# Research Studies Related to Snowmobiling Impacts

## WILDLIFE – Deer, Elk, Moose and Reindeer

### Mammals / Deer

1. **Ungulates effects of recreation on Rocky mountain wildlife: A review for Montana.** Canfield, J. E., Lyon, L.J., Michael, H.J. & Thompson, M.J. (1999) Montana Chapter of the Wildlife Society.

Abstract: Ungulates provide a large percentage of the recreational opportunities for wildlife enthusiasts in the State of Montana. Hunting, wildlife viewing, and photography generate economic benefits in excess of $450 million annually. However, recreational activities have the potential not only to displace ungulates to private land where they may cause damage, but also to have negative direct and indirect effects to the populations themselves. During winter, many ungulates are seasonally confined to restricted geographic areas with limited forage resources. In these conditions, physiological adaptations and behavioral adaptations tend to reduce energy requirements. Despite lowered metabolic and activity rates, most wintering ungulates normally lose weight. Responses of ungulates to human recreation during this critical period range from apparent disinterest to flight, but every response has a cost in energy consumption. Snowmobiles have received the most attention compared to other wintertime disturbances, and the majority of reports dwell on negative aspects of snowmobile traffic.

However, snowmobiles appear less distressing than cross-country skiers, and for several ungulate species, the greatest negative responses were measured for unpredictable or erratic occurrences. In addition to increasing energy costs for wintering animals, recreational activity can result in displacement to less desirable habitats, or in some situations, to tolerance of urban developments. Tendencies to habituation vary by species, but habituated ungulates are almost always undesirable.

Managers can provide an important contribution to energy conservation by reducing or eliminating disturbance of wintering ungulates and restricting recreational use of spring ranges that are important for assuring recovery from winter weight loss. During summer, the biological focus for ungulates includes restoring the winter-depleted body condition and accumulating new fat reserves. In addition, females must support young of the year and males meet the energy demands of horn and antler growth. The potential for impacts increase and options for acquiring high quality nutrition, with the least possible effort, decline as the size of the area affected by recreationists expands to fill an increasing proportion of summer range. Disturbance of the highly productive seeps and wet sites may cause animals to withdraw to less productive areas. In addition, ungulates may be especially vulnerable to disturbance around special habitat features, such as salt licks. Persistently high levels of recreational use and the proximity to human population centers is predicted to impact reproductive performance of ungulate populations, but little direct research at this level of disturbance has been reported. Recreational traffic on and off roads has been linked with high rates of establishment and spread of noxious weeds in wildlife habitat.

The importance of summer range to most ungulate populations has gone unrecognized for many years. It is apparent, however, that managers can contribute substantially to the health, productivity, and survival of these populations by reducing human disturbances to summering animals. Big game hunting has more immediate effects on ungulate population densities and structures than any other recreational activity. Hunting season security and management affects short and long term hunting opportunities. Managers of public lands control only a few of the potential variables that contribute to security; including retention of important vegetative cover, travel management, and enforcement of travel regulations. There is a strong relationship between adequate security and predicted buck/bull carryover, but excessive hunter numbers will overwhelm any level of security. Hunting also has the potential to negatively affect herd productivity as mature males are lost from populations. Violations of ethical considerations including the concept of "fair chase" and the perception of the

"sportsman" in the public mind, can increase ungulate vulnerability as well as influence social acceptance of the sport of hunting. Pursuit of pronghorns with ORVs and killing of trophy animals within game farm enclosures are presented as ethical violations.

2. **How off-highway vehicles affect deer.** Laing, M. E. (1992) National Off-Highway Vehicle Conservation Council: 1-4 http://nohvcclibrary.forestry.uga.edu/SCANNED%20FILES/W-0015-how%20OHV%20affect%20deer.pdf

Abstract: A NOHVCC Fact Sheet summarizing seven studies by different researchers in seven different sites. Habituation to predictable motor vehicle activity was a consistent finding.

3. **Rock Creek off-road vehicle/deer study.** Jones & Stokes Associates, Inc. (1991) Prepared for CA. Department of Fish and Game; CA. Department of Parks and Recreation and El Dorado National Forest, Sacramento, CA. *(NOTE: included as an example of how newer ORV study results are comparable to old snowmobile studies)*

Abstract: The response of six to eight radio-collared deer to four levels of ORV use was determined by evaluating changes in the size of 2-day activity centers and foraging behavior. During low levels of use approximately 13 riders per day were in the study area; approximately 28 riders per day were present during moderate levels; and 47 riders per day were present during high levels of ORV use. No ORV use was used as a control.

No statistically significant differences were detected in the size of 2-day activity centers or the amount of feeding time along the different levels of ORV use. This study concluded that the deer at Rock Creek were not affected by the ORV's because no trends in the data existed to suggest otherwise. The total amount of time that deer foraged and the daily cycle of feeding periods were similar to populations of deer that had not been disturbed by ORV's. There was a low probability of an ORV encountering a deer because of the low population densities and large home ranges in the study area. Hikers had a minimum amount of disturbance on deer mostly related to harassment by dogs. This was decreased with education of visitors. Further impacts can be reduced by moving ORV use out of deer critical habitat.

4. **Rock Creek Off-Road Vehicle/Deer study – Interim Report.** Jones & Stokes Associates, Inc. (1990) California Department of Fish and Game and California Department of Parks and Recreation and El Dorado National Forest. . *(NOTE: included as an example of how newer ORV study results are comparable to old snowmobile studies)*

Abstract: The study was conducted to determine the response of mule deer to off-road vehicle use and other forms of recreation. The interim report describes the work completed in 1990. The flight response of deer at Rock Creek suggests they were not as wary of people as other deer herds, and this may result from the difference in habitat types between study areas. Distribution of deer was not affected by hikers and equestrian/mountain bike riders. Different recreation levels had no effect on deer.

5. **Responses of black-tailed deer to off-highway vehicles in Hollister Hills State Vehicular Recreation Area Hollister, CA.** Ferns, R. M., & Kutiiek, M.J. (1989) Department of Biological Sciences, San Jose State University: 42pp. . *(NOTE: included as an example of how newer ORV study results are comparable to old snowmobile studies)* http://nohvcclibrary.forestry.uga.edu/SCANNED%20FILES/W-0035-black%20tailed%20deer%20in%20hollister%20hills.pdf

Abstract: The responses of black-tailed deer were studied at Hollister Hills State Vehicular Recreation area in Hollister, CA. Researchers captured 14 female deer and equipped them with radio-collars. Movements, habitat use, and activity levels were recorded for one year and compared with OHV levels. Home range sizes for deer living within the riding area were similar to those of previously studied deer populations living in similar habitats but were not exposed to OHV use. No significant correlation was found between OHV activity levels

and deer activity levels. Deer generally avoided OHV riding areas during peak use but returned to their established home ranges after traffic levels subsided. Studies have shown that animals reacted minimally to disturbances on established trails and roads but there were increased responses to disturbances where none had occurred before. Researchers found that home-ranges of deer at Hollister Hills were centered around water and food supplies. It is recommended that future trails are developed away from major drainages and other preferred habitat types. An effort should also be made to educate trail users and encourage them to ride only on established trails.

6. **Responses of mule deer to disturbance by persons afoot and in snowmobiles.** Freddy, D. J., Bronaugh, W.M., & Fowler, M.C. (1986) Wildlife Society Bulletin, 14: 63-68.

Abstract: Controlled disturbance of mule deer occurred from mid-January until early March in 1979-1980 within a 3-km2 portion of the Junction Butte State Wildlife Area in north-central Colorado. The study found that mule deer were disturbed more by persons on foot than by snowmobiles. Responses by deer to persons were longer in duration, involved more frequent running, and were greater in energy expenditure. Intensity of responses by deer was dependent upon distance between animals and disturbances. Minimizing all responses by deer would require persons afoot and snowmobiles to remain >334m and >470m from deer.

7. **Effects of disturbance by snowmobiles on heart rate of captive white-tailed deer**. Moen, A., N. (1982) New York Fish and Game Journal, 29(2), 176-186.

Abstract: Captive white-tailed deer exhibited increased heart rates in response to controlled tests of the effect of disturbance by snowmobiles conducted from December through March. Initial heart rate responses to the starting of a snowmobile and responses to its moving by indicated that deer can react to stimuli without changes in their overt behavior. When the snowmobile circled the pen, the deer showed greater heart rate and behavioral responses. Other deer in the yard also showed greater fright responses when snowmobiles approached them directly, versus when snowmobiles moved tangentially to their activity area. Moen concluded that, the increase in heart rate and additional movements caused by encounters with snowmobiles increase rather than decrease energy expenditures by deer. Such increases have potential to affect productivity of individuals and, ultimately, of the population. Management should take into consideration the basic biological characteristics of wildlife species. It is evident that disturbance by snowmobiles is contrary to long-term energy-conservation adaptations of white-tailed deer.

8. **Snowmobile impacts on the natural environment.** Aasheim, R. (1980) R.L. Andrews and P.F. Nowak, (eds.) Off-road Vehicle Use: A management challenge conference. Ann Arbor, MI.

Abstract: Snowmobiling and its impacts on natural environments in Montana are described. Studies of impacts on deer and elk have produced conflicting results, but there is little doubt that additional stress on poor-condition animals in winter is undesirable. Animals accustomed to humans are less affected by snowmobiles than animals in more remote areas. Effects on small mammals and possible effects of packed snowmobile trails are discussed.

9. **Snowmobile effects on movements of white-tailed deer: A case study.** Eckstein, R. G., O'Brien, T.F., Rongstad, O.J., & Bollinger, J.G. (1979) Environmental Conservation, 6: 45-51. http://nohvcclibrary.forestry.uga.edu/SCANNED%20FILES/W-0034.pdf

Abstract: Data showed that snowmobile activity had no significant effect on home-range size, habitat use, or daily activity patterns of white-tailed deer wintering in Wisconsin. Snowmobile activity did cause some deer to leave the immediate vicinity of the snowmobile trail. Darkness appeared to decrease reaction to disturbance. Deer appeared to react more to a person walking/skiing than on snowmobiles.

10. **Response of white-tailed deer to snowmobiles and snowmobile trails in Maine.** Richens, V. B., & Lavigne, G. R. (1978) Canadian Field-Naturalist, 92(4), 334-344. http://nohvcclibrary.forestry.uga.edu/SCANNED%20FILES/W-003.pdf

Abstract: White-tailed deer response to snowmobiles seemed dependent on the deer's apparent security. Animals in the open or in hardwood stands tended to run when approached by snowmobile. Deer in softwood stands, which provide more cover, showed a greater tendency to stay when approached. A significantly greater number of deer ran from a person walking than from a person on snowmobile.

11. **Winter response of deer to snowmobiles and selected natural factors.** Lavigne, G. R. (1976) University of Maine. http://nohvcclibrary.forestry.uga.edu/SCANNED%20FILES/W-003A.pdf

Abstract: Deer responses to snowmobiles and selected natural factors were studied during winters of 1972/73. Use of snowmobile trail was significantly correlated with deer density and winter severity. Most movements on snowmobile trails were for short distances. Disturbance of deer by snowmobiles did not cause them to abandon preferred bedding and feeding sites. Snowmobile trails enhanced deer mobility and probably reduced their energy expenditure.

12. **Effects of snowmobiles on white-tailed deer**. Dorrance, M., & Savage, P.J. (1975) Journal of Wildlife Management, 39(3): 563-569. http://nohvcclibrary.forestry.uga.edu/SCANNED%20FILES/W-006.pdf

Abstract: The effects of snowmobiles on white tailed deer were studied in Minnesota during 1973 and 1974. Study areas were in St. Croix State Park, where numbers of snowmobiles per day averaged 10 on weekdays and 195 on weekends, and in Mille Lacs Wildlife Management Area, where snowmobiling was prohibited except by project personnel. Home range size, movement, and distance from radio-collared deer to the nearest trail increased with snowmobile activity at Mille Lacs, but remained unchanged at St. Croix. Numbers of deer along a l0-km trail decreased as snowmobile traffic increased at St. Croix. Light snowmobile traffic caused the displacement of deer from areas immediately adjacent to trails at St. Croix; thereafter, increased snowmobile traffic caused no additional response. Deer returned to areas along trails within hours after snowmobiles ceased at St. Croix. Deer responded to very low intensities of intrusion by man and vehicles.

13. **Effect of snowmobile noise and deer and rabbits in their natural habitat**. Bollinger, J. (1974)

Abstract: The behavioral patterns of deer and rabbits before, during, and after extensive snowmobile activities were studied. The data gathered was used to assess the noise wildlife levels associated with various behavior patterns, and to assess the noise levels generated by different snowmobile uses on various types of terrain. Additional objectives were to determine the effects snowmobile noise and activity had on the home range of deer and rabbits and their seasonal movements; to determine reactions these animals had to men in the area not using snowmobiles but equipped with skis and snowshoes; and to determine if there was a difference in predator behavior in areas where snowmobiles were used versus those where no vehicles were operated. The research team was unable to detect severe or negative animal reactions to the noise generated by the vehicles. Conclusions of the study indicate that the deer and rabbits were not forced to move out of their normal home ranges, nor did they seek shelter or remain stationary with fright while snowmobiles were being operated. The only negative effect determined was that the animals did increase their movement during extensive vehicle use periods. Researchers were unable to determine whether it was the noise, physical presence, or both that caused the disturbance.

14. **Effects of snowmobiles on the movements of white-tailed deer in Northern Wisconsin.** Eckstein, R. G., & Rongstad, O.J. (1973) Proceedings of the Midwest Fish and Wildlife Conference.

Abstract: Studies in northern Wisconsin evaluated the effects of snowmobile use on white-tailed deer in wintering yards. Movements and activities of tele-metered deer were compared between a yard receiving snowmobile use and one with no use. Some deer showed avoidance of snowmobile trails while machines were present, but no significant changes in home range size or daily movement patterns were observed.

## Mammals / Elk

1. **Wildlife Responses to Motorized Winter Recreation in Yellowstone**. White, P.J., Davis, T., & Borkowski, J. (2005) Yellowstone Center for Resources & Montana State University. . http://www.nps.gov/yell/parkmgmt/upload/winterrec05.pdf

Abstract: This study monitored the behavioral responses of bison (*Bison bison*), elk (*Cervus elaphus*), and trumpeter swans (*Olor buccinator*) to motorized winter recreation by repeatedly surveying seven groomed or plowed road segments in Yellowstone National Park during December 2004 through March 20005. The study sampled >2,100 interactions between vehicles and wildlife groups and used multinominal logits models to identify conditions leading to behavioral responses. Responses by these wildlife species to over-snow vehicles were relatively infrequent, short in duration, and of minor to moderate intensity, with >81% categorized as no apparent response or look/resume activities, 9% attention/alarm, 7% travel, and 3% flight or defense. Analyses of similar data collected during 1999-2004 indicated the likelihood of active responses by wildlife increased significantly if (1) wildlife were on or near roads, (2) more vehicles were in a group, (3) wildlife groups were smaller, (4) ungulates were in meadows instead of forest or geothermal habitats, (5) interaction times increased, (6) wildlife were traveling instead of resting, and (7) humans dismounted vehicles and/or approached wildlife. The likelihood of an active response by bison or elk decreased as cumulative visitation increased, suggesting that these ungulates habituated somewhat to motorized recreation. There was no evidence of population-level effects to ungulates from motorized winter use because estimates of abundance either increased or remained relatively stable during three decades of motorized recreation prior to wolf colonization in 1998. **Thus, we suggest that the debate regarding the effects of motorized recreation on wildlife is largely a social issue as opposed to a wildlife management issue.** The likelihood of active responses by wildlife can be diminished by (1) restricting travel to predictable routes and times, (2) reducing the number of vehicles in groups, (3) reducing the number and length of stops to observe wildlife, (4) stopping vehicles at distances >100 meters, and (5) preventing human activities away from vehicles.

2. **Bison and Elk Responses to Winter Recreation in Yellowstone National Park.** Hardy, A.R. (2001) Montana State University master's thesis.

Abstract: The National Park Service (NPS) is tasked with protecting wildlife and providing public access to parklands; winter recreation in Yellowstone National Park (YNP) has challenged NPS managers to balance this dual mandate. This study addresses bison and elk responses to winter recreation in the Upper Madison River drainage of YNP. Using data on weather; winter recreation activity; elk and bison distribution, behavior, abundance, and fecal stress hormone (glucocorticoid) levels collected during the winters of 1998 – 1999 and 1999 – 2000, I developed models to analyze if if variables related to winter recreation contributed to bison and elk distribution, behavior, and stress hormone levels responses. As distance between human activities and bison and elk decreased, behavioral responses increased. Both species behaviorally responded more often to people off-trail than to people on trails ($P<0.001$ for both species), and these activities prompted more behavioral responses than activities on roads. Elk were farther from the road ($P=0.092$) after exposure to >7,500 cumulative vehicles entering the West Yellowstone gate. Elk residing along the road segment with the greatest amount of oversnow vehicle (OSV) activity had higher stress levels (unknown elk: $P<0.001$; collared cow elk: $P=0.004$) and may have been displaced from habitat along the road (distance: $P=<0.001$; numbers sighted: $P=0.082$) compared to elk residing along the less-traveled segment. Collared cow elk stress levels increased ($P=0.057$) while the probability of bison and elk behaviorally responding to human activities on the road decreased ($P=0.001$ for both species) as daily vehicles entering the West Yellowstone gate increased. The predictability and frequency of OSV activities facilitated habituation to the majority of the winter recreation activities. Abundance estimates indicated populations of wintering bison increased and wintering elk remained stable over 20 years. Despite varying responses to increased winter visitation since the late 1970s, bison and elk return to winter in the same area each year, coexisting with winter recreation without incurring losses at the population level.

3. **Effects of Winter Recreation on Elk.** (1999) Effects of Winter Recreation on Wildlife of the Greater Yellowstone Area: A Literature Review and Assessment. Olliff, T., Legg, K. & Kaeding, B. Greater Yellowstone Coordinating Committee, Yellowstone National Park. pp. 17-30. http://www.nps.gov/yell/parkmgmt/upload/wildlifewint.pdf

Potential Effects: Groomed routes are likely to have impacts similar to those of primary transportation routes and scenic routes (particularly if they are located in low-elevation areas and along river corridors), depending on the level of human use. Groomed routes may provide an energy efficient travel route for elk, but may also do the same for predators of elk. Human activity in backcountry areas is likely to be less predictable than in other motorized recreation areas and, therefore, has more potential to create flight response in individual elk or groups of elk. Motorized use of these areas is likely to occur over a less-confined area than transportation routes, potentially increasing the area of disturbance or displacement of elk. This type of recreation usually occurs in higher elevation, deep-snow areas and so may impact only scattered groups of adult males.

Management Guidelines: Avoid placing transportation and motorized routes in low-elevation, low-snow, riparian, and open habitats favored by elk. Where this is necessary, attempt to occasionally move the route away from those areas and through denser timber or areas with adequate hiding cover. Avoid creating road-side barriers that may prevent elk from crossing roads or trails or that may trap animals along the route.

4. **Ungulates effects of recreation on Rocky mountain wildlife: A review for Montana.** Canfield, J. E., Lyon, L.J., Michael, H.J. & Thompson, M.J. (1999) Montana Chapter of the Wildlife Society.

Abstract: Ungulates provide a large percentage of the recreational opportunities for wildlife enthusiasts in the State of Montana. Hunting, wildlife viewing, and photography generate economic benefits in excess of $450 million annually. However, recreational activities have the potential not only to displace ungulates to private land where they may cause damage, but also to have negative direct and indirect effects to the populations themselves. During winter, many ungulates are seasonally confined to restricted geographic areas with limited forage resources. In these conditions, physiological adaptations and behavioral adaptations tend to reduce energy requirements. Despite lowered metabolic and activity rates, most wintering ungulates normally lose weight. Responses of ungulates to human recreation during this critical period range from apparent disinterest to flight, but every response has a cost in energy consumption. Snowmobiles have received the most attention compared to other wintertime disturbances, and the majority of reports dwell on negative aspects of snowmobile traffic.

However, snowmobiles appear less distressing than cross-country skiers, and for several ungulate species, the greatest negative responses were measured for unpredictable or erratic occurrences. In addition to increasing energy costs for wintering animals, recreational activity can result in displacement to less desirable habitats, or in some situations, to tolerance of urban developments. Tendencies to habituation vary by species, but habituated ungulates are almost always undesirable.

Managers can provide an important contribution to energy conservation by reducing or eliminating disturbance of wintering ungulates and restricting recreational use of spring ranges that are important for assuring recovery from winter weight loss. During summer, the biological focus for ungulates includes restoring the winter-depleted body condition and accumulating new fat reserves. In addition, females must support young of the year and males meet the energy demands of horn and antler growth. The potential for impacts increase and options for acquiring high quality nutrition, with the least possible effort, decline as the size of the area affected by recreationists expands to fill an increasing proportion of summer range. Disturbance of the highly productive seeps and wet sites may cause animals to withdraw to less productive areas. In addition, ungulates may be especially vulnerable to disturbance around special habitat features, such as salt licks. Persistently high levels of recreational use and the proximity to human population centers is predicted to impact reproductive performance of ungulate populations, but little direct research at this level of disturbance has been reported. Recreational traffic on and off roads has been linked with high rates of establishment and spread of noxious weeds in wildlife habitat.

The importance of summer range to most ungulate populations has gone unrecognized for many years. It is apparent, however, that managers can contribute substantially to the health, productivity, and survival of these populations by reducing human disturbances to summering animals. Big game hunting has more immediate effects on ungulate population densities and structures than any other recreational activity. Hunting season security and management affects short and long term hunting opportunities. Managers of public lands control only a few of the potential variables that contribute to security; including retention of important vegetative cover, travel management, and enforcement of travel regulations. There is a strong relationship between adequate security and predicted buck/bull carryover, but excessive hunter numbers will overwhelm any level of security. Hunting also has the potential to negatively affect herd productivity as mature males are lost from populations. Violations of ethical considerations including the concept of "fair chase" and the perception of the "sportsman" in the public mind, can increase ungulate vulnerability as well as influence social acceptance of the sport of hunting. Pursuit of pronghorns with ORVs and killing of trophy animals within game farm enclosures are presented as ethical violations.

5. **Elk responses to disturbance by cross country skiers in Yellowstone National Park.** Cassirer, E. F., Freddy, D.J. & Abies, E.D. (1992) Wildlife Society Bulletin 20: 375-381.

Abstract: Radio marked elk were intentionally disturbed by groups of people walking or skiing directly into their location. Disturbance resulted in displacement of elk and increased energy expenditure. Upon disturbance, distances moved were 1,675 m, and were related to distance to topographic barriers. The elk seemed to use ridges as primary cover and stands of trees secondarily, after they had gone over a ridge. Elk in this study had a low tolerance for disturbance by people on foot or skis. Disturbance caused temporary displacement of the elk.

Elk generally returned after people left the area, however, it is believed that this tendency may decline with repeated disturbances. The energy expended moving away from skiers represented approximately 5.5% of an estimated average daily expenditure of 6,035 kcal for elk in winter and is more than the normal estimated daily energy expenditure for movement.
Researchers believe that restricting cross-country skiers to locations >650m from elk wintering areas would probably minimize displacement of most non habituated elk. Skiers would likely have to remain at distances of >1,700m to completely avoid disturbing elk. The amount of winter range used by skiers and the number of days involved seemed to have more of an effect on elk than skier numbers. Therefore, when skier activity is located on elk wintering range it was recommended that concentrating use in sites with abundant topographic relief, and providing security areas in drainages adjacent to those where skiing occurs might minimize the added energy costs and displacement of elk.

6. **How off-highway vehicles affect elk.** Laing, M. E. (1992). National Off-Highway Vehicle Conservation Council: 1-3 http://nohvcclibrary.forestry.uga.edu/SCANNED%20FILES/W-0013-OHV%20effect%20on%20elk.pdf

Abstract: A NOHVCC Fact Sheet summarizing four different studies by different researchers in different regions of the western U.S, revealing varying responses. Generally, habituation to predictable disturbances is commonly observed, and ATV/motorcycle traffic is not especially or uniquely disturbing when compared with other types of disturbances. The bibliography cites these four studies only.

7. **Influence of Nordic skiing on distribution of moose and elk in Elk Island National Park, Alberta.** Ferguson. M.A.D., & Langvatn, R. (1985) Canadian Field Naturalist, 96: 69-78.

Abstract: Effects of cross-country skiing on distribution of Moose and Elk during winter were studied on Elk Island National Park, Alberta. Aerial observations and track and pellet-group counts provided indices to distribution that could be related to trail location and/or use. Cross-country skiing influenced the general over winter distribution of Moose but not of Elk. Both species, however, tended to move away from areas near

heavily-used trails during the ski season (January-March). Day to day movements away from trails occurred after the onset of skiing, but such displacement did not increase with the passage of additional skiers.

8. **Snowmobile impacts on the natural environment.** Aasheim, R. (1980) R.L. Andrews and P.F. Nowak, (eds.) Off-road Vehicle Use: A management challenge conference. Ann Arbor, MI.

Abstract: Snowmobiling and its impacts on natural environments in Montana are described. Studies of impacts on deer and elk have produced conflicting results, but there is little doubt that additional stress on poor-condition animals in winter is undesirable. Animals accustomed to humans are less affected by snowmobiles than animals in more remote areas. Effects on small mammals and possible effects of packed snowmobile trails are discussed.

9. **Telemetered heart rate of three Elk as effected by activity and human disturbance.** Ward, A. L., & Cupal, J. J. (1980) U.S. Forest Service, Fort Collins, Colorado.

Abstract: The effects of human disturbances on elk in Wyoming were studied during 1975/76. Two adult cows and one yearling male were fitted with heart rate monitors. Teams observed and encountered the elk 344 times to ascertain the effects of different stimuli. Positive heart and flight reactions were recorded. Elk responded most strongly to sonic booms, gunshots, and people on foot. Elk seldom reacted when approached by an OHV.

## Mammals / Moose

1. **Effects of Winter Recreation on Moose.** (1999) Effects of Winter Recreation on Wildlife of the Greater Yellowstone Area: A Literature Review and Assessment. Olliff, T., Legg, K. & Kaeding, B. Greater Yellowstone Coordinating Committee, Yellowstone National Park. pp. 73-86. http://www.nps.gov/yell/parkmgmt/upload/wildlifewint.pdf

Potential Effects: Individual animals may be affected if a flight response is initiated by contact with vehicles. Moose may use the groomed surface as a travel route and invite collisions with oversnow vehicles. If human activities are predictable, moose may become habituated..
Management Guidelines: Where human use does occur in moose winter range, regulate activities to make them as predictable as possible. This can be accomplished by restricting them spatially and temporally. For example, restrict skiing or snowmobiling to designated paths and to daylight hours.

2. **Reaction of Moose to Snowmobile Traffic in the Greys River Valley, Wyoming.** Colescott, J.H. & Gillingham, M.P. (1998) ALCES Vol. 34(2): 329-338.

Abstract: Understanding how human activities influence wildlife populations is increasingly important as recreational demands on critical habitat increase. We studied the effects of snowmobile traffic on wintering moose (*Alces alces*) in the Greys River drainage, Wyoming from January through February, 1994. Based on 736 moose-hours of direct observations on large willow flats, moose (6 females, 8 males, and 3 juveniles) were active 41.7% and inactive 58.3% of the observation time. Bedding activity lasted on average 118.7 minutes (range: 1 – 144 minutes) and feeding averaged 32.1 minutes (range: 1 – 274 minutes). Standing, walking, and running occurred only for short periods of time, less than 7 minutes on average. Moose bedding within 300 meters and feeding within 150 meters of passing snowmachines altered their response to the disturbance. This response was more pronounced when moose were within 150 meters of the disturbance. The frequency of snowmobile traffic did not seemingly affect the average percent of moose active, or the number of moose present in the study areas. Moose appeared to move away from the active snowmobile trail as the day progressed. Consequently, snowmobile traffic, although it did not appear to alter moose activity significantly, did influence the behavior of moose positioned within 300 meters of a trail and did displace moose to less favorable habitats.

3. **Influence of Nordic skiing on distribution of moose and elk in Elk Island National Park, Alberta.** Ferguson. M.A.D., & Langvatn, R. (1985) Canadian Field Naturalist, 96: 69-78.

Abstract: Effects of cross-country skiing on distribution of Moose and Elk during winter were studied on Elk Island National Park, Alberta. Aerial observations and track and pellet-group counts provided indices to distribution that could be related to trail location and/or use. Cross-country skiing influenced the general over winter distribution of Moose but not of Elk. Both species, however, tended to move away from areas near heavily-used trails during the ski season (January-March). Day to day movements away from trails occurred after the onset of skiing, but such displacement did not increase with the passage of additional skiers.

4. **Snowmobilers, Their Experience and Habitat Preferences, and the Implications for Wintering Moose.** Jonker, P.M. Jr. (1984) University of Calgary Master's Thesis.

Abstract: The compatibility of habitat requirements of snowmobilers and of moose was assessed. 306 snowmobile users were interviewed from January to April, 1982, at McLean Creek Snowmobiling Area, Alberta. Physical, psychological, and socio-economic dimensions of the sample were derived and described, as well as local behavioral characteristics, and their preferences for vegetation type, density, slope angle, snow depth, and snow type.

Comparison of the snowmobiler's requirements with those of moose indicates clear conflict of demand over "short deciduous" vegetation stands, and conifer and deciduous stands having densities of 100 – 1000 stems per hectare; such stands offer at the same time good snowmobiling and the bulk of moose browse. Moderate potential conflict exists over "roads and trails," moderate slopes, tree stands having densities of 1001 – 2000 stems per hectare, and powder snow on a firm base. A clear conflict over these is expected to be initiated actually only in the presence of deep snow accumulations, such as do not occur at McLean Creek Area. Minimum demand conflict exists for most parameters measured, including non-vegetated terrain, dense stands of trees, thin powder snow, deep powder snow, landform types, flat topography, and steep slopes.

## Mammals / Reindeer

1. **Behavior Responses of Wild Reindeer to Direct Provocation by a Snowmobile or Skier.** Reimers, E., Eftesddl, S., & Colman, J.E. (2003) The Journal of Wildlife Management, Vol. 67, No. 4, pp. 747-754.

Abstract: To better understand the effect of winter tourism and public recreation on wild mountain reindeer *(Rang* tarandus tarandus),* we compared reindeer response distances after direct provocations by skiers and snowmobiles during three winters in Setesdal-Ryfylke, southern Norway. Reindeer being provoked by a snowmobile discovered the observer at longer distances than reindeer being provoked by a skier *(370* [skier] vs. *534* [snowmobile] m; *P = 0.002),* while total flight *(756* vs. *570* m; *P= 0.037)* and total distance moved *(970* vs. *660* m; *P= 0.008)* by reindeer were shorter for snowmobile than skier provocation. The fright *(328* [skier] vs. *328* [snowmobile] m), flight (281 vs. *264* m), and escape *(543* vs. *486* m) distances due to skier or snowmobile provocation were not different *(P> 0.05).*For pooled data, fright distances of reindeer were affected by *two* other independent variables. Fright distance was longer when the animals were provoked from below rather than from above *(P= 0.046),* while their escape distances were longer when the animals were lying rather than when grazing prior to being provoked
*(P< 0.05).* Based on maximum and minimum distance moved for all provocations pooled, daily estimated energy expenditure of reindeer increased between *31* and *590* **kJ,** representing *0.2* and 2.9% of their estimated total daily energy expenditure. Overall, provocations by skiers or snowmobiles revealed similar behavioral responses. An estimated maximum rate of *3* daily encounters between reindeer and skiers or snowmobiles during winter vacation and Easter would result in moderate energy costs that should be easily compensated for and thus have no demographic consequences. Increasing snowmobile use will, however, significantly expand the area where humans are in contact with reindeer during winter and spring, a period of negative energy balance for reindeer.