Impacts of winter recreationists on wildlife in a portion of Yellowstone National Park, Wyoming
by Keith Edward Aune

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE
in Fish and Wildlife Management
Montana State University

Abstract:
The impacts of winter recreationists on wildlife in Yellowstone National Park were investigated from 1978-80, Total winter visitation has increased 995 per cent since 1966 and exceeded 50,000 visitors the winter of 1979-80. Winter recreation includes such activities as snowmobiling, cross-country skiing, snowshoeing, winter camping, and snowcoach tours through the park. The number of private oversnow vehicles entering the park ranges from 20,000 to 30,000 per year.

Over 15,000 snowcoach passengers travel through the park each year.

The general responses of wildlife to disturbance include: Attention or alarm response, flight response, and aggressive response. Only two instances of aggresssive responses were recorded. Flight and attention responses varied with the species involved. The response of wildlife to snowmobiles was more intense and more frequent in the control area than along the groomed snowmobile trail. Wildlife reactions were more frequent and intense during the preseason period than during the recreation season. Much of the wildlife-snowmobile interaction occurred while elk or bison traveled on the groomed trail. Elk were the most frequently encoutered wildlife species followed by bison, coyote, mule deer, and moose. Ninety-four percent of the encounters were within the 0-60 meter encounter distance range. Ninety-one per cent of the distances of flight recorded for all species were less than 100 meters. Wildlife-skier interaction per mile skied and the per cent of wildlife responding by fleeing was greater than for snowmobiling. Average encounter distance and average distance of flight for all species combined were greater for approaches by skiers than by snowmobile. Wildlife-skier interaction was greater off the trails than on the established trails. Wildlife developed crepuscular activity patterns in response to winter recreation activity. Winter recreation activity in Yellowstone was not a major factor influencing wildlife distribution, population, or movement. Some displacement of wildlife from areas adjacent to the trails was observed. Wildlife movement across the trails was inhibited by intense traffic and by the berm created by plowing and grooming operations. Harrassment of wildlife by snowmobiles and skiers increased energy expenditure of wildlife. Elk, mule deer, and bison were observed to habituate to the snowmobile noise. The observed effects of winter recreationists on the physical environment include: minor air and snow pollution by snowmobile exhaust, litter, noise pollution, and limited physical damage to soils and plants.

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Approved:

Chairman, Graduate Committee

Head, Major Department

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MONTANA STATE UNIVERSITY
Bozeman, Montana

March, 1981

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ACKNOWLEDGEMENTS

To the following, among others, the author wishes to express his most sincere appreciation for their contributions to this study: Dr. Harold Picton, Montana State University, for project planning, technical supervision and aid in preparation of the manuscript; Dr. Mary Meagher, National Park Service, for project planning and direction; Don Despain for providing vegetation maps of the area; Drs. Robert Eng and William Gould, for critically reviewing this manuscript; Joan Pribanic and Frederick Dewalt, Montana State University, for chemical analysis and guidance; the Old Faithful and West District Rangers, for field assistance during the study; Personnel of the Yellowstone Park Company for data contributions and assistance in the field. My deepest appreciation goes to my wife, Cynthia, for her patience and faithful support during the duration of this study.

This study was funded by the National Park Service under Contract Number CX-1570-9-0002.

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ABSTRACT

The impacts of winter recreationists on wildlife in Yellowstone National Park were investigated from 1978-80. Total winter visitation has increased 995 per cent since 1966 and exceeded 50,000 visitors the winter of 1979-80. Winter recreation includes such activities as snowmobiling, cross-country skiing, snowshoeing, winter camping, and snowcoach tours through the park. The number of private oversnow vehicles entering the park ranges from 20,000 to 30,000 per year. Over 15,000 snowcoach passengers travel through the park each year. The general responses of wildlife to disturbance include: Attention or alarm response, flight response, and aggressive response. Only two instances of aggresssive responses were recorded. Flight and attention responses varied with the species involved. The response of wildlife to snowmobiles was more intense and more frequent in the control area than along the groomed snowmobile trail. Wildlife reactions were more frequent and intense during the preseason period than during the recreation season. Much of the wildlife-snowmobile interaction occurred while elk or bison traveled on the groomed trail. Elk were the most frequently encoutered wildlife species followed by bison, coyote, mule deer, and moose. Ninety-four percent of the encounters were within the 0-60 meter encounter distance range. Ninety-one per cent of the distances of flight recorded for all species were less than 100 meters. Wildlife-skier interaction per mile skied and the per cent of wildlife responding by fleeing was greater than for snowmobiling. Average encounter distance and average distance of flight for all species combined were greater for approaches by skiers than by snowmobile. Wildlife-skier interaction was greater off the trails than on the established trails. Wildlife developed crepuscular activity patterns in response to winter recreation activity. Winter recreation activity in Yellowstone was not a major factor influencing wildlife distribution, population, or movement. Some displacement of wildlife from areas adjacent to the trails was observed. Wildlife movement across the trails was inhibited by intense traffic and by the berm created by plowing and grooming operations. Harrassment of wildlife by snowmobiles and skiers increased energy expenditure of wildlife. Elk, mule deer, and bison were observed to habituate to the snowmobile noise. The observed effects of winter recreationists on the physical environment include: minor air and snow pollution by snowmobile exhaust, litter, noise pollution, and limited physical damage to soils and plants.

INTRODUCTION

Significant changes have occurred in winter use of Yellowstone National Park since the early 1960's. Prior to 1963, winter visitation to Yellowstone Park was very limited. The development of efficient oversnow vehicles and winter recreation facilities within the park has contributed to increased winter visitation which exceeded 50,000 during 1979-80. Since 1966, the total number of visitors to the park during the winter has risen 955 per cent. This presents new and challenging management problems associated with retaining natural ecological relationships in the face of increased recreational use and the accompanying impacts. Houston (1971) noted that "Providing for the educational and esthetic enjoyment of man while maintaining pristine ecological relationships, represents the greatest challenge in the management of natural areas."

Winter recreation in Yellowstone National Park includes such activities as snowmobiling, cross-country skiing, snowshoeing, winter camping, and scenic snowcoach tours through the park. These activities have the potential to adversely impact wildlife and the natural winter environment. To date, little research has been done on specific impacts of such activities on wildlife in the winter environment. Schmid (1971), Jarvinen and Schmid (1971), and Pruitt (1971) discuss the impacts of snowmobiles on the subnivean environment. Newmann and Merriam (1972) reported the effects of snowmobiling on

snowshoe hare (Lepus americanus) and red fox (Vulpes fulva) mobility and distribution. Dorrance, et al. (1975), Huff and Savage (1975), Eckstien and Rongstad (1973), Richens and Lavigne (1978), and Bury (1978) examined the impacts of snowmobiles on white-tailed deer (Odocoileus virginianus). Bollinger (1973) provided a study on the effects of snowmobile noise on wildlife. Schultz and Bailey (1978), Young and Boyce (1971), and Bayfield (1970), mention some impacts of skiing on wildlife and the environment. Several other authors report impacts of snowmobiles on soil and vegetation (Wanek 1971, 1973, Whittaker 1971, Baldwin 1969, 1971, and Newmann and Merriam 1972).

This study represents the first intensive investigation to assess the impacts of winter recreationists upon wildlife and the environment in Yellowstone National Park. The primary objectives were: 1) classify recreational use density and distribution within the study area; 2) to determine the acute and chronic reactions of wildlife to recreationists and implications of effects on energy balance; 3) to determine any adverse effects on the general quality of the winter environment in the study area. Considerable emphasis was placed on the impacts of oversnow vehicles and cross-country skiers on elk (Cervus elaphus nelsoni) and bison (Bison bison), the two most numerous ungulates within the study area. Field work was conducted from November 1978 until April 1979 and from December 1979 until April 1980.

DESCRIPTION OF THE STUDY AREA

Location, Physiography, and Geology

The study area includes portions of the Madison, Firehole, and Gibbon River valleys inside Yellowstone National Park between the elevations of 2000 to 2400 meters (Figure 1). Craighead, et. al. (1973) and Cole (1972 and 1978) gave brief descriptions of the area. A general description of the physiography of the park was given by Meagher (1973). Extensive volcanism and glaciation shaped many of the physiographic features. The unusual geology of the park has been discussed by Hague (1899), Fischer (1976), and Keefer (1976). Soils are mainly derived from volcanic rhyolite.

Vegetation

General descriptions of Park vegetation are provided by Bailey (1930), Bailey and Bailey (1949), McDougall and Baggley (1956), Meagher (1973), Despain (1973), Barmore (1975), and Houston (1976). About three-fourths of the study area is dominated by moderate to very dense stands of lodgepole pine (*Pinus contorta*) forest. The lodgepole pine zone is dominated by climax lodgepole pine or seral stages with very little or no spruce or fir in the understory (Despain, 1973). A small portion of the Madison River Valley is occupied by Douglas-Fir (*Pseudotsuga menziesii*) in conjunction with open sagebrush/grasslands. Other habitat types present are meadows or parks (covering about 20 percent of the study area) and scattered geothermal areas (Cole 1972).

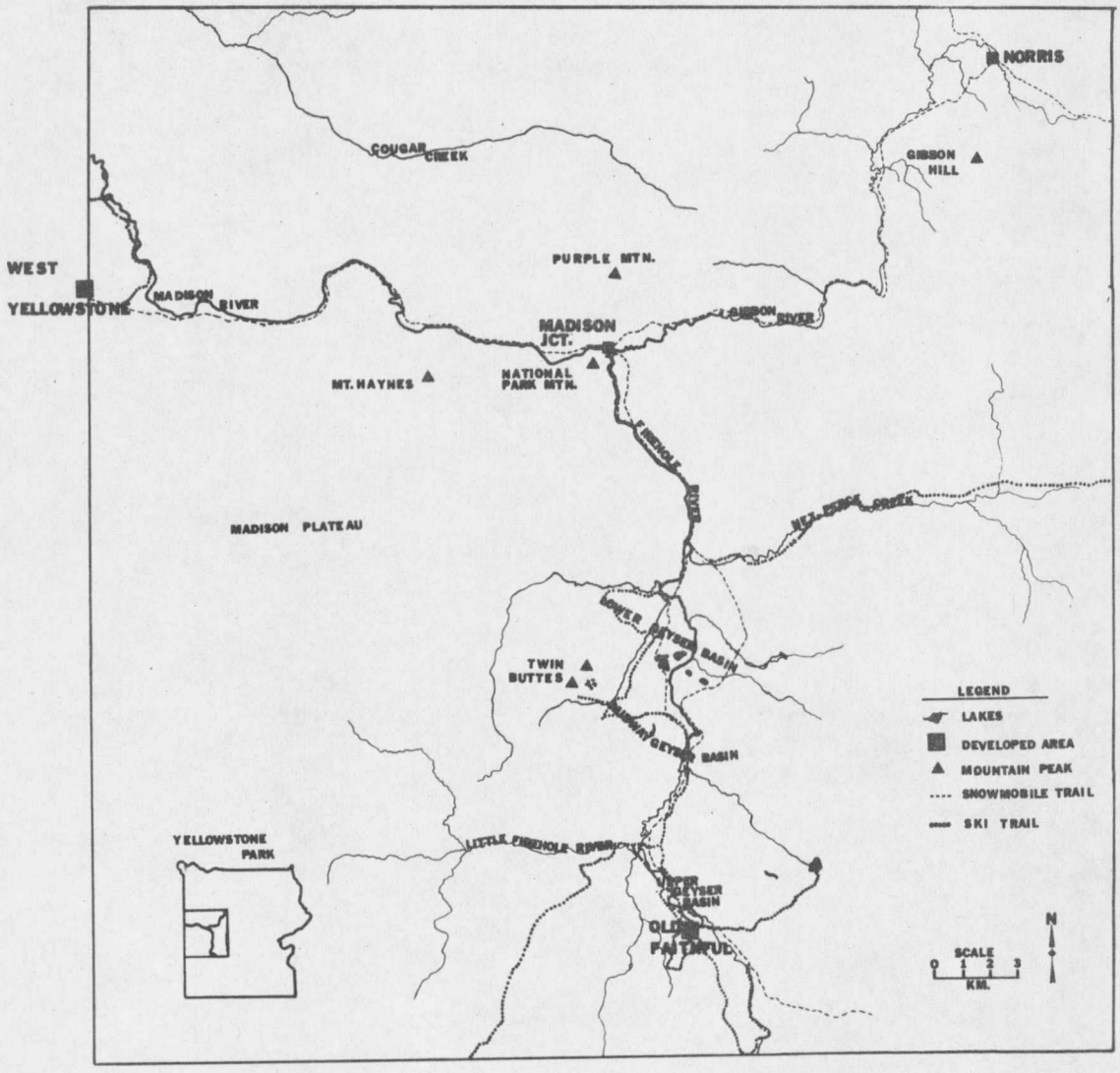

Figure 1. Map of the Study Area

The meadows are characterized by grasses, sedges (Carex spp.), marsh reedgrass (Calamagrostis spp.) and willows (Salix spp.). The dominant grasses of drier sites are Idaho fescue (Festuca idahoensis) and bluegrass (Poa spp.)

Climate

Houston (1976) gave a comprehensive history of climatic changes in Yellowstone Park. Presently the climate is characterized by long, cold winters and short cool summers. U.S. Department of Commerce (NOAA) records for West Yellowstone, Montana show the mean annual temperature for 1940-1969 was 1.7°C, 15.3°C for July was the warmest month and a -10.6°C for January the coldest month. Midwinter extremes are bitterly cold; the coldest observed in the basin was -66°F on February 9, 1933. Most of the subzero weather in the area appears to be generated locally as a combined result of clear sky nocturnal radiation cooling from a substantial and consistent snowpack (U.S. Dept. of Commerce). Annual precipitation for the 1940-1969 period was 58.3 cm., most of it falling as snow during the winter months. Mean annual snowfall was 418 cm. and mean depth exceeded 46 cm. for an average of 126 days per year.

Fauna

In the Firehole, Gibbon, and Madison river valleys there are about 16,200 ha. of winter habitat which supports about 800 elk and from 100 to 500 Bison as well as small numbers of moose (Alces alces)

and mule deer (Odocoileus hemionus) (Cole 1978). Secondary consumers common to the area include coyotes (Canis latrans), black bear (Ursus americanus), grizzly bears (Ursus arctos), and a host of avian scavengers and predators. Mountain lions (Felis concolor) and wolverine (Gulo luscus) are reported occasionally. Endangered or threatened species present in the area include grizzly bears, bald eagles (Haliaeetus leucocephalus), and trumpeter swans (Olor buccinator) with occasional reports of gray wolves (Canis lupus). A large number of Canada geese (Branta canadensis) and several species of ducks winter on rivers in the study area. Thermal activity along the Gibbon, Firehole, and Madison rivers produce conditions under which the wildlife can winter. Thermal input to rivers keep them relatively ice-free which attracts wintering populations of bald eagles, trumpeter swan, Canada geese, bald eagles, and other waterfowl. This open water is also important to beaver (Castor canadensis) and river otter (Lutra canadensis) inhabiting the area.

History of Winter Use

Prior to 1955, snow conditions and unplowed roads kept most of the park inaccessible except to those visitors who ventured into the park on snowshoes or skiis. Snowplanes came into the park prior to World War II and the Park Service operated one or two after the war as well as "weasels". The only motorized access was by the north entrance road from Gardiner, Montana, to Mammoth, Park headquarters.

The first permit issued to operate snowmobiles in Yellowstone Park was given on January 18, 1955 to William J. Nicholes and Harold M. Young of West Yellowstone who had formed a partnership under the name Snowmobiles of West Yellowstone. Their concession provided for carrying passengers on occasional trips to Old Faithful from West Yellowstone. The permit was for one year. When the operation proved successful, the Park Service offered a longer franchise to the Yellowstone Park Company who accepted it and contracted with Snowmobiles, Inc. of West Yellowstone to provide the service. In 1966, the Yellowstone Park Company purchased the snowcoaches and began to operate them. In 1967, they began to operate coaches out of Mammoth Hot Springs as well as West Yellowstone and the Canyon Village run was started. In 1971, Snowlodge was opened for its first winter of operation.

The first privately owned snowmobiles began operating in the park during the winter of 1963-1964. The first snowmobile rally was held at West Yellowstone, Montana in 1964-1965. On that one day 60-70 private machines came into Old Faithful from West Yellowstone. Seven or eight machines a day was considered heavy use at that time. Unrestricted, unregulated, uncontrolled snowmobile use within the park was deemed unacceptable by the National Park Service. However, regulated use, which meant restricting the travel of snowmobiles to the roads

utilized by conventional motor vehicles at other times of the year, appeared to be reasonable and acceptable.

Yellowstone Park Company began grooming the trail for snowcoaches as early as 1969. In 1970 or 1971, the National Park Service began trail grooming operations.

At the present time aside from the operation of facilities at Old Faithful Village, warming stations are operated at Madison Junction, West Thumb, and Canyon Village. Three hundred and forty two kilometers of unplowed roads are groomed regularly and heavily used areas are groomed almost daily. Over 30,000 privately owned snowmobiles enter the park each year. On days receiving heavy use as many as 1000 snowmobiles will travel from West Yellowstone to Old Faithful. Snowcoaches transport over 10,000 persons a season throughout the Park. Approximately 80 km. of ski trails are present within the study area.

METHODS

Cover Use, Distribution and Behavior of Wildlife

Wildlife cover use, distribution and behavior data were obtained while snowmobiling and skiing on roads and trails throughout the study area. The area of each habitat type present was determined using a planimeter on a current vegetation map of the area. Each snowmobile trip consisted of a relatively fixed circuit on the major roads in the study area. The mileage and riding time for each day were recorded. A control route of 5.6 km. where snowmobiling by park visitors was not allowed was travelled at random intervals during the winter to compare wildlife reactions to snowmobiles in an unused area to responses in well used areas. Ski tours were made off as well as on the established trails. Time and mileage during each ski trip were also recorded.

Observations and Encounters

According to Chester (1976) a wildlife encounter is defined as a mutual interaction between humans and the animal encountered. An observation would not necessarily involve a mutual interaction. This definition was adopted and the methods employed by Chester (1976) to study human and wildlife interaction were modified to fit this study. At each approach to wildlife, data were gathered about encounter distance, distance of flight, behavioral response to approach, activity

engaged in upon approach, and distance from the road or trail. Number, sex, age, and habitat type data were also recorded. Observations were recorded for all species of wildlife encountered.

Aerial Observation

Six aerial observation flights were made in 1978-79 and 3 in 1979-80 in a Piper Super Cub to supplement ground observations. Distribution of wildlife was recorded using UTM coordinates. Core and peripheral big game wintering areas were identified using these data. Once delineated core and perpheral ranges were planimetered on a map to determine area.

Intensity and Distribution of Human Use

The National Park Service provided entrance records, historical information, back-country use data, and data from electric eyes placed on several major roads and ski-trailheads. The Yellowstone Park Company and TWA Services also provided historical and current use data relating to the concessioner operation. Personal observation provided additional data on winter recreationist distribution.

Impacts of Recreationists on the Winter Environment

Snow and air samples were collected to determine gross hydrocarbon and lead input to the ecosystem by snowmobile exhaust emissions. Personal observations of smog due to engine exhaust, litter, and damage to the soil or vegetation by snowmobiles and skiing were also recorded.

Snow samples were collected weekly in the Old Faithful area during January and February of 1980. Samples were collected with a standard "Federal Snow Sampler." Core samples of the entire column of snow were taken from the groomed trail, adjacent to the trail, at 30 m from the road and from a control area. These samples were placed in one liter plastic bottles, frozen, and transported to Montana State University for analysis of lead and total organic carbon.

Analysis for organic carbon was conducted by research personnel at the MSU Chemistry Department. In the laboratory triplicate 5 ml. aliquots of the sample were transferred to precombusted glass ampoules (Oceanography International) containing 0.25 gm. potassium persulfate. A Hamilton "Gas-Tite" syringe was used for the transfer. Six percent H_3PO_4 (0.25 ml) was added to each ampoule. Each sample was purged for 8 minutes with oxygen which had been passed over a catalyst at 500°C and sealed in Oceanography International ampoule sealing unit. Sealed ampoules were autoclaved at 15 psc for about 15 hours (overnight). Samples were then analyzed using a Total Carbon analyzer (Oceanography International).

Analysis for lead was conducted also at Montana State University. In the laboratory a core sample from the one liter plastic bottles was taken using a glass tube snow sampler. The sample was melted down and

two percent distilled HNO_3 was added to make the sample more homogeneous. These were then placed into a Woodriff furnace type atomizer and analyzed by atomic absorption.

Contamination of the snow samples using the methods discussed above proved to be a considerable problem. A second set of snow samples was collected when the maximum snow accumulation on the ground was reached. Samples of the entire column of snow adjacent to the road and at 30 meters from the road were taken. In order to minimize possible contamination from sample handling, clean glass core samplers were used to extract these samples. The core was cut into two inch increments and each increment placed in a cleaned glass container so only lead free surfaces came into contact with the snow. The samples were analyzed by atomic absorption.

A simple low volume air sampling technique was used in 1978-79 to determine if snowmobile exhaust emissions caused a significant air pollution problem. Staplex TFA #41 filters were used in the sampler which was set to draw air at the rate of 30 cf/min. for a 2 hour sampling period. Filters were weighed before and after sampling on a Mettler balance. The air samples were taken monthly from January to March at one sampling station. The December sample was taken at four stations. The air sampler was powered by a portable generator when electrical outlets were not accessable. When powered by the generator

care was taken to place the generator unit down wind at least 30 meters from the sampler.

In 1979-1980 air was sampled for lead and the low volume sampling technique discontinued because of negative results. Lead analysis of air was accomplished by pulling a known quantity of air through a porous graphite cup housed in a teflon container. The air was pulled through the cup using a 60 cc plastic syringe. The graphite cup was transported to the lab in cleaned closed containers and placed in a Woodriff furnace type atomizer where it was analyzed by atomic absorption. Air samples were taken on random days each week, one sample each hour of the day between 8:00 A.M. and 5:00 P.M. All samples were taken in Old Faithful Village.

RESULTS

Wildlife Populations Distributions and Cover Use

Core and Peripheral Winter Ranges

Core and peripheral winter ranges were delineated primarily (Figure 2) with the data collected during aerial and ground surveys of elk and bison distribution. Information on topography and vegetation types supplemented the distribution data. During the winters of 1978-79 and 1979-80, elk and bison were distributed across an area of approximately 18,688 hectares within an elevational range of 2011 meters to 2377 meters. Peripheral ranges encompassed an area of 13,080 hectares and were used primarily during early winter and early spring when snow depth and conditions allowed occupation of these areas. Core ranges encompassed an area of 5608 hectares and are used heaviest during the severe winter months of January through early March.

Habitat Types Present on Winter Ranges

The relative amount of each habitat type present within the study area is presented in Table 1. Six nonforested and ten forested habitat types have been identified and mapped within the area. For a complete description of each habitat type see Despain (1980). Nonforested types identified by Despain (1980) include: sedge type (*Carex spp.*), hot springs-warm ground type, willow-sedge (*Salix spp./Carex spp.*), tufted hairgrass/sedge (*Deschampsia caespitosa/carex spp.*), big