same trails, with the exception that under certain circumstances it may be necessary to permit joint use of certain limited sections of trail – but with the caveat that any joint use is subject to the approval of the landowner. Joint use must be approved in advance by a Joint Trails Committee (JTC) that has three representatives from each association. Exceptions that can be considered for joint use include: 1) road crossings (must not exceed 200 meters/0.12 mile without consent of the JTC), 2) bridge crossings (must not exceed 200 meters/0.12 mile without consent of the JTC), 3) railway crossings (must not exceed 200 meters/0.12 mile without consent of the JTC), and 4) access to services (must not exceed 500 meters/0.31 mile without consent of the JTC). Emergency use by both parties is also authorized. Adequate signage, approved by the JTC and installed by the party requesting joint use, must be installed prior to joint use of the trail. Additionally, the snowmobile federation's trails on Crown lands can generally be used by the ATV federation between April 15 and November 15. [1999 Agreement between the New Brunswick Federation of Snowmobile Clubs and the New Brunswick All-Terrain Vehicle Federation]
- **Nova Scotia**: The two associations agree that, under certain circumstances, it may be advantageous to permit shared operation of trails or certain sections of trails. The agreement states that, once the ATV and snowmobile club have agreed to work together in principle, three criteria shall be met and documented: 1) the landowner must give approval by signing a Shared Operation Land Use Agreement, 2) the ATV and snowmobile club must enter into a Shared Operation Trail Management Agreement, and 3) approval must be given by the provincial Shared Operation Trail Committee (3 representatives from each association). The two associations "recognize that simultaneous 'Trail Use' by ATVs and snowmobiles pose risks for both trail users and operators." Consequently, ATVs are permitted to use Shared Operation Trails from April 1 to November 30 and snowmobiles are permitted to use them from December 1 to March 31. [2005 Agreement between the Snowmobilers Association of Nova Scotia and the All-Terrain Vehicle Association of Nova Scotia]

Examples of Laws/Regulations/Policies that Allow Concurrent ATV Use
The most common method by which concurrent ATV use on groomed snowmobile trails is allowed is simply that there is "no formal action to prohibit" concurrent ATV use (60.9% of all jurisdictions).

Jurisdictions that specifically allow some level of concurrent ATV use on groomed snowmobile trails typically do it by "designating" and/or "posting" trails open for use. Examples of language typically used include:

- **Maine**: "Permission Required: a person may not operate an ATV on the land of another without the permission of the landowner or lessee. Permission is presumed on ATV trails that are conspicuously posted or in areas open to ATVs by landowner policy." [Maine Title 12, Chapter 939 ATVs – 13157] and "Unlawfully operating vehicle on snowmobile trail: a person may not operate any 4-wheel-drive vehicle, dune buggy, all-terrain vehicle, motorcycle or any other motor vehicle, other than a snowmobile and appurtenant equipment, on snowmobile trails that are financed in whole or in part with funds from the Snowmobile Trail Fund, unless that use has been authorized by the landowner or the landowner's agent, or unless the use is necessitated by an emergency involving safety of persons or property." [Maine Title 12, Chapter 937 Snowmobiles – 13107]

- **Minnesota**: While most OHV trails are typically open only from April 1 to November 30 (or shorter in some areas), two sections of railroad grade trails that are also groomed snowmobile trails are open to ATV use year-round: the Gandy-Dancer Trail which connects with Wisconsin trail systems and the portion of the Soo Line South Trail that is located in Carlton County.
- **Pennsylvania**: "All-terrain vehicles may be operated only on designated and posted roads, trails and other areas." and "All-terrain vehicles may be operated on State Forest land from the Friday before Memorial Day through the last full weekend in September, and from the day following the last day of the regular or extended antlerless deer season as established by the Game Commission through the following April 1." [Title 17. Pennsylvania Code, Part 1. Department of Conservation and Natural Resources, Subpart C: State Forests – 21.23a (b) and (c)]
- **Wisconsin**: Concurrent use of snowmobile trails, typically regulated by counties on a willing landowner basis, has a long history that dates back to the 1980s. Examples of county rules and policies include:
    - <u>Barron County</u>: Full season ATV/snowmobile trails are limited to old railroad corridors. They are advertised as open year-round for both, so when there is snow both users are on them. With light snow, use is primarily by ATVs. Overall traffic is always heavy. Under normal snow conditions, use by ATVs is moderate and snowmobile use is heavy. Trail managers report that, "We do not see much difference in damage to groomed snow between ATVs and snowmobiles – the warmer the weather the more damage by both."
    - <u>Clark County</u>: When the trails are open to snowmobiles they are open to ATVs. There are no regulations that restrict ATVs that operate on snowmobile trails.
    - <u>Dodge County</u>: A 20-mile railroad grade trail is managed as a "multi-use" trail that allows ATV and snowmobile use concurrently, thus it is not really a "snowmobile trail" that allows ATVs. ATV use is permitted when ground is frozen between December 1 and March 31.
    - <u>Langlade County</u>: ATVs are allowed on 501 miles of state-funded snowmobile trails, but only after ten days from when the trails are officially opened for snowmobiling by public notice in the Antigo Daily Journal. Once trails are officially closed for snowmobiling, ATVs must keep off the trails. No person shall operate an ATV on any state-funded snowmobile trail when the temperature on the trail at a point four feet above the trail surface is 28 degrees Fahrenheit or higher. Chains and studded tires are prohibited on snowmobile trails. On county forest lands, ATVs are allowed on all forest roads and trails, including those with gates, if the gate is open for snowmobiling. No ATVs are allowed on any cross-country ski trail.
    - <u>Lincoln County</u>: Winter ATV trails may be opened for use one week after the official opening of the state-funded snowmobile trail system (selected and announced by the County Snowmobile Coordinator) and close when the temperatures on the trail at a point four feet above the trail surface is 28 degrees Fahrenheit or higher. Trails may not be opened earlier than December 1 and may not remain open later than March 31.

CONCURRENT ATV/SNOWMOBILE USE CASE STUDIES

State of Utah

There are approximately 1,200 miles of groomed snowmobile trails in the State of Utah that comprise nine different snowmobile trail systems. Concurrent ATV/snowmobile use is allowed on all groomed snowmobile trails in the state during the winter season which typically runs from December 1 through April 15. Trail managers report that "all groomed systems receive heavy snowmobile use and very light ATV use – approximately 90% snowmobile use and 10% ATV use."

The reasons stated for allowing concurrent ATV use on groomed snowmobile trails include: 1) financial – snowmobile registrations alone cannot pay for the services required during the winter season and 2) philosophical – the State of Utah manages all off-highway vehicles including ATVs, motorcycles, and snowmobiles under a very similar philosophy: make as much opportunity available as possible.

Trail managers report they receive a few complaints by snowmobilers about ATVs on the trail, but they receive many more complaints about cross-country skiers on the snowmobile trails than about ATVs. They also report that they do not experience off-season impacts from unauthorized ATV use on snowmobile trail routes, primarily because ATV use is managed year-round.

Iron River, Wisconsin

Trail grooming officials in the Iron River, Wisconsin area (Bayfield County) state that snowmobile trail conditions have generally improved on the joint use trails in their area since concurrent snowmobile/ATV was approved on some of their area's trails several years ago. They say this is primarily because the addition of ATV use brought along with it funding for year-round trail maintenance.

Prior to this joint use agreement, routes used for snowmobile trails often became severely rutted from spring, summer, and fall ATV use which contributed to poor snowmobile trails due to drainage problems and roughness of the underlying trail base. The trails are now graded during the summer and fall to keep proper trail drainage established. Some parts of the trail system have also seen major reconstruction efforts due to this additional funding partnership.

Not all snowmobile trails in the area are open to winter ATV use since landowner approval is required and not all landowners are agreeable to winter ATV use because of non-winter season ATV use concerns they have on their property.

Iron County, Wisconsin

<u>Two Recreation Groups Come Together in Northern Wisconsin</u> (From an August 24, 2006 *Ironwood Daily Globe* article) - Hurley, Wis. Two recreation groups in Iron County, Wisconsin have come together as one to promote both ATV riding and snowmobiling on the Gogebic Range. The former Iron County Snowmobile Council and Iron County ATV Association reorganized to become the Iron County Off-Road Vehicle Council. Trail issues and maintenance were catalysts for the reorganization of groups, located in northeast Wisconsin near the border with the Michigan's Upper Peninsula.

"It became very apparent over the years that the snowmobile and ATV clubs were having the same problems with trail maintenance and all trail issues," said Iron County Off-Road Vehicle Council Treasurer Don Richards. The newly organized Off-Road Vehicle Council "will bring all ATV and snowmobile clubs together with city, town, and county officials, as well as Department of Natural Resources officials. Since ATV and snowmobile enthusiasts share somewhat the same trail systems, it was a natural move to combine all of the trail users and clubs, as well as obtain input from the DNR and the Iron County departments," Richards said.

RECOMMENDATIONS FOR MANAGING OFF-SEASON ATV IMPACTS

Trail managers in over 70% of states with groomed snowmobile trails, and over 80% of the Canadian jurisdictions, indicated in the Trail Manager Survey that they experience off-season (spring, summer, fall) impacts from unauthorized ATV use on snowmobile trail routes. Their top off-season issues included the following, listed from the greatest level to least level of overall impacts:

1. Private Property Trespass – landowner permission is only for the winter season
2. Public Land Issues – agency permission is only for winter use of the trail route
3. Severe, Moderate, and/or Slight Resource Damage from ATV use of the route in the off-season
4. Social Conflicts with Heavy Nonmotorized Use of the trail route during the off-season
5. Conflicts with Exclusive Nonmotorized Use of the trail route during the off-season

One observation regarding these off-season impacts is that, generally, the states and provinces with either no formal or a relatively young ATV trail management program routinely experience many of the issues that were identified. While this does not mean the jurisdictions with active or more mature ATV management programs are exempt from these issues, they generally have fewer or a lower degree of severity than those with no ATV management in place. In many respects, this tiers to the same principles as the U.S. Forest Service's "four greatest threats" that includes *unmanaged recreation* and specifically unmanaged off-highway vehicle (OHV) recreation. There simply has to be active management of ATV activities to minimize and mitigate impacts from their use.

While the sales of ATVs continue to outpace snowmobile sales, most areas have not kept pace with a supply of ATV trails commensurate with this growth. (Example: New Hampshire provides roughly 0.12 miles of snowmobile trail for each registered snowmobile as compared to an average of 0.03 miles of Off-Highway Recreation Vehicle (OHRV) trail per registered OHRV. Source: A Plan for Developing New Hampshire's Statewide Trail System for ATV's and Trail Bikes 2004 – 2008) Consequently ATV riders, who continue to grow in numbers, seek out routes that appear to them to be open, simply because they're there. This situation is compounded by the fact that many snowmobilers are also ATV riders – so many are simply following the routes they're familiar with. If good (and legal) alternatives are not provided, ATV riders *will* continue to go to their familiar riding areas until either law enforcement catches up with them or they become educated otherwise.

Trail managers should strive to employ management practices that, to the greatest extent possible, protect resources and continued access to private and public lands and at the same time enhance riding experiences and ensure the safety of trail users.

A key to addressing this off-season issue for snowmobile trails is working to ensure ATV riders have proper alternatives since the blanket closure of areas to ATV use, which is the "management" prescribed in some areas, is not really management but rather is issue avoidance by land managers.

Recommendation: Work to promote partnerships and/or stand-alone programs that encourage or result in ATV trails as an option to illegal use of snowmobile trail routes, along with ATV trail management that addresses issues on a year-round basis.

Recommendation: Snowmobile trail maps should clearly state that "these snowmobile trails are open for winter-use only" to help educate snowmobilers and local businesses that the snowmobile trail routes shown on the map are not open for any other use unless specified as "open" on a separate summer-season use or travel map.

Recommendation: In areas that have an active ATV management program, ensure that there is communication and coordination between the snowmobile and ATV management entities, particularly if they are different. Special emphasis should be placed on cross-selling "open to/closed to" messages on all information produced by each activity's management team. The potential for varying degrees of partnerships should also be explored, as may be appropriate for the local area, since funding seems to always be a challenge for everyone and partnerships may help to share expenses, resources, and/or expertise.

Illegal ATV operation on snowmobile trails during the off-season is the leading cause of private landowners terminating snowmobile trail lease agreements in many jurisdictions. It has also endangered the continued use of some snowmobile trail routes across public lands that are not open to motorized travel the balance of the year (i.e., the route is cross-country versus being located on an open roadway, or the trail is a nonmotorized trail during the non-winter season.). Continued access to these lands is of the utmost importance and must be given top priority by trail managers and user groups. It is critical that they collectively take action to show landowners they are responsive to problems and willing to help with solutions.

Recommendation: Intensive on-the-ground signing and route identification is critical, particularly in high risk areas across private or public lands. Open snowmobile trail and ATV trails routes need to be clearly identified with signing on the ground. Many areas use a "positive signing" scheme at trail access points which clearly identify what uses are open, versus heavy prohibitive signing. Trailhead signing should stress desired behavior of riders and clearly communicate which uses are allowed on the trail.

Recommendation: Intensive "check before you go" public education efforts should target ATV riders through area businesses, ATV dealerships, ATV clubs, newspapers, etc. to stress the importance of respecting private property and the fact that winter trail routes are not (or may not be) open to spring, summer, and fall trail use.

Recommendation: Consider using seasonal gates or portable barriers, such as sections of buck-and-pole fencing, to close off access in problem areas. Appropriate signing that identifies the route as "closed to wheeled vehicles" and also explains why should also accompany all gates or barriers.

Recommendation: Law enforcement efforts may need to be stepped up, particularly if important linkages that cross private or public lands are at risk of being lost due to summer trespass. This may necessitate spending winter trail money to provide contract or other law enforcement efforts during the non-winter season. Volunteer trail patrols or trail ambassador programs may also be utilized to monitor and educate riders about illegal off-season trespass issues in sensitive areas.

CHAPTER TWO: SURVEY OF TRAIL MANAGERS RESULTS

A Survey of Trail Managers was conducted by Trails Work Consulting between November 1, 2005 and January 30, 2006 to identify information and issues related to allowing concurrent ATV use on groomed snowmobile trails during the winter season. See Appendix B for a sample of this survey.

A total of 66 trail managers responded to the survey, representing 31 states, ten provinces, one Canadian territory, and 15 U.S. Forest Service offices. While there were multiple responses from some states, responses were grouped to reflect only one jurisdictional response when determining whether or not concurrent use is allowed. There was an overall 100% response rate from all jurisdictions who actively manage groomed snowmobile trails in the United States and Canada.

The goals of the survey were to:
1. Identify which jurisdictions do and which jurisdictions do not allow some level of concurrent snowmobile/ATV use on groomed snowmobile trails.
2. Identify examples of laws, rules, regulations, and management policies by which concurrent use is either allowed or disallowed in jurisdictions.
3. Identify statistics related to crashes, social conflicts, or other incidents that are the result of concurrent snowmobile/ATV use on groomed snowmobile trails.
4. Identify information and examples of management practices related to successful concurrent snowmobile/ATV use.
5. Identify information and issues related to off-season impacts on snowmobile trail routes caused by unauthorized non-winter use by ATVs.

Concurrent Snowmobile/ATV Use – Where is it Allowed or Not Allowed?

There were a total of 36 jurisdictions with groomed snowmobile trails that responded to the survey. Twenty-three jurisdictions (63.9%) allow (or cannot prevent) some level of concurrent use, while 13 jurisdictions (36.1%) do not allow any concurrent snowmobile/ATV use on groomed snowmobile trails. In total, 16 of 25 states (64%) allow some level of concurrent use while 7 of 11 Canadian jurisdictions (63.6%) allow (or in all seven cases, cannot prevent) some level of concurrent use. It should be noted that while six more states (Maryland, Nebraska, Nevada, Ohio, Virginia, and West Virginia) responded to the survey, they all have zero miles of groomed snowmobile trails so were discounted from the total percentage.

There are a total of 197,484 miles/317,830 kilometers of groomed snowmobile trails in the United States and Canada. A total of 53,147 miles/85,531 kilometers (26.9%) are legally open to concurrent use, while a total of 144,337 miles/232,299 kilometers (73.1%) are not open to concurrent use. A total of 22% of all U.S. groomed trails are open to concurrent use, while 35% of all Canadian trails are classified as being technically open to concurrent use since they are located on Crown Lands (although ATV use is not encouraged).

Table 1: Total Miles/KM of Concurrent Use Trails

	Total Miles/KM of Groomed Trails	**Total Miles/KM Open* to Concurrent Use**	**% of Miles/KM Open to Concurrent Use**
United States	122,819 miles/197,674 km	27,012 miles/43,471 km	22.0
Canada	74,665 miles/120,156 km	26,135 miles/42,060 km*****	35.0
Total:	**197,484 miles/317,830 km**	**53,147 miles/85,531 km**	**26.9**

***** Note: Canadian trail managers cannot prevent ATV use on these groomed snowmobile trails since the trails are located on Crown Lands with the stipulation that they must be open for multiple uses. While the trails noted in Table 1 are technically classified as "open," concurrent ATV use is not encouraged.

Looked at by region, 100% of the western states (10 of 10) and 75% of the western provinces/territories (3 of 4) allow some level of concurrent snowmobile/ATV use on groomed snowmobile trails. Comparatively, only

37.5% of Midwestern states (3 of 8) and 42.3% of Northeastern states (3 of 7) allow some level of concurrent use. The central/eastern Canadian provinces of Manitoba, Ontario, and Quebec all cannot prohibit some level of concurrent use while only one Maritime Province allows (cannot prohibit) concurrent use.

The U.S. jurisdictions which do allow some level of concurrent use include 16 states with a total of 27,012 miles of trail open to concurrent snowmobile/ATV use. This represents 28.1% of their total 95,986 miles of groomed trails. Additionally, six provinces and one territory in Canada have 42,060 kilometers of groomed trail classified as open to (cannot prevent) concurrent use out of a total of 98,290 kilometers of trail in these jurisdictions (42.8%). Levels of concurrent use range from "100% of all groomed trails" in eight jurisdictions (Alaska, Alberta, British Columbia, Colorado, Manitoba, Newfoundland/Labrador, Utah, and Yukon) to "less than 1%" of the groomed trails in three jurisdictions (Minnesota, Washington, and Wyoming). Table 2 below provides a breakdown of the jurisdictions that allow some level of concurrent use on groomed snowmobile trails. It should be noted that, while numbers for some jurisdictions are estimates, they represent the best available information. It should also be stressed that, while some snowmobile trail managers (particularly throughout Canada since there is no funding in place to support ATV use) would prefer that some of these trails *not* be open to concurrent use, the numbers below reflect the trails that are technically classified as open to legal concurrent use irrespective of trail manager preferences.

Table 2: Jurisdictions That Have Some Level of Legal Concurrent Snowmobile/ATV Use on Groomed Snowmobile Trails – Ranked by Total Miles/KM Classified as Open* to ATVs

Jurisdiction	Total Miles/Km Groomed	Total Concurrent Miles/Km Open*	% of Total
Ontario	25,658 miles/41,290 km	9,607 miles/15,460 km*	37.4
Manitoba	6,835 miles/11,000 km	6,835 miles/11,000 km*	100
Oregon	6,410 miles/10,316 km	6,200 miles/9,978 km	96.7
Idaho	7,200 miles/11,587 km	5,000 miles/8,047 km	69.4
Wisconsin	19,028 miles/30,622 km	4,215 miles/6,783 km	22.2
Alberta	3,107 miles/5,000 km	3,107 miles/5,000 km*	100
Montana	4,000 miles/6,437 km	3,100 miles/4,989 km	77.5
British Columbia	2,796 miles/4,500 km	2,796 miles/4,500 km*	100
Newfoundland/Labrador	2,796 miles/4,500 km	2,796 miles/4,500 km*	100
Colorado	2,356 miles/3,792 km	2,356 miles/3,792 km	100
Michigan	6,200 miles/9,978 km	2,000 miles/3,219 km	32.2
Utah	1,200 miles/1,931 km	1,200 miles/1,931 km	100
New Hampshire	7,187 miles/11,566 km	1,144 miles/1,841 km	15.9
California	2,000 miles/3,219 km	1,000 miles/1,609 km	50.0
Quebec	19,823 miles/31,900 km	932 miles/1,500 km*	4.7
Alaska	350 miles/563 km	350 miles/563 km	100
Maine	13,000 miles/20,921 km	260 miles/418 km	2.0
Minnesota	20,385 miles/32,806 km	100 miles/161 km	0.5
Yukon	62 miles/100 km	62 miles/100 km*	100
Pennsylvania	1,570 miles/2,527 km	52 miles/84 km	3.3
Washington	3,000 miles/4,828 km	25 miles/40 km	0.8
Wyoming	2,100 miles/3,380 km	10 miles/16 km	0.5
Arizona	unknown	unknown	?
Total U.S.:	95,986 miles/154,473 km	27,012 miles/43,471 km	28.1
Total Canada:	61,077 miles/98,290 km	26,135 miles/42,060 km*	42.8
Grand Total:	**157,063 miles/252,763 km**	**53,147 miles/85,531 km**	**33.8**

***** Note: Canadian trail managers cannot prevent ATV use on groomed snowmobile trails located on Crown Lands since they must be open for multiple uses. While the Canadian trails noted in Table 2 must technically be classified as "open," concurrent ATV use is not encouraged since there is no funding in place to support ATVs.

The jurisdictions which do not allow any concurrent use include nine states with 26,833 total miles (43,201 kilometers) of groomed snowmobile trails and four provinces with a total 21,866 kilometers (13,588 miles) of groomed trails. Table 3 below lists the jurisdictions that do not allow any concurrent use:

Table 3: Jurisdictions That Do Not Allow Any Concurrent Snowmobile/ATV Use On Groomed Snowmobile Trails

Jurisdiction	Miles/KM of Groomed Trails
Connecticut	90 miles/145 km
Illinois	365 miles/587 km
Indiana	210 miles/356 km
Iowa	5,000 miles/8,047 km
Massachusetts	1,100 miles/1,770 km
New Brunswick	4,661 miles/7,500 km
New York	10,161 miles/16,352 km
North Dakota	3,650 miles/5,874 km
Nova Scotia	2,113 miles/3,400 km
Prince Edward Island	600 miles/966 km
Saskatchewan	6,214 miles/10,000 km
South Dakota	1,572 miles/2,530 km
Vermont	4,685 miles/7,540 km
Total U.S.:	26,833 miles/43,201 km
Total Canada:	13,588 miles/21,866 km
Grand Total:	**40,421 miles/65,067 km**

How is Concurrent Use Allowed or Disallowed?

Concurrent ATV use on groomed snowmobile trails is allowed in 23 jurisdictions by the following methods. The total exceeds 100% since some jurisdictions gave multiple methods by which they allow ATV use:

No Formal Action to Prohibit (14)	60.9%
Agency Policy (5)	21.7%
Legislation (5)	21.7%
Agency Rule or Regulation (3)	13.0%
Unknown (1)	4.3%

Specific reasons given by respondents as to why concurrent ATV use is allowed on groomed snowmobile trails in their jurisdictions included:

- There are no laws or regulations in place to prohibit ATV use. (By far the most common reason.)
- Historical combined use.
- The decision is set by county ordinance.
- ATVs are included in the regulation that defines a snowmachine.
- ATVs are considered “snow vehicles” when operated on snow.
- Agency policy allows ATV use on state forest roads so, since designated snowmobile trails are also considered state forest roads, dual use is permitted.
- Landowner preference and forest policies that allow multiple/concurrent use.
- The result of negotiated agreements with ATV groups and government.
- Increased numbers of ATVs and the need for additional and more diverse funding for the maintenance of trail systems.
- Financial (snowmobile registrations alone cannot pay for the required services) and philosophical (make as much opportunity as possible available to all off-highway vehicle users, which includes both snowmobiles and ATVs).
- In Canada, a “Free Use of Crown Land” policy generally precludes limiting use to only one group so ATV use cannot typically be prohibited even when it is unwelcome by trail managers.

Concurrent ATV use on groomed snowmobile trails is prohibited in 13 jurisdictions by the following methods. The total exceeds 100% since some jurisdictions gave multiple methods by which they disallow ATV use:

Agency Rule or Regulation (7)	53.8%
Legislation (4)	30.8%
Agency Policy (4)	30.8%
Other/Agreement (1)	7.7%
Unknown (1)	7.7%

Specific reasons given by respondents as to why concurrent ATV use is prohibited on groomed snowmobile trails in their jurisdictions included:

- "Snowmobile-only" permission from landowners or government for snowmobile trail routes.
- Trenches that can be dug by ATVs can be a hazard for snowmobiles. (several gave this reason)
- Concerns that speeds at which the machines can travel can become a hazard since the speeds are extremely different.
- Trail liability insurance issues.
- Trail safety concerns.
- Depth of snow.
- Damage to groomed trail surface.
- Trail manager is respecting the attitude of snowmobilers that they don't want ATVs on their trail.
- Perception that ATV use would tear up trails.

What is the Typical Season During Which Concurrent Use is Allowed?

Concurrent ATV use on groomed snowmobile trails is most typically allowed during the same time period as the snowmobile season. While this is dictated by sufficient snowfall, most jurisdictions indicated that the "snowmobile season" begins December 1 to December 15, while two indicated that it begins in mid-October or November and another said it is year-round. The most common ending date for "snowmobile season" was the end of March to April 15, while some indicated that it could run as late as late-April or into May.

Are There Restrictions or Special Conditions Where Concurrent Use is Allowed?

Typically there are few restrictions or special conditions applied to ATVs when concurrent use is allowed. They are normally treated the same as snowmobiles. While special management guidelines are few, they include:

- One jurisdiction does not allow ATV use to begin until 10 days after trail grooming starts (public notice published in newspaper) and it ends when the trails are officially closed for snowmobiling. The air temperature must also be below 28 degrees Fahrenheit four feet above the trail surface for it to be open for ATV use. Chains and studded tires are prohibited on ATVs.
- Some concurrent use is allowed by trail sharing agreements by which sections of trail are shared by various user groups (snowmobilers and ATV riders) based upon the sharing of infrastructure like bridges and road crossings.
- Trail sharing is accomplished through "positive" signing that indicates a particular trail is open when signed as such. If there is no sign indicating ATV use posted, then the trail is closed to their use.

How Much ATV Use Occurs on the Trails Open to Concurrent Use?

Concurrent ATV use on groomed snowmobile trails is typically very light. Responses ranged as follows:

- 99% snowmobile, 1% ATV
- Minimal use by ATVs: 98% snowmobile and 2% ATV
- 95% snowmobile and 5% ATV
- All groomed systems receive heavy snowmobile use and very light ATV use – approximately 90% snowmobile and 10% ATV
- Majority of use is by snowmobilers, light use by ATVs primarily by home owners making short trips or occasional ATVs brought to the forest for access or towing tubes, etc. They are short trips close to the trailheads for the most part.

- ATV use is generally light to moderate although some counties have ATV use that runs as high as 30% to 35% of the total winter trail use. However, in low snow years, ATV use can move to as high as 70% during times of low snow. ATV traffic is generally, but not all, more local (short trips of 10 miles or less).
- While technically open to ATVs, ATV use is generally discouraged and the trails are marketed as snowmobile trails.

Conflict and Crash Rate Information

How does the "Crash Rate" on Concurrent Use Trails Compare to the Crash Rate on Snowmobile-Only Trails?

Generally, there is little data available to answer this question. Eleven respondents (16.7%) answered this question, while 55 (83.3%) skipped this question. The eleven responses indicated that the ATV crash rate is:

Unknown (7)	63.6%
About the Same (1)	9.1%
Higher (1)	9.1%
Lower (2)	18.2%

A total of 17 respondents offered specific comments about the ATV crash rate, summarized as follows:

- There is an average of about one incident/accident per year involving ATVs and snowmobiles colliding. However, these incidents have occurred on sections of trail where ATV use was NOT permitted. There have been no documented cases of collisions on shared sections of trail.
- There are no stats available, however I don't believe there has ever been an ATV crash with a snowmobile in our province, on or off trail.
- State has not experienced crashes between wheeled vehicles and snowmobiles on concurrent use trails.
- State only investigates and keeps data on fatal ATV and snowmobile accidents. Statistics provided indicated a total of 18 ATV fatalities in the state during 2005. However, only one occurred during the snow season (2/26/05: ATV collided head-on with a snowmobile at the crest of a small hill) while all others occurred in non-snow conditions between April and November. Comparatively, the state had 37 snowmobile fatalities during the 2004-05 snowmobiling season.
- In the last 10 years, no accidents were reported on groomed trails involving ATVs.
- We have no documentation on file of accidents involving snowmobiles and ATVs colliding.
- Never heard of a single collision.
- No concurrent use accidents recorded.
- To my knowledge, there has been no crashes between snowmobiles and ATVs, although there has been a few accidents caused by ATV ruts on the groomed trail.
- As far as we know or have heard, there have not been any wrecks of snowmobiles and ATVs. We are aware of snowmobile wrecks, most which were with obstacles off the trail.
- None/nothing available (6)

How does the "Social Conflict" Incident Rate on Concurrent Use Trails Compare to the Incident Rate on Snowmobile-Only Trails?

Generally, there is little data available to answer this question. Ten respondents (15.2%) answered this question, while 56 (84.8%) skipped this question. The ten responses indicated that the ATV incident rate is:

Unknown (5)	50.0%
About the Same (2)	20.0%
Higher (1)	10.0%
Lower (2)	20.0%

While no jurisdictions had formal statistics regarding incident rates on trails that allow ATV use, 16 respondents offered specific comments about the ATV social incident rate, summarized as follows:

- We receive a few complaints from snowmobilers about ATVs on the trail, but we receive many more complaints about cross-country skiers on the snowmobile trail than about ATVs.
- Unaware of conflicts or complaints.
- No statistics available. (7)
- No documented reports – most complaints about ATVs occur during non-snow months.
- A handful of social conflicts occur, specifically in the northern end of the state.
- With a major snowmobile rental vendor adjacent to the trailhead we would hear of any major problems – at this point none have been shared.
- Unable to track these statistics.
- No incidents have been reported by snowmobile clubs or land managers.
- Complaints have been filed by snowmobilers that ATVs rut groomed trails.
- Good information regarding ATV incidents is generally unavailable. Anecdotally, ATV incidents are generally believed to be on the rise. While relatively rare, ATV incidents involving snowmobiles have occurred.

Does Your Jurisdiction Currently Experience Off-Season (spring, summer, and/or fall) Impacts from ATV Use on Historic Snowmobile Trail Routes?

Yes (35 responses)	58.3%
No (25 responses)	41.7%

The 35 "Yes" responses came from 18 states (72% of the total number of states with groomed trails), nine provinces (81.8% of the Canadian jurisdictions), and six U.S. Forest Service areas. The states include: Alaska, California, Colorado, Connecticut (2 responses), Iowa, Maine, Massachusetts (2 responses), Michigan, Minnesota, Montana, New Hampshire, North Dakota, Pennsylvania, South Dakota, Vermont, Washington (Mt. Spokane State Park), Wisconsin, and Wyoming. The provinces include: Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Quebec, and Saskatchewan. The six U.S. Forest Service responses came from four areas in California and two areas in Washington State.

The 25 "No" responses came from eight states (32% of the total number of states with groomed trails), one province and one territory (18.2% of the Canadian jurisdictions), and eight U.S. Forest Service areas. Additionally, the six states with no groomed snowmobile trails also responded no. The states include: Arizona, Idaho, Illinois, Indiana, New York, Oregon, Utah, and Washington (2 responses, also this is a double response since there were also "yes" responses for this state). The Canadian jurisdictions include: Newfoundland/Labrador and Yukon. The U.S. Forest Service responses came from six areas in California, one in California/Nevada, and one in Wyoming/Utah.

Ranking of Potential Off-Season Impacts

The survey asked the trail managers that indicated "Yes" they do have off-season impacts to rank the same eleven potential impacts from the greatest to the least impacts in their jurisdiction. A summary of those rankings is provided below in descending order from greatest to least overall impacts. Keep in mind that this summary quantifies the impacts that 58.3% of the survey respondents said they do have.

1. **Private Property Trespass – there is landowner permission for only snowmobile season use:** 85% of respondents ranked this as a "Top 5" issue and 12% ranked it as a "Bottom 5" issue. This issue received the greatest number of responses with 26. It also ranked as the "#1 greatest impact" with 46% of the respondents ranking it #1 and another 23% ranking it the "#2 greatest impact."
2. **Public Land Use Issues – there is agency permission for only winter use of the trail route:** 78% of the respondents ranked it as a Top 5 issue while 17% ranked it as a Bottom 5 issue. This issue tied for the second greatest number of responses with 23. It ranked second as the "#1 greatest impact" with 30% of the response. "Number 1 greatest" impact was also the most frequent response for this issue.
3. **Severe Resource Damage from non-winter wheeled vehicle/ATV use during the off-season:** 75% of the respondents ranked this as a Top 5 issue while 20% ranked it as a Bottom 5 issue. This issue tied for the

fourth greatest number of responses with 20. "Number 2 greatest" impact was the most frequent response for this issue with a total of 20%. 15% of the respondents said this was their "#1 overall impact."

4. **Social Conflicts with heavy nonmotorized use of the trail route during the off-season:** 74% of the respondents ranked this as a Top 5 issue while 9% ranked it as a Bottom 5 issue. This issue tied for the second greatest number of responses with 23. It ranked fifth as the "#1 overall impact" with 13% of the response. "Number 5 greatest" impact was the most frequent response for this issue with a total of 22%.
5. **Moderate Resource Damage from non-winter wheeled vehicle/ATV use during the off-season:** 68% of the respondents ranked this as a Top 5 issue while only 5% ranked it as a Bottom 5 issue. The most frequent response for this issue was a tie between "#2, #3, #4, #5, and #6 greatest impact" with each receiving 16% of the response. Only 5% stated that this was their "#1 overall impact."
6. **Conflicts with exclusive nonmotorized use of the trail route during the off-season:** 67% of the respondents ranked this as a Top 5 issue while 14% ranked it as a Bottom 5 issue. This issue tied for the third greatest number of responses with 21. "Number 3 greatest" impact was the most frequent response for this issue with a total of 29%. Only 5% stated that this was their "#1 overall impact."
7. **Slight Resource Damage from non-winter wheeled vehicle/ATV use during the off-season:** 62% of the respondents ranked this as a Top 5 issue while 19% ranked it as a Bottom 5 issue. This issue tied for the third greatest number of responses with 21. It ranked fourth as the "#1 overall impact" with 14% of the response. "Number 5 greatest" impact was the most frequent response for this issue with a total of 19%.
8. **Conflicts with livestock grazing, gates left open, etc.:** Only 30% of the respondents ranked this as a Top 5 issue while 50% ranked it as a Bottom 5 issue. "Number 6 greatest" impact was the most frequent response for this issue with a total of 20%. This issue tied for the fourth greatest number of responses with 20.
9. **Conflicts with wildlife production and rearing areas:** Only 22% of the respondents ranked this as a Top 5 issue while 56% ranked this as a Bottom 5 issue. The most frequent response for this issue was a tie between "#4 and #8 greatest impact" with a total of 17%. There were a total of 18 responses for this issue.
10. **Harassment of Wildlife:** Only 18% of the respondents ranked this as a Top 5 issue while 64% ranked this as a Bottom 5 issue. "Number 8 greatest" impact was the most frequent response for this issue with a total of 27%. There were only 11 responses that indicated that this is an issue.
11. **Harassment of Livestock:** Only 10% of the respondents ranked this as a Top 5 issue while 80% ranked this as a Bottom 5 issue. 20% indicated this was their "least issue." The most frequent response for this issue was a tie between "#9, #10, and #12 greatest impact" with each receiving 20%. There were only 10 responses that indicated that this is an issue.

Table 4 below provides a comparison of the percent of respondents who ranked each impact in the groupings of either "Top 5" issues or "Bottom 5" issues out of the list of eleven potential impacts.

Table 4: Potential Off-Season Impacts – Comparison as "Top 5" and "Bottom 5" Issues

Potential Off-Season Impact	% Who Ranked as a "Top 5" Issue	% Who Ranked as a "Bottom 5" Issue
Private Property Trespass: Permission only for Snowmobiles	85	12
Public Land Use Issues: Agency permission only for winter use of route	78	17
Severe Resource Damage from ATV use during the off-season	75	20
Social Conflicts with Heavy Nonmotorized Use of the trail route during the off-season	74	9
Moderate Resource Damage from ATV use during the off-season	68	5
Conflicts with Exclusive Nonmotorized Use of the trail route during the off-season	67	14
Slight Resource Damage from ATV use during the off-season	62	19
Conflicts with Livestock Grazing, gates left open, etc.	30	50
Conflicts with Wildlife Production and Rearing Areas	22	56
Harassment of Wildlife	18	64
Harassment of Livestock	10	80

The survey also asked the trail managers that indicated “Yes” they do have off-season impacts to rank eleven potential impacts as to whether they are an extreme, major, slight, or not a problem in the jurisdiction. A summary of those rankings is shown in Table 5 below. Keep in mind that 41.7% of the respondents said they have no off-season impacts, so this summary quantifies the impacts the other 58.3% said they do have.

Table 5: Potential Off-Season Impacts – Average and Individual Rankings of Degree of Problem with the Most Frequent Response highlighted in Bold

Potential Off-Season Impact	Average Score / Degree of Problem	Number of Responses: 3 - Extreme Problem	Number of Responses: 2- Major Problem	Number of Responses: 1 - Slight Problem	Number of Responses: 0 - Not a Problem
Private Property Trespass: Permission only for Snowmobiles	1.83 Nearly a Major Problem	**11**	6	10	3
Severe Resource Damage from ATV use during the off-season	1.56 A Slight / approaching a Major Problem	5	7	**10**	3
Moderate Resource Damage from ATV use during the off-season	1.52 A Slight / approaching a Major Problem	2	10	**12**	1
Slight Resource Damage from ATV use during the off-season	1.38 A Slight Problem	2	6	**18**	0
Social Conflicts with Heavy Nonmotorized Use of the trail route during the off-season	1.32 A Slight Problem	2	**9**	**9**	5
Conflicts with Exclusive Nonmotorized Use of the trail route during the off-season	1.29 A Slight Problem	2	8	**9**	5
Public Land Use Issues: Agency permission only for winter use of route	1.21 A Slight Problem	4	7	8	**9**
Conflicts with Wildlife Production and Rearing Areas	0.86 Approaching a Slight Problem	1	1	**14**	6
Harassment of Wildlife	0.71 Approaching a Slight Problem	0	3	6	**8**
Conflicts with Livestock Grazing, gates left open, etc.	0.65 Approaching a Slight Problem	0	3	9	**11**
Harassment of Livestock	0.28 Not a Problem	0	0	5	**13**

Finally, it is worth comparing responses to the two similar questions about the same potential off-season impacts to help define the magnitude of each issue. However, one must also keep in mind that almost 42% of the survey’s respondents indicated they have none of these off-season issues.

Private property trespass by ATVs during the off-season was consistently identified as the greatest issue facing trail managers. It received the highest average score of 1.83 (a 2.0 average indicates a "major" problem) and was also identified by 85% of the respondents as a Top 5 issue.

Public land use issues received mixed rankings when comparing the results of the two questions. While 78% of the respondents identified it as a Top 5 issue, it had an average score of only 1.21 (a 1.0 average indicates a "slight" problem) which ranked it number 7 out of 11 for that question. This is most likely due to the fact that some jurisdictions are more dependant upon public lands than others, which is why 17% ranked it as a Bottom 5 issue and 32% said it was not a problem in their jurisdiction.

Severe, moderate, or slight resource damage from ATV use during the off-season ranked number 2, 3, and 4 with average scores of 1.56, 1.52, and 1.38, respectively. (a 1.0 average indicates a "slight" problem, while a 2.0 average indicates a "major" problem) Comparatively in the other question they ranked number 3, 5, and 7, with 75% identifying severe resource damage, 68% identifying moderate resource damage, and 62% identifying slight resource damage as Top 5 issues. Collectively, there is no doubt that off-season resource damage by ATVs is an increasing concern for trail managers.

Social conflicts with heavy nonmotorized use of the trail route during the off-season ranked number 5 with an average score of 1.32 (a 1.0 average indicates a "slight" problem, while a 2.0 average indicates a "major" problem) and ranked number 4 in the other question with 74% of the respondents indicating it is a Top 5 issue. Additionally, only 9% of the respondents ranked it as a Bottom 5 issue (the second lowest Bottom 5 ranking) which indicates this issue is definitely a top to middle ranked issue overall.

Conflicts with exclusive nonmotorized use of the trail route during the off-season ranked number 6 in both questions. It had an average score of 1.29 (a 1.0 average indicates a "slight" problem) while 67% of the respondents ranked it as a Top 5 issue.

Four issues consistently ranked low in both questions, with 50% to 80% of respondents ranking them as Bottom 5 issues and average scores that placed them in the range between "Not a Problem" and a "Slight Problem."

Conflicts with livestock grazing, gates left open, etc. ranked number 10 out of 11 with an average score of 0.65 (a 1.0 average indicates a "slight" problem, while a 0 average indicates "not" a problem) and number 8 in the other question with only 30% of the respondents indicating it is a Top 5 issue. Additionally, 50% of the respondents ranked it as a Bottom 5 issue, which was the fourth lowest overall ranking.

Conflicts with wildlife production and rearing areas ranked number 8 out of 11 with an average score of 0.86 (a 1.0 average indicates a "slight" problem, while a 0 average indicates "not" a problem) and number 9 in the other question with only 22% of the respondents indicating it is a Top 5 issue. Additionally, 56% of the respondents ranked it as a Bottom 5 issue, which was the third lowest overall ranking.

Harassment of wildlife ranked number 9 out of 11 with an average score of 0.71 (a 1.0 average indicates a "slight" problem, while a 0 average indicates "not" a problem) and number 10 in the other question with only 18% of the respondents indicating it is a Top 5 issue. Additionally, 64% of the respondents ranked it as a Bottom 5 issue, which was the second lowest overall ranking.

Harassment of livestock ranked number 11 out of 11 in both questions. It had an average score of 0.28 (a 1.0 average indicates a "slight" problem, while a 0 average indicates "not" a problem) while only 10% of the respondents ranked it as a Top 5 issue. Additionally, 80% of the respondents ranked it as a Bottom 5 issue, which was the lowest overall ranking of all issues.

CHAPTER THREE: FIELD STUDY RESULTS

Background and Need

The number of all-terrain vehicles (ATVs) has increased dramatically over the past 20 years. While there were around a half million in the United States in the mid 1980s, today they number more than 8 million. At the same time, their sales in Canada have more than tripled in recent years. Along with this explosive growth in numbers has come a growing need for more places to operate them, whether for recreation or for utility purposes. In some areas of the Snowbelt this growth has created a growing interest for ATV operation on groomed snowmobile trails. But snowmobilers have not always embraced this new use of "their trails" which were created by the fees they pay, their volunteer construction and maintenance efforts, their work with landowners, along with the perception that ATV tires rut their trails and cause safety issues. There are often strong opinions on both sides of the discussion but generally a lack of good information on the subject.

The only formal field evaluation of ATV use on groomed snowmobile trails, prior to this study, was done in 1984 by the Idaho Department of Parks and Recreation (All Terrain Vehicles on Groomed Snowmobile Trails, Chuck Wells, Idaho Department of Parks and Recreation, 1984). This study looked at snowmobile and ATV operation in an area north of Boise, Idaho from February 7 through March 4, 1984 and concluded that, "It is very evident that most of the impacts created by ATVs on groomed snowmobile trails are similar to the impacts created by snowmobiles under the same conditions, and it would be hard to say objectively that ATVs and snowmobiles have a significant difference in the impacts they create on a groomed snowmobile trail."

Much has changed since the Idaho study. The vehicles that were evaluated in 1984 included three 3-wheeled ATVs and one 4-wheeled ATV. Today most ATVs have four wheels, or even six wheels, since 3-wheeled ATVs have not been manufactured for nearly two decades and are rarely used for trail recreation. Additionally, the ATV engine sizes in the 1984 study were 185cc, 200cc, and 250 cc, while the three snowmobiles had 440 cc, 485 cc, and 600 cc size engines. Today most ATV and snowmobile engines are substantially larger and more powerful. And there are paddle tracks, traction devices, and carbides on snowmobiles. Consequently, many believed this study was no longer applicable to the present day situation and that there was an overdue need for an updated field evaluation of ATV and snowmobile impacts on groomed snowmobile trails.

Field Study Goals

This project commissioned a new field study to evaluate vehicle use on groomed snowmobile trails. The goals of the field study included:

1. Collect data related to the 'depth and width' of impressions upon the groomed trail surface that are the result of ATV and snowmobile operation at 'slow/normal' and 'fast/aggressive' speeds, including effects related to 'starts,' 'stops,' and 'pass-bys' on straightaway sections of trail.
2. Collect data related to the 'depth and width' of impressions upon the groomed trail surface that are the result of ATV and snowmobile operation while negotiating corners/curves and hills/grades.
3. Record data including 'width, depth, and/or length' of impressions caused by the deliberate damaging operation of an ATV or snowmobile (deliberate weaving while 'on the throttle,' in-trail turns/doughnuts, aggressive starts and stops, etc.).
4. Compare the stopping distance at 35 mph of ATVs versus snowmobiles while operated on groomed snowmobile trails, along with the stopping distance of ATVs at 35 mph when operated on non-snow trail surfaces such as dirt, grass, and gravel.

The intent of this project was not to measure each and every indentation in the trail's surface, but rather to document what were observed to be the worst-case impressions in regard to depth and width. Additionally, the project should be viewed as a snapshot of impacts observed at that point in time under the very specific recorded conditions, rather than a comprehensive look at the issues under all possible scenarios in the universe. It should be recognized that these results are subject to change under other snow and weather conditions, with different vehicles, and/or with different vehicle operators. This "snapshot in time" can be used to further more informed discussions regarding concurrent ATV/snowmobile use and management and, potentially, identify needs for more specific research.

Field Study Procedures and Testing Protocol

Trails Work Consulting conducted controlled field testing to collect data related to the goals outlined above at fifteen sites in five different states (South Dakota, Wyoming, Wisconsin, Minnesota, and Idaho) between January 9 and February 21, 2006. One additional field test scheduled for the first week of March in Maine was cancelled due to poor snow conditions. The field study test protocol and forms were also made available to all IASA jurisdictions in an attempt to broaden the project's database; however no jurisdictions submitted data from local non-control field testing.

Trails Work used four "control" vehicles to ensure optimum consistency from site to site. The control vehicles were provided for the project by Polaris Industries and transported to each test site by Trails Work. They included two types of ATVs, a 2005 Sportsman EFI 700 (4-wheel drive, automatic transmission, typical of units used for trail riding) and a 2006 Predator 500 (2-wheel drive, manual transmission, very high torque racing model), along with two types of snowmobiles, a 2006 RMK 700 (2-inch paddle track) and a 2006 Switchback 900 (1¼ -inch track lugs). Nine other "non-control" vehicles (seven different ATVs and four different snowmobiles that represented other makes and models) were provided by local agencies or local volunteers and used at six different sites in four of the states to help broaden the database of information.

Only "real" groomed trails that were actually in use and had been regularly groomed for trail users were used for test sites (versus packing a special "test track" in an open field) since it was important to collect data from real-life situations to best evaluate and compare impacts. This required that extra precautions were followed (advance warning signing, traffic cones, and flaggers) to ensure the safety of both the public and testing participants. Additionally, testing was done only on weekdays to minimize conflicts with normal trail traffic. Test locations were chosen where 'start,' 'stop,' and 'pass-by' impressions could be simultaneously observed, measured, and recorded for each respective "slow/normal" and "fast/aggressive" vehicle pass. Groomed trail width allowed only one test lane at the first test site (SD 1), whereas two lanes were used at all other start/pass-by/stop test sites to provide side-by-side comparisons of ATVs in one lane and snowmobiles in the second.

"Slow/Normal" operation was defined as a start that was not fast and aggressive (no intentional spinning of track or tires) with a pass-by at a speed of 15 mph and a stop that was controlled, gradual, and constant (no intentional sliding) typical from a non-aggressive rider. Traffic cones were used to delineate a 300 feet long test track at each trail location. A distance of 75 feet was allowed for the 'start' zone, 150 feet for the 'pass-by' zone, and 75 feet for the 'stop' zone. Tire and track impressions were measured, photographed, and recorded in respect to starts, pass-bys, and stops.

"Fast/Aggressive" operation was defined as aggressive riding from start to finish beginning with a start that was full-throttle (often spinning and/or fish-tailing), accelerating to a pass-by speed of 35 mph, and ending with a stop that was as abrupt as possible from quickly and fully applying the vehicle's brakes (often involved coming to a sliding stop). Traffic cones were used to delineate a 450 feet long test track at each trail location. A distance of 125 feet was allowed for the 'start' zone, 200 feet for the 'pass-by' zone, and 125 feet for the 'stop' zone. Tire and track impressions were measured, photographed, and recorded in respect to starts, pass-bys, and stops. The vehicle's stopping distance at 35 mph was also measured and recorded.

Testing on corners, curves, and hills was a 'pass-by' at speeds typical for that area. Conditions at some sites allowed fairly aggressive/fast pass-bys while others allowed only a fairly slow pass-by. The range of pass-by speeds was documented for each individual site, along with the radius of the curve and/or slope of the hill. When conditions allowed, the operator was typically accelerating through the corner or up the hill with the tires or track spinning and operating at the most aggressive speed prudent for the site to try to create the worst-case results. When testing on hills, both uphill and downhill impressions were documented if there was a noticeable difference.

If the test area became excessively rutted after multiple test runs, it was often necessary to either move the test track down the trail to a new/firm trail surface or flip-flop the lanes used by the ATVs and snowmobiles (the ATV tire impressions were typically wider than the snowmobile track impressions so a flip-flop of lanes typically provided a "new" surface without totally relocating the track). The test track was typically moved between the slow/normal and fast/aggressive testing to provide as fresh of a trail surface as possible. If there was any change in the character of the test location (snow depth, compaction, and/or grade), it was documented.

The "test drivers" for the snowmobiles and ATVs were all volunteers from local agencies or clubs. The number of test drivers was kept to a minimum to provide the maximum consistency related to varying reaction times between drivers. One driver (but not the same driver) was used for all tests conducted in South Dakota, Wyoming, and Minnesota, whereas two drivers (one for the ATVs and one for the snowmobiles) were used for the Idaho and Wisconsin tests in an effort to involve more people since they were conducted in conjunction with regional IASA meetings. In total, nine different individuals operated the vehicles used at the fifteen sites, which likely contributes some degree of variance to the test's results. However, this variance in reaction times and other individualistic traits also replicates variance that is found within the recreating public, so results are still considered to be valid.

All 'depth and width' impressions at all test sites were measured, photographed, and recorded by only one person, Kim Raap – owner of Trails Work Consulting, to provide the maximum consistency. While the initial intent was to also document the 'length' of impressions, testing of the protocol quickly determined that length was somewhat irrelevant – if the impressions were there, they were there throughout the zone. All 'depth and width' measurements were done with a metric ruler or tape measure and converted to English measurements for the report using www.onlineconversion.com. All 'stopping distance' measurements were done in combination with local agency volunteers and Trails Work using two open measuring tapes (one metric scale, one English scale). They were then recorded by Trails Work and converted for the report using www.onlineconversions.com.

All pertinent local conditions were also recorded by Trails Work at each test site. A tiling spade was used to dig a snow pit in the middle of the trail so that compacted snow depth could be measured with a tape measure and recorded along with general density observations of the trail base. Uncompacted snow depth beside the trail was measured with a tape measure. Altitude and temperature was measured with a High Gear Precision Digital Altimeter and Compass. Wind speed was measured with a La Crosse Technology Anemometer. Trail grade and curve radius was measured with a Brunton Clino Master. Pertinent information regarding each vehicle was also recorded, including make, model, engine size, tire or track types and lug depths, tire pressure, etc. A sample Cover Sheet used to record these measurements and observations is provided in Appendix C.

A total of four passes (two up and two back) were typically run with each vehicle at each site to gather representative average samples that documented impressions left by each vehicle. While preliminary test protocol envisioned the need to run up to ten passes with each vehicle, initial testing at site SD 1 found that achieving this goal was possible with only four vehicle passes. If the vehicle was going to leave an impression in a particular mode of operation, it was typically consistent time after time. Therefore, the only purpose of running ten passes would be to dig the same ruts deeper and deeper, typically the same increments time after time, until either ice or frozen ground was reached. Given that a groomed snow surface can typically be worn out after multiple repetitions regardless of vehicle type, the decision was made that four passes would be reasonable and prudent for this field study.

A Daily Test Log was used to record measurements and observations regarding each individual vehicle. A sample is provided in Appendix D. Daily Test Logs were then compiled by Trails Work into a Field Testing Journal (see Appendix A) for each specific test site. All daily test logs and testing journals were coded to reflect the site location (SD 1 = South Dakota site #1, WI 2 = Wisconsin site #2, etc.).

The Field Tests' Range of Actual Conditions

First, the air temperature during these tests ranged from 11.0 F (-11.7 C) to 31.9 F (-0.1 C). Second, the compacted snow depth on the trails ranged from 15 to 60 centimeters (5.9 to 23.6 inches) in depth. The exception was the Wisconsin curve test (Site Wisconsin 2) where there were only 4 to 9 centimeters (1.6 to 3.5 inches) of snow on top of an ice layer. The uncompacted depth of snow along side the groomed trails ranged from 30 to 76 centimeters (12 to 30 inches) in depth, although the uncompacted snow adjacent to the trail at Site Wisconsin 2 was only 20 centimeters (8 inches) deep. Third, while this testing was done during what could be considered the middle of the snowmobiling season (January-February), some sites had been groomed for only three weeks or less (Sites South Dakota 1, 2, and 3 and Wyoming 2) even though the testing occurred in January and, therefore, were somewhat representative of earlier season conditions than what the January dates might suggest. Finally, most trails used for this field testing had a very well compacted trail base – consistent with what would generally be considered "good" snowmobile trails. Trails that had been regularly groomed with a multi-blade drag were generally very firm (irrespective as to whether they had been groomed for three weeks or up to eight weeks) and showed minimal impressions from either vehicle type. The exceptions to having 'very firm trails' were Site Wyoming 2, which had been groomed only three times with a single blade drag and was very soft underneath the surface crust, and Site Idaho 1 which was a bit soft due to recent tilling and which had a sub-base which was noticeably less dense than the other trails groomed with multi-blade drags.

The Results

Specific results from field testing conducted at the fifteen sites are compiled in *Appendix A – Summary of Field Testing Journals with Photo Documentation* that is available electronically on-line from IASA at www.snowiasa.org or from ACSA at www.snowmobilers.org . It is important that readers interpret these results in their whole and proper context that includes observed weather and trail conditions along with individual vehicle characteristics. A condensed summary of general and average observations are as follows:

Slow/Normal Operation: Generally all starts, stops, and 15 mph/24 kph pass-bys resulted in minimal ATV tire and snowmobile track impressions on the trail surface. Therefore, only the four control vehicles were run on the slow/normal track after initial protocol testing at site SD 1.

Table 6 below summarizes the range of depth measurements for each vehicle at each specific site. It shows that the minimum depth of tire impressions left by both ATVs was 1 centimeter/0.4 inch while the minimum depth of snowmobile track impressions on the trail ranged from 1 to 2.5 centimeters/0.4 to 1.0 inch. The maximum depth of tire impressions left by the Sportsman ATV with the more aggressive tires was 3 centimeters/1.2 inches while the maximum depth of tire impressions left by the Predator ATV with a flatter tire profile was 2 centimeters/0.8 inch. Comparatively, the maximum depth of snowmobile track impressions on the trail ranged from 2.5 to 3 centimeters/1.0 to 1.2 inches. The maximum depths of ATV and snowmobile impressions recorded during slow/normal operation were identical.

Table 6: Slow Start/Stop/Pass-By – Summary of Depth Impressions by Vehicle and Location

	SD 1	**SD 4**	**WY 1**	**WI 1**	**ID 1**	**Min. Depth**	**Max. Depth**
Control Vehicles							
ATV 1: Polaris Sportsman 700	2 – **3 cm** 0.8 – **1.2 in**	1 – 2 cm 0.4 – 0.8 in	2 cm 0.8 in	1 – 2 cm 0.4 – 0.8 in	2 – **3 cm** 0.8 – **1.2 in**	1 cm 0.4 in	**3 cm** **1.2 in**
ATV 2: Polaris Predator 500	2 cm 0.8 in	1 cm 0.4 in	1.5 cm 0.6 in	1.5 cm 0.6 in	2 cm 0.8 in	1 cm 0.4 in	2 cm 0.8 in
Sled 1: Polaris Switchback 900	2.5 cm 1 in	2 cm 0.8 in	1 cm 0.4 in	1.5 – 2 cm 0.6 – 0.8 in	2 cm 0.8 in	1 cm 0.4 in	2.5 cm 1 in
Sled 2: Polaris RMK 700	2.5 cm 1 in	2 cm 0.8 in	2 cm 0.8 in	2 cm 0.8 in	2 – **3 cm** 0.8 – **1.2 in**	2 cm 0.8 in	**3 cm** **1.2 in**
Other Vehicles							
SD 1/Sled 3: Arctic Cat Firecat 700	2.5 cm 1 in					2.5 cm 1 in	2.5 cm 1 in
Other				**WI 2**			
Footprints on Trail Surface		2 cm 0.8 in		3 cm 1.2 in	**5 cm** **2 in**	2 cm 0.8 in	**5 cm** **2 in**

Since the very top of most compacted snow trail surfaces is generally slightly less dense than the compacted snow layer below it, these types of impressions would be expected as normal “surface chew” from almost anything that travels over it, including such common things as footprints from a person. It is worth noting that the typical depth of footprints on the trail surface at three of the test sites (SD 4, WI 2, and ID 1) were 2 centimeters/0.8 inch, 3 centimeters/1.2 inches, and 5 centimeters/2 inches, respectively.

Aggressive Starts: Table 7 on the next page summarizes the range of depth measurements for each vehicle at each specific site. It shows that the minimum depth of tire impressions left by ATVs during aggressive starts ranged from 2 to 4 centimeters/0.8 to 1.6 inches, while the minimum depth of snowmobile track impressions on the trail ranged from 1 to 4 centimeters/0.4 to 1.6 inches. At the other end of the spectrum, the maximum depth of tire impressions left by ATVs during aggressive starts ranged from 2 to 12 centimeters/0.8 to 4.7 inches. Comparatively, the maximum depth of snowmobile track impressions from aggressive starts ranged from 2 to 10 centimeters/0.8 to 3.9 inches. The maximum ATV depth recorded was 2 centimeters/0.8 inch deeper than the maximum snowmobile impression that was recorded. Alternately, the average maximum ATV impression was 5.5 centimeters/2.17 inches deep while the average maximum snowmobile impression was 5.7 centimeters/2.24 inches deep. When looked at as a whole, the difference between maximum depth impressions caused by the two vehicle types during aggressive starts is minute. Additionally, in regard to depth of impressions, deliberate in-trail turns, etc. were observed to be very similar to what was observed for aggressive starts.

Fast Pass-Bys: Table 8 on page 39 summarizes the range of depth measurements for each vehicle at each specific site. It shows that the minimum depth of tire impressions left by ATVs during the 35 mph/56 kph pass-bys ranged from 1 to 3 centimeters/0.4 to 1.2 inches, while the minimum depth of snowmobile track impressions on the trail ranged from 1 to 2 centimeters/0.4 to 0.8 inch. At the other end of the spectrum, the maximum depth of tire impressions left by ATVs during fast pass-bys ranged from 1.5 to 5 centimeters/0.6 to 2 inches. Comparatively, the maximum depth of snowmobile track impressions from fast pass-bys ranged from 1 to 4 centimeters/0.4 to 1.6 inches. The maximum ATV depth recorded was 1 centimeter/0.4 inch deeper than the maximum snowmobile impression that was recorded. Alternately, the average maximum ATV impression was 2.61 centimeters/1.07 inches deep while the average maximum snowmobile impression was 2.58 centimeters/ 1.02 inches deep. When looked at as a whole, the difference between maximum depth impressions caused by the two vehicle types during fast pass-bys is miniscule and generally consistent with what would be considered normal “surface chew” from traffic on a groomed snow trail surface.

Aggressive Stops: Table 9 on page 40 summarizes the range of depth measurements for each vehicle at each specific site. It shows that the minimum depth of tire impressions left by ATVs during aggressive stops ranged from 2 to 3 centimeters/0.8 to 1.2 inches while the minimum depth of snowmobile track impressions on the trail ranged from 1 to 3 centimeters/0.4 to 1.2 inches. At the other end of the spectrum, the maximum depth of tire impressions left by ATVs during aggressive stops ranged from 2.5 to 13 centimeters/1 to 5.1 inches. Comparatively, the maximum depth of snowmobile track impressions from aggressive stops ranged from 2 to 6 centimeters/0.8 to 2.4 inches. The maximum ATV depth recorded was 7 centimeters/2.8 inches deeper than the maximum snowmobile impression that was recorded. Additionally, the average maximum ATV impression was 6.6 centimeters/2.6 inches deep while the average maximum snowmobile impression was 4.2 centimeters/1.7 inches deep. When looked at as a whole, aggressive stops are the only area where there were small yet substantive differences between the ATV and snowmobile impressions while operated on the fast/aggressive track. This most likely due to a tendency of heavier ATVs to “dig in” when the tires are locked up in aggressive braking versus more of a tendency for the snowmobiles to plane or slide on the snow surface when braked aggressively.

Table7: Aggressive Starts – Summary of Depth Impressions by Vehicle and Location

	SD 1	**SD 4**	**WY 1**	**WY 2**	**WY 3**	**WI 1**	**ID 1**	**Min. Depth**	**Max. Depth**
Control Vehicles									
ATV 1: Polaris Sportsman 700	2 – 7 cm 0.8 – 2.8 in	2 – 5 cm 0.8 – 2 in	2 – 5 cm 0.8 – 2 in			2 – 3 cm 0.8 – 1.2 in	3 – 6 cm 1.2 – 2.4 in	2 cm 0.8 in	7 cm 2.8 in
ATV 2: Polaris Predator 500	3 – 6 cm 1.2 – 2.4 in	4 – 5 cm 1.6 – 2 in	3 – 8 cm 1.2 – 3.1 in			5 – 6 cm 2 – 2.4 in	5 – **12 cm** 2 – **4.7 in**	3 cm 1.2 in	**12 cm** **4.7 in**
Sled 1: Polaris Switchback 900	2 – 3 cm 0.8 – 1.2 in	3 – 6 cm 1.2 – 2.4 in	2.5 – 5 cm 1 – 2 in			5 – 6 cm 2 – 2.4 in	4 – 5 cm 1.6 – 2 in	2 cm 0.8 in	6 cm 2.4 in
Sled 2: Polaris RMK 700	5 – 6 cm 2 – 2.4 in	3 – 7 cm 1.2 – 2.8 in	3 – 4 cm 1.2 – 1.6 in			3 – 5 cm 1.2 – 2 in	4 – 7 cm 1.6 – 2.8 in	3 cm 1.2 in	7 cm 2.8 in
Other Vehicles									
SD 1 / Sled 3: Arctic Cat Firecat 700 / picks	4 – **10 cm** 1.6 – **3.9 in**							4 cm 1.6 in	**10 cm** **3.9 in**
WY 2 & 3 / ATV 3: Bombardier Traxter 500				4 – 5 cm 1.6 – 2 in	2 cm 0.8 in			2 cm 0.8 in	5 cm 2 in
WY 2 & 3 / ATV 4: Polaris 6x6 500				2 – 3 cm 0.8 – 1.2 in	2 – 3 cm 0.8 – 1.2 in			2 cm 0.8 in	3 cm 1.2 in
WY 3 / ATV 5: Yamaha Kodiak 400					2 cm 0.8 in			2 cm 0.8 in	2 cm 0.8 in
WY 3 / Sled 3: Arctic Cat Turbo Touring 660 4-S.					1 – 2 cm 0.4 – 0.8 in			1 cm 0.4 in	2 cm 0.8 in
WI 1 / ATV 3: Kawasaki Brut Force 750						4 – 8 cm 1.6 – 3.1 in		4 cm 1.6 in	8 cm 3.1 in
WI 1 / ATV 4: Honda Foreman 450						2 – 2.5 cm 0.8 – 1 in		2 cm 0.8 in	2.5 cm 1 in
WI 1 / Sled 3: Yamaha Viper 700						2 – 4 cm 0.8 – 1.6 in		2 cm 0.8 in	4 cm 1.6 in
WI 1 / Sled 4: Arctic Cat Bearcat 660 4-stroke						4 – 5 cm 1.6 – 2 in		4 cm 1.6 in	5 cm 2 in
ID 1 / ATV 3: Suzuki Vinson 500							3 – 5 cm 1.2 – 2 in	3 cm 1.2 in	5 cm 2 in
ID 1 / ATV 4: Polaris Scrambler 500							3 – 5 cm 1.2 – 2 in	3 cm 1.2 in	5 cm 2 in

Table 8: Fast Pass-Bys – Summary of Depth Impressions by Vehicle and Location

	SD 1	**SD 4**	**WY 1**	**WY 2**	**WY 3**	**WI 1**	**MN 1**	**ID 1**	**Min. Depth**	**Max. Depth**
Control Vehicles										
ATV 1: Polaris Sportsman 700	2 – 3 cm 0.8 – 1.2 in	3 cm 1.2 in	2 cm 0.8 in			1 – 2 cm 0.4 – 0.8 in	2 – 4 cm 0.8 – 1.6 in	3 cm 1.2 in	1 cm 0.4 in	4 cm 1.6 in
ATV 2: Polaris Predator 500	2 cm 0.8 in	3 cm 1.2 in	3 cm 1.2 in			2 – 3 cm 0.8 – 1.2 in	1 – 4 cm 0.4 – 1.6 in	2 – **5 cm** 0.8 – **2 in**	1 cm 0.4 in	**5 cm** **2 in**
Sled 1: Polaris Switchback 900	2 -3 cm 0.8 – 1.2 in	2 – 3 cm 0.8 – 1.2 in	2 cm 0.8 in			3 cm 1.2 in		3 cm 1.2 in	2 cm 0.8 in	3 cm 1.2 in
Sled 2: Polaris RMK 700	2.5 – **4 cm** 1 – **1.6 in**	2 – 3 cm 0.8 – 1.2 in	2 – **4 cm** 0.8 – **1.6 in**			2.5 – 3 cm 1 – 1.2 in		3 – **4 cm** 1.2 – **1.6 in**	2 cm 0.8 in	**4 cm** **1.6 in**
Other Vehicles										
SD 1 / Sled 3: Arctic Cat Firecat 700	2 – 3 cm 0.8 – 1.2 in								2 cm 0.8 in	3 cm 1.2 in
WY 2 & 3 / ATV 3: Bombardier Traxter 500				2 cm 0.8 in	2 cm 0.8 in				2 cm 0.8 in	2 cm 0.8 in
WY 2 & 3 / ATV 4: Polaris 6x6 500				2 cm 0.8 in	2 cm 0.8 in				2 cm 0.8 in	2 cm 0.8 in
WY 3 / ATV 5: Yamaha Kodiak 400					2 cm 0.8 in				2 cm 0.8 in	2 cm 0.8 in
WY 3 / Sled 3: Arctic Cat Turbo Touring 660 4-S.					1 cm 0.4 in				1 cm 0.4 in	1 cm 0.4 in
WI 1 / ATV 3: Kawasaki Brut Force 750						2 cm 0.8 in			2 cm 0.8 in	2 cm 0.8 in
WI 1 / ATV 4: Honda Foreman 450						1.5 – 2 cm 0.6 – 0.8 in			1.5 cm 0.6 in	2 cm 0.8 in
WI 1 / Sled 3: Yamaha Viper 700						1.5 – 2 cm 0.6 – 0.8 in			1.5 cm 0.6 in	2 cm 0.8 in
WI 1 / Sled 4: Arctic Cat Bearcat 660 4-stroke						2 – 2.5 cm 0.8 – 1 in			2 cm 0.8 in	2.5 cm 1 in
ID 1 / ATV 3: Suzuki Vinson 500								1.5 cm 0.6 in	1.5 cm 0.6 in	1.5 cm 0.6 in
ID 1 / ATV 4: Polaris Scrambler 500								3 cm 1.2 in	3 cm 1.2 in	3 cm 1.2 in

Table 9: Aggressive Stops – Summary of Depth Impressions by Vehicle and Location

	SD 1	SD 4	WY 1	WY 2	WY 3	WI 1	ID 1	Min. Depth	Max. Depth
Control Vehicles									
ATV 1: Polaris Sportsman 700	2 – **13 cm** 0.8 – **5.1 in**	2 – 3 cm 0.8 – 1.2 in	2 – 4 cm 0.8 – 1.6 in			2 – 3 cm 0.8 – 1.2 in	3 – 5 cm 1.2 – 2 in	2 cm 0.8 in	**13 cm** **5.1 in**
ATV 2: Polaris Predator 500	4 – 5 cm 1.6 – 2 in	3 – 4 cm 1.2 – 1.6 in	3 – 4 cm 1.2 – 1.6 in			2 – 4 cm 0.8 – 1.6 in	3 – 7 cm 1.2 – 2.8 in	2 cm 0.8 in	7 cm 2.8 in
Sled 1: Polaris Switchback 900	2 – 3 cm 0.8 – 1.2 in	2 – 3 cm 0.8 – 1.2 in	5 cm 2 in			2 – 5 cm 0.8 – 2 in	3 – 5 cm 1.2 – 2 in	2 cm 0.8 in	5 cm 2 in
Sled 2: Polaris RMK 700	5 – **6 cm** 2 – **2.4 in**	2 – 5 cm 0.8 – 2 in	3 – 4 cm 1.2 – 1.6 in			3 – 5 cm 1.2 – 2 in	4 – 5 cm 1.6 – 2 in	2 cm 0.8 in	**6 cm** **2.4 in**
Other Vehicles									
SD 1 / Sled 3: Arctic Cat Firecat 700	3 – 4 cm 1.2 – 1.6 in							3 cm 1.2 in	4 cm 1.6 in
WY 2 & 3 / ATV 3: Bombardier Traxter 500				2 – 10 cm 0.8 – 3.9 in	2 – 3 cm 0.8 – 1.2 in			2 cm 0.8 in	10 cm 3.9 in
WY 2 & 3 / ATV 4: Polaris 6x6 500				5 – 8 cm 2 – 3.1 in	2 – 4 cm 0.8 – 1.6 in			2 cm 0.8 in	8 cm 3.1 in
WY 3 / ATV 5: Yamaha Kodiak 400					2 – 4 cm 0.8 – 1.6 in			2 cm 0.8 in	4 cm 1.6 in
WY 3 / Sled 3: Arctic Cat Turbo Touring 660 4-S.					1 -2 cm 0.4 – 0.8 in			1 cm 0.4 in	2 cm 0.8 in
WI 1 / ATV 3: Kawasaki Brut Force 750						3 – 5 cm 1.2 – 2 in		3 cm 1.2 in	5 cm 2 in
WI 1 / ATV 4: Honda Foreman 450						2 – 2.5 cm 0.8 – 1 in		2 cm 0.8 in	2.5 cm 1 in
WI 1 / Sled 3: Yamaha Viper 700						2 – 3 cm 0.8 – 1.2 in		2 cm 0.8 in	3 cm 1.2 in
WI 1 / Sled 4: Arctic Cat Bearcat 660 4-stroke						2 – 5 cm 0.8 – 2 in		2 cm 0.8 in	5 cm 2 in
ID 1 / ATV 3: Suzuki Vinson 500							2 – 4 cm 0.8 – 1.6 in	2 cm 0.8 in	4 cm 1.6 in
ID 1 / ATV 4: Polaris Scrambler 500							2.5 – 6 cm 1 – 2.4 in	2.5 cm 1 in	6 cm 2.4 in

Curve Pass-Bys: Table 10 below summarizes the range of depth measurements for each control vehicle at each specific site (only control vehicles were tested at the five curve sites). It shows that the minimum depth of tire impressions left by ATVs during the curve pass-bys ranged from 2 centimeters/0.8 inch for the Sportsman to 3 centimeters/1.2 inches for the Predator, while the minimum depth of track impressions from both snowmobiles was 2 centimeters/0.8 inch. At the other end of the spectrum, the maximum depth of tire impressions left by ATVs during curve pass-bys ranged from 7 centimeters/2.8 inches for the Sportsman to 14 centimeters/5.5 inches for the Predator in the 90 degree curve. Comparatively, the maximum depth of snowmobile track impressions from curve pass-bys ranged from 4 centimeters/1.6 inches for the Switchback to 9 centimeters/3.5 inches for the RMK in the 180 degree curve. The maximum ATV depth recorded was 5 centimeters/2 inches deeper than the maximum snowmobile impression that was recorded. Overall, the ATVs tires tended push a berm of snow up on the outside edge as the vehicle negotiated the curve while the snowmobiles tended to slide more around the curve.

One additional curve pass-by was planned at site ID 2 but heavy drifting caused by high winds caused the ATVs to become stuck as the test crew approached the bottom of the site. As a result, the ID 2 curve test had to be abandoned.

Table 10: Curve Pass-Bys – Summary of Depth Impressions by Vehicle and Location

	SD 3 **180 degree**	**SD 3** **90 degree**	**SD 5** **35 degree**	**WY 1** **40 degree**	**WI 3** **140 degree**	**Min.** **Depth**	**Max.** **Depth**
Control Vehicles							
ATV 1: Polaris Sportsman 700	4 cm 1.6 in	5 – 7 cm 2 – 2.8 in	3 – 5 cm 1.2 – 2 in	2 – 4 cm 0.8 – 1.6 in	3 – 5 cm 1.2 – 2 in	2 cm 0.8 in	7 cm 2.8 in
ATV 2: Polaris Predator 500	7 – 13 cm 2.8 – 5.1 in	9 – **14 cm** 3.5 – **5.5 in**	4 – 5 cm 1.6 – 2 in	5 cm 2 in	3 – 8 cm 1.2 – 3.1 in	3 cm 1.2 in	**14 cm** **5.5 in**
Sled 1: Polaris Switchback 900			2 – 4 cm 0.8 – 1.6 in		2 – 3 cm 0.8 – 1.2 in	2 cm 0.8 in	4 cm 1.6 in
Sled 2: Polaris RMK 700	4 – **9 cm** 1.6 – **3.5 in**	3 – 4 cm 1.2 – 1.6 in	3 – 4 cm 1.2 – 1.6 in	5 cm 2 in	2 – 3 cm 0.8 – 1.2 in	2 cm 0.8 in	**9 cm** **3.5 in**

Hill Pass-Bys: Table 11 on the next page summarizes the range of 'uphill' pass-by depth measurements for each vehicle at each specific site. It shows that the minimum depth of tire impressions left by ATVs during the uphill pass-bys ranged from 2 centimeters/0.8 inch for the Sportsman to 3 centimeters/1.2 inches for the Predator, while the minimum depth of track impressions from the snowmobiles was 1.5 centimeters/0.6 inch for the Switchback and 2 centimeters/0.8 inch for the RMK and Arctic Cat F7. At the other end of the spectrum, the maximum depth of tire impressions left by ATVs during uphill pass-bys was 12 centimeters/4.7 inches for both vehicles as they struggled to climb the 19% grade at site SD 2. Comparatively, the maximum depth of snowmobile track impressions from uphill pass-bys ranged from 2 to 5 centimeters/0.8 to 2 inches. The maximum ATV depth recorded was 7 centimeters/2.8 inches deeper than the maximum snowmobile impression that was recorded.

One additional hill pass-by was planned at site ID 2 but heavy drifting caused by high winds caused the ATVs to become stuck as the test crew approached the bottom of the site. As a result, the ID 2 hill test had to be abandoned.

Downhill pass-bys resulted in tire and track impressions consistent with results obtained from fast pass-bys on the fast/aggressive test track. At higher speeds, the ATVs were often viewed by the test drivers as "squirrelly" and hard to control.

Snowmobile pass-bys on the hills typically redistributed snow on the trail surface and, in essence, re-leveled tire impressions/ruts left by ATV pass-bys.

Table 11: Uphill Pass-Bys – Summary of Depth Impressions by Vehicle and Location

	SD 2 **19%**	**SD 5** **14 – 18%**	**WY 1** **16%**	**WI 2** **15%**	**Minimum Depth**	**Maximum Depth**
Control Vehicles						
ATV 1: Polaris Sportsman 700	10 – **12 cm** 3.9 – **4.7 in**	3 – 5 cm 1.2 – 2 in	2 – 4 cm 0.8 – 1.6 in	3 – 6 cm 1.2 – 2.4 in	2 cm 0.8 in	**12 cm** **4.7 in**
ATV 2: Polaris Predator 500	10 – **12 cm** 3.9 – **4.7 in**	4 – 5 cm 1.6 – 2 in	5 cm 2 in	3 cm 1.2 in	3 cm 1.2 in	**12 cm** **4.7 in**
Sled 1: Polaris Switchback 900	2 cm 0.8 in	2 – 4 cm 0.8 – 1.6 in		1.5 – 3 cm 0.6 – 1.2 in	1.5 cm 0.6 in	3 cm 1.2 in
Sled 2: Polaris RMK 700	2 cm 0.8 in	3 – 4 cm 1.2 – 1.6 in	**5 cm** **2 in**	2 – **5 cm** 0.8 – **2 in**	2 cm 0.8 in	**5 cm** **2 in**
Other Vehicles						
SD 1 / Sled 3: Arctic Cat Firecat 700	2 cm 0.8 in				2 cm 0.8 in	2 cm 0.8 in

35 mph/56 kph Pass-By Stopping Distance: Table 13 on the following page summarizes the average stopping distance at 35 mph/56 kph for each vehicle at each specific site. It shows that the minimum average stopping distance for ATVs ranged from 11.2 meters/36.7 feet to 18.4 meters/60.4 feet, while the minimum average stopping distance for snowmobiles ranged from 17.3 meters/56.8 feet to 22.6 meters/74.2 feet (22.8% to 54.5% greater than the ATVs). At the other end of the spectrum, the maximum average stopping distance at 35 mph/56 kph for ATVs ranged from 13.7 meters/45.1 feet to 27.7 meters/90.7 feet. Comparatively, the maximum average snowmobile stopping distance ranged from 17.3 meters/56.8 feet to 27.4 meters/89.9 feet. The maximum ATV average stopping distance recorded was just 0.3 meter/11.8 inches (1.1%) farther than the maximum average snowmobile stopping distance that was recorded. Alternately, the overall average ATV stopping distance was 16.6 meters/54.5 feet while the overall average snowmobile stopping distance was 21.4 meters/70.2 feet (28.8% greater than the ATVs).

Table 14 on page 44 provides a comparison of the average stopping distance at 35 mph/56 kph for ATVs versus snowmobiles. It shows that the overall average stopping distance was shorter than all snowmobiles other than the Arctic Cat F7 snowmobile whose track was equipped with 153 1½-inch picks. Without these traction devices, it is extremely likely that all ATVs would have had an average stopping distance that was 0.3 meter/0.98 feet (1.5%) to as much as 10.2 meters/33.5 feet (74.5%) shorter than the snowmobiles.

Table 12 below provides a comparison of the control ATVs average stopping distance at 35 mph/56 kph on various trail surfaces including grass, gravel, dirt, and snow. The Sportsman ATV generally stopped in a shorter distance on snow as compared to when it was operated on the other trail surfaces (tires dug into surface more during aggressive stops on snow versus little rutting of the surface during aggressive stops on the other surface types). At the same time, the stopping distance for the Predator ATV varied more by trail surface type with substantively shorter stops on grass than on the other surface types. This variance was most likely attributed to the flatter tread design of the Predator's rear wheels interacting differently with the varying trail surfaces (grabbed hold on the grass versus skidding more on gravel, snow, and dirt). Note: the grass/gravel/dirt stopping tests were run with the vehicles operated side-by-side to enable using the Sportsman (equipped with a speedometer versus none on the Predator) as a pace vehicle.

Table 12: Comparison of Control ATVs 35 mph/56 kph Average Stopping Distance by Trail Surface

Control ATVs	**Average Stopping Distance on Grass**	**Average Stopping Distance on Gravel**	**Average Stopping Distance on Dirt**	**Average Stopping Distance on Snow**
ATV 1: Polaris Sportsman 700	19.2 meters 63.1 feet	20.3 meters 66.7 feet	19.9 meters 65.3 feet	18.5 meters 60.7 feet
ATV 2: Polaris Predator 500	14.9 meters 49.0 feet	20.3 meters 66.6 feet	18.8 meters 61.6 feet	19.6 meters 64.4 feet

Table 13: 35 mph/56 kph Pass-By Average Stopping Distance – Summary by Vehicle and Location

	SD 1	SD 4	WY 1	WY 2	WY 3	WI 1	ID 1	Min. Ave. Distance	Max. Ave. Distance	Overall Ave. Stop Distance
Control Vehicles										
ATV 1: Polaris Sportsman 700	19.8 m 65.0 f	25.5 m 83.6 f	21.1 m 69.2 f			14.9 m 49.0 f	11.2 m 36.7 f	11.2 m 36.7 f	25.5 m 83.6 f	18.5 meters 60.7 feet
ATV 2: Polaris Predator 500*	**27.7 m 90.7 f**	19.6 m 64.4 f	23.2 m 76.0 f			11.4 m 37.4 f	16.3 m 53.5 f	11.4 m 37.4 f	**27.7 m 90.7 f**	**19.6 meters 64.4 feet**
Sled 1: Polaris Switchback 900	23.6 m 77.4 f	24.8 m 81.5 f	**27.4 m 89.9 f**			20.6 m 67.5 f	23.2 m 76.1 f	20.6 m 67.5 f	**27.4 m 89.9 f**	**23.9 meters 78.5 feet**
Sled 2: Polaris RMK 700	21.5 m 70.5 f	25.0 m 82.0 f	24.6 m 80.8 f			18.5 m 60.8 f	22.7 m 74.5 f	18.5 m 60.8 f	25.0 m 82.0 f	22.5 meters 73.7 feet
Other Vehicles										
SD 1 / Sled 3: Arctic Cat Firecat 700	17.3 m 56.8 f									17.3 meters 56.8 feet
WY 2 & 3 / ATV 3: Bombardier Traxter 500				14.7 m 48.1 f	17.1 m 56.2 f			14.7 m 48.1 f	17.1 m 56.2 f	15.9 meters 52.2 feet
WY 2 & 3 / ATV 4: Polaris 6x6 500				12.8 m 42.1 f	16.9 m 55.3 f			12.8 m 42.1 f	16.9 m 55.3 f	14.9 meters 48.7 feet
WY 3 / ATV 5: Yamaha Kodiak 400					18.2 m 59.7 f					18.2 meters 59.7 feet
WY 3 / Sled 3: Arctic Cat Turbo Touring 660 4-S.					19.9 m 65.3 f					19.9 meters 65.3 feet
WI 1 / ATV 3: Kawasaki Brut Force 750						16.1 m 52.8 f				16.1 meters 52.8 feet
WI 1 / ATV 4: Honda Foreman 450						13.7 m 45.1 f				13.7 meters 45.1 feet
WI 1 / Sled 3: Yamaha Viper 700						22.4 m 73.5 f				22.4 meters 73.5 feet
WI 1 / Sled 4: Arctic Cat Bearcat 660 4-stroke						22.6 m 74.2 f				22.6 meters 74.2 feet
ID 1 / ATV 3: Suzuki Vinson 500							18.4 m 60.4 f			18.4 meters 60.4 feet
ID 1 / ATV 4: Polaris Scrambler 500							14.5 m 47.6 f			14.5 meters 47.6 feet

* The Polaris Predator ATV did not have a speedometer so the 35 mph pass-by speed was "estimated" by the operators which likely contributed to a variation in results.

Table 14: Comparison of Average Stopping Distance at 35 mph/56 kph – ATVs versus Snowmobiles

Rank: Shortest to Longest Stop Distance	Vehicle	SD 1	SD 4	WY 1	WY 2	WY 3	WI 1	ID 1	Overall Average Stop Distance
	ATVs								
1	WI 1 / ATV 4: Honda Foreman 450						13.7 m 45.1 f		13.7 meters 45.1 feet
2	ID 1 / ATV 4: Polaris Scrambler 500							14.5 m 47.6 f	14.5 meters 47.6 feet
3	WY 2 & 3 / ATV 4: Polaris 6x6 500				12.8 m 42.1 f	16.9 m 55.3 f			14.9 meters 48.7 feet
4	WY 2 & 3 / ATV 3: Bombardier Traxter 500				14.7 m 48.1 f	17.1 m 56.2 f			15.9 meters 52.2 feet
5	WI 1 / ATV 3: Kawasaki Brut Force 750						16.1 m 52.8 f		16.1 meters 52.8 feet
6	WY 3 / ATV 5: Yamaha Kodiak 400					18.2 m 59.7 f			18.2 meters 59.7 feet
7	ID 1 / ATV 3: Suzuki Vinson 500							18.4 m 60.4 f	18.4 meters 60.4 feet
8	Control ATV 1: Polaris Sportsman 700	19.8 m 65.0 f	25.5 m 83.6 f	21.1 m 69.2 f			14.9 m 49.0 f	11.2 m 36.7 f	18.5 meters 60.7 feet
9	Control ATV 2: Polaris Predator 500*	27.7 m 90.7 f	19.6 m 64.4 f	23.2 m 76.0 f			11.4 m 37.4 f	16.3 m 53.5 f	19.6 meters 64.4 feet
	Snowmobiles								
1	SD 1 / Sled 3: Arctic Cat Firecat 700 / with picks	17.3 m 56.8 f							17.3 meters 56.8 feet
2	WY 3 / Sled 3: Arctic Cat Turbo Touring 660 4-S.					19.9 m 65.3 f			19.9 meters 65.3 feet
3	WI 1 / Sled 3: Yamaha Viper 700						22.4 m 73.5 f		22.4 meters 73.5 feet
4	Control Sled 2: Polaris RMK 700	21.5 m 70.5 f	25.0 m 82.0 f	24.6 m 80.8 f			18.5 m 60.8 f	22.7 m 74.5 f	22.5 meters 73.7 feet
5	WI 1 / Sled 4: Arctic Cat Bearcat 660 4-stroke						22.6 m 74.2 f		22.6 meters 74.2 feet
6	Control Sled 1: Polaris Switchback 900	23.6 m 77.4 f	24.8 m 81.5 f	27.4 m 89.9 f			20.6 m 67.5 f	23.2 m 76.1 f	23.9 meters 78.5 feet

* The Polaris Predator ATV did not have a speedometer so the 35 mph pass-by speed was "estimated" by the operators which likely contributed to a variation in results.

Operation on Trail with New, Ungroomed Snow: Field tests MN 1 and MN 2 provided good opportunities to observe operation of the two control ATVs on real trails open to concurrent use by both ATVs and snowmobiles. The trails also had 6 to 20 centimeters/2.4 to 7.9 inches of new snow on them which provided somewhat of a "fresh powder" riding perspective, particularly in the deeper snow on the side trails at site MN 2. The Sportsman ATV handled the trail riding on fresh, ungroomed snow relatively well and noticeably better in the 4-wheel drive mode where you could feel the extra pulling of the front wheels providing more stability versus the noticeable pushing of the front end when in 2-wheel drive mode. The Predator ATV generally felt very "squirrelly" and unsafe much of the time, particularly at higher speeds and in the deeper snow as the 2-wheel drive vehicle struggled to push the front end through the uncompacted snow. In the new snowfall the Sportsman's tires generally compressed the new snow to a depth of 2 to 3 centimeters/0.8 to 1.2 inches while the Predator's tires generally compressed the new snow to a depth of 1 to 2 centimeters/0.4 to 0.8 inch, irrespective as to how deep the new snow was. This is indicative of a major difference between ATVs and snowmobiles in snow – an ATV's tires penetrate the snow whereas a snowmobile is designed to have more flotation to stay on top of the snow. One other observation in respect to the Predator is that, because of its lower clearance as compared to the Sportsman, operation in snow much deeper than the 20 centimeters/7.9 inches likely would have been extremely difficult, if not impossible. This position is further enforced by the experience as site ID 2 when, due to severe wind drifting on the trail, the ATVs became stuck on the trail while trying to approach the test site. As a result, this curve/hill testing was cancelled since the ATVs could not negotiate the new snow on the trail.

ATVs Stuck When Off the Compacted Trail: There were multiple instances during several of the field tests were an ATV got stuck when it got off the compacted trail base, either intentionally in an attempt to turn around or when going down the trail the outside tires were sucked into softer snow. The worst incident occurred at site SD 3 when the Predator ATV's outside front tire got off the compacted base on a windswept curve (it all looked like compacted trail) and the vehicle flipped end-over-end. Fortunately the operator was not hurt and the vehicle was not damaged, but the results could have easily been much different.

Snowmobile Ski Skag Grooves on the Trail: Snowmobile ski skags (carbides or other runners on the bottom side of the skis) left grooves in the trail that were consistently present and varied from 2.5 to 6 centimeters (1 to 2.4 inches) in width and 1 to 4 centimeters (0.4 to 1.6 inches) deep. It is common when riding a snowmobile to have ski skag grooves on the trail from previous snowmobile traffic sometimes "hook" or grab the snowmobile's ski and cause a sudden and unexpected pull to the right or left as the sled's ski is pulled into and often trapped in the pre-existing skag groove. Some have expressed a concern that impressions left on a snowmobile trail from ATV tires could cause a similar hooking or trapping of a snowmobile's ski. That was not the observation during this field testing. Tire impressions are typically 20 to 30 centimeters (7.9 to 11.8 inches) wide and therefore substantially wider than the ski skag grooves, so there was no similar "trapping" of the ski within the tire impression observed. While there could certainly be a ridge in the trail due to a tire impression, the wider width of the depression allows some movement of the ski within the depression, to allow changing the angle of the ski while turning, versus when a ski is trapped in a skag groove which often requires a strong steering effort to power the ski loose from the skag groove. One must also keep in mind that, if there are tire impressions on the trail deep enough to cause steering problems, then most likely there are also going to be similar impressions from snowmobile tracks. Either way, there is room to begin maneuvering a snowmobile's skis within tire or track impressions.

ATV Operation on Heavily Moguled Trails: ATVs had a difficult time negotiating and maintaining much speed on sections of trail with deep and heavy moguls. Their shorter length caused them to bob up and down when traversing the moguls much more than the snowmobiles did when traversing the same moguls. Consequently, snowmobiles were able to stay more under control and also operate at much higher speeds across rough, heavily moguled trails.

Summary of Field Testing Observations

The following general observations represent results from this specific series of field tests. Keep in mind that the observed impacts represent a snapshot of effects related to the very specific conditions at the specific site at that specific point in time. Also keep in mind that a primary factor of “trail durability” with any groomed snow surface is the number of vehicles that use it between grooming repetitions and how well the trail surface is able to refreeze/set up prior to traffic resuming on its surface. If a trail has 50 vehicles a day on it versus 250 vehicles per day, the impacts are going to be different irrespective as to whether the vehicles are snowmobiles or/and ATVs.

Most trails used for this field testing had a very well compacted trail base. As a result, the overall average depths of tire or track impressions on the trail were nominal. Trails that had been regularly groomed with a multi-blade drag were generally very firm and had minimal impacts from either vehicle type. However, impression depths at two sites, WY 2 and ID 1, were generally deeper than at the other sites. Site WY 1 had been groomed only three times with a single blade drag and was very soft below the top crust. Site ID 1, which was a bit soft from having been tilled the same morning as the testing, also had a sub-base that was noticeably less dense than the trails groomed with multi-blade drags.

Generally, on the well compacted trails and under the conditions where these vehicles were tested, there were no substantive differences observed between the impacts of ATV or snowmobile operation on groomed snowmobile trails. This was particularly true on flat, straight sections of trail such as what is typical of railroad grade trails. As curves and/or hills were considered, these results diverged slightly but not substantively. The bottom line is that, when operated under the same conditions, impacts to the groomed trail surface from both vehicles were very similar.

In respect to ‘slow/normal’ operation speeds of 15 mph/24 kph or less, there were no observed adverse impacts from either ATVs or snowmobiles. Impressions on the groomed trail surface were generally what is considered normal “surface chew.”

In respect to ‘aggressive starts,’ the worst-case observation was that ATVs created tire impressions that were only a bit deeper (2 centimeters/0.8 inch) than the deepest snowmobile track impressions. The deepest impressions from ATVs during aggressive starts ranged from 2 to 12 centimeters/0.8 to 4.7 inches in depth while the deepest snowmobile track impressions ranged from 2 to 10 centimeters/0.8 to 3.9 inches in depth.
In respect to ‘fast pass-bys,’ there were no observed adverse impacts such as rutting or trenching of the trail surface from either ATVs or snowmobiles. Tire and track impressions on the groomed trail surface were generally what is considered normal “surface chew.” The worst case observation was that ATVs created tire impressions that were only a bit deeper (1 centimeters/0.4 inch) than the deepest snowmobile track impressions. The deepest impressions from ATVs during fast pass-bys ranged from 1.5 to 5 centimeters/0.6 to 2 inches while the deepest snowmobile track impressions ranged from 1 to 4 centimeters/0.4 to 1.6 inches. Comparatively, footprints on the same trail surfaces ranged from 2 to 5 centimeters/0.8 to 2 inches in depth.

In respect to ‘aggressive stops,’ the worst-case observation was that ATVs created tire impressions that were slightly deeper (7 centimeters/2.8 inches) than the deepest snowmobile track impressions. The deepest impressions from ATVs during aggressive starts ranged from 2.5 to 13 centimeters/1 to 5.1 inches in depth while the deepest snowmobile track impressions ranged from 2 to 6 centimeters/0.8 to 2.4 inches in depth. This is the only area where there was a small yet noticeable difference between ATV and snowmobile impressions while operated on the fast/aggressive track.

In respect to ‘curve pass-bys,’ the worst-case observation was that ATVs created tire impressions that were slightly deeper (5 centimeters/2 inches) than the deepest snowmobile track impressions. The deepest impressions from ATVs during curve pass-bys ranged from 7 to 14 centimeters/2.8 to 5.5 inches in depth while the deepest snowmobile track impressions ranged from 4 to 9 centimeters/1.6 to 3.5 inches in depth. Overall, the ATVs tires tended push a berm of snow up on the outside edge as the vehicle negotiated the curves while the snowmobiles tended to slide more around the curves.

In respect to 'hill pass-bys,' the worst-case observation was that ATVs created tire impressions that were slightly deeper (7 centimeters/2.8 inches) than the deepest snowmobile track impressions and, in general, they struggled on the steepest grades. The deepest impressions from ATVs during uphill pass-bys were 12 centimeters/4.7 inches in depth while the deepest snowmobile track impressions ranged from 2 to 5 centimeters/0.8 to 2 inches in depth. Downhill pass-bys resulted in tire and track impressions that were primarily "surface chew" consistent with results from fast pass-bys. At higher speeds, the ATVs were often viewed by the test drivers as "squirrelly" and hard to control. Of note, snowmobile pass-bys on the hills typically redistributed snow on the trail surface and, in essence, re-leveled tire impressions/ruts left by ATV pass-bys.

In respect to 'stopping distance at 35 mph/56 kph,' the overall average stopping distance of all ATVs was shorter than all snowmobiles except the Arctic Cat F7 equipped with 153 1½-inch picks in its track. The maximum average stopping distance for ATVs ranged from 13.7 meters/45.1 feet to 27.7 meters/90.7 feet while the maximum average snowmobile stopping distance ranged from 17.3 meters/56.8 feet to 27.4 meters/89.9 feet. The overall average snowmobile stopping distance was 28.8% greater than the overall average ATV stopping distance. The average stopping distance for ATVs on snow was also typically greater than when on grass, dirt, or gravel trail surfaces.

In respect to 'ATV operation on new, ungroomed snow,' the vehicles typically compressed the new snow to a depth of 1 to 3 centimeters/0.4 to 1.2 inches, which means they had little flotation as compared to a snowmobile. The 4-wheel drive model with higher clearance negotiated new snow on top of the compacted trail surface relatively well while the 2-wheel drive model with lower clearance often struggled, particularly as uncompacted snow depth increased.

ATVs had a difficult time negotiating and maintaining much speed on sections of trail at Site MN 2 that had deep and heavy moguls. Their shorter length caused them to bob up and down when traversing the moguls much more than what snowmobiles would when traversing the same moguls.

Snowmobile ski skags consistently left grooves in the trail that varied from 2.5 to 6 centimeters (1 to 2.4 inches) in width and 1 to 4 centimeters (0.4 to 1.6 inches) deep. It is common when riding a snowmobile to have ski skag grooves on the trail from previous snowmobile traffic sometimes "hook" or grab the snowmobile's ski and cause a sudden and unexpected pull to the right or left as the sled's ski is pulled into and often trapped in the pre-existing skag groove. Some have expressed a concern that impressions left on a snowmobile trail from ATV tires could cause a similar hooking or trapping of a snowmobile's ski. That was not the observation during this field testing. Tire impressions are typically 20 to 30 centimeters (7.9 to 11.8 inches) wide and therefore substantially wider than the ski skag grooves, so there was no similar "trapping" of the ski within the tire impression observed.

Finally, the ATVs almost always got stuck when they got off the compacted trail base. Sometimes this happened when the operator was attempting to turn around while other times it happened when the vehicle was going down the trail and the outside tires were sucked into softer snow at the edge of the trail or off to the side of the trail. The worst-case scenario resulted in an ATV flipping end-over-end when it was sucked off the trail base.

These Results as Compared to the 1984 Idaho Study

As mentioned earlier, the only other formal field evaluation of ATV use on groomed snowmobile trails was conducted in 1984 by the Idaho Department of Parks and Recreation. That study concluded that, "It is very evident that most of the impacts created by ATVs on groomed snowmobile trails are similar to the impacts created by snowmobiles under the same conditions, and it would be hard to say objectively that ATVs and snowmobiles have a significant difference in the impacts they create on a groomed snowmobile trail."

Even though ATVs and snowmobiles have both changed substantively since 1984, the results of this study would generally concur with the 1984 conclusion – the impacts created by ATVs and snowmobiles operated on groomed snowmobile trails under the same conditions are very similar.

REFERENCES

Canada Safety Council. *The All-Terrain Vehicle Boom.* www.safety-council.org/info/sport/atv.html

Gurtner, S. p*ersonal communication*. February 7-9, 2006. Bayfield County Snowmobile Alliance, Iron River, Wisconsin.

Hayes, F. *IASA Trail Manager Survey*. December, 2005. Utah State Parks and Recreation Division.

Ironwood Daily Globe. "Two Recreation Groups Come Together in Northern Wisconsin." August 24, 2006.

ISMA. *Snowmobiling Fact Book.* 2006. International Snowmobile Manufacturers Association (ISMA). www.snowmobile.org

OnlineConversion.com. 2006. www.onlineconversion.com

Raap, K. *Guidelines for Snowmobile Trail Groomer Operator Training – A Resource Guide for Trail Grooming Managers and Equipment Operators*. 2005. International Association of Snowmobile Administrators (IASA). www.snowiasa.org

U.S. Consumer Products Safety Commission (CPSC). *2004 Annual Report on ATV Deaths and Injuries*. September 2005. www.cpsc.gov

Wells, C. *All Terrain Vehicles on Groomed Snowmobile Trails*. 1984. Idaho Department of Parks and Recreation.

Woodlot Alternatives. *A Plan for Developing New Hampshire's Statewide Trail System for ATV's and Trail Bikes 2004 – 2008*. December 2003. New Hampshire Division of Parks and Recreation – Bureau of Trails.

EVALUATION OF ATV USE ON GROOMED SNOWMOBILE TRAILS

Part 2: Appendixes A – D

APPENDIX A: SUMMARY OF DAILY FIELD TESTING JOURNALS WITH PHOTO DOCUMENTATION

Field Testing Journal: January 9, 2006
New Effington – Northeast Trail, South Dakota (SD 1)

Photo 1: Site of SD 1 field test

Field Study Code/Number: SD 1
Location: Northeast Trail east of New Effington, South Dakota along SD Highway 127
Elevation: 1090 feet
Temperature: 28.7 F/-1.8 C (start) to 26.7 F/-2.9 C (end)
Time of Day: 10:05 AM to 1:12 PM
Weather: clear, sunny, 2 mph/3.2 kph wind
Trail Aspect: flat, located in highway road ditch
Trail Conditions: hard packed and very slight surface wear from weekend traffic; last groomed 3 days prior (groomed Friday, tested on Monday) but in good condition; traces of new snow on surface from wind drifting the prior evening
Compacted Snow Depth: 18 cm (7.1 in) at location 1 (the slow/normal track) and 22 cm (8.7 in) at location 2 (the fast/aggressive track); both sites were packed hard to the ground.
Uncompacted snow depth adjacent to the trail: 30 to 40 cm (12 to 16 inches)
Area Grooming Equipment: Tucker 2000 with Mogul Master 18-08 drag

<u>Control Vehicles</u>
A1 – 2005 Polaris Sportsman EFI 700 (4x4; auto transmission; 26 x 11R-12 rear tires / ½" lugs, 4 psi)
A2 – 2006 Polaris Predator 500 (2x4; manual transmission; 20 x 11-9 rear tires / ½" lugs, 4 psi)
S1 – 2006 Polaris Switchback 900 (144 x 15 x 1¼" track)
S2 – 2006 Polaris RMK 700 (144 x 15 x 2" track)
<u>Other Vehicles</u>
S3 – 2005 Arctic Cat Firecat F7 (131 x 13½ x 13/8" track / 153 1½" picks)

<u>Individual Vehicle Observations</u>

A1: 2005 Polaris Sportsman 700 ATV
<u>Slow/normal track</u> – generally, all starts, stops and 15 mph/24 kph pass-bys resulted in visible tire tread tracks that were 2 to 3 cm (0.8 to 1.2 in) deep and 18 to 21 cm (7.1 to 8.3 in) wide. Tire tracks were generally consistently visible and the same the entire length of the start and pass-by zones. Four passes were run in 4x4 mode and another 4 passes were run in 2x4 mode. Results were generally similar with only slightly more rear tire spin in the 2x4 mode. Since there was insignificant difference observed between the 4x4 and 2x4 testing, it was decided that all additional tests with this vehicle would be conducted only in the 4x4 mode.

Photo 2: Surface chew from slow pass-by

<u>Fast/aggressive track</u> – starts resulted in tire tracks that varied from 2 to 7 cm (0.8 to 2.8 in) deep, 18 to 20 cm (7.1 to 7.9 in) wide and 300 to 360 cm (9.8 to 11.8 feet) in length. The 35 mph/56 kph pass-by resulted in visible tire tracks 2 to 3 cm (0.8 to 1.2 in) deep and 18 to 21 cm (7.1 to 8.3 in) wide and left no visible trenching or

rutting. Stops resulted in tire impressions that varied from 2 to 13 cm (0.8 to 5.1 in) deep and 22 to 30 cm (8.7 to 11.8 in) wide. Stopping distance at 35 mph/56 kph ranged from 18.7 to 21.6 meters (61.4 to 70.9 feet), with an average stopping distance of 19.8 meters (65 feet).

Photo 3: Aggressive start

Photo 4: Aggressive stop

Other – the vehicle got stuck twice. The first time was when the operator tried to turn around off the trail surface. The vehicle sunk in to its axles before it could make it back onto the trail. (The tracks to the right of the trail in Photo 5) The second time was when the right wheels of the ATV got off the edge of the packed base while it was going down the trail and the right tires were sucked into the softer snow adjacent to the trail.

Photo 5: Tracks at right where vehicle got stuck

Photo 6 (above): ATV stuck off-trail

A2: 2006 Polaris Predator 500 ATV

Slow/normal track – generally, all starts, stops and 15 mph/24 kph pass-bys resulted in visible tire tread tracks that were 2 cm (0.8 in) deep and 28 to 30 cm (11 to 11.8 in) wide. Tire tracks were generally visible and consistent the entire length of the start and pass-by zones.

Photo 7: Surface chew from slow pass-by

Fast/aggressive track – starts resulted in tire tracks that varied from 3 to 6 cm (1.2 to 2.4 in) deep and 27 to 30 cm (10.6 to 11.8 in) wide. The 35 mph/56 kph pass-bys resulted in visible tire tracks 2 cm (0.8 in) deep and 27 to 30 cm (10.6 to 11.8 in) wide and left no visible trenching or rutting. Stops resulted in tire impressions that varied from 4 to 5 cm (1.6 to 2 in) deep and 27 to 30 cm (10.6 to 11.8 in) wide. Stopping distance at 35 mph/56 kph ranged from 22.7 to 31.9 meters (74.5 to 104.7 feet), with an average stopping distance of 27.7 meters (90.7 feet).

Photo 8: Tracks from aggressive start

Photo 9: Tracks and snow piles from acceleration

Other – the vehicle got stuck twice. The first time was when the operator was attempting a 3-point turn around and the rear wheels dropped off the packed trail surface. The vehicle sunk in to the rear axle – see the impressions left in Photo 10 at right. The second time was when the right wheels of the vehicle got off the packed base while it was going down the trail. The ATV was sucked into the softer snow adjacent to the side of the trail. See Photos 11 and 12.

Photo 10: Tracks where vehicle was stuck beside trail

Photo 11: Stuck on edge of trail

Photo 12: Stuck vehicle

S1: 2006 Polaris Switchback 900 Snowmobile

Slow/normal track – generally, all starts, stops and 15 mph/24 kph pass-bys resulted in 2.5 cm (1 in) deep grooves from the ski skags and normal "surface chew" from the track that was 2 to 3 cm (0.8 to 1.2 in) deep and 38 to 40 cm (15 to 15.7 in) wide. The skag marks and surface chew were generally consistently visible and the same the entire length of the start, pass-by, and stop zones, consistent with trail wear from normal snowmobile traffic.

Photo 13: Surface chew from slow pass-by

Fast/aggressive track – starts resulted in track marks that varied from 2 to 3 cm (0.8 to 1.2 in) deep and 40 to 43 cm (15.7 to 16.9 in) wide. There were also 2.5 cm (1 in) deep ski skag grooves. The 35 mph/56 kph pass-bys resulted in normal "surface chew" from the track that was 2 to 3 cm (0.8 to 1.2 in) deep and 38 to 40 cm (15 to 15.7 in) wide), along with the 2.5 cm (1 in) deep ski skag grooves. There was no visible trenching or rutting. Stops resulted in track impressions that varied from 2 to 3 cm (0.8 to 1.2 in) deep and 42 to 43 cm (16.5 to 16.9 in) wide. Stopping distance at 35 mph/56 kph ranged from 22.5 to 25.2 meters (73.8 to 82.7 feet), with an average stopping distance of 23.6 meters (77.4 feet)

Photo 14: Impressions from aggressive stop

Photo 15: Aggressive stop

Photo 16: Surface chew from fast pass-by

S2: 2006 Polaris RMK 700 Snowmobile

<u>Slow/normal track</u> – generally, all starts, stops and 15 mph/24 kph pass-bys resulted in 2.5 cm (1 in) deep grooves from the ski skags and normal "surface chew" from the track that was 2.5 to 4 cm (1 to 1.6 in) deep and 38 to 40 cm (15 to 15.7 in) wide. The skag marks and surface chew were generally consistently visible and the same the entire length of the start, pass-by, and stop zones, consistent with trail wear from normal snowmobile traffic.

Photo 17: Surface chew from slow pass-by

<u>Fast/aggressive track</u> – starts and stops both resulted in track marks that varied from 5 to 6 cm (2 to 2.4 in) deep and 42 to 43 cm (16.5 to 16.9 in) wide, along with 2.5 cm (1 in) deep ski skag grooves. The start left trenching while the stop left slide marks – both more prominent than those left by S1 which has shorter track lugs. The 35 mph/56 kph pass-bys resulted in impressions from the track that were 2.5 to 4 cm (1 to 1.6 in) deep and 38 to 40 cm (15 to 15.7 in) wide, along with 2.5 cm (1 in) deep ski skag grooves. There was no visible trenching or rutting. Stopping distance at 35 mph/56 kph ranged from 20.2 to 23.2 meters (66.3 to 76.1 feet), with an average stopping distance of 21.5 meters (70.5 feet).

Photo 18: An aggressive start

Photo 19: An aggressive stop

S3: 2005 Arctic Cat Firecat F7 Snowmobile

Slow/normal track – generally, all starts, stops and 15 mph/24 kph pass-bys resulted in ski skag grooves that were 2.5 cm (1 in) deep and normal "surface chew" from the track that was 2 to 3 cm (0.8 to 1.2 in) deep and 35 cm (13.8 in) wide. The skag marks and surface chew were generally consistently visible and the same the entire length of the start, pass-by, and stop zones, consistent with trail wear from normal snowmobile traffic.

Fast/aggressive track – starts resulted in track marks that varied from 4 to 10 cm (1.6 to 3.9 in) deep and were generally 35 cm (13.8 in) wide, along with 2.5 cm (1 in) deep ski skag grooves. The 35 mph/56 kph pass-by resulted in 2 to 3 cm (0.8 to 1.2 in) deep and 35 cm (13.8 in) wide "surface chew" from the track, along with 2.5 cm (1 in) deep ski skag grooves. There was no visible trenching or rutting. Stops resulted in track impressions that varied from 3 to 4 cm (1.2 to 1.6 in) deep and were 35 to 38 cm (13.8 to 15 in) wide. Stopping distance at 35 mph/56 kph ranged from 16.5 to 18.9 meters (54.1 to 62 feet), with an average stopping distance of 17.3 meters (56.8 feet).

Photo 20: Surface chew from slow pass-by

Photo 21: Impression from aggressive start

Photo 22: An aggressive stop

Summary of Observations from SD 1 Field Test

- SLOW/NORMAL OPERATION: None of the vehicles created noticeable adverse impacts when operated in the slow/normal mode whether in the start, 15 mph/24 kph pass-by, or stop zones.
- FAST/AGGRESSIVE PASS-BY: None of the vehicles created noticeable adverse impacts when operated in the 35 mph/56 kph pass-by mode.
- AGGRESSIVE STARTS: Snowmobiles created deeper impressions in the trail than what ATVs did. Aggressive starts resulted in ATV tire tracks 3 to 7 cm (1.2 to 2.8 in) deep and 18 to 30 cm (7.1 to 11.8 in.) wide. Snowmobile track impressions were 2 to 10 cm (0.8 to 3.9 in) deep and 35 to 43 cm (13.8 to 16.9 in.) wide. The deepest snowmobile track impressions were 3 cm (1.2 in) deeper than the deepest ATV tire tracks.
- AGGRESSIVE STOPS: ATVs created deeper impressions in the trail than what snowmobiles did. Aggressive stops resulted in ATV tire tracks 2 to 13 cm (0.8 to 5.1 in) deep and 22 to 30 cm (8.7 to 11.8 in) wide. Snowmobile track impressions were 2 to 5 cm (0.8 to 2 in) deep and 35 to 43 cm (13.8 to 16.9 in) wide. The deepest ATV tire tracks were 8 cm (3.1 in) deeper than the deepest snowmobile track impressions.

- STOPPING DISTANCE – ALL VEHICLES: When comparing all vehicles tested, the snowmobiles generally stopped quicker than what the ATVs did. The Sportsman stopped the quicker of the two ATVs, while the Firecat stopped the quickest of the three snowmobiles. The Switchback required the greatest distance to stop of the three snowmobiles. Average ATV stopping distance at 35 mph/56 kph ranged from 19.8 to 27.7 meters (65.0 to 90.7 feet). The average snowmobile stopping distance ranged from 17.3 to 23.6 meters (56.8 to 77.4 feet). The minimum average snowmobile stopping distance (the Firecat) was 2.5 meters/8.2 feet (14.5%) less than the shortest ATV stopping distance, while the maximum average ATV stopping distance (the Predator) was 4.1 meters/13.3 feet (17.2%) greater than the longest average snowmobile stopping distance.
- STOPPING DISTANCE – CONTROL VEHICLES: When comparing just the four control vehicles, the results were mixed. The Sportsman stopped quicker of the two control ATVs, while the Switchback required the greatest distance to stop of the two control snowmobiles. The Sportsman ATV stopped quicker than both snowmobiles, while the Predator ATV required a longer distance to stop than what the snowmobiles did. The average ATV stopping distances at 35 mph/56 kph ranged from 19.8 to 27.7 meters (65.0 to 90.7 feet), while the average snowmobile stopping distance ranged from 21.5 to 23.6 meters (70.5 to 77.4 feet). The minimum average ATV stopping distance (the Sportsman) was 1.7 meters/5.6 feet (8.6%) less than the shortest average snowmobile stopping distance, while the maximum average ATV stopping distance (the Predator) was 4.1 meters/13.5 feet (17.4%) greater than the snowmobiles.
- Both ATVs immediately became stuck when they got off the packed trail base.
- Note: Due to the narrower width (8 feet) of this trail, ATVs were tested first, followed by snowmobiles on the same track. On all subsequent tests, ATVs and snowmobiles were tested side-by-side on wider trails.

****

Field Testing Journal: January 9, 2006
Lake Traverse – Northeast Trail. South Dakota (SD 2)

Field Study Code/Number: SD 2
Location: adjacent to Lake Traverse on the Northeast Trail, South Dakota
Elevation: 1050 feet
Temperature Range: 28.0 F/-2.2 C (start) to 18.5 F/-7.5 C (end)
Time of Day: 4:12 PM to 4:48 PM
Weather: clear, sunny, 3 mph/4.8 kph wind
Trail Aspect: south facing, 19% grade for 320 feet/97.5 meters, located in county road ditch
Trail Conditions: hard packed and very slight surface wear from weekend traffic; last groomed 3 days prior (groomed Friday, tested on Monday) but in good condition; traces of new snow on surface from wind drifting the prior evening

Photo 23: Site of SD 2 testing

Compacted Snow Depth: 40 cm (15.7 in) – packed hard to ground
Uncompacted snow depth adjacent to the trail: greater than 60 cm (24 in)
Area Grooming Equipment: Tucker 2000 with Mogul Master 18-08 drag

Control Vehicles

A1 – 2005 Polaris Sportsman EFI 700 (4x4; auto transmission; 26 x 11R-12 rear tires / ½” lugs, 4 psi)
A2 – 2006 Polaris Predator 500 (2x4; manual transmission; 20 x 11-9 rear tires / ½” lugs, 4 psi)
S1 – 2006 Polaris Switchback 900 (144 x 15 x 1¼” track)
S2 – 2006 Polaris RMK 700 (144 x 15 x 2” track)

Other Vehicles

S3 – 2005 Arctic Cat Firecat F7 (131 x 13½ x 13/8” track / 153 1½” picks)

Individual Vehicle Observations

A1: 2005 Polaris Sportsman 700 ATV

Hill pass-by – the vehicle struggled with the steepness of the grade, so all uphill pass-bys would be considered 'aggressive' versus 'normal.' The vehicle's tires were spinning all the way up the hill on all uphill passes, making it hard to control and keep straight while climbing. Impressions from the tire tracks were 10 to 12 cm (3.9 to 4.7 in) deep and 20 cm (7.9 in) wide on the uphill passes. Tire impressions left by downhill passes varied from 2 to 5 cm (0.8 to 2 in) in depth and were 20 cm (7.9 in) wide.

Photo 24: An uphill pass

Photo 25: Impressions from an uphill pass

Photo 26: Impressions from a downhill pass

A2: 2006 Polaris Predator 500 ATV

Hill pass-by – the vehicle struggled with the steepness of the grade and had a hard time making it up the hill, so all uphill pass-bys would be considered 'aggressive' versus 'normal.' The vehicle was swerving and hard to control with its tires spinning all the way up the hill on all uphill passes. Impressions from the tire tracks were 10 to 12 cm (3.9 to 4.7 in) deep and 28 to 30 cm (11 to 11.8 in) wide on the uphill passes. Downhill passes left only 2 cm (0.8 in) impressions of the tire tread (due to the flatter tire design) with no visible impact to the trail.

Photo 27: An uphill pass

Photo 28: Impressions from an uphill pass

Photo 29: Impressions from an uphill pass

Photo 30: Tire impressions from a downhill pass

S1: 2006 Polaris Switchback 900 Snowmobile

Hill pass-by – Slow/normal uphill and downhill pass-bys actually helped to somewhat re-level the trail surface after the ATVs had rutted the hill. On slow/normal pass-bys at 15 mph/24 kph, both uphill and downhill, the vehicle left only skag marks and normal track marks with minimal surface chew 2 cm (0.8 in) deep. On fast/aggressive runs at 32 to 35 mph/ 51 to 56 kph, only normal track marks (surface chew) 2 cm (0.8 in) deep and 40 cm (15.7 in) wide were left on the trail. 2 cm (0.8 in) deep ski skag marks were also visible. There was no spinning or rutting during slow/normal or fast/aggressive passes, up or down hill.

Photo 31: A downhill pass

S2: 2006 Polaris RMK 700 Snowmobile

Hill pass-by – Results were identical to those of the Switchback (S1) runs. Slow/normal uphill and downhill pass-bys actually helped to re-level trail surface after the ATVs had rutted the hill. On slow/normal pass-bys at 15 mph/24 kph, both uphill and downhill, the vehicle left only skag marks and minimal surface chew track marks.

On the fast/aggressive runs at 32 to 35 mph/ 51 to 56 kph, only 2 cm (0.8 in) deep track surface chew and 2 cm (0.8 in) deep ski skag marks were left on the trail. There was no spinning or rutting during slow/normal or fast/aggressive passes, up or down hill.

Photos 32 and 33: The hill after snowmobile passes – note that the ATV tire marks were re-leveled

S3: 2005 Arctic Cat Firecat F7 Snowmobile

Hill pass-by – Results were identical to those of the S1 and S2 runs. On slow/normal pass-bys at 15 mph/24 kph, both uphill and downhill, the vehicle left only skag marks and normal track marks with minimal surface chew. On the fast/aggressive runs at 32 to 35 mph/ 51 to 56 kph, only track surface chew marks 2 cm (0.8 in) deep and 2 cm (0.8 in) deep ski skag marks were left on the trail. There was no spinning or rutting during slow/normal or fast/aggressive passes, up or down hill.

Photo 34: An uphill pass

Summary of Observations from SD 2 Field Test

- ATV PASS-BYS: Both ATVs struggled, were hard to control, and were hard to keep going straight when climbing the 19% grade. When going downhill, they primarily left only 2 cm (0.8 in) deep tire tread tracks on the trail. However, when traveling uphill, they cut 10 to 12 cm (3.9 to 4.7 in) deep and 20 to 30 cm (7.9 to 11.8 in) wide tire ruts into the trail.
- SNOWMOBILE PASS-BYS: The snowmobiles had no problems climbing or descending the 19% grade, remained fully under control, and actually helped to re-level the trail surface after the ATVs had cut ruts into it. When traveling downhill and uphill, they left only minimal surface chew about 2 cm (0.8 in) in depth. There was no spinning or rutting during the slow/normal or the fast/aggressive passes, up or down hill.

****

Field Testing Journal: January 10, 2006
Sica Hollow State Park – Northeast Trail, South Dakota (SD 3)

Field Study Code/Number: SD 3
Location: Sica Hollow State Park on the Northeast Trail, South Dakota
Elevation: 1626 feet
Temperature Range: 31.2 F/-0.4 C (start) to 27.0 F/-2.8 C (end)
Time of Day: 10:45 AM to 12:15 PM
Weather: clear, sunny, 10 to 15 mph / 16 to 24 kph wind
Trail Aspect: Site 1 - 180 degree curve, flat at one end with a 3% grade at the other end, 300 feet/91 meters in length; Site 2 - 90 degree curve with 10% grade throughout the corner, 225 feet/68.6 meters in length
Trail Conditions: hard packed and very slight surface wear from weekend traffic; last groomed 4 days prior (groomed Friday, tested on Tuesday) but in good condition; traces (0 to 2 cm/0.8 in) of loose snow on surface from wind drifting the prior days
Compacted Snow Depth: 180 degree curve – 19 cm (7.5 in.) hard compaction to ice layer; 90 degree curve – 15 cm (5.9 in.) hard compaction to ice layer
Uncompacted snow depth adjacent to the trail: 38 cm (15 in)
Area Grooming Equipment: Tucker 2000 with Mogul Master 18-08 drag

Photo 35: SD 3 site – 180 degree curve/3% grade

Photo 36: SD 3 site – 90 degree curve/10% grade

__Control Vehicles__
A1 – 2005 Polaris Sportsman EFI 700 (4x4; auto transmission; 26 x 11R-12 rear tires / ½" lugs, 4 psi)
A2 – 2006 Polaris Predator 500 (2x4; manual transmission; 20 x 11-9 rear tires / ½" lugs, 4 psi)
S2 – 2006 Polaris RMK 700 (144 x 15 x 2" track)

__Individual Vehicle Observations__

A1: 2005 Polaris Sportsman 700 ATV
__180 degree curve with 3% grade pass-by__ – slow/normal passes at 15 mph/24 kph resulted in surface chew 3 cm (1.2 in) deep and 28 cm (11 in) wide. No tire impressions got into the compacted trail base. The first two fast/aggressive runs at 30 to 35 mph/48 to 56 kph resulted in 4 cm (1.6 in) deep and 30 cm (11.8 in) wide tire impressions. The third and fourth passes resulted in a berm, 20 cm (7.9 in) high and 30 cm (11.8 in) wide, being formed on the outside edge of the tire tracks.

Photo 37: A slow pass-by

Photo 38: Impressions from a fast pass-by

Photo 39: An aggressive pass-by

Photo 40: Berm created by fast pass-bys

90 degree curve with 10% grade pass-by – slow/normal downhill passes at 15 mph/24 kph resulted in surface chew 2 cm (0.8 in) deep and 20 cm (7.9 in) wide, while uphill passes generated surface chew 3 cm (1.2 in) deep and 28 cm (11 in) wide due to slightly more tire spin. Fast/aggressive passes at 30 to 35 mph/48 to 56 kph produced similar results, irrespective of uphill or downhill travel, and resulted in tire impressions 5 to 7 cm (2 to 2.8 in) deep and 28 cm (11 in) wide on the first two passes. The third and fourth fast repetitions resulted in tire ruts that were 14 cm (5.5 in) deep and 32 to 40 cm (12.6 to 15.8 in) wide.

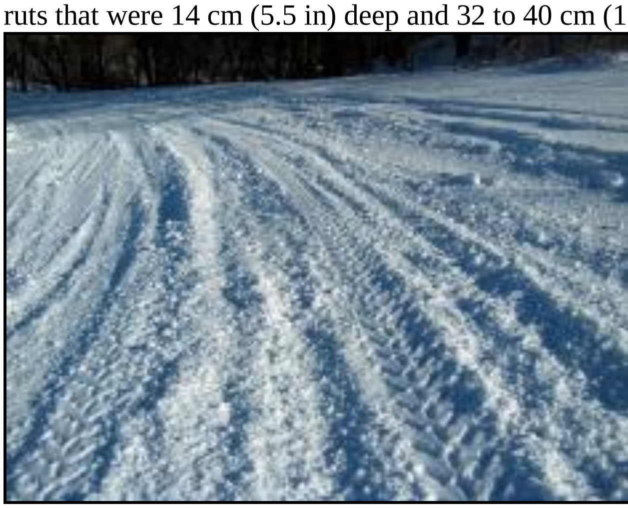

Photo 41: Surface chew from slow pass-by

Photo 42: Tire impressions from fast pass-by

Other – the testing sites for the two curves required a three mile ride on the groomed trail system to reach the two test sites. At one point the operator pulled to the side of the trail to allow a snowmobile to pass. The outside wheels got off the compacted trail base and the vehicle was sucked into the soft, unpacked snow beside the trail, resulting in the vehicle becoming stuck.

A2: 2006 Polaris Predator 500 ATV

180 degree curve with 3% grade pass-by – slow/normal passes at 15 mph/24 kph resulted in surface chew that was 2 cm (0.8 in) deep and 25 cm (9.8 in) wide. No tire impressions got into the compacted trail base. There was a slight (3%) grade at one end of the curve and the fast/aggressive downhill runs at 25 to 30 mph/40 to 48 kph resulted in tire impressions 7 to 9 cm (2.8 to 3.5 in) deep and 30 cm (11.8 in.) wide. The uphill fast passes resulted in 13 cm (5.1 in) deep by 40 to 43 cm (15.8 to 16.9 in) wide tire tracks. The vehicle was sliding and generating a full snow spray on all aggressive runs.

Photo 43: A slow pass-by

Photo 44: Surface chew from slow pass-by

Photo 45: An aggressive pass-by

Photo 46: Berm from aggressive pass-bys

90 degree curve with 10% grade pass-by – slow/normal passes, uphill and downhill at 15 mph/24 kph, resulted in surface chew that was 2 cm (0.8 in) deep and 32 cm (12.6 in) wide. Fast/aggressive passes at 25 to 30 mph/40 to 48 kph produced similar results, irrespective of uphill or downhill travel, and resulted in tire impressions that were 9 cm (3.5 in) deep and 30 cm (11.8 in) wide on the first two passes. The third and fourth repetitions resulted in tire ruts that were 14 cm (5.5 in) deep and 30 cm (11.8 in) wide. The vehicle was sliding and generating a full snow spray on all aggressive runs.

Photo 47: An aggressive pass-by **Photo 48: Impressions from an aggressive pass-by**

Photo 49: ATV that flipped over

Other – the testing sites for the two curves required a three mile ride on the groomed trail system to reach the two test sites. As the operator came around the 90 degree curve while moving between test sites, the outside wheels of the ATV got off the compacted trail base and the vehicle was sucked into the softer, unpacked snow beside the trail. The curve was windswept, so it was difficult to tell exactly where the groomed trail edge was since it all looked like it was hard packed. It is estimated that the ATV was traveling at approximately 25 to 30 mph / 40 to 48 kph when it came through the curve. The result of the ATV's right front tire dropping off the compacted trail base at this speed was that the ATV flipped end-over-end. It came to rest upside-down facing the opposite direction than it had been traveling. Fortunately there were no injuries to the operator or damage to the vehicle.

Photos 50 and 51: ATV flipped end-over-end when its right tires got off the compacted trail base

S2: 2006 Polaris RMK 700 Snowmobile

Photo 52: Fast pass-by

<u>180 degree curve with 3% grade pass-by</u> – slow/normal passes at 15 mph/24 kph resulted in surface chew 3 cm (1.2 in) deep and 40 cm (15.8 in8.) wide and ski skag marks that were 2 cm (0.8 in) deep. No track or ski impressions got into the compacted trail base. The first three fast/aggressive runs at 30 mph/48 kph resulted in track marks 4 to 9 cm (1.6 to 3.5 in) deep and 45 cm (17.7 in) wide. The fourth pass resulted in a 20 cm (7.9 in) high berm being formed on the outside edge of the track.

Photo 53: Impressions from a slow pass-by

Photo 54: Impressions from a fast pass-by

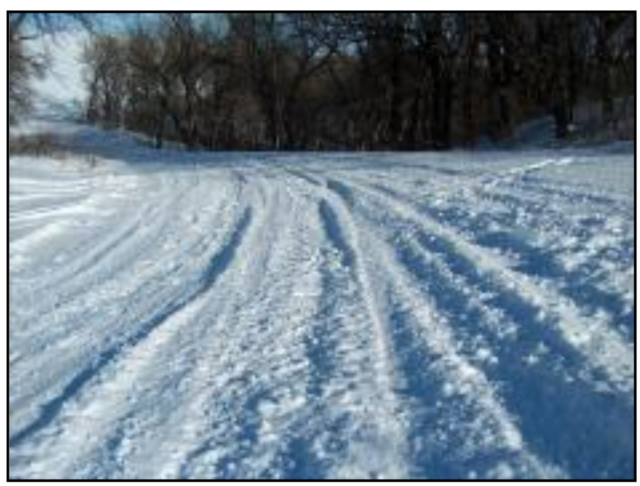

Photo 55: Impressions from a fast pass-by

<u>90 degree curve with 10% grade pass-by</u> – slow/normal passes, up and down hill at 15 mph/24 kph, resulted in surface chew 2 cm (0.8 in) deep and 45 cm (17.7 in) wide and ski skag marks 2 cm (0.8 in) deep and. No track or ski impressions got into the compacted trail base. The fast/aggressive runs at 30 mph/48 kph resulted in track marks 3 to 4 cm (1.2 to 1.6 in) deep and 45 cm (17.7 in) wide when traveling downhill. The track marks were the same depth but 100 cm (39.4 in) wide when traveling uphill due to more ‘sliding’ action through the corner. No ruts or berms were created even though there was significant snow spray during each aggressive pass-by (but less spray than from A2/the Predator ATV during its aggressive runs). The snowmobile’s track was displacing/ spraying surface snow versus digging snow from the compacted trail base.

<u>Other</u> – the testing sites for the two curves required a three mile ride to reach the two test sites. Since there were only three people on the test crew, the decision was made to initially take the two ATVs and the snowmobile with the most aggressive track (S2 = 2” versus S1 =1¼”) for the initial testing. Since the S2 pass-bys did not indicate substantive impacts to the trail base, it was decided it was unnecessary to make the 3-mile trip back to

the trailer for the second snowmobile (S1) with the less aggressive track. Therefore, only one control snowmobile was run for these two curve tests.

Summary of Observations from SD 3 Field Test

- SLOW/NORMAL OPERATION: None of the vehicles created noticeable adverse impacts to the trail base on either curve when operated in the slow/normal mode at 15 mph/24 kph. There was only normal surface chew.
- FAST/AGGRESSIVE ATV OPERATION: Fast/aggressive passes by the ATVs generated tire impressions 5 to 14 cm (2 to 5.5 in) deep that were 30 to 43 cm (11.8 to 16.9 in) wide. A berm was also generated on the outside edge of the 180 degree corner that was 20 cm (7.9 in) high.
- FAST/AGGRESSIVE SNOWMOBILE OPERATION: Fast/aggressive passes by the snowmobile generated track marks 4 to 9 cm (1.6 to 3.6 in) deep and 45 to 100 cm (17.7 to 39.4 in) wide. A berm was also generated on the outside edge of the 180 degree corner that was 20 cm (7.9 in) high.
- The Sportsman ATV (A1) became stuck when its outside wheels dropped off the compacted/groomed trail base when traveling on the trail between testing sites. The Predator ATV (A2) flipped end-over-end off the trail when its outside wheels dropped off the compacted/groomed trail base when traveling on the trail between testing sites.

****

Field Testing Journal: January 23, 2006
Black Hills, South Dakota (SD 4)


Photo 56: Site of SD 4 field test

Field Study Code/Number: SD 4
Location: Trail 2 cut-across south of Hardy Camp; Black Hills of South Dakota
Elevation: 6675 feet
Temperature Range: 21.9 F/-5.6 C (start) to 27.5 F/-2.5 C (end)
Time of Day: 8:38 AM to 11:06 AM
Weather: clear, sunny, 3.5 mph / 5.6 kph wind
Trail Aspect: the slow/normal track was flat; the fast/aggressive had a 4% grade for a distance of 125 feet (38.1 meters) at one end with the balance having a 2% grade
Trail Conditions: freshly groomed within 1 hour of start, very hard
Compacted Snow Depth: 60 cm (23.6 in) to gravel at location 1 (the slow/normal track) and 19 cm (7.5 in) to ice at location 2 (the fast/aggressive track). Both sites were packed very hard to the ground.
Uncompacted snow depth adjacent to the trail: 45.7 to 61 cm (18 to 24 inches)
Area Grooming Equipment: Tucker 2000 TERRA with Mogul Master 18-09 drag

Control Vehicles

A1 – 2005 Polaris Sportsman EFI 700 (4x4; auto transmission; 26 x 11R-12 rear tires / ½" lugs, 4 psi)
A2 – 2006 Polaris Predator 500 (2x4; manual transmission; 20 x 11-9 rear tires / ½" lugs, 4 psi)
S1 – 2006 Polaris Switchback 900 (144 x 15 x 1¼" track)
S2 – 2006 Polaris RMK 700 (144 x 15 x 2" track)

Individual Vehicle Observations

A1: 2005 Polaris Sportsman 700 ATV

Slow/normal track – generally, all starts, stops and 15 mph/24 kph pass-bys resulted in "surface chew" from the tires that was 1 to 2 cm (0.4 to 0.8 in) deep and 20 cm (7.9 in)wide. Tire tracks were visible and consistent the entire length of the start and pass-by zones.

Photo 57: A slow pass-by

Photo 58: Tire impression from slow pass-by

Fast/aggressive track – starts resulted in tire tracks that varied from 2 to 5 cm (0.8 to 2 in) deep and 22 to 25 cm (8.7 to 9.8 in) wide. The 35 mph/56 kph pass-bys resulted in visible tire tracks 3 cm (1.2 in) deep and 24 to 25 cm (9.5 to 9.8 in) wide and left no visible trenching or rutting. Stops resulted in tire impressions that were 2 to 3 cm (0.8 to 1.2 in) deep and 18 to 25 cm (7.1 to 9.8 in) wide. Stopping distance at 35 mph/56 kph ranged from 23.2 to 26.9 meters (76.0 to 88.8 feet), with an average stopping distance of 25.5 meters (83.6 feet).

Photo 59: Tire impressions from an aggressive start

Photo 60: Impressions from an aggressive stop

Other – the vehicle got stuck when the operator attempted a 3-point turn around on the trail and the front tires dropped off the compacted trail base. This resulted in ruts from the rear tires spinning that were 9 cm (3.5 in) deep and 26 cm (10.2 in) wide before the vehicle was pushed out. Footprints on the trail surface left impressions in the snow that were 2 cm (0.8 in) deep.

A2: 2006 Polaris Predator 500 ATV

Slow/normal track – generally, all starts, stops and 15 mph/24 kph pass-bys resulted in “surface chew” from the tires that was 1 cm (0.4 in) deep and 25 to 28 cm (9.8 to 11 in)wide. Tire tracks were visible and consistent the entire length of the start and pass-by zones. When the vehicle was shifted between gears, it left 26 cm (10.2 in) wide and 5 cm (2 in) high snow piles, with a 2 cm (0.8 in) deep “dish” beside the snow pile from where the tires bit into the trail surface.

Photo 61: Tire impression from slow pass-by **Photo 62: Snow piles from shifting gears**

Fast/aggressive track – starts resulted in tire tracks that 4 to 5 cm (1.8 to 2 in) deep and 25 to 26 cm (9.8 to 10.2 in) wide. The 35 mph/56 kph pass-bys resulted in visible tire tracks 3 cm (1.2 in) deep and 25 cm (9.8 in) wide and left no visible trenching or rutting. Stops resulted in tire impressions that were 3 to 4 cm (1.2 to 1.6 in) deep and 25 to 28 cm (9.8 to 11 in) wide. Stopping distance at 35 mph/56 kph ranged from 17.4 to 21.4 meters (57.0 to 70.3 feet), with an average stopping distance of 19.6 meters (64.4 feet). When the vehicle was shifted to second gear, it left a 5 cm (2 in) high snow pile that backfilled the tire track.

Photo 63: Impressions and piles from a fast start **Photo 64: Impressions from an aggressive stop**

S1: 2006 Polaris Switchback 900 Snowmobile

Slow/normal track – generally, all starts, stops and 15 mph/24 kph pass-bys resulted in 1.5 cm (0.6 in) deep grooves from the ski skags and "surface chew" from the track that was 2 cm (0.8 in) deep and 39 cm (15.4 in) wide. The skag marks and surface chew were generally consistently visible and the same the entire length of the start, pass-by, and stop zones, consistent with trail wear from normal snowmobile traffic.

Photo 65: A slow pass-by

Photo 66: Impressions from slow pass-bys

Fast/aggressive track – starts resulted in track marks that were 3 to 6 cm (1.2 to 2.4 in) deep and 39 cm (15.4 in) wide. The 35 to 40 mph/56 to 64 kph pass-bys resulted in "surface chew" from the track that was 2 to 3 cm (0.8 to 1.2 in) deep and 38 to 40 cm (15 to 15.7 in) wide). There was no visible trenching or rutting. Stops resulted in track impressions that were 2 to 3 cm (0.8 to 1.2 in) deep and 39 cm (15.4 in) wide. Stopping distance at 35 to 40 mph/56 to 64 kph ranged from 22.6 to 27.1 meters (74.1 to 89.0 feet), with an average stopping distance of 24.8 meters (81.5 feet).

Photo 67: Surface chew from fast pass-bys

Photo 68: Impression from an aggressive start

Photo 69: Impression from a fast stop

S2: 2006 Polaris RMK 700 Snowmobile

Slow/normal track – generally, all starts, stops and 15 mph/24 kph pass-bys resulted in 0.5 cm (0.2 in) deep 4 cm (1.6 in) wide grooves from the ski skags and surface chew from the track that was 2 cm (0.8 in) deep and 38 to 39 cm (15 to 15.4 in) wide. The skag marks and surface chew were generally visible and consistent the entire length of the start, pass-by, and stop zones, consistent with trail wear from normal snowmobile traffic.

Photo 70: Track surface chew from slow pass-by

Photo 71: Mark from ski skag

Fast/aggressive track – starts resulted in track marks that were 3 to 7 cm (1.2 to 2.8 in) deep and 41 cm (16.1 in) wide. The 35 mph/56 kph pass-bys resulted in surface chew from the track that was 2 to 3 cm (0.8 to 1.2 in) deep and 39 to 41 cm (15.4 to 16.1 in) wide). There was no visible trenching or rutting. Stops resulted in track impressions that were 2 to 5 cm (0.8 to 2 in) deep and 41 cm (16.1 in) wide. Stopping distance at 35 mph/56 kph ranged from 23.3 to 25.9 meters (76.3 to 85.0 feet), with an average stopping distance of 25.0 meters (82.0 feet).

Photo 72: Impression from a fast start

Photo 73: Surface chew from a fast pass-by

Photo 74: Impression from an aggressive stop

Summary of Observations from SD 4 Field Test

- SLOW/NORMAL OPERATION: None of the vehicles created noticeable adverse impacts when operated in the slow/normal mode whether in the start, 15 mph/24 kph pass-by, or stop zones.
- FAST/AGGRESSIVE PASS-BY: None of the vehicles created noticeable adverse impacts when operated in the 35 mph/56 kph pass-by mode.
- AGGRESSIVE STARTS: Snowmobiles created slightly deeper impressions in the trail than what the ATVs did. Aggressive starts resulted in ATV tire impressions 2 to 5 cm (0.8 to 2 in) deep and 22 to 26 cm (8.7 to 10.2 in) wide. Snowmobile track impressions were 3 to 7 cm (1.2 to 2.8 in) deep and 39 to 41 cm (15.4 to

16.1 in) wide. The deepest track impressions from the snowmobiles were 2 cm (0.8 in) deeper than the deepest ATV tire tracks.

- AGGRESSIVE STOPS: Snowmobiles created slightly deeper impressions in the trail than what the ATVs did. Aggressive stops resulted in ATV tire impressions 2 to 4 cm (0.8 to 1.8 in) deep and 18 to 25 cm (7.1 to 9.8 in) wide. Snowmobile track impressions were 2 to 5 cm (0.8 to 2 in) deep and 39 to 41 cm (15.4 to 16.1 in) wide. The deepest snowmobile track impressions were 1 cm (0.4 in) deeper than the deepest ATV tire tracks.
- STOPPING DISTANCE – CONTROL VEHICLES: When comparing the four control vehicles, the results were mixed. The Predator ATV stopped quicker than both snowmobiles, while the Sportsman required a slightly longer distance to stop than what the two snowmobiles did. The Predator stopped the quicker of the two control ATVs, while the Switchback required the greatest distance to stop of the two snowmobiles. The average ATV stopping distances at 35 mph/56 kph ranged from 19.6 to 25.5 meters (64.4 to 83.6 feet), while the average snowmobile stopping distance ranged from 24.8 to 25.0 meters (81.5 to 82.0 feet). The minimum average ATV stopping distance (the Predator) was 5.2 meters/17.1 feet (21.0%) less than the shortest average snowmobile stopping distance, while the maximum average stopping distance for the Sportsman ATV was just 0.5 meters/1.6 feet (2.0%) greater than the longest average snowmobile stopping distance.
- Both ATVs became stuck when they got off the packed trail base.

Photo 75: Footprints on the trail

- Impressions from footprints on the trail surface were 2 cm (0.8 in) deep.

****

Field Testing Journal: January 23, 2006
Black Hills, South Dakota (SD 5)

Photo 76: Site of SD 5 field test

Field Study Code/Number: SD 5
Location: Trail 1 alternate southeast of Hardy Camp; Black Hills of South Dakota
Elevation: 6675 feet
Temperature Range: 31.0 F/-0.6 C (start) to 29.2 F/-1.6 C (end)
Time of Day: 11:58 AM to 12:35 PM
Weather: clear, sunny, 3.5 mph / 5.6 kph wind
Trail Aspect: this site provided a hill/curve combination over a distance of approximately 0.3 mile (0.48 kilometer). The segment had a 14% to 18% grade over the entire distance; with a 28% grade for a short distance at the crown of the hill. There was a 20 degrees curve about 0.1 mile (0.16 km) from the bottom and a sweeping 35 degrees curve about 0.1 mile (0.16 km) from the top.
Trail Conditions: groomed the prior night, very hard, excellent condition
Compacted Snow Depth: 29 cm (11.4 in) to grass; packed very hard to the ground
Uncompacted snow depth adjacent to the trail: 51 to 76 cm (20 to 30 inches)
Area Grooming Equipment: Tucker 2000 TERRA with Mogul Master 18-09 drag

Control Vehicles

A1 – 2005 Polaris Sportsman EFI 700 (4x4; auto transmission; 26 x 11R-12 rear tires / ½" lugs, 4 psi)
A2 – 2006 Polaris Predator 500 (2x4; manual transmission; 20 x 11-9 rear tires / ½" lugs, 4 psi)
S1 – 2006 Polaris Switchback 900 (144 x 15 x 1¼" track)
S2 – 2006 Polaris RMK 700 (144 x 15 x 2" track)

Individual Vehicle Observations

Photo 77: Tire impressions on hill

A1: 2005 Polaris Sportsman 700 ATV
Hill/curve pass-by – four uphill and downhill pass-bys were done at 30 to 40 mph/48 to 64 kph. Tire impressions were the most predominant in the 35 degree curve and near the crest of the hill. They were generally 3 to 5 cm (1.2 to 2 in) deep and 25 to 27 cm (9.8 to 10.6 in) wide. The operator described the vehicle as being "squirrelly" when coming downhill.

Photo 78: Tire impressions at curve

A2: 2006 Polaris Predator 500 ATV
Hill/curve pass-by – four uphill and downhill pass-bys were done at 30 to 40 mph/48 to 64 kph. This vehicle was much more squirrelly than the Sportsman ATV and struggled all the way up the hill. The vehicle's tires also produced lots of snow spray. Tire impressions were prevalent through most all of the test area due to lots of tire spin. They were generally 4 to 5 cm (1.6 to 2 in) deep and 28 to 31 cm (11 to 12.2 in) wide, although one corner had 5 cm (2 in) deep by 45 cm (17.7 in) wide marks due to extreme sliding through the 35 degree curve. The operator described the vehicle as being "extremely squirrelly."

Photo 79: Surface chew from snowmobile pass-bys

S1: 2006 Polaris Switchback 900 Snowmobile
Hill/curve pass-by – four uphill and downhill pass-bys were done at 45 to 55 mph/72 to 88 kph. Track marks throughout the test area were predominantly "surface chew" 2 cm (0.8 in) deep, with 2 to 4 cm (0.8 to 1.6 in) deep and 38 to 42 cm (15 to 16.5 in) wide track impressions in the 35 degrees curve.

S2: 2006 Polaris RMK 700 Snowmobile
Hill/curve pass-by – four uphill and downhill pass-bys were done at 50 to 60 mph/80 to 96 kph. Track marks throughout the test area were predominantly "surface chew" 3 cm (1.2 in) deep, along with 2 to 3 cm (0.8 to 1.2 in) deep ski skag marks. Track impressions in the 35 degrees curve were 3 to 4 cm (1.2 to 1.6 in) deep and 41 to 45 cm (16.1 to 17.7 in) wide. There was significant snow spray from the track during uphill acceleration.

Summary of Observations from SD 5 Field Test

- ATV OPERATION: Passes by the ATVs generated tire tracks 3 to 5 cm (1.2 to 2 in) deep that were 25 to 31 cm (9.8 to 12.2 in) wide.

- SNOWMOBILE OPERATION: Passes by the snowmobiles generated track marks 2 to 4 cm (0.8 to 1.6 in) deep and 38 to 45 cm (15 to 17.7 in) wide.
- None of the vehicles created severe rutting of the trail surface. The snowmobiles were run after the two ATVs and their passes re-leveled the tire tracks left by the ATVs.
- The snowmobiles easily negotiated the hill and curves at relatively high rates of speed, while the ATVs were both squirrelly and hard to control even though they were operated at speeds that were 15 to 20 mph/24 to 32 kph less than the snowmobiles.

****

Field Testing Journal: January 26, 2006
South Pass, Wyoming (WY 1)

Photo 80: Site of WY 1 field test

Field Study Code/Number: WY 1
Location: CDA Trail at the CDA/Trail F junction; near Lander, Wyoming
Elevation: 8431 feet
Temperature Range: 24.7 F/-4.1 C (start) to 31.9 F/-0.1 C (end)
Time of Day: 9:38 AM to 11:56 AM
Weather: overcast, very flat light, 16 mph / 25.7 kph wind
Trail Aspect: the slow/normal and fast/aggressive tracks were flat; the hill/curve test area had a long straightaway that started at the junction and ended with a 16% grade and a 40 degrees corner/curve at the top of the hill. Both were on a wide, open gravel roadway.
Trail Conditions: groomed 30 to 36 hours prior to testing (groomed Tuesday night/early Wednesday morning and tested Thursday morning; slightly wind blown, very good compaction, very hard trail base
Compacted Snow Depth: 40 cm (15.7 in) to gravel; packed hard to the ground.
Uncompacted snow depth adjacent to the trail: 45.7 to 61 cm (20 to 24 inches)
Area Grooming Equipment: Tucker 2000 TERRA with Mogul Master 18-08 drag

Control Vehicles
A1 – 2005 Polaris Sportsman EFI 700 (4x4; auto transmission; 26 x 11R-12 rear tires / ½" lugs, 4 psi)
A2 – 2006 Polaris Predator 500 (2x4; manual transmission; 20 x 11-9 rear tires / ½" lugs, 4 psi)
S1 – 2006 Polaris Switchback 900 (144 x 15 x 1¼" track)
S2 – 2006 Polaris RMK 700 (144 x 15 x 2" track)

Individual Vehicle Observations
Note: Due to flat light conditions, it was difficult to get photos with good contrast from this field test.

A1: 2005 Polaris Sportsman 700 ATV
Slow/normal track – all starts, stops and 15 mph/24 kph pass-bys resulted in tire "surface chew" that was 2 cm (0.8 in) deep. Tire tracks were visible and consistent the entire length all zones.

Photo 81: Tire impressions from slow pass-by

Fast/aggressive track – starts resulted in tire tracks that were 2 to 5 cm (0.8 to 2 in) deep and 20 to 28 cm (7.9 to 11 in) wide. The 35 mph/56 kph pass-bys resulted in visible tire tracks 2 cm (0.8 in) deep and 25 to 28 cm (9.8 to 11 in) wide and left no visible trenching or rutting. Stops resulted in tire impressions that were 2 to 4 cm (0.8 to 1.6 in) deep and 20 to 25 cm (7.9 to 9.8 in) wide. Stopping distance at 35 mph/56 kph ranged from 18.3 to 25.0 meters (60.1 to 82.0 feet), with an average stopping distance of 21.1 meters (69.2 feet).

16% Hill/40 degree corner pass-by – the maximum uphill speed that could be attained was 30 mph/48 kph, while downhill speed was 40 mph/64 kph. The operator described the vehicle's operation as "squirrelly" on all passes. Tire impressions were 2 to 4 cm (0.8 to 1.6 in) deep and 20 to 26 cm (7.9 to 11 in) wide.

A2: 2006 Polaris Predator 500 ATV

Slow/normal track – all starts, stops and 15 mph/24 kph pass-bys resulted in tire "surface chew" that was 1.5 cm (0.6 in) deep and 25 cm (9.8 in) wide. Tire tracks were visible and consistent the entire length all zones.

Fast/aggressive track – starts resulted in tire tracks that were 3 to 8 cm (1.2 to 3.1 in) deep and 25 to 29 cm (9.8 to 11.4 in) wide. The 35 mph/56 kph pass-bys resulted in visible tire tracks 3 cm (1.2 in) deep and 28 cm (11 in) wide and left no visible trenching or rutting. Stops resulted in tire impressions that were 3 to 4 cm (1.2 to 1.6 in) deep and 28 cm (11 in) wide. Stopping distance at 35 mph/56 kph ranged from 17.4 to 27.7 meters (57.2 to 91.0 feet), with an average stopping distance of 23.2 meters (76.0 feet).

16% Hill/40 degree corner pass-by – the maximum uphill and downhill speed was estimated at 55 to 60 mph/88 to 96 kph through the straightaway and into and out of the bottom side of the curve. The operator described the vehicle's operation as "it felt out of control from start to finish at all speeds." Tire impressions were generally 5 cm (2 in) deep and 25 cm (9.8 in) wide on the hill and in the curve.

S1: 2006 Polaris Switchback 900 Snowmobile

Slow/normal track – all starts, stops and 15 mph/24 kph pass-bys resulted in 1 cm (0.4 in) deep grooves from the ski skags and "surface chew" from the track that was also 1 cm (0.4 in) deep. The skag marks and surface chew were visible and consistent the entire length of the start, pass-by, and stop zones.

Photo 82: Surface chew & skag mark from slow pass-by

Fast/aggressive track – starts resulted in track marks that were 2.5 to 5 cm (1 to 2 in) deep and 39 cm (15.4 in) wide. The 35 mph/56 kph pass-bys resulted in "surface chew" from the track that was 2 cm (0.8 in) deep and 38 to 39 cm (15 to 15.4 in) wide. There was no visible trenching or rutting of the trail. Stops resulted in track impressions that were generally 5 cm (2 in) deep and 42 cm (16.5 in) wide. Stopping distance at 35 mph/56 kph ranged from 24.3 to 30.4 meters (79.8 to 99.9 feet), with an average stopping distance of 27.4 meters (89.9 feet).

16% Hill/40 degree corner pass-by – this vehicle was not tested on the hill/curve since the RMK snowmobile with its aggressive track was chosen for "worst-case" comparison purposes.

S2: 2006 Polaris RMK 700 Snowmobile

Slow/normal track – all starts, stops and 15 mph/24 kph pass-bys resulted in 1 cm (0.4 in) deep grooves from the ski skags and "surface chew" from the track that was 2 cm (0.8 in) deep. The skag marks and surface chew were visible and consistent the entire length of the start, pass-by, and stop zones.

Fast/aggressive track – starts resulted in track marks that were 3 to 4 cm (1.2 to 1.6 in) deep and 38 cm (15 in) wide. The 35 mph/56 kph pass-bys resulted in surface chew from the track that was 2 to 4 cm (0.8 to 1.6 in) deep and 39 to 41 cm (15.4 to 16.1 in) wide). There was no visible trenching or rutting of the trail. Stops resulted in track impressions that were 3 to 4 cm (1.2 to 1.6 in) deep and 38 to 41 cm (15 to 16.1 in) wide. Stopping distance at 35 mph/56 kph ranged from 20.6 to 28.3 meters (67.6 to 92.9 feet), with an average stopping distance of 24.6 meters (80.8 feet).

16% Hill/40 degree corner pass-by – the maximum uphill and downhill speed was 60 to 70 mph/96 to 113 kph through the straightaway and into and out of the bottom side of the curve. Track marks were generally 5 cm (2 in) deep surface chew on the hill and in the curve.

Summary of Observations from WY 1 Field Test

- SLOW/NORMAL OPERATION: None of the vehicles created noticeable adverse impacts when operated in the slow/normal mode whether in the start, 15 mph/24 kph pass-by, or stop zones.
- FAST/AGGRESSIVE PASS-BY: None of the vehicles created noticeable adverse impacts when operated in the 35 mph/56 kph pass-by mode.
- AGGRESSIVE STARTS: ATVs created slightly deeper tracks in the trail than what the snowmobiles did. Aggressive starts resulted in ATV tire tracks 2 to 8 cm (0.8 to 3.1 in) deep and 25 to 29 cm (9.8 to 11.4 in) wide. Snowmobile track impressions were 2.5 to 5 cm (1 to 2 in) deep and 38 to 41 cm (15 to 16.1 in) wide. The deepest tire tracks from the Predator ATV were 3 cm (1.2 in) deeper than the deepest snowmobile track impressions.
- AGGRESSIVE STOPS: Snowmobiles created slightly deeper tracks in the trail than what the ATVs did. Aggressive stops resulted in ATV tire tracks 2 to 4 cm (0.8 to 1.8 in) deep and 20 to 28 cm (7.9 to 11 in) wide. Snowmobile track impressions were 3 to 5 cm (1.2 to 2 in) deep and 39 to 42 cm (15.4 to 16.5 in) wide. The deepest snowmobile track impressions from the Switchback snowmobile were 1 cm (0.4 in) deeper than the deepest ATV tire tracks.
- STOPPING DISTANCE – CONTROL VEHICLES: The two ATVs generally stopped in a shorter distance than what the two snowmobiles did. The Sportsman ATV had the shortest average stopping distance, while the Switchback snowmobile had the longest average stopping distance. The average ATV stopping distances at 35 mph/56 kph ranged from 21.1 to 23.2 meters (69.2 to 76.0 feet), while the average snowmobile stopping distance ranged from 24.6 to 27.4 meters (80.8 to 89.9 feet). The minimum average ATV stopping distance (the Sportsman ATV) was 3.5 meters/11.5 feet (14.2%) less than the shortest average snowmobile stopping distance, while the maximum average snowmobile stopping distance (the Switchback snowmobile) was 4.2 meters/13.8 feet (18.1%) greater than longest average ATV stopping distance.
- HILL/CURVE PASS-BYS: These pass-bys were run at top speeds to observe the difference in operational characteristics between the vehicles, as well as to observe the effects upon the trail surface. The RMK snowmobile was able to stay "under control" up the hill and through the curve, while both ATVs were judged as "very squirrelly" by the operator and the 2-wheel drive Predator deemed "pretty much out of control." By comparison, the snowmobile remained much more in control through the curve despite being operated at speeds that were 10 to 40 mph/16 to 64 kph faster than the ATVs. Tire tracks on the hill and in the curve from the Sportsman ATV were 2 to 4 cm (0.8 to 1.6 in) deep, while tire impressions from the Predator ATV and track marks from the RMK snowmobile were both 5 cm (2 in) deep.

****

Field Testing Journal: January 26, 2006
South Pass, Wyoming (WY 2)

Field Study Code/Number: WY 2
Location: F Trail at the CDA Trail/Trail F junction; near Lander, Wyoming
Elevation: 8431 feet
Temperature Range: 29.3 F/-1.5 C (start) to 27.2 F/-2.7 C (end)
Time of Day: 2:24 PM to 3:05 PM
Weather: sunny, clear, 12 mph/19 kph wind
Trail Aspect: flat, open meadow
Trail Conditions: smooth and in good condition; had been groomed one week prior. While the trail appeared to be in good condition, it quickly deteriorated after only eight runs on it by ATVs.

Photo 83: Site of WY 2 field test

Further investigation determined that this particular trail segment had a different grooming schedule and different grooming equipment than the CDA Trail immediately adjacent to it (location of WY 1 test). Whereas the CDA Trail had been groomed multiple times weekly for several weeks with a multi-blade drag, this particular trail had been groomed only three times over the previous six week period (and only three times the entire season) and with a single blade drag rather than with a multi-blade drag.
Compacted Snow Depth: 30 cm (11.8 in) to grass, but only the top 10 cm (3.9 in) was compacted while the bottom 20 cm (7.9 in) was loose and sugary
Uncompacted snow depth adjacent to the trail: 35.5 to 45.7 cm (14 to 18 inches)
Area Grooming Equipment: Tucker 2000 TERRA with Freese 8–feet wide single blade drag

<u>Control Vehicles</u>
None, they were run on the WY 1 location which is directly adjacent to this location – this new location was used to give the "Other" vehicles a fresh test track

<u>Other Vehicles</u>
A3 – 2005 Bombardier Traxter XL 500 (4x4; auto/manual transmission; 26 x 10-12 rear tires / ½" lugs, 7 psi)
A4 – 2003 Polaris Sportsman 500 6x6 (6x6; auto transmission; 25 x 11-10 rear tires / ½" lugs, 5 psi)

<u>Individual Vehicle Observations</u>

A3: 2005 Bombardier Traxter 500 ATV
<u>Slow/normal track</u> – this vehicle was run only on the fast/aggressive track

<u>Fast/aggressive track</u> – starts resulted in tire tracks that were 4 to 5 cm (1.6 to 2 in) deep and 20 to 21 cm (7.9 to 8.3 in) wide. The pass-bys at 35 mph/56 kph left visible tire tracks 2 cm (0.8) deep but no trenching or rutting of the trail surface. Stops resulted in tire impressions that were 2 cm {1st pass only} to 10 cm (0.8 to 3.9 in) deep and 21 to 30 cm (8.3 to 11.8 in) wide. Stopping distance at 35 mph/56 kph ranged from 13.3 to 16.9 meters (43.6 to 55.4 feet), with an average stopping distance of 14.7 meters (48.1 feet). The trail base quickly became soft and rutted in the start and stop zones.


Photo 84: Impressions from an aggressive start


Photo 85: Impressions from an aggressive stop

A4: 2003 Polaris Sportsman 500 6X6 ATV
<u>Slow/normal track</u> – this vehicle was run only on the fast/aggressive track

<u>Fast/aggressive track</u> – starts resulted in tire tracks that were 2 to 3 cm (0.8 to 1.2 in) deep and 24 cm (9.5 in) wide. The pass-bys at 35 mph/56 kph left visible tire tracks 2 cm (0.8) deep and 19 cm (7.5 in) wide, but no trenching or rutting of the trail surface. Stops resulted in tire impressions that were 5 to 8 cm (2 to 3.1 in) deep and 26 cm (10.2 in) wide. Stopping distance at 35 mph/56 kph ranged from 11.0 to 16.5 meters (36.1 to 54.0

feet), with an average stopping distance of 12.8 meters (42.1 feet). The trail base quickly became soft and rutted in the start and stop zones.

Photo 86: Impressions from an aggressive start

Photo 87: Impressions from an aggressive stop

Summary of Observations from WY 2 Field Test

- FAST/AGGRESSIVE PASS-BY: Neither of the vehicles created noticeable adverse impacts when operated in the 35 mph/56 kph pass-by mode, just normal surface chew.
- AGGRESSIVE STARTS: Starts resulted in ATV tire impressions that were 2 to 5 cm (0.8 to 2 in) deep and 20 to 24 cm (7.9 to 9.5 in) wide. While the 6X6 ATV was substantially heavier than the other ATV, its tire impressions were less, most likely due to its weight being distributed over six tires versus four on the other ATV.
- AGGRESSIVE STOPS: Stops resulted in ATV tire impressions 2 to 10 cm (0.8 to 3.9 in) deep and 21 to 30 cm (8.3 to 11.8 in) wide. Stops at both ends of the track quickly began breaking through the compacted surface which was only 10 cm (3.9 in) thick.
- STOPPING DISTANCE – OTHER VEHICLES: The two ATVs generally stopped in a relatively short distance compared to the vehicle stopping distances in other tests. This was most likely due to the less densely compacted trail that quickly led to soft trail conditions after just a few passes by the ATVs. The 6X6 ATV stopped very quickly due to its heavier weight and six wheels braking.
- Due to the quick deterioration of the trail after just eight vehicle passes, the decision was made to relocate the test track back onto the CDA Trail, and to rerun these two vehicles on the firmer CDA Trail surface.
- Even though this testing was done on January 26, this trail segment is likely a good indicator of early season trail compaction given that it had been groomed only a total of three times (snow came late so grooming started late). It may also serve as an indicator that trails groomed with single blade drags may not have enough compaction to withstand ATV traffic.

Photo 88: Poorly compacted trail – note hollow pocket 4” down

Photo 89: A well compacted trail from Site SD 4

****

Field Testing Journal: January 26, 2006
South Pass, Wyoming (WY 3)


Photo 90: Site of WY 3 field test

Field Study Code/Number: WY 3
Location: CDA Trail approximately 1.5 miles west of the Trail F junction; near Lander, Wyoming
Elevation: 8509 feet
Temperature Range: 29.3 F/-1.5 C (start) to 25.9 F/-3.4 C (end)
Time of Day: 3:23 PM to 4:12 PM
Weather: sunny, clear, 8 mph/12.8 kph wind
Trail Aspect: on a flat, open roadway
Trail Conditions: smooth and in good condition; was groomed 30 to 36 hours prior to testing (groomed Tuesday night/early Wednesday morning and tested Thursday morning; slightly wind blown, very good compaction, very hard trail base
Compacted Snow Depth: 46 cm (18.1 in) to gravel, packed hard to the ground
Uncompacted snow depth adjacent to the trail: 45.7 to 61cm (20 to 24 inches)
Area Grooming Equipment: Tucker 2000 TERRA with Mogul Master 18-08 drag

<u>Control Vehicles</u>
None – they were run at the WY 1 location

<u>Other Vehicles</u>
A3 – 2005 Bombardier Traxter XL 500 (4x4; auto/manual transmission; 26 x 10-12 rear tires / ½" lugs, 7 psi)
A4 – 2003 Polaris Sportsman 500 6x6 (6x6; auto transmission; 25 x 11-10 rear tires / ½" lugs, 5 psi)
A5 – 2002 Yamaha Kodiak 400 (4x4; auto transmission; 25 x 10-12 rear tires / 3/8" lugs, 4 psi)
S3 – 2004 Arctic Cat Turbo Touring T660 4-stroke (136 x 15 x ¾" track)

<u>Individual Vehicle Observations</u>
A3: 2005 Bombardier Traxter 500 ATV
<u>Slow/normal track</u> – this vehicle was run only on the fast/aggressive track

<u>Fast/aggressive track</u> – starts resulted in tire tracks that were 2 cm (0.8 in) deep and 21 cm (8.3 in) wide. In comparison, tire tracks from the same vehicle when it was run at site WY 2 (a less firm trail base) were 4 to 5 cm (1.6 to 2 in) deep and 20 to 21 cm (7.9 to 8.31 in) wide. The pass-bys resulted in tire tracks 2 cm (0.8 in) deep and 26 cm (10.2 in) wide, compared to site WY 2 which were also 2 cm (0.8 in) deep. There was no visible


Photo 91: Impressions from an aggressive start


Photo 92: An aggressive stop

trenching or rutting of the trail surface from the pass-bys. Stops resulted in tire impressions that were 2 to 3 cm (0.8 to 1.2 in) deep and 21 to 30 cm (8.3 to 11.8 in) wide, compared to 8 to 10 cm (3.1 to 3.9 in) deep and 21 to 30 cm (8.3 to 11.8 in) wide tire impressions at site WY 2. Stopping distance at 35 mph/56 kph ranged from 13.0 to 21.1 meters (42.7 to 69.3 feet), with an average stopping distance of 17.1 meters (56.2 feet). This compared to a range of 13.3 to 16.9 meters (43.6 to 55.4 feet) and an average stopping distance of 14.7 meters (48.1 feet) at site WY 2.

A4: 2003 Polaris Sportsman 500 6X6 ATV

Slow/normal track – this vehicle was run only on the fast/aggressive track

Photo 93: Tire impressions from an aggressive stop

Fast/aggressive track – starts resulted in tire tracks that were 2 to 3 cm (0.8 to 1.2 in) deep and 18 to 21 cm (7.1 to 8.3 in) wide. In comparison, tire tracks from the same vehicle when it was run at site WY 2 (a less firm trail base) were also 2 to 3 cm (0.8 to 1.2 in) deep but were 24 cm (9.5 in) wide. The pass-bys resulted in tire tracks 2 cm (0.8 in) deep and 19 cm (7.5 in) wide, which were the same results from the vehicle at the WY 2 pass-by site. There was no visible trenching or rutting of the trail surface from the pass-bys. Stops resulted in tire impressions that were 2 to 4 cm (0.8 to 1.6 in) deep and 18 to 27 cm (7.1 to 10.6 in) wide, compared to 5 to 8 cm (2 to 3.1 in) deep and 26 cm (10.2 in) wide tire impressions at site WY 2. Stopping distance at 35 mph/56 kph ranged from 14.3 to 19.3 meters (46.9 to 63.3 feet), with an average stopping distance of 16.9 meters (55.3 feet). This compared to a range of 11.0 to 16.5 meters (36.1 to 54.0 feet) and an average stopping distance of 12.8 meters (42.1 feet) at site WY 2.

A5: 2002 Yamaha Kodiak 400 ATV

Slow/normal track – this vehicle was run only on the fast/aggressive track

Fast/aggressive track – starts resulted in tire tracks that were 2 cm (0.8 in) deep and 20 cm (7.9 in) wide. The pass-bys resulted in surface chew from the tire treads that was 2 cm (0.8 in) deep. There was no trenching or rutting of the trail surface. Stops resulted in tire impressions that were 2 to 4 cm (0.8 to 1.6 in) deep and 20 to 30 cm (7.9 to 11.8 in) wide. Stopping distance at 35 mph/56 kph ranged from 14.3 to 20.9 meters (46.9 to 68.5 feet), with an average stopping distance of 18.2 meters (59.7 feet).

Photo 94: An aggressive start

Photo 95: Tire impressions from an aggressive stop

S3: 2004 Arctic Cat Turbo Touring T660 4-stroke Snowmobile

Slow/normal track – this vehicle was run only on the fast/aggressive track

Fast/aggressive track – starts resulted in track impressions that were 1 to 2 cm (0.4 to 0.8 in) deep. The pass-bys resulted in surface chew from the track that was 1 cm (0.4 in) deep. There was no trenching or rutting of the trail surface. Stops resulted in track marks that were 1 to 2 cm (0.4 to 0.8 in) deep and 36 cm (14.2 in) wide due to the vehicle sliding sideways during the stop. Stopping distance at 35 mph/56 kph ranged from 13.7 to 26.1 meters (45.0 to 85.7 feet), with an average stopping distance of 19.9 meters (65.3 feet). One reason for the wide variation in stopping distance was that one end of the track was icier and the vehicle's shorter track lugs allowed it to slide easily on the smooth trail surface.

Photo 96: Impression from an aggressive stop

Summary of Observations from WY 3 Field Test

- FAST/AGGRESSIVE PASS-BYS: None of the vehicles created noticeable adverse impacts when operated in the 35 mph/56 kph pass-by mode, just normal surface chew.
- AGGRESSIVE STARTS: ATVs created slightly deeper tracks in the trail than what the snowmobile did. Starts resulted in ATV tire impressions that were 2 to 3 cm (0.8 to 1.2 in) deep and 18 to 21 cm (7.1 to 8.3 in) wide. By comparison, snowmobile track impressions from the Arctic Cat snowmobile were 1 to 2 cm (0.4 to 0.8 in) deep.
- AGGRESSIVE STOPS: ATVs created slightly deeper tracks in the trail than what the snowmobile did. Stops resulted in ATV tire impressions 2 to 4 cm (0.8 to 1.6 in) deep and 18 to 30 cm (7.1 to 11.8 in) wide. By comparison, snowmobile track impressions from the Arctic Cat snowmobile were 1 to 2 cm (0.4 to 0.8 in) deep and 36 cm (14.2 in) wide.
- STOPPING DISTANCE – OTHER VEHICLES: The ATVs generally stopped in a shorter distance than what the snowmobile did. The Sportsman 6x6 ATV had the shortest average stopping distance, while the Arctic Cat snowmobile had the longest average stopping distance at this location. The average ATV stopping distances at 35 mph/56 kph ranged from 16.9 to 18.2 meters (55.3 to 59.7 feet), while the average snowmobile stopping distance was 19.9 meters (65.3 feet). The minimum average ATV stopping distance (the Sportsman 6x6 ATV) was 3.0 meters/9.8 feet (15.1%) less than the shortest average snowmobile stopping distance, while the average snowmobile stopping distance for the Arctic Cat snowmobile was 1.7 meters/5.6 feet (9.3%) greater than longest average ATV stopping distance.

Comparison of All Vehicles (Control and Other Vehicles) from WY 1 and WY 3 Field Tests

The four 'control' vehicles were tested at site WY 1, while four 'other' vehicles were tested at site WY 3. Both sites had nearly identical conditions so the results of the start, pass-by, and stop tests are comparable.

- FAST/AGGRESSIVE PASS-BY: None of the vehicles created noticeable adverse impacts when operated in the 35 mph/56 kph pass-by mode.
- AGGRESSIVE STARTS: ATVs created slightly deeper tracks in the trail than what the snowmobiles did. Aggressive starts resulted in ATV tire tracks 2 to 8 cm (0.8 to 3.1 in) deep and 18 to 29 cm (7.1 to 11.4 in) wide. Snowmobile track impressions were 1 to 5 cm (0.4 to 2 in) deep and 38 to 41 cm (15 to 16.1 in) wide. The deepest tire tracks were from the Predator ATV and were 3 cm (1.2 in) deeper than the deepest snowmobile track impressions which were from the Switchback snowmobile.
- AGGRESSIVE STOPS: Snowmobiles created slightly deeper tracks in the trail than what the ATVs did. Aggressive stops resulted in ATV tire tracks 2 to 4 cm (0.8 to 1.8 in) deep and 18 to 30 cm (7.1 to 11.8 in) wide. Snowmobile track impressions were 1 to 5 cm (0.4 to 2 in) deep and 36 to 42 cm (14.2 to 16.5 in) wide. The deepest snowmobile track impressions were from the Switchback snowmobile and were 1 cm (0.4

in) deeper than the deepest ATV tire tracks left by four of the five ATVs that were tested and 2 cm (0.8 in) deeper than the Bombardier Traxter's deepest tire impressions.

- STOPPING DISTANCE – ALL VEHICLES: The four 'other' vehicles (three ATVs and one snowmobile) all had a shorter average stopping distance than what the four 'control' vehicles (two ATVs and two snowmobiles) did. All ATVs generally stopped in a shorter distance than what the two control snowmobiles did, while the Arctic Cat snowmobile stopped in a shorter distance than what the two control ATVs did. The Sportsman 6x6 ATV had the shortest average stopping distance of all vehicles, while the Switchback snowmobile had the longest average stopping distance of all vehicles. The average ATV stopping distances at 35 mph/56 kph ranged from 16.9 to 23.2 meters (55.3 to 76.0 feet), while the average snowmobile stopping distance ranged from 19.9 to 27.4 meters (65.3 to 89.9 feet). The minimum average ATV stopping distance (the Sportsman 6x6 ATV) was 3.0 meters/9.8 feet (15.1%) less than the shortest average snowmobile stopping distance, while the maximum average snowmobile stopping distance (the Switchback snowmobile) was 4.2 meters/13.8 feet (18.1%) greater than longest average ATV stopping distance.

****

Field Testing Journal: February 8, 2006
Iron River, Wisconsin (WI 1)


Photo 97: Site of WI 1 field test

Field Study Code/Number: WI 1
Location: State Corridor Trail 2/4 3 miles east of Iron River, Wisconsin
Elevation: 1336 feet
Temperature Range: 11.0 F/-11.7 C (start) to 24.6 F/-4.1 C (end)
Time of Day: 8:55 AM to 11:36 AM
Weather: clear, calm
Trail Aspect: flat, located on railroad grade trail corridor
Trail Conditions: hard packed and very slight surface wear from traffic; last groomed the prior day (approx.16 hours prior) and was in good condition even though there had been lots of snowmobile traffic on the trail
Compacted Snow Depth: 24 cm (9.45 in) – packed very hard to the ground, some layers of ice.
Uncompacted snow depth adjacent to the trail: 30 to 46 cm (12 to 18 in)
Area Grooming Equipment: New Holland tractor with Lacrosse drag

<u>Control Vehicles</u>
A1 – 2005 Polaris Sportsman EFI 700 (4x4; auto transmission; 26 x 11R-12 rear tires / ½" lugs, 4 psi)
A2 – 2006 Polaris Predator 500 (2x4; manual transmission; 20 x 11-9 rear tires / ½" lugs, 4 psi)
S1 – 2006 Polaris Switchback 900 (144 x 15 x 1¼" track)
S2 – 2006 Polaris RMK 700 (144 x 15 x 2" track)

<u>Other Vehicles</u>
A3 – 2005 Kawasaki Brute Force 750 (4x4; auto transmission; 25 x 10-12 rear tires / ½" lugs, 6 psi)
A4 – 1999 Honda Foreman ES 450 (4x4; auto transmission; 25 x 10-12 rear tires / 3/8" lugs, 2 psi)
S3 – 2002 Yamaha Viper 700 (121 x 15 x ¾" track)
S4 – 2004 Arctic Cat Bearcat 660 4-stroke (141 x 19.5 x 1" track)

Individual Vehicle Observations

A1: 2005 Polaris Sportsman 700 ATV

Slow/normal track – generally, all starts, stops, and 15 mph/24 kph pass-bys resulted in visible tire tread tracks consistent with tire lug depth and width that were consistently 1 cm (0.4 in) deep and 19 cm (7.5 in) wide. Tire tracks were generally visible, consistent and the same the entire length of the start and pass-by zones. The stops resulted in tire impressions 2 cm (0.8 in) deep and 22 cm (8.7 in) wide.

Photo 98: Surface chew from a slow pass-by

Fast/aggressive track – starts resulted in tire tracks that varied from 2 to 3 cm (0.8 to 1.2 in) deep and 22 to 24 cm (8.7 to 9.5 in) wide. The fast pass-bys resulted in visible tire tracks 1 to 2 cm (0.4 to 0.8 in.) deep and 18 to 21 cm (7.1 to 8.3 in) wide and left no visible trenching or rutting. Stops resulted in tire impressions that varied from 2 to 3 cm (0.8 to 1.2 in) deep and 26 to 30 cm (10.2 to 11.8 in) wide. Stopping distance at 35 mph/56 kph ranged from 12.8 to 17.8 meters (42 to 58.3 feet), with an average stopping distance of 14.9 meters (49 feet).

Photo 99: Impressions from an aggressive start

Photo 100: Impressions from an aggressive stop

A2: 2006 Polaris Predator 500 ATV

Slow/normal track – generally, all starts, stops and 15 mph/24 kph pass-bys resulted in visible tire tread tracks consistent with tire lug depth and width that were consistently 1.5 cm (0.6 in) deep and 27 to 30 cm (10.6 to 11.8 in) wide. Tire tracks were generally visible, consistent and the same the entire length of the start and pass-by zones. The stops resulted in tire impressions 1.5 cm (0.6 in) deep and 27 cm (10.6 in) wide.

Photo 101: Surface chew from a slow pass-by

Fast/aggressive track – starts resulted in tire tracks that varied from 5 to 6 cm (2 to 2.4 in) deep and 28 to 30 cm (11 to 11.8 in) wide. The fast pass-bys resulted in visible tire tracks 2 to 3 cm (0.8 to 1.2 in.) deep and 28 to 30 cm (11 to 11.8 in) wide and left no visible trenching or rutting. Stops resulted in tire impressions that varied from 2 to 4 cm (0.8 to 1.6 in) deep and 30 to 46 cm (10.8 to 18.1 in) wide. Stopping distance at 35 mph/56 kph ranged from 10.5 to 12.0 meters (34.4 to 39.5 feet), with an average stopping distance of 11.4 meters (37.4 feet).

Photo 102: Impressions from an aggressive start

Photo 103: Impressions from an aggressive stop

A3: 2005 Kawasaki Brute Force 750 ATV

Slow/normal track – this vehicle was run only on the fast/aggressive track

Fast/aggressive track – starts resulted in tire tracks that varied from 4 to 8 cm (1.6 to 3.1 in) deep and 24 to 28 cm (9.5 to 11 in) wide. The fast pass-bys resulted in visible tire tracks 2 cm (0.8) deep and 24 to 26 cm (9.5 to 10.2 in) wide and left no visible trenching or rutting. Stops resulted in tire impressions that varied from 3 to 5 cm (1.2 to 2 in) deep and 20 to 24 cm (7.9 to 9.5 in) wide. Stopping distance at 35 mph/56 kph ranged from 15 to 18 meters (49.3 to 58.9 feet), with an average stopping distance of 16.1 meters (52.8 feet).

Photo 104: Impressions from an aggressive start

Photo 105: Impressions from an aggressive stop

A4: 1999 Honda Foreman ES 450 ATV

Slow/normal track – this vehicle was run only on the fast/aggressive track

Fast/aggressive track – starts resulted in tire tracks that varied from 2 to 2.5 cm (0.8 to1 in) deep and 27 to 28 cm (10.6 to 11 in) wide. The fast pass-bys resulted in visible tire tracks 1.5 to 2 cm (0.6 to 0.8) deep and 27 to 28 cm (10.6 to 11 in) wide and left no visible trenching or rutting. Stops resulted in tire impressions that varied from 2 to 2.5 cm (0.8 to 1 in) deep and 25 to 26 cm (9.8 to 10.2 in) wide. Stopping distance at 35 mph/56 kph ranged from 12.9 to 15.2 meters (42.3 to 49.8 feet), with an average stopping distance of 13.7 meters (45.1 feet).

Photo 106: Impressions from an aggressive start

Photo 107: Impressions from an aggressive stop

S1: 2006 Polaris Switchback 900 Snowmobile

Slow/normal track – generally, all starts, stops, and 15 mph/24 kph pass-bys resulted in visible grooves from the ski skags that were 2.5 cm (1 in) deep and 6 cm (2.4 in) wide. "Surface chew" from the track was 1.5 to 2 cm (0.6 to 0.8 in) deep and 38 cm (15 in) wide. The skag marks and surface chew were generally consistently visible and the same the entire length of the start, pass-by, and stop zones consistent with trail wear from normal snowmobile traffic.

Photo 108: Surface chew and skag marks from slow pass-by

Fast/aggressive track – starts resulted in track marks that were 5 to 6 cm (2 to 2.4 in) deep and 40 cm (15.7 in) wide. The 35 mph/56 kph pass-bys resulted only in normal surface chew from the track that was 3 cm (1.2 in) deep and 38 to 40 cm (15 to 15.7 in) wide. There was no visible trenching or rutting other than the 2.5 cm (1 in) deep and 6 cm (2.4 in) wide ski skag grooves that were visible throughout all three zones. Stops resulted in trail surface impressions that were 2 to 5 cm (0.8 to 2 in) deep and 40 to 42 cm (15.7 to 16.5 in) wide. Stopping distance at 35 mph/56 kph ranged from 19.3 to 21.1 meters (63.3 to 69.3 feet), with an average stopping distance of 20.6 meters (67.5 feet).

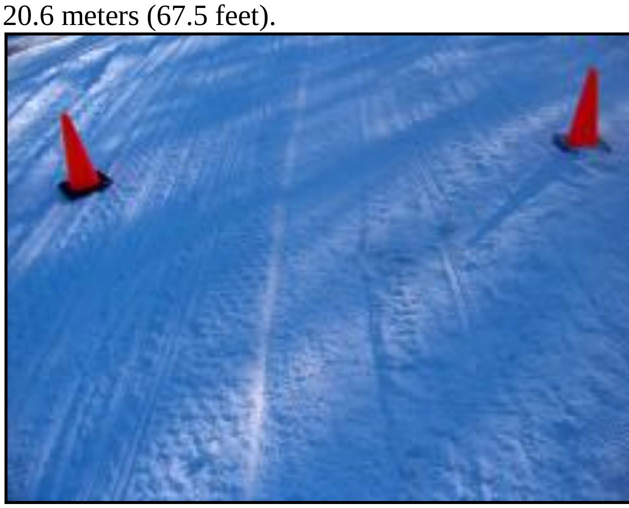

Photo 109: Impression from an aggressive start

Photo 110: Impression from an aggressive stop

S2: 2006 Polaris RMK 700 Snowmobile

Photo 111: Surface chew and skag marks from a slow pass

Slow/normal track – generally, all starts, stops and 15 mph/24 kph pass-bys resulted in visible grooves from the ski skags that were 2 cm (0.8 in) deep and 5 cm (2 in) wide. "Surface chew" from the track was 2 cm (0.8 in) deep and 38 cm (15 in) wide. The skag marks and surface chew were generally consistently visible and the same the entire length of the start, pass-by, and stop zones consistent with trail wear from normal snowmobile traffic. Track impressions in the stop zone were 3 cm (1.2 in) deep and 38 cm (15 in) wide.

Fast/aggressive track – starts resulted in track marks that were 3 to 5 cm (1.2 to 2 in) deep and 38 to 40 cm (15 to 15.7 in) wide. The 35 mph/56 kph pass-bys resulted only in normal surface chew from the track that was 2.5 to 3 cm (1 to 1.2 in) deep and 38 to 40 cm (15 to 15.7 in) wide. There was no visible trenching or rutting other than the 2 cm (0.8 in) deep and 5 cm (2 in) wide ski skag grooves that were visible throughout all three zones. Stops resulted in trail surface impressions that were 3 to 5 cm (1.2 to 2 in) deep and 40 to 45 cm (15.7 to 17.7 in) wide. Stopping distance at 35 mph/56 kph ranged from 16.1 to 21.1 meters (52.8 to 69.3 feet), with an average stopping distance of 18.5 meters (60.8 feet).

Photo 112: Impression from an aggressive start

Photo 113: Impression from an aggressive stop

S3: 2002 Yamaha Viper 700 Snowmobile

Slow/normal track – this vehicle was run only on the fast/aggressive track

Fast/aggressive track – starts resulted in track marks that were 2 to 4 cm (0.8 to 1.6 in) deep and 42 to 43 cm (16.5 to 16.9 in) wide. The 35 mph/56 kph pass-bys resulted in surface chew from the track that was 1.5 to 2 cm (0.6 to 0.8 in) deep and 38 to 40 cm (15 to 15.7 in) wide. There was no visible trenching or rutting. 2 cm (0.8 in) deep and 5 cm (2 in) wide ski skag grooves were visible throughout all three zones. Stops resulted in trail surface impressions that were 2 to 3 cm (0.8 to 1.2 in) deep and 45 to 47 cm (17.7 to 18.5 in) wide. Stopping distance at 35 mph/56 kph ranged from 19.9 to 24.6 meters (65.3 to 80.8 feet), with an average stopping distance of 22.4 meters (73.5 feet).

Photo 114: Impression from an aggressive start Photo 115: Impression from an aggressive stop

S4: 2004 Arctic Cat Bearcat 660 4-stroke Snowmobile
Slow/normal track – this vehicle was run only on the fast/aggressive track

Fast/aggressive track – starts resulted in track marks that were 4 to 5 cm (1.6 to 2 in) deep and 52 cm (20.5 in) wide. The 35 mph/56 kph pass-bys resulted in surface chew from the track that was 2 to 2.5 cm (0.8 to 1 in) deep and 52 cm (20.5 in) wide. Stops resulted in trail surface impressions that were 2 to 5 cm (0.8 to 2 in) deep and 52 cm (20.5 in) wide. Stopping distance at 35 mph/56 kph ranged from 21 to 23.4 meters (68.8 to 76.8 feet), with an average stopping distance of 22.6 meters (74.2 feet).

Photo 116: Impression from an aggressive start Photo 117: Impression from an aggressive stop

Summary of Observations from the WI 1 Field Test

- SLOW/NORMAL OPERATION: None of the vehicles created noticeable adverse impacts when operated in the slow/normal mode whether in the start, 15 mph/24 kph pass-by, or stop zones.
- FAST/AGGRESSIVE PASS-BY: None of the vehicles created noticeable adverse impacts when operated in the 35 mph/56 kph pass-by mode.
- AGGRESSIVE STARTS: ATVs created slightly deeper impressions in the trail than what snowmobiles did. Aggressive starts resulted in ATV tire impressions 2 to 8 cm (0.8 to 3.1 in.) deep and 22 to 30 cm (8.7 to 11.8 in.) wide. Snowmobile track impressions were 2 to 6 cm (0.8 to 2.4 in.) deep and 38 to 52 cm (15 to 20.5 in.) wide. The deepest ATV tire tracks from were only slightly deeper (1 cm / 0.4 in) than the deepest snowmobile track impressions.
- AGGRESSIVE STOPS: There was no difference between the impressions created by ATVs and snowmobiles. Aggressive stops resulted in ATV tire impressions 2 to 5 cm (0.8 to 2 in.) deep and 20 to 30

cm (7.9 to 11.8 in.) wide. Snowmobile track impressions were 2 to 5 cm (0.8 to 2 in.) deep and 40 to 52 cm (15.7 to 20.5 in.) wide. The deepest ATV tire tracks and snowmobile track impressions were exactly the same.

- STOPPING DISTANCE – ALL VEHICLES: When comparing all vehicles tested, the ATVs generally stopped quicker than the snowmobiles. The Predator stopped the quickest of the four ATVs and the RMK stopped the quickest of the four snowmobiles. The Kawasaki Brute required the greatest distance to stop of the four ATVs, while the Bearcat required the greatest distance to stop of the four snowmobiles. The average ATV stopping distances at 35 mph/56 kph ranged from 11.4 to 16.1 meters (37.4 to 52.8 feet). The average snowmobile stopping distance ranged from 18.5 to 22.6 meters (60.8 to 74.2 feet). The minimum average ATV stopping distance (the Predator) was 7.1 meters/23.3 feet (62.3%) less than the shortest average snowmobile stopping distance, while the maximum average snowmobile stopping distance (the Bearcat) was 6.5 meters / 21.3 feet (40.4%) greater than the longest average ATV stopping distance.
- STOPPING DISTANCE – CONTROL VEHICLES: When comparing just the four control vehicles, the ATVs generally stopped quicker than the snowmobiles. The Predator stopped quicker of the two control ATVs, while the Switchback required the greatest distance to stop of the two control snowmobiles. The average ATV stopping distances at 35 mph/56 kph ranged from 11.4 to 14.9 meters (37.4 to 49 feet), while the average snowmobile stopping distance ranged from 18.5 to 20.6 meters (60.8 to 67.5 feet). The minimum average ATV stopping distance (the Predator) was 7.1 meters/23.3 feet (38.4%) less than the shortest average snowmobile stopping distance, while the maximum average snowmobile stopping distance (the Switchback) was 5.7 meters/8.7 feet (38.3%) greater than the longest average ATV stopping distance.

****

Field Testing Journal: February 8, 2006
Iron River, Wisconsin (WI 2)


Photo 118: Site of WI 2 testing

Field Study Code/Number: WI 2
Location: State Corridor Trail 31 approx. 3 miles northeast of Iron River, Wisconsin
Elevation: 1336 feet
Temperature Range: 25.9 F/-3.4 C
Time of Day: 1:45 PM to 2:25 PM
Weather: clear, calm
Trail Aspect: trail located in borrow ditch along plowed roadway; approx. ¼ mile / 0.4 km long segment with 15% grade on each end with a valley in the middle of the two hills
Trail Conditions: hard packed and very slight surface wear from traffic; last groomed the prior day (approximately 16 hours prior) and was in good condition even though there had been lots of snowmobile traffic on the trail
Compacted Snow Depth: 9 cm (3.5 in) to ice layer in middle of the trail; 13 cm (5.1 in) to ground along edges of groomed trail – trail surface was generally packed very hard
Uncompacted snow depth adjacent to the trail: 30 to 46 cm (12 to 18 in)
Area Grooming Equipment: New Holland tractor with Lacrosse drag

Control Vehicles
A1 – 2005 Polaris Sportsman EFI 700 (4x4; auto transmission; 26 x 11R-12 rear tires / ½” lugs, 4 psi)
A2 – 2006 Polaris Predator 500 (2x4; manual transmission; 20 x 11-9 rear tires / ½” lugs, 4 psi)
S1 – 2006 Polaris Switchback 900 (144 x 15 x 1¼” track)
S2 – 2006 Polaris RMK 700 (144 x 15 x 2” track)

Individual Vehicle Observations

A1: 2005 Polaris Sportsman 700 ATV

Hill pass-by – four pass-bys were run at a speed of approximately 50 mph/80 kph. Tire impressions from downhill passes were 3 to 4 cm (1.2 to 1.6 in) deep and 25 to 26 cm (9.8 to 10.2 in) wide. Tire impressions left by uphill passes were 4 to 6 cm (1.6 to 2.4 in) deep and 22 to 25 cm (8.7 to 9.8 in) wide. Tire impressions at the bottom of the valley between the two hills were generally 2 cm (0.8 in) deep.

Photo 119: A fast pass-by

Photo 120: Tire impressions from a fast pass-by

A2: 2006 Polaris Predator 500 ATV

Hill pass-by – four pass-bys were run at a speed of approximately 45 to 50 mph/72 to 80 kph. Tire impressions from downhill passes were 1 to 2 cm (0.4 to 0.8 in) deep and 26 to 28 cm (10.2 to 11 in) wide. Tire impressions left by uphill passes were 2 to 3 cm (0.8 to 1.2 in) deep and 26 to 28 cm (10.2 to 11 in) wide. Tire impressions at the bottom of the valley between the two hills were generally 1 to 1.5 cm (0.4 to 0.6 in) deep.

Photo 121: A fast downhill pass-by

Photo 122: Tire impressions from a fast uphill pass-by

S1: 2006 Polaris Switchback 900 Snowmobile

Hill pass-by – four pass-bys were run at a speed of approximately 50 mph/80 kph. Track marks on both uphill and downhill pass-bys generally consisted of surface chew 1.5 to 3 cm (0.6 to 1.2 in) deep and 40 to 41 cm (15.7 to 16.1 in) wide. The same surface chew was also generally present at the bottom of the valley between the two hills.

Photo 123: A fast pass-by

Photo 124: Impressions from uphill fast pass-by

S2: 2006 Polaris RMK 700 Snowmobile

Hill pass-by – four pass-bys were run at a speed of approximately 50 mph/80 kph. Track impressions on both uphill and downhill pass-bys generally consisted of surface chew 2 to 5 cm (0.8 to 2 in) deep and 40 cm (15.7 in) wide. The same surface chew was also generally present at the bottom of the valley between the two hills. One additional observation was that footprints on the trail surface were generally 3 cm (1.2 in) deep.

Photo 125: Footprint on the trail surface

Photo 126: A fast pass-by

Photo 127: Impressions from a fast pass-by

Summary of Observations from the WI 2 Field Test

- ATV PASS-BYS: The relatively fast pass-bys on the hard trail surface left minimal tire impressions that were 2 to 6 cm (0.8 to 2.4 in) in depth. There was slightly more tire spin when traveling uphill, but no trenching or rutting of the trail surface.

- SNOWMOBILE PASS-BYS: The relatively fast pass-bys on the hard trail surface left minimal track impressions that were 1.5 to 5 cm (0.6 to 2 in) in depth. There was no noticeable track spin when traveling uphill and no trenching or rutting of the trail surface.
- FOOTPRINTS: Footprints on the trail surface were generally 3 cm (1.2 in) deep.

****

Field Testing Journal: February 8, 2006
Iron River, Wisconsin (WI 3)

Photo 128: Site of WI 3 field test

Field Study Code/Number: WI 3
Location: State Corridor Trail 31 approx. 4 miles northeast of Iron River, Wisconsin
Elevation: 1345 feet
Temperature Range: 24.0 F/-4.4 C to 25.9 F/-3.4 C
Time of Day: 2:45 PM to 3:15 PM
Weather: clear, calm
Trail Aspect: flat through the woods; 140 degrees curve that was 150 feet/45.7 meters in length
Trail Conditions: moderately packed snow surface with ice layer beneath; surface wear from traffic but was in good condition even though there had been lots of snowmobile traffic on the trail
Compacted Snow Depth: 4 to 17 cm (1.6 to 6.7 in) to ice layer – trail surface was compacted but the snow was nearly worn out so it did not bond well
Uncompacted snow depth adjacent to the trail: 20 to 40 cm (8 to 16 in)
Area Grooming Equipment: New Holland tractor with Lacrosse drag

<u>Control Vehicles</u>
A1 – 2005 Polaris Sportsman EFI 700 (4x4; auto transmission; 26 x 11R-12 rear tires / ½" lugs, 4 psi)
A2 – 2006 Polaris Predator 500 (2x4; manual transmission; 20 x 11-9 rear tires / ½" lugs, 4 psi)
S1 – 2006 Polaris Switchback 900 (144 x 15 x 1¼" track)
S2 – 2006 Polaris RMK 700 (144 x 15 x 2" track)

<u>Individual Vehicle Observations</u>
A1: 2005 Polaris Sportsman 700 ATV
<u>140 degree curve pass-by</u> – the four pass-bys were all relatively slow (25 to 30 mph/40 to 48 kph) since icy conditions near the trail surface led to the vehicles sliding easily when negotiating the curve. Visible tire tracks were 3 to 5 cm (1.2 to 2 in) deep and 16 to 19 cm (6.3 to 7.5 in) wide, although one pass resulted in tire tracks that were 27 cm (10.6 in) wide.

Photo 129: A curve pass-by

Photo 130: Impressions from a curve pass-by

A2: 2006 Polaris Predator 500 ATV

<u>140 degree curve pass-by</u> – the four pass-bys were all relatively slow (25 to 30 mph/40 to 48 kph) since icy conditions near the trail surface led to the vehicles sliding easily when negotiating the curve. Visible tire tracks were 3 to 8 cm (1.2 to 3.1 in) deep and 26 to 30 cm (10.2 to 11.8 in) wide. The last two passes were into the ice layer at the top of the curve and resulted in a 6 to 8 cm (2.4 to 3.1 in) high berm starting to form on the outside edge.

Photo 131: A curve pass-by

Photo 132: Berm created by curve pass-by

S1: 2006 Polaris Switchback 900 Snowmobile

<u>140 degree curve pass-by</u> – the four pass-bys were all relatively slow (25 to 30 mph/40 to 48 kph) since icy conditions near the trail surface led to the vehicle sliding easily when negotiating the curve. Visible track marks were 2 to 3 cm (0.8 to 1.2 in) deep and 40 cm (15.7 in) wide. All passes were into the ice layer at the top of the curve and resulted in a 5 cm (2 in) high berm starting to form on the outside edge.

Photo 133: A curve pass-by

Photo 134: Icy surface uncovered by curve pass-bys

S2: 2006 Polaris RMK 700 Snowmobile

<u>140 degree curve pass-by</u> – the four pass-bys were all relatively slow (25 to 30 mph/40 to 48 kph) since icy conditions near the trail surface led to the vehicle sliding easily when negotiating the curve. Visible track marks were 2 to 3 cm (0.8 to 1.2 in) deep and 47 cm (18.5 in) wide.

Photo 135: A curve pass-by

Photo 136: Impressions from a curve pass-by

Summary of Observations from the WI 3 Field Test

- ATV OPERATION: Passes by the ATVs generated tire tracks 3 to 8 cm (1.2 to 3.1 in) deep that were 16 to 30 cm (6.3 to 11.8 in) wide. A slight (8 cm/3.1 in) berm also began to form on the outside edge of the corner, but the height was limited by the ice layer just below the surface.
- SNOWMOBILE OPERATION: Passes by the snowmobiles generated track marks 2 to 3 cm (0.8 to 1.2 in) deep and 40 to 47 cm (15.7 to 18.5 in) wide. A slight (5 cm/2 in) berm also began to form on the outside edge of the corner, but the height was limited by the ice layer just below the surface.
- The curve was generally quite icy just below the surface which prevented much speed in the corner, as well as any significant impacts from any of the four vehicles sliding around/through the corner.

****

Field Testing Journal: February 10, 2006
Soo Line South Trail; Moose Lake, Minnesota (MN 1)

Field Study Code/Number: MN 1
Location: Soo Line South Trail, starting from the Moose Lake Depot
Elevation: 1081 feet
Temperature Range: 23.6 F/-4.7 C (start) to 27.0 F/-2.8 C (end)
Time of Day: 1:30 PM to 3:35 PM
Weather: clear, sunny, calm
Trail Aspect: railroad grade trail; flat
Trail Conditions: the first two miles of the trail heading east from the depot had been freshly groomed that morning; the balance of the trail had 6 to 10 cm (2.4 to 3.9 in) of new snow on it that fell the previous night (there was more new snow on the trail the farther you went from town); the trail base below the new snowfall was smooth and in good condition

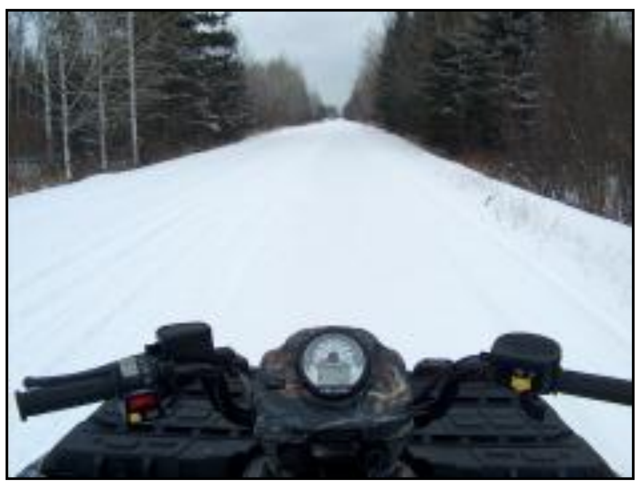

Photo 137: Site of MN 1 Field Observations

Control Vehicles

A1 – 2005 Polaris Sportsman EFI 700 (4x4; auto transmission; 26 x 11R-12 rear tires / ½" lugs, 4 psi)
A2 – 2006 Polaris Predator 500 (2x4; manual transmission; 20 x 11-9 rear tires / ½" lugs, 4 psi)

Individual Vehicle Observations

A1 – 2005 Polaris Sportsman 700 ATV

The vehicle was ridden from the depot parking area east on the trail for a distance of nine miles and then back to the depot, for a total distance of 18 miles, with the following observations:

Operation on Freshly Groomed Portion of the Trail – Tire impressions on the freshly groomed trail surface were 2 cm (0.8 in) deep and 26 cm (10.2 in) wide. Comparatively, track marks from other snowmobile traffic on the trail were 1 cm (0.4 in) deep and 40 cm (15.7 in) wide and were accompanied by ski skag marks that were 2 cm (0.8 in) deep and 4 cm (1.6 in) wide. Footprints from snow boots left a 1 cm (0.4 in) deep impression on the trail.

Photo 138: Tire, sled, and foot impressions on the groomed trail

Operation on Trail with New/Ungroomed Snow – Tire impressions on the trail where there was 6 to 10 cm (2.4 to 3.9 in) of new snow that had not yet been groomed were 4 cm (1.6 in) deep and 28 cm (11 in) wide. Deliberate in-trail weaving also left the same 4 cm (1.6 in) deep and 28 cm (11 in) wide tire tracks. The vehicle handled much better than the Predator and was able to travel at a speed of 40 mph/64 kph while being only slightly "squirrelly." The vehicle was operated in 4WD the nine miles out from the parking area, and then in 2WD on the return trip. It was less squirrelly in 4WD and tracked better than when it was operated in 2WD. One road crossing had 38 cm (15 in) high berms from the snowplow – there was spinning while crossing them in 2WD while they were not an issue when crossing them while in 4WD.

Photo 139: Tire impression on the new snowfall

Photo 140: Tire impressions in new snow

Photo 141: Impressions from in-trail weaving

A2 – 2006 Polaris Predator 500 ATV

The vehicle was ridden from the depot parking area east on the trail for a distance of six miles and then back to the depot, for a total distance of 12 miles, with the following observations:

Operation on Freshly Groomed Portion of the Trail – Tire impressions on the freshly groomed trail surface were 1 cm (0.4 in) deep and 26 cm (10.2 in) wide. Comparatively, snowmobile track and ski skag impressions from other traffic on the trail were 1 to 2 cm (0.4 to 0.8 in) deep and footprints from snow boots left a 1 cm (0.4 in) deep impression on the trail.

Photo 142: Tire imprints on groomed trail surface

Photo 143: Tire and footprint impressions

Operation on Trail with New/Ungroomed Snow – Tire impressions on the trail where there was 6 cm (2.4 in) of new snow that had not yet been groomed were 4 cm (1.6 in) deep and 26 cm (10.2 in) wide. When shifting the vehicle between gears while accelerating during takeoff, piles of snow that were 12 cm (4.7 in) high, 32 cm (12.6 in) wide, and 36 cm (14.2 in) long were left on the trail by the tires. Deliberate in-trail turns (cookies/doughnuts in the middle of the trail) dug 6 cm (2.4 in) deep and 24 to 26 cm (9.5 to 11in) wide ruts in the trail. These ruts were down to an ice layer; otherwise, the ruts would likely have been even deeper. This also created 12 to 14 cm (4.7 to 5.5 in) high berms at the outside edges of the turn. Again, these likely would have been higher if there had not been the ice layer in the trail. The vehicle handled better when it could follow a track made in the snow by previous snowmobile traffic. Overall, the vehicle was very "squirrelly" and it felt like its front tires were skating around all of the time, making it hard to control.

Photo 144: Tire impressions on fresh snow


Photo 145: Snow piles from shifting gears


Photo 146: Impressions from an in-trail turn

Summary of Observations from the MN 1 Field Test

- This field test was a good opportunity to observe ATV operation on a real trail open to concurrent use by both ATVs and snowmobiles. The trail also had 6 to 10 cm (2.4 to 3.9 in) of new snow on it, which also offered a perspective that had not yet been observed. The two control ATVs were operated a combined total of 30 miles (48 kilometers) on the trail.
- The Sportsman ATV handled the trail conditions quite well and was enjoyable to ride at all speeds. Tire impressions were generally 4 cm (1.6 in) deep and 28 cm (11 in) wide in the new snow on the trail, irrespective as to whether it was normal operation down the trail or deliberate in-trail weaving with the vehicle.
- The Predator ATV was generally very squirrelly to operate and generally felt unsafe on this trail surface at all but a very low speed. Tire impressions were also generally 4 cm (1.6 in) deep, but 26 cm (10.2 in) wide, when going down the trail with the new snow. Deliberate in-trail turns dug 6 cm (2.4 in) deep ruts down to the ice layer of the trail's base. The vehicle also left small piles of snow generally 12 cm (4.7 in) high, 32 cm (12.6 in) wide, and 36 cm (14.2 in) long when shifting between gears.

****

Field Testing Journal: February 11, 2006
Gandy Dancer Trail and St. Croix State Forest, Minnesota (MN 2)

Field Study Code/Number: MN 2
Location: Gandy Dancer Trail and St. Croix State Forest, starting from the Danbury, Wisconsin trailhead which is located just across the state line from the trail
Elevation: 930 feet
Temperature Range: 17.0 F/-8.3 C (start) to 30.8 F/-0.7 C (end)
Time of Day: 10:30 AM to 1:30 PM
Weather: clear, sunny, calm
Trail Aspect: the main trail was flat and located on an old railroad grade; the side trails on the state forest were hilly and winding through the forest on narrow logging trails
Trail Conditions: the first one mile (1.6 km) north from the parking lot to the St. Croix River Bridge (the Minnesota state line) was ungroomed and heavily moguled. The railroad grade trail north from the bridge had been groomed, but not since there had been new snowfall. There was 8 to 10 cm (3.1 to 3.9 in) of new snow

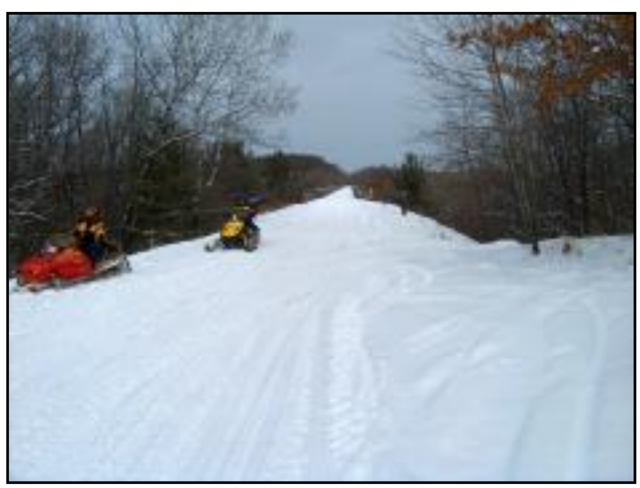
Photo 147: Railroad grade trail at Site MN 2

that had been heavily trafficked by snowmobiles. The side trails on the state forest had 10 to 20 cm (3.9 to 7.9 in) of new snowfall that had not been trafficked or groomed, which provided a bit of a fresh powder characteristic.

Photo 148: Site MN 2 side trails

Control Vehicles

A1 – 2005 Polaris Sportsman EFI 700 (4x4; auto transmission; 26 x 11R-12 rear tires / ½" lugs, 4 psi)
A2 – 2006 Polaris Predator 500 (2x4; manual transmission; 20 x 11-9 rear tires / ½" lugs, 4 psi)

Individual Vehicle Observations

A1 – 2005 Polaris Sportsman 700 ATV

The vehicle was ridden from the parking area north on the railroad grade trail to Markville, a distance of about 6 miles (9.7 km), and then back south to the state forest side trails where various loops totaling 19 miles (30.6 km) were ridden before returning to the parking area in Danbury via the railroad grade trail. A total distance of 31 miles (49.9 km) were ridden, 12 miles (19.3 km) on the railroad grade and 19 miles (30.6 km) on the state forest, with the following observations:

Photo 149: Vehicle on the railroad grade trail

Operation on the Railroad Grade Trail – There was 8 to 10 cm (3.1 to 3.9 in) of new snow on the trail that had been heavily trafficked and beaten down by snowmobiles. Tire impressions on the trail surface were 2 cm (0.8 in) deep and 26 cm (10.2 in) wide. Comparatively, track marks from other snowmobile traffic on the trail were generally 1 cm (0.4 in) deep and 38 cm (15 in) wide and were accompanied by ski skag marks that were 1 cm (0.4 in) deep and 4 cm (1.6 in) wide. The vehicle reached a top speed of 45 mph/ 72 kph and was relatively stable, although there was a tendency to want to hug the middle of the trail, particularly where the grade was very high and elevated. The vehicle was operated in both 2-wheel drive (2WD) and 4-wheel drive (4WD) with 4WD providing a more stable feeling of being in control of the vehicle. In 2WD, there was a greater tendency for the rear end of the vehicle to spin and wander. In 4WD, you could feel the difference of the front wheels helping to pull the vehicle. The vehicle was extremely cold to operate (no windshield, hand warmers or cowling to offer protection), particularly when going down the trail at 45 mph/72 kph. Snowmobile traffic was relatively heavy (approximately 90 sleds over the three hour period) on the trail (it was a Saturday morning/early afternoon), as compared to seeing only one other ATV on the trail over the same time period.

Photo 150: ATV and snowmobile impressions on the trail

Photo 151: Snowmobile and footprint impressions **Photo 152: Tire impression on packed trail**

Photo 153: Fresh snowfall on the side trails

Photo 154: The vehicle in fresh snow

<u>Operation on the State Forest Side Trails</u> – There was 10 to 20 cm (3.9 to 7.9 in) of new snowfall on the side trail loops that had not been heavily trafficked or groomed, with over half of the trails having had no prior traffic on the new snowfall. Tire impressions where there was 20 cm (7.9 in) of new snow were 17 cm (6.7 in) deep and 29 cm (11.4 in) wide. In another location where the new snow was 14 cm (5.5 in) deep, the tire impressions in the snow were 12 cm (4.7 in) deep. And where the new snowfall was 18 cm (7.1 in) deep, the tire impressions were 15 cm (5.9 in) deep. Generally, in all locations that were sampled, the tire impressions in the new snow were 2 to 3 cm (0.8 to 1.2 in) less than what the total depth of the new snowfall was. Said another way, the tires consistently compressed the new snow to a depth of 2 to 3 cm (0.8 to 1.2 in). On a 25 mph/40 kph pass-by through a particularly winding and hilly section of the trail, 8 to 10 cm (3.1 to 3.9 in) high and 20 cm (7.9 in) wide berms were created at the outside edges of the trail. However, these berms were re-leveled by only two snowmobiles passing over the same trail soon after they had been created. The vehicle was operated in 2-wheel drive (2WD) mode for only a short distance since it generally struggled and was hard to control in the deeper snow. The 4-wheel drive (4WD) mode provided much better control, particularly when negotiating the curves and hills. Snowmobile traffic was relatively light (approximately 10 sleds over the three hour period) on the trail. Generally, in 4WD mode, the vehicle provided a very enjoyable ride and negotiated the trail features well at a speed of 20 to 25 mph/32 to 40 kph. Four other ATVs (a group of three ATVs and a single rider on a 3-wheeler) were seen on these trail loops over the same time period.


Photo 155: Tracks in the fresh snow


Photo 156: Tire impression in fresh snow


Photo 157: Downhill on a side trail


Photo 158: Around a curve on a side trail

A2 – 2006 Polaris Predator 500 ATV

The vehicle was ridden from the parking area north on the railroad grade trail to turn-off to the state forest side trails, a distance of about 2.5 miles (4 km). It was then ridden a short distance on the state forest side trails, about 3.5 miles (5.6 km), at which point the vehicle was turned around and ridden back to the trailhead in Danbury. The ATV was ridden a total distance of about 12 miles (19.3 km), 5 miles (8 km) on the railroad grade and about 7 miles (11.3 km) on the state forest, with the following observations:

Operation on the Railroad Grade Trail – There was 8 to 10 cm (3.1 to 3.9 in) of new snow on the trail that had been heavily trafficked and beaten down by snowmobiles. Tire impressions on the trail surface were 1 cm (0.4 in) deep and 27 cm (10.6 in) wide. Comparatively, track marks from snowmobile traffic on the trail were generally 1 cm (0.4 in) deep and 38 cm (15 in) wide and accompanied by ski skag marks that were 1 cm (0.4 in) deep and 4 cm (1.6 in) wide. The vehicle had a difficult time negotiating the rough moguls near the trailhead since the short wheel base of the vehicle made it very hard to control the vehicle as it went up and down in the deep holes. Overall, the vehicle was very hard to control, very squirrelly, and didn't have a very safe feel going down the trail. The vehicle was extremely cold to operate (no windshield, hand warmers or cowling to offer protection). Snowmobile traffic was relatively heavy on the trail and, when meeting snowmobile traffic, it required slowing the vehicle way down – nearly to a stop – to keep control of the vehicle at the edge of the trail where there was more new snow that had not been compressed by the snowmobile traffic on the trail.

Photo 159: Tire impression on the railroad grade trail

Operation on the State Forest Side Trails – There was 10 to 20 cm (3.9 to 7.9 in) of new snowfall on the side trail loops that had not been heavily trafficked or groomed, with over half of the trails having had no prior traffic on the new snowfall. Tire impressions where there was 10 cm (3.9 in) of new snow were 9 cm (3.5 in) deep and 27 cm (10.6 in) wide. In another location where the new snow was 17 cm (6.7 in) deep, the tire impressions in the snow were 15 cm (5.9 in) deep and 28 cm (11 in) wide. Generally, in all locations that were sampled, the tire impressions in the new snow were 1 to 2 cm (0.4 to 0.8 in) less than what the total depth of the new snowfall was. Said another way, the tires consistently compressed the new snow to a depth of 1 to 2 cm (0.4 to 0.8 in). The front tires of this 2-wheel drive (2WD) vehicle tended to "push" in the deeper snow that was moderately moist (the snow easily made a loose snowball) and the vehicle was particularly hard to control. Also, in the 17 cm (6.7 in) deep new snowfall, the front A-arm/steering and suspension on the vehicle had only 1 cm (0.4 in) of clearance between it and the top of the snow since the front tires penetrated the new snow to a depth of 16 cm (6.3 in), which could make the operation of this vehicle in much deeper snow very difficult, if not impossible. While the Sportsman ATV (A1) easily negotiated these same side trails at 20 to 25 mph/32 to 40 kph, this vehicle struggled to negotiate them at 10 to 15 mph/16 to 24 kph. The vehicle was extremely squirrelly to operate and it felt very unsafe to operate under the same conditions that, just a short time earlier, the Sportsman had easily handled in a much safer manner.

Photo 160: Tracks on a side trail

Photo 161: Snow is almost as deep as vehicle's suspension

Photo 162: Tire impression in new snow

Summary of Observations from the MN 2 Field Test

- This field test was another good opportunity to observe ATV operation on a variety of real trails open to concurrent use by both ATVs and snowmobiles. The railroad grade trail had 8 to 10 cm (3.1 to 3.9 in) of new snow that had been heavily trafficked by snowmobiles, while the side trails on the state forest had 10 to 20 cm (3.9 to 7.9 in) of new snowfall that had not been trafficked or groomed and provided somewhat of a fresh powder characteristic. The two control ATVs were operated a combined total of 45 miles (72 kilometers) on these trails.
- The Sportsman ATV handled the trail conditions quite well and was enjoyable to ride at all speeds. The winding and hilly side trails were a particularly enjoyable experience on this vehicle. Tire impressions on the railroad grade trail were generally 2 cm (0.8 in) deep and 26 cm (10.2 in) wide in the new snow on the trail that had been heavily trafficked by snowmobiles. On the side trails, tire impressions ranged from being 12 cm (4.7 in) to 17 cm (6.7 in) deep and generally compressed the new snow to a depth of 2 to 3 cm (0.8 to 1.2 in).
- The Predator ATV was generally very squirrelly to operate and generally felt unsafe on these trails, particularly in the new snow on the side trails. Tire impressions on the railroad grade trail were generally 1 cm (0.4 in) deep and 27 cm (10.6 in) wide. On the side trails, tire impressions ranged from being 9 cm (3.5 in) deep to 15 cm (5.9 in) deep and generally compressed the new snow to a depth of 1 to 2 cm (0.4 to 0.8 in).

****

Field Testing Journal: February 21, 2006
Paris Canyon, Idaho (ID 1)

Photo 163: ID 1 field test site

Field Study Code/Number: ID 1
Location: Paris Canyon Trail approximately 2 miles west of the Paris Canyon parking area; near Paris, Idaho
Elevation: 7535 feet
Temperature Range: 25.0 F/-3.9 C (start) to 21.4 F/-5.9 C (end)
Time of Day: 10:10 AM to 12:05 PM
Weather: cloudy, flat light, 6 mph/9.6 kph wind
Trail Aspect: on a flat, open roadway with a 4% grade
Trail Conditions: smooth and in good condition, slightly wind blown; was groomed 3 hours prior to testing; good compaction with hard trail base but 2 cm (0.8 in) of loose snow on the surface due to recent grooming (trail base had not fully setup)
Compacted Snow Depth: 60 cm (23.6 in) to ground, packed hard but with 2 cm (0.8 in) loose snow on top due to fresh grooming
Uncompacted snow depth adjacent to the trail: 64 to 76 cm (25 to 30 inches)
Area Grooming Equipment: Pisten Bully EDGE with a 12-foot tiller

Control Vehicles
A1 – 2005 Polaris Sportsman EFI 700 (4x4; auto transmission; 26 x 11R-12 rear tires / ½" lugs, 4 psi)
A2 – 2006 Polaris Predator 500 (2x4; manual transmission; 20 x 11-9 rear tires / ½" lugs, 4 psi)
S1 – 2006 Polaris Switchback 900 (144 x 15x 1¼" track)
S2 – 2006 Polaris RMK 700 (144 x 15 x 2" track)

Other Vehicles
A3 – 2003 Suzuki Vinson 500 (4x4; auto transmission; 25 x 10-12 rear tires / 3/8" lugs, 6 psi)
A4 – 2001 Polaris Scrambler 500 (4x4; auto transmission; 22 x 11-10 rear tires / 5/8" lugs, 9 psi)

Individual Vehicle Observations
Note: Due to flat light conditions, it was difficult to get photos with good contrast to document this field test.

A1: 2005 Polaris Sportsman 700 ATV
Slow/normal track – all starts, stops, and 15 mph/24 kph pass-bys resulted in tire "surface chew" that was 2 to 3 cm (0.8 to 1.2 in) deep and 23 to 24 cm (8.7 to 9.5 in) wide. Tire tracks were visible and consistent the entire length all zones.

Photo 164: Impressions from a fast pass-by

Fast/aggressive track – starts resulted in tire tracks that were 3 to 6 cm (1.2 to 2.4 in) deep and 22 to 28 cm (8.7 to 11 in) wide. The 35 mph/56 kph pass-bys resulted in visible tire tracks 3 cm (1.2 in) deep and 24 cm (9.5 in) wide and left no visible trenching or rutting. Stops resulted in tire impressions that were 3 to 5 cm (1.2 to 2 in) deep and 20 to 28 cm (7.9 to 11in) wide. Top vehicle speed varied from 26 to 29 mph/42 to 47 kph uphill and 33 to 35 mph/53 to 56 kph downhill, which caused the stopping distance to vary. The uphill stopping distance ranged from 9.4 to 9.6 meters (30.8 to 31.5 feet) while the downhill stopping distance ranged from 12.8 to 12.9 meters (42.1 to 42.3 feet). The overall average stopping distance was 11.2 meters (36.7 feet), although the downhill average stopping distance of 12.9 meters (42.2 feet) provides a better comparison in respect to other tests that were run at 35 mph/56 kph.

Photo 165: An aggressive start

Photo 166: Impressions from an aggressive stop

A2: 2006 Polaris Predator 500 ATV

Slow/normal track – the vehicle got off the compacted trail base on the first slow run and became stuck, which resulted in tire ruts that were 16 cm (6.3 in) deep and 32 cm (12.6 in) wide. All starts, stops, and 15 mph/24 kph pass-bys on the compacted trail surface resulted in tire "surface chew" that was 2 cm (0.8 in) deep and 28 cm (11 in) wide. Tire tracks were visible and consistent the entire length all zones.

Photo 167: Surface chew from slow pass

Fast/aggressive track – starts resulted in tire tracks that were 5 to 12 cm (2 to 4.7 in) deep and 26 to 28 cm (10.2 to 11 in) wide. The 35 mph/56 kph pass-bys resulted in visible tire tracks 2 to 5 cm (0.8to 2 in) deep and 28 cm (11 in) wide. Stops resulted in tire impressions that were 3 to 7 cm (1.2 to 2.8 in) deep and

Photo 168: Impressions from an aggressive start

Photo 169: Impressions from an aggressive stop

28 to 30 cm (11 to 11.8 in) wide. Stopping distance at 35 mph/56 kph varied widely depending upon whether the vehicle was stopping uphill or downhill on the 4% grade. The uphill stopping distance ranged from 11.3 to 13.0 meters (37.1 to 42.6 feet) while the downhill stopping distance ranged from 18.7 to 22.2 meters (61.5 to 72.9 feet). The overall average stopping distance was 16.3 meters (53.5 feet), although the downhill average stopping distance of 20.5 meters (67.2 feet) most likely provides a better comparison in respect to other tests that were run at 35 mph/56 kph.

Other – footprints on the trail surface were 5 cm (2 in) deep. Also, the vehicle got stuck on the first slow run even though the operator was on what looked like a “fresh groomed” trail surface. However, the fresh grooming marks were wider than what the compacted trail surface was since the most recent grooming pass had widened the trail. The result was that, even though the outside edges of the trail “looked to be part of” the groomed trail base, both outside edges were not compacted sufficient enough to support ATV traffic.

Photos 170 and 171: The vehicle got off the edge of the compacted base and got stuck

A3: 2003 Suzuki Vinson 500 ATV
Slow/normal track – this vehicle was run only on the fast/aggressive track

Fast/aggressive track – starts resulted in tire tracks that were 3 to 5 cm (1.2 to 2 in) deep and 15 to 22 cm (5.9 to 8.7 in) wide. The pass-bys resulted in tire tracks 1.5 cm (0.6 in) deep with no visible trenching or rutting of the trail surface. Stops resulted in tire impressions that were 2 to 4 cm (0.8 to 1.6 in) deep and 18 to 20 cm (7.1 to 7.9 in) wide. The top pass-by speed was31 mph/50 kph when operating uphill and 35 mph/56 kph when operating downhill. This, along with the slight grade, caused the stopping distance to vary widely depending upon whether the vehicle was stopping uphill or downhill on the 4% grade. The uphill stopping distance ranged from 11.6 to 13.4 meters (38.0 to 43.8 feet) while the downhill stopping distance ranged from 23.6 to 25.1 meters (77.4 to 82.3 feet). The overall average stopping distance was 18.4 meters (60.4 feet), although the downhill average stopping distance of 24.4 meters (79.9 feet) most likely provides a better comparison in respect to other tests that were run at 35 mph/56 kph.

Photo 172: An aggressive start

Photo 173: An aggressive stop

A4: 2001 Polaris Scrambler 500 ATV
Slow/normal track – this vehicle was run only on the fast/aggressive track

Fast/aggressive track – starts resulted in tire tracks that were 3 to 5 cm (1.2 to 2 in) deep and 21 to 24 cm (8.3 to 9.5 in) wide. The pass-bys resulted in tire tracks 3 cm (1.2 in) deep with no visible trenching or rutting of the trail surface. Stops resulted in tire impressions that were 2.5 to 6 cm (1 to 2.4 in) deep and 23 to 27 cm (9.1 to 10.6 in) wide. Stopping distance at 35 mph/56 kph on the slight 4% grade varied widely depending upon whether the vehicle was stopping uphill or downhill. The uphill stopping distance ranged from 9.5 to 12.4 meters (31.1 to 40.8 feet) while the downhill stopping distance ranged from 17.4 to 18.7 meters (57.0 to 61.5 feet). The overall average stopping distance was 14.5 meters (47.6 feet), although the downhill average stopping distance of 18.1 meters (59.3 feet) most likely provides a better comparison in respect to other tests that were run at 35 mph/56 kph.

Photo 174: An aggressive start

Photo 175: An aggressive stop

S1: 2006 Polaris Switchback 900 Snowmobile
Slow/normal track – all starts, stops, and 15 mph/24 kph pass-bys resulted in 2 cm (0.8 in) deep and 40 cm (15.7 in) wide "surface chew" from the track. 2.5 cm (1 in) wide and 4 cm (1.6 in) deep grooves from the ski skags were also visible. The skag marks and surface chew were visible and consistent the entire length of the start, pass-by, and stop zones.

Fast/aggressive track – starts resulted in track marks that were 4 to 5 cm (1.6 to 2 in) deep and 38 to 39 cm (15 to 15.4 in) wide. The 35 mph/56 kph pass-bys resulted in "surface chew" from the track that was 3 cm (1.2 in) deep and 38 to 39 cm (15 to 15.4 in) wide. There was no visible trenching or rutting of the trail. The 2.5 cm (1 in) wide and 4 cm (1.6 in) deep ski skag marks were also visible throughout the fast track area. Stops resulted in track impressions that were generally 3 to 5 cm (1.2 to 2 in) deep and 47 cm (18.5 in) wide. Stopping distance at 35 mph/56 kph on the slight 4% grade varied slightly depending upon whether the vehicle was stopping uphill or downhill. The uphill stopping distance ranged from 19.6 to 21.9 meters (64.3 to 71.8 feet) while the downhill stopping distance ranged from 24.8 to 26.5 meters (81.3 to 87.0 feet). The overall average stopping distance was 23.2 meters (76.1 feet), although the downhill average stopping distance of 25.7 meters (84.2 feet) most likely provides a better comparison in respect to other stopping tests run at 35 mph/56 kph.

Photo 176: An aggressive start

Photo 177: An aggressive stop

S2: 2006 Polaris RMK 700 Snowmobile

Slow/normal track – all starts, stops, and 15 mph/24 kph pass-bys resulted in 2 to 3 cm (0.8 to 1.2 in) deep and 40 cm (15.7 in) wide "surface chew" from the track. 3 cm (1.2 in) wide and 4 cm (1.6 in) deep grooves from the ski skags were also visible. The skag marks and surface chew were visible and consistent the entire length of the start, pass-by, and stop zones.

Photo 178: Surface chew from a slow pass-by

Fast/aggressive track – starts resulted in track marks that were 4 to 7 cm (1.6 to 2.8 in) deep and 39 to 42 cm (15.4 to 16.5 in) wide. The 7 cm (2.8 in) deep start also left a 12 cm (4.7 in) high pile of snow behind the track on take off. The 35 mph/56 kph pass-bys resulted in "surface chew" from the track that was 3 to 4 cm (1.2 to 1.6 in) deep and 42 to 45 cm (16.5 to 17.7 in) wide. There was no visible trenching or rutting of the trail. The 3 cm (1.2 in) wide and 4 cm (1.6 in) deep ski skag marks were also visible throughout the fast track area. Stops resulted in track impressions that were generally 4 to 5 cm (1.6 to 2 in) deep and 39 to 42 cm (15.4 to 16.5 in) wide. Stopping distance at 35 mph/56 kph on the slight 4% grade varied depending upon whether the vehicle was stopping uphill or downhill. The uphill stopping distance ranged from 17.9 to 19.3 meters (58.8 to 63.3 feet) while the downhill stopping distance ranged from 26.4 to 27.3 meters (86.5 to 89.5 feet). The overall average stopping distance was 22.7 meters (74.5 feet), although the downhill average stopping distance of 26.8 meters (88.0 feet) most likely provides a better comparison in respect to other stopping tests run at 35 mph/56 kph.

Photo 179: An aggressive start

Photo 180: Impressions from an aggressive stop

Summary of Observations from the ID 1 Field Test

- SLOW/NORMAL OPERATION: None of the vehicles created noticeable adverse impacts when operated in the slow/normal mode whether in the start, 15 mph/24 kph pass-by, or stop zones. There was only normal surface chew that was 2 to 3 cm (0.8 to 1.2 in) deep.
- FAST/AGGRESSIVE PASS-BY: None of the vehicles created noticeable adverse impacts when operated in the 35 mph/56 kph pass-by mode. There was only surface chew that was 1.5 to 5 cm (0.6 to 2 in) deep.
- AGGRESSIVE STARTS: ATVs created deeper impressions in the trail than what snowmobiles did. Aggressive starts resulted in ATV tire impressions 3 to 12 cm (1.2 to 4.7 in.) deep and 15 to 28 cm (5.9 to 11 in.) wide. Snowmobile track impressions were 4 to 7 cm (1.6 to 2.8 in.) deep and 38 to 42 cm (15 to 16.5 in.) wide. The deepest ATV tire tracks from the Predator were 5 cm (2 in) deeper than the deepest snowmobile track impressions from the RMK.
- AGGRESSIVE STOPS: ATVs created slightly deeper impressions in the trail than what snowmobiles did. Aggressive stops resulted in ATV tire impressions 2 to 7 cm (0.8 to 2.8 in.) deep and 18 to 30 cm (7.1 to 11.8 in.) wide. Snowmobile track impressions were 3 to 5 cm (1.2 to 2 in.) deep and 39 to 47 cm (15.4 to 18.5 in.) wide. The deepest ATV tire tracks from the Predator were 2 cm (0.8 in) deeper than the deepest snowmobile track impressions from both snowmobiles.
- AVERAGE STOPPING DISTANCE – ALL VEHICLES: When comparing all vehicles tested, the ATVs generally stopped quicker than the snowmobiles. The Sportsman stopped the quickest of the four ATVs and the RMK stopped the quicker of the two snowmobiles. The Suzuki Vinson required the greatest distance to stop of the four ATVs, while the Switchback required the greatest distance to stop of the two snowmobiles. The average ATV stopping distances at 35 mph/56 kph ranged from 11.2 to 18.4 meters (36.7 to 60.4 feet). The average snowmobile stopping distance ranged from 22.7 to 23.2 meters (74.5 to 76.1 feet). The minimum average ATV stopping distance (the Sportsman) was 11.5 meters/37.7 feet (50.7%) less than the shortest average snowmobile (the RMK) stopping distance, while the maximum average snowmobile stopping distance (the Switchback) was 4.8 meters / 15.7 feet (26.1%) greater than the longest average ATV (the Vinson) stopping distance.
- AVERAGE STOPPING DISTANCE – CONTROL VEHICLES: When comparing just the four control vehicles, the ATVs generally stopped quicker than the snowmobiles. The Sportsman stopped quicker of the two control ATVs, while the Switchback required the greatest distance to stop of the two control snowmobiles. The average ATV stopping distances at 35 mph/56 kph ranged from 11.2 to 16.3 meters (36.7 to 53.5 feet), while the average snowmobile stopping distance ranged from 22.7 to 23.2 meters (74.5 to 76.1 feet). The minimum average ATV stopping distance (the Sportsman) was 11.5 meters/37.7 feet (50.7 %) less than the shortest average snowmobile (the RMK) stopping distance, while the maximum average snowmobile stopping distance (the Switchback) was 6.9 meters/22.6 feet (42.3%) greater than the longest average ATV (the Predator) stopping distance.
- DOWNHILL AVERAGE STOPPING DISTANCE – ALL VEHICLES: The testing area had a 4% grade which caused the stopping distance at 35 mph/56 kph to vary slightly depending upon whether the vehicle

was stopping uphill or downhill. Therefore, the downhill average stopping distance most likely provides a better comparison in respect to other 35 mph/56 kph stopping tests run at other flatter test sites. When comparing the downhill average stopping distance of all vehicles tested, the ATVs generally stopped quicker than the snowmobiles. The Sportsman stopped the quickest of the four ATVs and the Switchback stopped the quicker of the two snowmobiles. The Suzuki Vinson required the greatest distance to stop of the four ATVs, while the RMK required the greatest distance to stop of the two snowmobiles. The downhill average ATV stopping distances at 35 mph/56 kph ranged from 12.9 to 24.4 meters (42.2 to 79.9 feet). The downhill average snowmobile stopping distance ranged from 25.7 to 26.8 meters (84.2 to 88.0 feet). The minimum downhill average ATV stopping distance (the Sportsman) was 12.8 meters/42.0 feet (49.8 %) less than the shortest downhill average snowmobile (the Switchback) stopping distance, while the maximum downhill average snowmobile stopping distance (the RMK) was just 2.4 meters / 7.9 feet (9.8%) greater than the longest downhill average ATV (the Vinson) stopping distance.

- DOWNHILL AVERAGE STOPPING DISTANCE – CONTROL VEHICLES: The testing area had a 4% grade which caused the stopping distance at 35 mph/56 kph to vary slightly depending upon whether the vehicle was stopping uphill or downhill. Therefore, the downhill average stopping distance most likely provides a better comparison in respect to other 35 mph/56 kph stopping tests run at other flatter test sites. When comparing the downhill average stopping distance of just the four control vehicles, the ATVs generally stopped quicker than the snowmobiles. The Sportsman stopped quicker of the two control ATVs, while the RMK required the greatest distance to stop of the two control snowmobiles. The downhill average ATV stopping distances at 35 mph/56 kph ranged from 12.9 to 20.5 meters (42.2 to 67.2 feet), while the downhill average snowmobile stopping distance ranged from 25.7 to 26.8 meters (84.2 to 88.0 feet). The minimum downhill average ATV stopping distance (the Sportsman) was 12.8 meters/42.0 feet (49.8 %) less than the shortest downhill average snowmobile (the Switchback) stopping distance, while the maximum average downhill snowmobile stopping distance (the RMK) was 6.3 meters/20.7 feet (30.7%) greater than the longest average downhill ATV (the Predator) stopping distance.
- The Predator ATV got stuck when its right wheels dropped off the compacted trail surface during the slow testing. Even though the operator was on what looked like a fresh groomed trail surface, the fresh grooming marks were actually wider than the compacted trail surface since the recent grooming had widened the trail. So even though the outside edges of the trail looked to be part of the groomed trail base, both outside edges of the trail were not compacted sufficient enough to support ATV traffic.
- Impressions from footprints on the test track were 5 cm (2 in) deep.

****

Field Testing Journal: February 21, 2006
Paris Canyon, Idaho (ID 2)

Field Study Code/Number: ID 2
Location: Paris Canyon Trail approximately 7 miles west of the Paris Canyon parking area at the junction of Forest Service Roads 421 and 408; near Paris, Idaho
Elevation: 7880 feet
Temperature Range: 19.0 F/-7.2 C
Time of Day: 12:15 PM to 1:05 PM
Weather: cloudy, 21 mph/33.8 kph wind with 35+ mph/56+ kph gusts
Trail Aspect: a sweeping curve at the bottom of a switchback with a rise of 30.5 meters / 100 feet over a distance of 0.4 kilometer / 0.25 mile
Trail Conditions: very wind blown and heavily drifted

<u>**Control Vehicles**</u>
A1 – 2005 Polaris Sportsman EFI 700 (4x4; auto transmission; 26 x 11R-12 rear tires / ½" lugs, 4 psi)
A2 – 2006 Polaris Predator 500 (2x4; manual transmission; 20 x 11-9 rear tires / ½" lugs, 4 psi)
S1 – 2006 Polaris Switchback 900 (144 x 15 x 1¼" track)
S2 – 2006 Polaris RMK 700 (144 x 15 x 2" track)

Other Vehicles

A3 – 2003 Suzuki Vinson 500 (4x4; auto transmission; 25 x 10-12 rear tires / 3/8" lugs, 6 psi)
A4 – 2001 Polaris Scrambler 500 (4x4; auto transmission; 22 x 11-10 rear tires / 5/8" lugs, 9 psi)

Observations

Site ID 2 was a climbing curve located approximately 5 miles beyond site ID 1. All test vehicles were driven to this site with the intent of measuring impacts on the climbing curve. The group encountered heavy winds and heavy drifting as it approached the new test site, with heavy pillow drifts across the trail for the last mile of the trip.

The Suzuki Vinson (A3) and the Polaris Scrambler (A4) were the first ATVs to reach the site and quickly became stuck as soon as they tried to go up the hill. The Vinson dug 12 cm (4.7 in) deep ruts before it could no longer go uphill in the drifted snow, while the Scrambler dug 24 cm (9.5 in) deep ruts before it could no longer go uphill and became stuck just a short distance up the curve. The other two control ATVs also struggled for the last mile of the trip while negotiating the pillow drifts and turned around at the bottom of the curve before reaching the location where the Vinson and Scrambler were stuck.

By comparison, the two control snowmobiles easily negotiated the drifts on the hill and curve and left track impressions on the drifted snow that were only 4 cm (1.6 in) deep.

Given the severe drifting conditions and the fact that the ATVs became stuck before making it very far up the curve, the group cancelled the remainder of the climbing curve test and returned to the trailhead.

APPENDIX B: SURVEY OF TRAIL MANAGERS

International Association of Snowmobile Administrators (IASA)
EVALUATION OF ATV USE
ON GROOMED SNOWMOBILE TRAILS
SURVEY OF TRAIL MANAGERS

This survey is being conducted by Trails Work Consulting to gather information for a project sponsored by the International Association of Snowmobile Administrators, *Evaluation of ATV Use on Groomed Snowmobile Trails.* One part of this evaluation project includes collecting information from jurisdictions across the Snowbelt to identify information and issues related to ***allowing concurrent ATV use on groomed snowmobile trails*** during the winter season.

This survey is collecting information to help identify:

1. Jurisdictions that allow some level of concurrent snowmobile/ATV use on groomed snowmobile trails, including examples of their laws, rules, regulations, and management policies for this concurrent use;
2. Jurisdictions that do not allow any concurrent snowmobile/ATV use on groomed snowmobile trails, including their reasons why and examples of their laws, rules, regulations, and management policies prohibiting concurrent use;
3. Any statistics related to crashes, social conflicts or other incidents that are the result of concurrent snowmobile/ATV use on groomed snowmobile trails;
4. Testimonials or case studies of successful concurrent snowmobile/ATV use on groomed snowmobile trails; and
5. Information related to potential off-season impacts on snowmobile trails as the result of unauthorized ATV use. Results from this survey will be used to develop recommendations for 'best business practices' for managing ATV use on groomed snowmobile trails.

Please take a few minutes to complete this survey and return it to Trails Work Consulting by December 9, 2005. **Please respond regardless of whether your jurisdiction allows or prohibits concurrent snowmobile/ATV use** since your answers will help gauge the degree that this may be an accepted management practice across the Snowbelt. If you are not person best able to complete this survey for your jurisdiction, please forward it to the person who is. If you have questions about this survey, please contact Kim Raap at 605-371-9799 or by e-mailing Trailswork@aol.com . *Thank you for your assistance and prompt response!*

****

Agency/Organization/State/Province: ____
Name of Person Completing Survey: _________________________ Title: ______________________
Phone: ____________________ E-Mail Address: ____
Mailing Address: ____

Part I: Please check the situation below (No or Yes) that applies to your agency, organization, state, or provincial jurisdiction and provide the requested information as it applies to your area.

_____ **No**, our jurisdiction does not allow any level of concurrent ATV use on groomed snowmobile trails during the winter season.

A. Please indicate how concurrent ATV use on groomed snowmobile trails is prohibited in your area: (please check all that are applicable)
____ legislation ____ rule/regulation ____ policy ____ no formal action to prohibit
____ other (explain): ____

B. Please explain reason(s) why concurrent ATV use is not allowed on groomed snowmobile trails in your jurisdiction:

C. Total miles/kilometers of groomed snowmobile trails in your jurisdiction: __________

D. Please mail copies of legislation, rules/regulations and/or policies that prohibit concurrent ATV use on groomed snowmobile trails in your area to: Trails Work Consulting, 4015 S. Brady Court, Sioux Falls, SD 57103, or send as e-mail attachments to Trailswork@aol.com

Thank you! Please skip to Part III.

_____ **Yes**, our jurisdiction allows some level of concurrent ATV use on groomed snowmobile trails during the winter season.

E. Total miles/kilometers of groomed snowmobile trails in your jurisdiction: __________
F. Total miles/kilometers of groomed snowmobile trails that are open to concurrent snowmobile/ATV use in your jurisdiction: __________
G. Total number of snowmobile trail systems in your jurisdiction: __________
H. Total number of snowmobile trail systems that are open to concurrent snowmobile/ATV use in your jurisdiction: __________
I. Please provide an estimate of the 'use level' on your trails that allow concurrent snowmobile/ATV use. If you have multiple areas with varying use levels, please provide multiple answers. Indicate use levels by using two different ratios: 1) snowmobile/ATV use in terms of heavy, moderate or minimal levels of overall use (example: moderate snowmobile/minimal ATV), and 2) in terms of percentage of estimated total use (example: 70% snowmobile/30% ATV):
If available, please provide total use statistics or estimates for each area (by name of area):
J. What is the time period when concurrent snowmobile/ATV use is allowed (check one and specify dates/months/times): ____ same as snowmobile season ____ special season restrictions
Concurrent use is generally allowed from ____________________ to ____________________
Please provide additional information if further explanation is required regarding 'season of use' conditions or parameters (snow depth, temperatures, time of day, etc.):
K. Please indicate how concurrent ATV use on groomed snowmobile trails is allowed in your area: (please check those applicable)
____ legislation ____ rule/regulation ____ policy ____ no formal action to allow
L. Please explain reason(s) why concurrent ATV use is allowed on groomed snowmobile trails in your jurisdiction:
M. Please mail copies of legislation, rules/regulations and/or policies that allow concurrent ATV use on groomed snowmobile trails in your area to: Trails Work Consulting, 4015 S. Brady Court, Sioux Falls, SD 57103, or send as e-mail attachments to Trailswork@aol.com

Part II: If your jurisdiction allows any level of concurrent ATV use on groomed snowmobile trails during the winter season, please provide the following information as it may apply to your area:

A. If available, please provide any information and statistics you may have regarding crashes on the trails that allow concurrent snowmobile/ATV use (total number of all [snowmobile and ATV] crashes reported, breakdown of all types of crashes, causes of all crashes, etc.). If applicable, please mail/e-mail full report to Trails Work Consulting:
- If available, provide statistics (with the same breakdown as above) regarding the total number of crashes that involved an ATV and also the total number of crashes documented between snowmobiles and ATVs:
- Please indicate if the crash rate is ____ about the same ____ higher ____ lower than crash rates on 'snowmobile-only' trails in your jurisdiction. Additional comments or observations about this:
B. If available, please provide any information, statistics, and incident reports you may have regarding social conflicts on the trails that allow concurrent snowmobile/ATV use (total number of incidents reported, breakdown on types of incidents, causes of incidents, etc.):
- If available, provide statistics (with the same breakdown as above) regarding the total number of social conflict incidents that involved an ATV:
- Please indicate if the incident rate is ____ about the same ____ higher ____ lower than incident rates on 'snowmobile-only' trails in your jurisdiction. Additional comments or observations about this:

C. Please provide details regarding any special management guidelines, policies, procedures, restrictions, practices, etc. used by your jurisdiction to manage concurrent snowmobile/ATV use:

D. Please provide any case history information you believe may be beneficial for developing BMPs:
Mail to Trails Work Consulting, 4015 S. Brady Court, Sioux Falls, SD 57103, or send as e-mail attachments to Trailswork@aol.com

Part III: Off-season impacts from ATV use on historic snowmobile trail routes may occur regardless if the jurisdiction allows any level of concurrent ATV use on groomed snowmobile trails during the winter season. Please answer the following questions to help identify the degree of existing off-season impacts and potential BMPs for this issue.

A. Does your jurisdiction currently experience off-season (spring, summer, and/or fall) impacts from ATV use on historic snowmobile trail routes? ____ No (Thank you for your time, you have finished the survey!)
____ Yes (please answer the remaining questions)

B. Please indicate the types of off-season impacts from ATV use on historic snowmobile trail routes that you experience in your area (specify all that apply to your area by ranking/placing a number next to those impacts pertinent to your jurisdiction: 1 = greatest impact, 2 = next greatest impact, 3 = third greatest impact, through 4, 5, 6, 7, 8, 9, or 10 {or higher} = least impact, as it is pertinent to your area. If the impact is not an issue in your area, leave it blank.)
____ Private property trespass – there is landowner permission for only snowmobile season use
____ Public land use issues – there is agency permission for only winter use of the trail route
____ Severe resource damage from non-winter wheeled vehicle/ATV use during the off-season
____ Moderate resource damage from non-winter wheeled vehicle/ATV use during the off-season
____ Slight resource damage from non-winter wheeled vehicle/ATV use during the off-season
____ Conflicts with livestock grazing, gates left open, etc.
____ Harassment of livestock
____ Conflicts with wildlife production and rearing areas
____ Harassment of wildlife
____ Social conflicts with heavy non-motorized use of the trail route during the off-season
____ Conflicts with exclusive non-motorized use of the trail route during the off-season
____ Other (specify): ____
____ Other (specify): ____

C. Please rate the same list of potential off-season impacts by indicating the severity of the problem in your jurisdiction (3 = an extreme problem, 2 = a major problem, 1 = a slight problem, 0 = not a problem. Please rate all potential impacts.)
____ Private property trespass – there is landowner permission for only snowmobile season use
____ Public land use issues – there is agency permission for only winter use of the trail route
____ Severe resource damage from non-winter wheeled vehicle use during the off-season
____ Moderate resource damage from non-winter wheeled vehicle/ATV use during the off-season
____ Slight resource damage from non-winter wheeled vehicle/ATV use during the off-season
____ Conflicts with livestock grazing, gates left open, etc.
____ Harassment of livestock
____ Conflicts with wildlife production and rearing areas
____ Harassment of wildlife
____ Social conflicts with heavy non-motorized use of the trail route during the off-season
____ Conflicts with exclusive non-motorized use of the trail route during the off-season
____ Other (specify): ____
____ Other (specify): ____

D. Please provide detailed information regarding any special management guidelines, policies, procedures, restrictions, practices, etc. used by your jurisdiction to manage unauthorized off-season ATV use on snowmobile trail routes. Please mail to Trails Work Consulting, 4015 S. Brady Court, Sioux Falls, SD 57103, or send as e-mail attachments to Trailswork@aol.com ***Thank You!***

APPENDIX C: *Evaluation of ATV Use on Groomed Snowmobile Trails*
FIELD STUDY REPORT FORM – COVER SHEET SAMPLE

Date __________________ Field Study State/Provincial Code & Number ____________________
Location ____
Observer ______________________ Elevation __________ Time/Temperature (update temperature hourly):
Start: ________/______ ________/______ ________/______ ________/______ ________/______
________/______ ________/______ ________/______ ________/______ End: ________/______

Weather: ☐ Clear ☐ Cloudy/Overcast ☐ Partly Cloudy ☐ Sunny ☐ Partly Sunny ☐ Snow ☐ Rain

☐ Sleet ☐ Other ____ (check all that apply)
Wind Speed _____________________ Depth of Compacted Snow on Trail Base ________________________

Trail Aspect: ☐ Flat ☐ Uphill ____ % grade ☐ Downhill ____ % grade ☐ Other ____________________

Trail Conditions: ☐ Fresh Groomed – hard ☐ Fresh Groomed – soft ☐ Hard Pack - smooth ☐ Normal

☐ Lightly Moguled ☐ Heavily Moguled – Mogul Depth: ☐ 2" – 6" ☐ 6" – 12" ☐ 12" – 18" ☐ 18"+

☐ Other ____ (check all that apply)

New Snow on Groomed Trail Base: ☐ None ☐ Skiff ☐ ¼" – 2" ☐ 2" – 6" ☐ 6" – 12" ☐ 12" – 18" ☐ 18"+
Date/Time of Last Grooming _________________________ Grooming Equipment ______________________

Measuring Equipment: Distance ____

Depth ____

Other ____
****

Vehicle Information: Complete an information block for each vehicle used during the day of field testing and then use the Vehicle Code (A1, S1, etc.) to track that vehicle's performance on each corresponding Daily Test Log.

ATV #1 **Code: A1**	Make:	Model:	Year:	License #:
☐ 2WD ☐ 4WD ☐ Track Conversion	Tire Size: Front - Rear -	Tire Brand/Model:	Tire Lug Depth:	Tire Pressure:
	# Tires:	Tire Tread Design:	Transmission Type:	Engine cc:
	Track Type (if equipped):			# Passengers on:

Snowmobile #1 **Code: S1**	Make:	Model:	Year:	License #:
Track Lug/ Paddle Height:	Track Length:	Ski Type: ☐ Metal ☐ Composite/Plastic ☐ Double Runner	Ski Carbide: ☐ Yes ☐ No	Engine cc:
	Track Width:			# Passengers on:

Date ____________________ Field Study State Code/Number _____________________________

<table>
<tr><td>ATV #2
Code: A2</td><td>Make:</td><td>Model:</td><td>Year:</td><td>License #:</td></tr>
<tr><td rowspan="3">☐ 2WD
☐ 4WD
☐ Track Conversion</td><td>Tire Size:
Front -
Rear -</td><td>Tire Brand/Model:</td><td>Tire Lug Depth:</td><td>Tire Pressure:</td></tr>
<tr><td># Tires:</td><td rowspan="2">Tire Tread Design:</td><td rowspan="2">Transmission Type:</td><td>Engine cc:</td></tr>
<tr><td>Track Type (if equipped):</td><td># Passengers on:</td></tr>
</table>

<table>
<tr><td>Snowmobile #2
Code: S2</td><td>Make:</td><td>Model:</td><td>Year:</td><td>License #:</td></tr>
<tr><td rowspan="2">Track Lug/ Paddle Height:</td><td>Track Length:</td><td rowspan="2">Ski Type: ☐ Metal
☐ Composite/Plastic
☐ Double Runner</td><td rowspan="2">Ski Carbide:
☐ Yes ☐ No</td><td>Engine cc:</td></tr>
<tr><td>Track Width:</td><td># Passengers on:</td></tr>
</table>

<table>
<tr><td>ATV #3
Code: A3</td><td>Make:</td><td>Model:</td><td>Year:</td><td>License #:</td></tr>
<tr><td rowspan="3">☐ 2WD
☐ 4WD
☐ Track Conversion</td><td>Tire Size:
Front -
Rear -</td><td>Tire Brand/Model:</td><td>Tire Lug Depth:</td><td>Tire Pressure:</td></tr>
<tr><td># Tires:</td><td rowspan="2">Tire Tread Design:</td><td rowspan="2">Transmission Type:</td><td>Engine cc:</td></tr>
<tr><td>Track Type (if equipped):</td><td># Passengers on:</td></tr>
</table>

<table>
<tr><td>Snowmobile #3
Code: S3</td><td>Make:</td><td>Model:</td><td>Year:</td><td>License #:</td></tr>
<tr><td rowspan="2">Track Lug/ Paddle Height:</td><td>Track Length:</td><td rowspan="2">Ski Type: ☐ Metal
☐ Composite/Plastic
☐ Double Runner</td><td rowspan="2">Ski Carbide:
☐ Yes ☐ No</td><td>Engine cc:</td></tr>
<tr><td>Track Width:</td><td># Passengers on:</td></tr>
</table>

<table>
<tr><td>ATV #4
Code: A4</td><td>Make:</td><td>Model:</td><td>Year:</td><td>License #:</td></tr>
<tr><td rowspan="3">☐ 2WD
☐ 4WD
☐ Track Conversion</td><td>Tire Size:
Front -
Rear -</td><td>Tire Brand/Model:</td><td>Tire Lug Depth:</td><td>Tire Pressure:</td></tr>
<tr><td># Tires:</td><td rowspan="2">Tire Tread Design:</td><td rowspan="2">Transmission Type:</td><td>Engine cc:</td></tr>
<tr><td>Track Type (if equipped):</td><td># Passengers on:</td></tr>
</table>

<table>
<tr><td>Snowmobile #4
Code: S4</td><td>Make:</td><td>Model:</td><td>Year:</td><td>License #:</td></tr>
<tr><td rowspan="2">Track Lug/ Paddle Height:</td><td>Track Length:</td><td rowspan="2">Ski Type: ☐ Metal
☐ Composite/Plastic
☐ Double Runner</td><td rowspan="2">Ski Carbide:
☐ Yes ☐ No</td><td>Engine cc:</td></tr>
<tr><td>Track Width:</td><td># Passengers on:</td></tr>
</table>

APPENDIX D: Evaluation of ATV Use on Groomed Snowmobile Trails – FIELD STUDY DAILY TEST LOG

Date ____________ Field Study Code/Number ___________ Unit of Measure: □ feet/inches □ meter/centimeters
Vehicle Code ________
Trail Conditions: ____ Smooth ____ Moguled Mogul Depth: ___________ Driver: ___________________________________
Start Time: _______________ Start Temp: _____________ End Time: _______________ End Temp: ______________

Vehicle Pass #	**Slow/Normal Start**		**Normal Pass-By**		**Slow/Normal Stop**		**Average Pass-By Speed: _____________________ Observations:**
	Depth/Width	Distance	Depth/Width	Distance	Depth/Width	Distance	
1							
2							
3							
4							
5							
6							

Comments:

Vehicle Pass #	**Aggressive Start**		**Aggressive Pass**		**Aggressive Stop**		**Average Pass-By Speed: _____________________ Observations:**
	Depth/Width	Distance	Depth/Width	Distance	Depth/Width	Distance	
1							
2							
3							
4							
5							
6							
7							
8							

Comments:

Vehicle Pass #	**Normal Corner**		**Aggressive Corner**		**Corner/Curve**		**Average Normal Speed: ______ Average Aggressive Speed: _____ Observations:**
	Depth/Width	Distance	Depth/Width	Distance	Radius	Distance	
1							
2							
3							
4							
5							
6							
7							
8							

Comments:
Date ____________ Field Study Code/Number ___________ Vehicle Code ________
Page 2

Vehicle Pass #	Normal Hill		Aggressive Hill		Hill - Up		**Average Normal Speed:** ______ **Average Aggressive Speed:** ______ **Observations:**
	Depth/Width	Distance	Depth/Width	Distance	% Grade	Distance	
1							
2							
3							
4							
5							
6							

Comments:

Vehicle Pass #	Normal Hill		Aggressive Hill		Hill - Down		**Average Normal Speed:** ______ **Average Aggressive Speed:** ______ **Observations:**
	Depth/Width	Distance	Depth/Width	Distance	% Grade	Distance	
1							
2							
3							
4							
5							
6							

Comments:

Additional General Comments: