WILDLIFE RESPONSES TO MOTORIZED WINTER RECREATION IN YELLOWSTONE

2008 ANNUAL REPORT
(December 14, 2007 through March 24, 2008)

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Executive Summary

Staff from the Yellowstone Center for Resources monitored wildlife responses to motorized winter recreation during December 14, 2007 through March 24, 2008. Oversnow vehicle traffic by visitors was slightly lower than winter 2006-07. This primarily reflected a 7% drop in snowmobiles. However, the park saw a 9% increase in snowcoaches during 2007-08.

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: 52% demonstrated no visible reaction; 38% stopped; 4% dismounted their vehicles; 5% approached wildlife; and 1% impeded or hastened wildlife on the roadway. Seventy-two percent of the wildlife showed no visible response to oversnow vehicle interactions, 20% looked at the oversnow vehicles or humans and resumed their previous activity, 4% traveled, 4% 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 was 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 2007-08 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 2007-08, one 2-person crew used snowmobiles 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 Drive, Firehole Canyon Drive and the Freight Road, all of which are designated for snowcoach-only travel for all or part of each day.

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 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. If the group was farther from the road than the maximum 850 yard capability of the range finder, or the range finder could not focus on the animals, then the observers estimated the distance using 7.5 minute quad maps.

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 87 days from December 14, 2007, through March 9, 2008, when all park grooming operations ceased. Plowing operations began at Mammoth Hot Springs on March 3, 2008, and progressed southward into the interior of the park. Monitoring of interactions between motorized vehicles and wildlife began on December 14, 2007, seven days prior to the scheduled opening for public use, and continued until March 24, 2008, approximately one week after roads closed to the public.

Total oversnow vehicles entering the park included 151 snowmobiles and 28 coaches through the East Entrance Station, 420 snowmobiles and 405 coaches through the North Entrance Station, 9,154 snowmobiles and 638 coaches through the South Entrance Station, and 14,135 snowmobiles and 1,582 coaches through the West Entrance Station. The maximum number of snowmobiles and coaches entering the West Entrance Station on any given day was 350 snowmobiles and 35 coaches (these numbers include administrative and non-recreational traffic). The maximum daily number of snowmobiles and coaches entering the South Entrance Station was 183 snowmobiles and 15 coaches. The maximum daily number of snowmobiles and coaches entering the East Entrance Station was 11 snowmobiles and 3 coaches. The maximum

daily number of snowmobiles and coaches entering the North Entrance Station was 16 snowmobiles and 11 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 progressively later in following winters (January 20, 2003; February 1, 2004; February 22, 2005; February 2, 2006; January 25, 2007). During winter 2007-08, the cumulative total of oversnow vehicles entering the West Entrance Station surpassed 7,500 vehicles on January 27th, which was within one week of the previous 5 winters, with the exception of winter 2004-05. According to the Visitor Services Office, the daily number of snowmobiles entering all entrances during the winter of 2007-08 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 97 surveys on the three road segments, covering 2,290 kilometers (1,423 miles). Observers recorded 1,158 groups of wildlife during these surveys, including 244 groups of elk, 571 groups of bison, 212 groups of swans, 93 groups of bald eagles, 23 groups of coyotes, and 15 groups of other species (e.g., foxes, golden eagles, wolves, etc.). Observers recorded human behaviors and the responses of wildlife to motorized winter vehicles during 770 oversnow vehicle interactions, 71 wheeled vehicle interactions, and 2 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: 51% had no visible reaction to wildlife; 38% stopped; 5% 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 59% (n = 543), 25% (n = 274), and <1% (n = 2), respectively, of the observed

wildlife-human interaction events with wildlife during winter 2007-08. Eight percent (n = 69) of observed interactions involved wheeled vehicles on plowed roads. The remaining 8% (n = 70) 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: 70% of the observed responses by groups of wildlife were categorized as no apparent response, 21% look/resume, 4% travel, 4% 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 91% of the bison, elk, and swan observations (Appendices D and E). Comparing wildlife responses between snowmobiles and snowcoaches, during interactions wildlife responded 28% to snowmobiles and 21% to snowcoaches. However, wildlife responses greater than look/resume occurred during 7% of the interactions with snowmobiles and 10% with snowcoaches.

Bison were observed on groomed roads during 109 of 571 observations of bison groups from December 14, 2007 through March 24, 2008. Thus, the majority of observed bison groups were using areas off the groomed roads. Bison use of groomed roads occurred throughout the daylight survey hours, with no apparent peak in daily time of road use. Eighty-eight of the bison groups observed on groomed roads were traveling, whereas 17 groups were categorized as stationary (four groups were feeding). There were 77 interactions between bison and oversnow vehicles when bison where on the road. Bison responses were as follows: 38% of the responses by bison were categorized as no apparent response, 38% look/resume, 19% travel, 4% attention/alarm, and 1% flight. Elk groups were observed using groomed roads 9 times out of 244 observations.

A total of 63 interaction events between oversnow vehicles and ungulates were documented when animal groups were on groomed roads, including 45 ungulate groups interacting with only snowmobiles and 10 ungulate groups interacting with only snowcoaches. In 8 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 2007-08 (i.e., elk responded two and half times as often as bison). However, monitoring during 2007-08 indicated that while the percentage of elk responses remained similar to those reported by Borkowski et al. (2006) there was a slight increase in 2007-08 in movement responses by bison (2%). These figures represented a slight increase in the intensity of response to interactions from 2006-07 and more closely match the averages from 1998-99 through 2003-04.

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. During the winter of 2007-08, the number of golden eagle sightings and interactions in the Madison-Firehole continued to increase from previous winters.

MANAGEMENT SUGGESTIONS

We suggest that training for guides, park staff, and concessionaires include the following : 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 14, 2007, through March 24, 2008, Yellowstone National Park, Wyoming. Abbreviations are: OSV (oversnow vehicle); WV (wheeled vehicle); and P (pedestrian).

Road Segment	**Species**	**Interactions**
Madison-Old Faithful	Bison	260 OSV, 13 WV, 2 P
	Elk	60 OSV, 4 WV
	Swans	28 OSV
	Coyote	9 OSV, 3 WV
	Bald Eagle	9 OSV
	Golden Eagle	2 OSV
	Wolf	2 OSV
Madison-West Yellowstone	Bison	100 OSV, 14 WV
	Elk	124 OSV, 23 WV
	Swans	110 OSV, 2 WV
	Coyote	4 OSV, 1 WV
	Bald Eagle	25 OSV, 2 WV
	Golden Eagle	1 OSV
Madison to Norris	Bison	18 OSV, 1 WV
	Elk	12 OSV
	Swans	13 OSV
	Coyote	1 OSV
	Bald Eagle	15 OSV, 1 WV
	Fox	1 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	504	43.6	368	43.7
Madison to Old Faithful	465	40.1	353	41.9
Norris to Madison	189	16.3	122	14.4

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 14, 2007, through March 24, 2008, Yellowstone National Park, Wyoming. This data does not include wheeled vehicles or pedestrian-only interactions.

Only Snowmobiles Present

Elk n=148

Human Behavior	Commercially Guided Groups (n = 86)		Administrative Groups (n = 59)		Mixed (guided and admin present simultaneously)	
	No. Events	Proportion	No. Events	Proportion	No. Events	Proportion
None	52	60.5%	18	30.5%	3	100%
Stop	34	39.5%	41	69.5%	0	
Dismount	3	3.5 %	0		0	
Approach	6	7.0 %	0		0	
Impede-Hasten	0		2	3.4%	0	

Bison n=270

Human Behavior	Commercially Guided Groups (n = 150)		Administrative Groups (n = 116)		Mixed (guided and admin present simultaneously)	
	No. Events	Proportion	No. Events	Proportion	No. Events	Proportion
None	104	69.3%	59	50.9%	3	75%
Stop	46	30.7%	57	49.1%	1	25%
Dismount	10	6.7 %	1	.9%	0	
Approach	7	4.7%	1	.9%	0	
Impede-Hasten	3	2.0%	2	1.7%	0	

Swans n=87

Human Behavior	Commercially Guided Groups (n = 44)		Administrative Groups (n = 40)		Mixed (guided and admin present simultaneously)	
	No. Events	Proportion	No. Events	Proportion	No. Events	Proportion
None	36	81.8%	28	70.0%	0	
Stop	8	18.2%	12	30.0%	2	66.6%
Dismount	8	18.2%	0		0	
Approach	0		0		1	33.3%

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

Elk n=41

Human Behavior	Number of Events	Proportion
None	23	56.1%
Stop	18	43.9%
Dismount	3	7.3%
Approach	3	7.3%
Impede-Hasten	1	2.4%

Bison n=126

Human Behavior	Number of Events	Proportion
None	80	63.5%
Stop	46	36.5%
Dismount	4	3.2%
Approach	7	5.6%
Impede-Hasten	2	1.6%

Swans n=43

Human Behavior	Number of Events	Proportion
None	28	65.1%
Stop	15	34.9%
Dismount	2	4.7%

Mixed Groups (snowmobiles and snowcoaches present simultaneously)

Elk n=18

Human Behavior	Number of Events	Proportion
None	5	27.8%
Stop	13	72.2%
Dismount	2	11.1%
Approach	6	33.3%

Bison n=42

Human Behavior	Number of Events	Proportion
None	12	28.6%
Stop	30	71.4%
Dismount	6	14.3%
Approach	8	19.0%

Swans n=10

Human Behavior	Number of Events	Proportion
None	1	10.0%
Stop	9	90.0%
Dismount	2	20.0%
Impede-Hasten	1	10.0%

Oversnow vehicle groups with pedestrians (skiers, snowshoers, etc)

Bison n=2

Human Behavior	Mixed Snowmobile Groups	
	No. Events	Proportion
None	1	50.0%
Stop	1	50.0%

Appendix D. Behavioral responses of wildlife species observed from December 14, 2007, through March 24, 2008, Yellowstone National Park, Wyoming.

Elk

Category of Response	No Events	Proportion
No Visible Response	96	48.0 %
Look-Resume	81	40.5 %
Travel	6	3.0 %
Alarm-Attention	16	8.0 %
Flight	1	.5 %

Bison

Category of Response	No Events	Proportion
No Visible Response	336	78.3 %
Look-Resume	63	14.7 %
Travel	20	4.7 %
Alarm-Attention	9	2.1 %
Flight	1	.2 %

Trumpeter Swans

Category of Response	No Events	Proportion
No Visible Response	112	89.6 %
Look-Resume	6	4.8 %
Travel	4	3.2 %
Alarm-Attention	3	2.4 %

Coyotes

Category of Response	No Events	Proportion
No Visible Response	5	29.4 %
Look-Resume	8	47.0 %
Travel	2	11.8 %
Alarm-Attention	2	11.8 %

Bald Eagles

Category of Response	No Events	Proportion
No Visible Response	26	59.1 %
Look-Resume	10	22.7 %
Alarm-Attention	1	2.3 %
Flight	7	15.9 %

Other species (wolf, golden eagle, fox)

Category of Response	No Events	Proportion
No Visible Response	3	60.0%
Look-Resume	1	20.0%
Flight	1	20.0%

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 14, 2007, through March 24, 2008, Yellowstone National Park, Wyoming. This data does not include wheeled vehicles or pedestrian-only interactions.

Wildlife responses to groups of only snowmobiles

Elk n= 128

Wildlife Response	Commercially Guided Groups *(n=61)*		Administrative Groups *(n=92)*		Mixed (guided and admin present simultaneously)	
	No. Events	Proportion	No. Events	Proportion	No. Events	Proportion
None	30	49.2%	27	42.2%	1	33.3%
Look-Resume	24	39.4%	30	46.9%	2	66.6%
Travel	1	1.6%	2	3.1%		
Alarm-Attention	5	8.2%	5	7.8%		
Flight	1	1.6%				

Bison n=270

Wildlife Response	Commercially Guided Groups *(n=150)*		Administrative Groups *(n=116)*		Mixed (guided and admin present simultaneously)	
	No. Events	Proportion	No. Events	Proportion	No. Events	Proportion
None	121	80.7%	87	75.0%	3	75.0%
Look-Resume	17	11.3%	25	21.5%	1	25.0%
Travel	6	4.0%	3	2.6%		
Alarm-Attention	5	3.3%	1	0.9%		
Flight	1	0.7%				

Swans n=95

Wildlife Response	Commercially Guided Groups *(n=58)*		Administrative Groups *(n=34)*		Mixed (guided and admin present simultaneously)	
	No. Events	Proportion	No. Events	Proportion	No. Events	Proportion

None	53	91.4%	29	85.3%	2	66.6%
Look-Resume	3	5.2%	2	5.9%		
Travel	2	3.4%	2	5.9%		
Alarm-Attention			1	2.9%	1	33.3%

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

Elk n=18

Wildlife Behavior	Number of Events	Proportion
None	9	50.0%
Look-Resume	4	22.2%
Travel	1	5.6%
Alarm-Attention	4	22.2%

Bison n=41

Wildlife Behavior	Number of Events	Proportion
None	29	70.7%
Look-Resume	6	14.7%
Travel	3	7.3%
Alarm-Attention	3	7.3%

Swans n=10

Wildlife Behavior	Number of Events	Proportion
None	10	100%

Wildlife responses to groups of only snowcoaches

Elk n=44

Wildlife Response	Number of Events	Proportion
None	25	56.8%
Look-Resume	10	22.7%
Travel	3	6.8%
Alarm-Attention	6	13.7%

Bison n=126

Wildlife Response	Number of Events	Proportion
None	104	82.5%
Look-Resume	11	8.7%
Travel	7	5.6%
Alarm-Attention	4	3.2%

Swans n=27

Wildlife Response	Number of Events	Proportion
None	26	96.3%
Look-Resume	1	3.7%

Wildlife responses to groups of Oversnow vehicles and pedestrians (skiers, snowshoers, etc)

Bison n=2

Wildlife Behavior	Number of Events	Proportion
None	2	100%

Appendix F. Encounters between oversnow vehicles and ungulates documented on groomed roads from December 14, 2007, through March 24, 2008, 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	16	35.6%	6	60.0%	2	25.0%
Stop	26	57.8%	4	40.0%	2	25.0%
Dismount	1	2.2%				
Approach					1	12.5%
Impede-Hasten	2	4.4%			3	37.5%