The National Park Service

WILDLIFE RESPONSES TO MOTORIZED WINTER RECREATION IN YELLOWSTONE

2009 ANNUAL REPORT
(December 10, 2008 through March 22, 2009)

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Executive Summary

Staff from the Yellowstone Center for Resources monitored wildlife responses to motorized winter recreation during December 10, 2008 through March 22, 2009. Oversnow vehicle traffic and general park visitation was lower this winter than the winter of 2007-2008 with a 28% drop in snowmobiles and a 10% drop in snowcoaches.

We used snowmobiles to conduct repeated surveys of wildlife responses to motorized winter vehicles and human activities along three groomed road segments in areas of both low and high intensity human and wildlife use. Our sampling unit was the interaction between oversnow vehicles and an observed group of wildlife within 500 meters (547 yards) of the road. We focused our efforts on monitoring the responses of bison, elk, and trumpeter swans owing to the proximity and/or perceived sensitivity of these species to motorized recreation activities during winter.

The behaviors of humans traveling in oversnow vehicles in response to observing wildlife groups were as follows: 55% demonstrated no visible reaction; 33% stopped; 6% dismounted their vehicles; 5% approached wildlife; and 1% impeded or hastened wildlife on the roadway. Seventy-five percent of the wildlife showed no visible response to oversnow vehicle interactions, 18% looked at the oversnow vehicles or humans and resumed their previous activity, 1% traveled, 5% displayed alarm or attention and less than 1% fled from the area.

METHODS

We examined the behavioral responses of bison, elk, and swans to motorized recreation to evaluate the following management objectives regarding human use and its potential adverse effects on wildlife during winter in Yellowstone National Park:

- Minimize the avoidance, displacement, or harassment of wildlife from noise, vehicles, or other human activities;
- Minimize vehicle-caused wildlife deaths or injuries;
- Minimize human conflicts with ungulate (e.g., bison, elk) movements on plowed roads;
- Minimize incidents of wildlife trapped by snow berms on plowed roads; and
- Minimize the facilitation of ungulate use of groomed roads.

Weather Data: Weather data is collected from four automated SNOTEL sites to assess the effects of snow pack on wildlife behavior, distribution, and stress levels. The Madison Plateau (ID 11e31s) and Canyon (ID 10e03s) SNOTEL sites were located within Yellowstone National Park, while the West Yellowstone (ID 11e07s) and Northeast Entrance (ID 10d07s) sites were located near the park's boundary. The West Yellowstone site was located at 2,042 meters (6,700 feet) elevation, while the Northeast Entrance, Madison Plateau and Canyon sites were located at 2,240 meters (7,350 feet), 2,362 meters (7,750 feet), and 2,466 meters (8,090 feet) elevation, respectively. Data from each site can be obtained from the Natural Resources Conservation Service website (http://www.wcc.nrcs.usda.gov/snotel/).

Motorized Use Data: In coordination with the Visitor Services Office, we analyzed daily visitation statistics for the 2008-09 winter season. The Visitor Services Office routinely compiles data from entrance stations, Business Management Office operations, entrance studies and visitor surveys to determine visitation statistics. Park staff at the west, south, and east entrances recorded numbers and types of oversnow vehicles that entered the park each day.

Human Behaviors and Wildlife Responses: Since the winter of 2002-03, we have focused our efforts on monitoring the responses of bison (*Bison bison*), elk (*Cervus elaphus*), bald eagles (*Haliaeetus leucocephalus*), and trumpeter swans (*Olor buccinator*) to motorized winter use

vehicles owing to the proximity and/or perceived sensitivity of these species to motorized recreation activities during winter. During winter 2008-09, one 2-person crew used snowmobiles and wheeled vehicles to conduct repeated surveys of wildlife distribution and responses to motorized winter use vehicles and human activities along three groomed road segments. The sampled road segments and their endpoints were as follows:

Road Segment	End-point	End-point
1. West Yellowstone to Madison	West entrance station	Madison junction
2. Madison to Old Faithful	Madison junction	Bridge south of Old Faithful
3. Madison to Norris	Madison junction	Norris junction

The survey crew was based at Old Faithful. The crew sampled the roads from Madison to West Yellowstone, from Madison to Old Faithful, and from Madison to Norris. The Madison road segments included surveying along Riverside and Firehole Canyon Drives. The Freight Road was not surveyed during the 2008-2009 winter since it was not open for public use.

The crew determined the order in which their assigned road segments were sampled using a restricted randomization design. The crew selected the order of monitoring for road segments without replacement, so that each segment was monitored before re-sampling occurred. The direction that a given road segment was traveled by the crew was reversed each time the segment was surveyed. Crews conducted surveys on weekdays, weekends, peak-use periods, low-use periods, and holidays. This sampling design enabled us to record daily and weekly variations in human and wildlife activities.

Surveys were only conducted during daylight hours for safety and efficiency reasons. Surveys were conducted by a pair of observers driving snowmobiles or wheeled vehicles at $\leq$50 kilometers (30 miles) per hour. Beginning and ending times of the survey were recorded as a measure of survey effort. Visibility was categorized as good, fair (i.e., small, patchy areas of low visibility), or poor (large areas of low visibility within 100 meters (109 yards) of the road). Precipitation was categorized as none, light rain, heavy rain, light snow, heavy snow, or fog. If conditions or visibility varied substantially along the road segment, then observers recorded the predominant condition for the segment. While traveling along each road segment, observers

used various pullouts and overlooks that provided vantages of wildlife in areas that could not be observed from the main road corridor.

While traveling a given road segment, observers documented the responses of wildlife to motorized winter vehicles and associated human activities. The observers traveled until a group (i.e., ≥1 animal) of a species was detected with the unaided eye. The observers then stopped in a position where they could observe the group without disturbing the animals and observe approaching motorized winter vehicles. The observers recorded the following information: 1) time of observation; 2) species; 3) habitat type for the majority of the group (i.e., aquatic, burned forest, unburned forest, wet meadow or riparian, dry meadow, geothermal); 4) group size and composition (i.e., adult males, adult females, young-of-the-year); and 5) predominant activity of the group of animals (i.e., if two animals are bedded and three are feeding, then the predominant activity was listed as feeding). Activity was recorded as standing (i.e., stand, perch, feed), traveling (i.e., walk, swim, fly), or resting (i.e., bed, float). Traveling was defined as animals walking, swimming, or flying in sustained movement. Animals were recorded as resting when they were stationary (i.e., lying, perching, floating). Owing to the difficulties of observing precise behaviors at large distances with binoculars, activity was only classified for that portion of the group that was within approximately within 500 meters of the road.

If several assemblages of animals of the same species were located in the same vicinity, then the observers defined group membership based on how the assemblages of animals were distributed and moving in space. Following Clutton-Brock et al. (1982), factors that were considered included the relative distances between individuals, degree and form of interaction, similarity or synchrony of behavior, and similarity of orientation.

Our sampling unit was the interaction between motorized vehicles and associated humans and an observed group of wildlife within 500 meters of the road. Though this definition of an "interaction" is somewhat arbitrary, the proposed 500-meter "interaction zone" enabled us to evaluate the influence of distance from a disturbance on wildlife responses to human activities. If any wildlife group member was within 500 meters of the road, then the observers remained in a position along the road to observe the group until ≥1 motorized vehicle (other than the observers' snowmobile or vehicle) entered a zone within 500 meters of the group. Motorized winter vehicles could enter the 500-meter zone from either direction along the road corridor. The observers categorized the motor vehicle/human activity and associated wildlife response

during a single interaction (i.e., one group of vehicles and the response by the group of wildlife) and then continued the survey to locate the next group of wildlife along the road segment. If motorized vehicles and/or humans were already present within 500 meters of a group of wildlife when the observers detected the wildlife group, then the observers began recording the interaction upon detection. If an interaction did not occur within 10 minutes of the observers detecting a group of wildlife within 500 meters of the road, then the observers recorded that no interaction occurred and continued the survey to locate the next group of wildlife.

Prior to departing an area with a group of wildlife, the observers drove up to a position on the road approximately perpendicular to the group of wildlife and recorded the location using a global positioning system (GPS) unit. Observers also recorded the perpendicular distance and direction from the road to the nearest animal using a laser range finder.

During an interaction, observers recorded the following information regarding human activity within the interaction zone: 1) number and type of motorized winter vehicles in the group; 2) if the group of motorized winter vehicles stopped within the interaction zone; 3) distance from the stopped motorized winter vehicles to the nearest animal in the group; 4) if the motorized winter vehicle group was guided by a commercial operator familiar with the park and its winter regulations; 5) duration that the motorized winter vehicles remained within the interaction zone; 6) whether humans dismounted the motorized winter vehicles (e.g., stepped off snowmobile or stepped out of snowcoach); 7) if humans approached the animal group and their distance from the road and nearest animal; 8) if humans initiated behaviors to attract the attention of wildlife (e.g., yelling, whistling, throwing objects); and 9) if wildlife movement was impeded, altered, or hastened by motorized winter vehicles.

The observers recorded the highest level of human activity (i.e., most potential for disturbance) during the interactions. Activities were categorized as follows:

- No visible reaction to wildlife;
- Stop (time in seconds);
- Dismount the motorized winter vehicle (i.e., exit the snowcoach or get off the snowmobile);
- Approach the wildlife (i.e., move from the location where the motorized winter use vehicle was parked in the direction of the animals); or

- Impede and/or hasten (e.g., chase wildlife, force animals to move faster ahead of motorized winter vehicle traffic, or block wildlife movement).

The observers also recorded the most extreme behavior of animals in the group to the motorized winter vehicle group and associated human activity with analysis focused on the most predominant response of the majority of the group. Response behaviors were categorized as follows (Chester 1976):

- No visible reaction to motorized winter vehicles or human activity;
- Look at motorized winter vehicles or human activity and then resume their behavior;
- Travel (e.g., walk/swim) away from motorized winter vehicles or human activity;
- Attention/alarm behavior, including rising from bed or agitation (e.g., buck, kick, bison tail rise);
- Flight (e.g., move quickly (e.g., run) away from motorized winter vehicles or human activity); or
- Defense (e.g., attack/charge at motorized winter vehicles or human activity).

The number of individual animals in the group displaying each response was recorded. The response behavior was only recorded for those animals within approximately 500 meters of the road.

The observers continued monitoring and recording the interaction until all members of the initial motorized winter vehicle and/or human group departed the area within 500 meters of the wildlife group. The observers recorded the number, type, and response of all motorized winter vehicles and associated humans that traveled within 500 meters of the wildlife group during the interaction (i.e., until all members of the initial motorized winter vehicle and associated human group departed the area within 500 meters of the wildlife group). No single interaction was monitored for >30 minutes.

Once the survey of a selected road segment was completed, the observers traveled to the next randomly selected road segment and began the next survey. If no animals of species of interest were detected along the selected road segment, then the observers traveled to the next randomly selected road segment and began that survey. Thus, it is possible that the same road segment was sampled more than once per day (e.g., morning and afternoon).

RESULTS

The public winter season was 92 days from December 15, 2008, through March 16, 2009, when all park grooming operations ceased. Plowing operations began at Mammoth Hot Springs on March 2, 2009, and progressed southward into the interior of the park. Monitoring of interactions between motorized vehicles and wildlife began on December 10, 2008, five days prior to the scheduled opening for public use, and continued until March 22, 2009, approximately one week after roads closed to the public.

Total oversnow vehicles entering the park included 73 snowmobiles and no coaches through the East Entrance Station, since coach travel through the East Entrance was eliminated in 2008-09 due to safety concerns, 360 snowmobiles and 343 coaches through the North Entrance Station, 6,680 snowmobiles and 580 coaches through the South Entrance Station, and 10,139 snowmobiles and 1,466 coaches through the West Entrance Station. The maximum number of snowmobiles and coaches entering the West Entrance Station on any given day was 265 snowmobiles and 34 coaches (these numbers include administrative and non-recreational traffic). The maximum daily number of snowmobiles and coaches entering the South Entrance Station was 149 snowmobiles and 13 coaches. The maximum daily number of snowmobiles and coaches entering the East Entrance Station was 8 snowmobiles and no coaches. The maximum daily number of snowmobiles and coaches entering the North Entrance Station was 12 snowmobiles and 10 coaches.

Hardy (2001) reported that levels of stress hormones in central Yellowstone elk were higher after exposure to >7,500 cumulative vehicles entering the West Entrance Station. Unfortunately, it is unknown how stress hormone levels in elk have been affected by current management programs. That being a concern, the >7,500 threshold was reached on December 31st during both winters of her study (i.e., 1998-99, 1999-2000), but later in following winters (January 20, 2003; February 1, 2004; February 22, 2005; February 2, 2006; January 25, 2007; January 27, 2008). During winter 2008-09, the cumulative total of oversnow vehicles entering the West Entrance Station surpassed 7,500 vehicles on February 5$^{th.}$ According to the Visitor Services Office, the daily number of snowmobiles entering all entrances during the winter of 2008-09 did not exceed the daily snowmobile entry limit under the first year of implementing the 2007 decision, which were the same limits as the temporary plan of the previous three winters. (i.e.,

West = 400 snowmobiles; South = 220 snowmobiles; East = 40 snowmobiles; North = 30 snowmobiles).

Winter use crews conducted 120 surveys on the three road segments, covering 2,991 kilometers (1,859 miles). Observers recorded 1,172 groups of wildlife during these surveys, including 488 groups of bison, 212 groups of elk, 297 groups of swans, 112 groups of bald eagles, 51 groups of coyotes, and 13 groups of other species (e.g., bobcats, golden eagles, wolves, foxes). Observers recorded human behaviors and the responses of wildlife to motorized winter vehicles during 797 oversnow vehicle interactions, 86 wheeled vehicle interactions, and 11 pedestrian interactions (e.g., skiers, snowshoers; Appendices A and B). Groups of wildlife were observed during all surveys of road segments.

Human Responses - The behaviors of humans associated with oversnow vehicles in response to observing wildlife groups were as follows: 55% had no visible reaction to wildlife; 33% stopped; 6% dismounted their vehicles; 5% approached wildlife; and 1% impeded or hastened wildlife (Appendix C). Groups of only snowmobiles, only snowcoaches, and only pedestrians were involved in 51% (n =398), 25% (n =195), and <1% (n = 11), respectively, of the observed wildlife-human interaction events with wildlife during winter 2008-09. Eleven percent (n = 85) of observed interactions involved wheeled vehicles on plowed roads. The remaining 12% (n = 96) was comprised of mixed groups of snowmobiles and coaches.

Wildlife Responses - Overall, the responses of all wildlife species observed to oversnow vehicles and associated humans were as follows: 75% of the observed responses by groups of wildlife were categorized as no apparent response, 18% look/resume, 5% travel, 1% attention/alarm, and 1% flight. Wildlife responses to motorized winter use were slightly lower for most species than in previous winters, with the “no apparent response” and “look-and-resume” categories accounting for greater than 93% of the bison, elk, and swan observations (Appendices D and E). Comparing wildlife responses between snowmobiles and snowcoaches, during interactions wildlife responded 26% to snowmobiles and 18% to snowcoaches. However, wildlife responses greater than look/resume occurred during 4% of the interactions with snowmobiles and 6% with snowcoaches.

Bison were observed on groomed roads during 46 of 320 observations of bison groups from December 10, 2008 through March 22, 2009. Thus, the majority of observed bison groups were using areas off the groomed roads. Thirty-four of the bison groups observed on groomed roads

were traveling, whereas 13 groups were categorized as stationary (five groups were feeding and one group was resting). Bison use of groomed roads occurred throughout the daylight survey hours, with no apparent peak in daily time of road use. Elk groups were observed using groomed roads 6 times out of 191 observations, with 3 groups traveling and 3 groups stationary.

A total of 47 interaction events between oversnow vehicles and ungulates were documented when animal groups were on groomed roads, including 33 ungulate groups interacting with only snowmobiles and 10 ungulate groups interacting with only snowcoaches. In 4 interaction events, mixed groups of snowmobiles and snowcoaches encountered ungulates on the road (Appendix F)

Borkowski et al. (2006) reported that, during 1998-99 through 2003-04, elk responded three times as often (52%) as bison (19%) during interactions with groups of snowmobiles and snowcoaches due to increased vigilance responses. The frequency of higher-intensity movement responses during this period by both bison and elk were 6–7% travel, 1–2% flight, and 1% defense. The overall pattern of species-specific responses continued in winter 2008-09 (i.e., elk responded three times as often as bison). However, monitoring during 2008-09 indicated there were more movement responses by bison (2%) than elk (1%). There are several factors which could have contributed to the observed differences between earlier winters and winter 2008-09. One factor, likely related to commercial guiding, was the temporal change in traffic patterns since 2003. As noted by project staff and discussed in the soundscapes section (3.7) of the Winter Use Plan Final EIS, much of the oversnow vehicle traffic from the West Entrance to Old Faithful occurred during two relatively short periods, (1) in the morning when most guided groups of snowmobiles and coaches were entering the park for the day, and (2) in the late afternoon when guided groups were returning to West Yellowstone. The resulting traffic pattern was different than that prior to winter 2002-03, and these busy periods can become sharply defined when weather and daily routines of guiding operations dictate when groups enter the park, schedule their arrival at destinations, and leave the park. This change in the timing of traffic does not mean that interactions between oversnow vehicles and wildlife did not occur during the rest of the day. However, this change does suggest that a number of the interactions between oversnow vehicles and wildlife along the West Yellowstone to Old Faithful corridor, which in the past were spread out over daylight hours, now occur in a more-constrained time period.

Patterns of eagle behavior in the Madison-Firehole drainage also appeared to differ somewhat from previous winters. Even though the majority of bald eagle sightings and interactions continued at the site of a pair nesting adjacent to the West Entrance Road, a larger proportion of the bald eagle sightings and interactions occurred along the Firehole drainage than in previous winters. A focused effort by National Park Service employees to educate local guide companies about the possible disturbance and traffic issues at the nesting area adjacent to the West Entrance Road appears to continue in helping reduce interactions in this area.

MANAGEMENT SUGGESTIONS

We suggest that training for guides, park staff, and concessionaires include the following recommendations: 1) stop at distances >100 meters (109 yards) from groups of wildlife, when possible; 2) reduce the frequency of multiple groups of motorized vehicles stopping in the same area to observe wildlife; 3) reduce the number of stops to observe wildlife; and 4) reduce human activities away from vehicles during these stops, especially leaving the roadway and traveling into areas not generally traveled by humans during the winter.

LITERATURE CITED

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Appendix A. Summaries of observed wildlife groups and interactions by road segment during December 10, 2008, through March 22, 2009, Yellowstone National Park, Wyoming. Abbreviations are: OSV (oversnow vehicle); WV (wheeled vehicle); and P (pedestrian).

Road Segment	**Species**	**Interactions**
Madison-Old Faithful	Bison	184 OSV, 22 WV, 1 P
	Elk	26 OSV, 4 WV
	Swans	33 OSV
	Coyote	12 OSV, 2 WV, 3P
	Bald Eagle	5 OSV, 1 WV
	Golden Eagle	1 OSV
	Wolf	2 OSV
Madison-West Yellowstone	Bison	67 OSV, 12 WV, 2 P
	Elk	115 OSV, 20 WV, 3 P
	Swans	150 OSV, 9 WV, 1 P
	Coyote	13 OSV, 2 WV
	Bald Eagle	30 OSV, 5 WV, 1 P
	Bobcat	1 OSV
Madison to Norris	Bison	28 OSV, 3 WV
	Elk	2 OSV, 3 WV
	Swans	10 OSV
	Coyote	2 OSV
	Bald Eagle	6 OSV

Appendix B: Number and percent of observations and interactions by road section

Road Segment	Observations	% of Total Observations	Interactions	% of Total Interactions
Madison to West Yellowstone	545	51.3	431	55.0
Madison to Old Faithful	401	37.8	297	37.9
Norris to Madison	116	10.9	56	7.1

Appendix C. Comparison of human behavior during interactions with wildlife (i.e., bison, elk, trumpeter swans) among over-the-snow vehicles in commercially guided groups of snowmobiles, snowcoaches and administrative groups (i.e., park and concessionaire staff) during December 10, 2008, through March 22, 2009, Yellowstone National Park, Wyoming. This data does not include wheeled vehicles or pedestrian-only interactions.

Only Snowmobiles Present

Bison n=161

Human Behavior	Commercially Guided Groups (n = 72)		Administrative Groups (n = 85)		Mixed (guided and admin present simultaneously)	
	No. Events	Proportion	No. Events	Proportion	No. Events	Proportion
None	55	76.4%	39	45.9%	1	16.7%
Stop	17	23.6%	46	54.1%	3	50.0%
Dismount	6	8.3%	2	2.4%	1	16.7%
Approach	5	6.9%	1	1.2%	1	16.7%

Elk n=88

Human Behavior	Commercially Guided Groups (n = 23)		Administrative Groups (n = 64)		Mixed (guided and admin present simultaneously)	
	No. Events	Proportion	No. Events	Proportion	No. Events	Proportion
None	12	52.2%	18	28.1%	1	33.3%
Stop	11	47.8%	46	71.9%	0	
Dismount	3	13.0 %	0		0	
Approach	5	21.7 %	0		2	66.6%

Swans n=113

Human Behavior	Commercially Guided Groups (n = 62)		Administrative Groups (n = 51)		Mixed (guided and admin present simultaneously)	
	No. Events	Proportion	No. Events	Proportion	No. Events	Proportion
None	47	75.8%	34	66.7%	0	
Stop	15	24.2%	17	33.3%	0	
Dismount	2	3.2%	0		2	100.0%
Approach	1	1.6%	0		0	

Only Snowcoaches Present (all coaches are considered guided for analysis)

Bison n=82

Human Behavior	Number of Events	Proportion
None	56	68.3%
Stop	26	31.7%
Dismount	1	1.2%
Approach	2	2.4%

Elk n=36

Human Behavior	Number of Events	Proportion
None	17	47.2%
Stop	19	52.8%
Dismount	4	11.1%
Approach	1	2.8%

Swans n=58

Human Behavior	Number of Events	Proportion
None	42	72.4%
Stop	16	27.6%
Dismount	2	3.4%
Approach	5	8.6%

Mixed Groups (snowmobiles and snowcoaches present simultaneously)

Bison n=41

Human Behavior	Number of Events	Proportion
None	7	17.1%
Stop	34	82.9%
Dismount	7	17.1%
Approach	3	7.3%
Impede-Hasten	3	7.3%

Elk n=20

Human Behavior	Number of Events	Proportion
None	3	15.0%
Stop	17	85.0%
Dismount	4	20.0%
Approach	4	20.0%

Swans n=22

Human Behavior	Number of Events	Proportion
None	7	31.8%
Stop	15	68.2%
Dismount	6	27.3%
Approach	1	4.5%
Impede-Hasten	1	4.5%

Appendix D. Behavioral responses of wildlife species observed from December 10, 2008, through March 22, 2009, Yellowstone National Park, Wyoming.

Bison

Category of Response	No Events	Proportion
No Visible Response	278	85.3 %
Look-Resume	37	11.4 %
Travel	6	1.8 %
Alarm-Attention	3	.9%
Flight	2	.6 %

Elk

Category of Response	No Events	Proportion
No Visible Response	102	62.6 %
Look-Resume	57	35.0 %
Travel	2	1.2 %
Alarm-Attention	2	1.2%

Trumpeter Swans

Category of Response	No Events	Proportion
No Visible Response	172	80.4 %
Look-Resume	23	10.7 %
Travel	18	8.4 %
Alarm-Attention	1	.5 %

Coyotes

Category of Response	No Events	Proportion
No Visible Response	16	41.0 %
Look-Resume	14	35.9 %
Travel	8	20.5 %
Flight	1	2.6 %

Bald Eagles

Category of Response	No Events	Proportion
No Visible Response	36	62.1 %
Look-Resume	12	20.7 %
Travel	5	8.6%
Alarm-Attention	3	5.2 %
Flight	2	3.4 %

Other species (wolf, golden eagle, bobcat)

Category of Response	No Events	Proportion
No Visible Response	3	37.5%
Look-Resume	5	62.5%

Appendix E. Comparison of wildlife (i.e., bison, elk, swans) responses during interactions with over-the-snow vehicles in commercially guided groups (including snowmobiles and snowcoaches), and administrative groups (i.e., park and concessionaire staff) during December 10, 2008, through March 22, 2009, Yellowstone National Park, Wyoming. This data does not include wheeled vehicles or pedestrian-only interactions.

Wildlife responses to groups of only snowmobiles

Bison n=157

Wildlife Response	Commercially Guided Groups *(n=72)*		Administrative Groups *(n=85)*		Mixed (guided and admin present simultaneously)	
	No. Events	Proportion	No. Events	Proportion	No. Events	Proportion
None	63	89.4%	58	70.8%	6	85.7%
Look-Resume	7	7.0%	25	27.0%	0	0%
Travel	1	2.8%	0	0.7%	1	14.3%
Alarm-Attention	1	0.7%	0	0%	0	0%
Flight	0	0%	2	1.5%	0	0%

Elk n= 87

Wildlife Response	Commercially Guided Groups *(n=23)*		Administrative Groups *(n=64)*		Mixed (guided and admin present simultaneously)	
	No. Events	Proportion	No. Events	Proportion	No. Events	Proportion
None	17	80.4%	34	57.7%	1	33.3%
Look-Resume	6	19.6%	28	40.2%	2	66.6%
Travel	0	0%	2	2.1%		

Swans n=109

Wildlife Response	Commercially Guided Groups *(n=58)*		Administrative Groups *(n=51)*		Mixed (guided and admin present simultaneously)	
	No. Events	Proportion	No. Events	Proportion	No. Events	Proportion
None	51	91.4%	40	85.3%	1	50.0%
Look-Resume	4	5.2%	7	5.9%	1	50.0%
Travel	3	3.4%	4	5.9%	0	0%

Wildlife responses to groups of only snowcoaches

Bison n=82

Wildlife Response	Number of Events	Proportion
None	74	90.2%
Look-Resume	5	6.1%
Travel	3	3.7%

Elk n=35

Wildlife Response	Number of Events	Proportion
None	28	80.0%
Look-Resume	7	20.0%

Swans n=58

Wildlife Response	Number of Events	Proportion
None	42	72.4%
Look-Resume	8	13.8%
Travel	7	12.1%
Alarm-Attention	1	1.7%

Wildlife responses to 'mixed' groups (snowmobiles and snowcoaches present simultaneously)

Bison n=87

Wildlife Behavior	Number of Events	Proportion
None	83	95.4%
Travel	2	2.3%
Alarm-Attention	2	2.3%

Elk n=41

Wildlife Behavior	Number of Events	Proportion
None	23	56.1 %
Look-Resume	16	39.0%
Alarm-Attention	2	4.9%

Swans n=47

Wildlife	Number of	Proportion

Behavior	Events	
None	39	83.0%
Look-Resume	4	8.5%
Travel	4	

Wildlife responses to pedestrians (skiers, snowshoers, etc)

Bison n=3

Wildlife Behavior	Number of Events	Proportion
None	3	100%

Elk n=3

Wildlife Behavior	Number of Events	Proportion
None	3	100%

Swan n=1

Wildlife Behavior	Number of Events	Proportion
one	1	100%

Coyote n=3

Wildlife Behavior	Number of Events	Proportion
Look-Resume	3	100%

Appendix F. Encounters between oversnow vehicles and ungulates documented on groomed roads from December 10, 2008, through March 22, 2009, Yellowstone National Park, Wyoming.

Human Behavior	Groups of only snowmobiles		Groups of only snowcoaches		Mixed groups	
	No. Events	Proportion	No. Events	Proportion	No. Events	Proportion
None	8	24.2%	3	30%	1	25%
Stop	20	60.6%	6	60%	1	25%
Dismount	3	9.1%	0	0%	1	25%
Impede-Hasten	2	6.1%	1	10%	1	25%