THE TATTLER

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Denali National Park and Preserve

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Research in Denali: The Foundation of Management Decisions and Our Contributions to Scientific Understanding

Denali National Park and Preserve is recognized internationally as an important area for scientific studies. Over 60 research projects focusing on cultural, physical and biological sciences are ongoing in Denali. Our research program takes a comprehensive approach to managing the resources in Denali on both local and landscape scales. Many of our programs (e.g., Breeding Bird Surveys) contribute to national and international monitoring efforts. Similarly, many projects in Denali address both local concerns (e.g., density estimates of wolves) and worldwide concerns (arctic haze and global warming). Equally important are our long-term projects that provide information on ecosystem processes (e.g., predator-prey relationships and ecology of long-lived species like moose, grizzly bears and golden eagles).

Strong collaboration among scientists from federal, state, and nongovernmental organizations with our Division of Research and Resource Preservation forms the backbone of Denali's research program. Accordingly, our research program provides a solid foundation for wise management decisions in Denali. Managing our biological, cultural and physical resources would be impossible without these studies. Furthermore, our research program will become even more important in the future as visitation to Denali increases and as environmental threats increase worldwide. This issue of the Tattler highlights just a few of the many current research projects in Denali, but they are representative of the importance the park plays in furthering scientific understanding.

Stephen P. Martin, Superintendent
Denali National Park and Preserve

Welcome to the Special Edition of the Tattler

Last autumn, Gordon Olson, Chief of the Division of Research and Resource Preservation in Denali, asked me to put together a special edition of the Tattler to highlight research projects that weren't necessarily part of Denali's Long-Term Inventory and Monitoring Program. It was difficult to choose which of the more than 60 current projects to include in this issue. It also was difficult to decide whether to highlight a few projects or highlight as many projects as space permits. I chose the latter as I felt that this was the best way to introduce our readers to many of Denali's research projects. I learned a great deal as I read and edited the articles for this Tattler. I hope our readers learn a little more about research in Denali and about the importance of research in Alaska's National Park areas as they read this issue of the Tattler. The distribution of the Tattler expands with this edition as well and I welcome our new readers.

I thank all the people who took time to submit contributions to the Tattler. Please contact the project leaders if you would like more details about any of these projects. Please contact the Division of Research and Resource Preservation if you would like information on other research projects or Denali's Long-term Inventory and Monitoring Program

Carol McIntyre-Hander
Wildlife Biologist
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Dynamics of Wolves and Their Ungulate Prey in Denali National Park and Preserve, Alaska. L.G. Adams, U.S.G.S.-Biological Resources Division, Alaska Biological Science Center, 1011 E. Tudor Rd., Anchorage, AK 99503, and L.D. Mech, U.S.G.S.-Biological Resources Division, Midcontinent Ecological Science Center, c/o Northcentral Forest Experiment Station, 1992 Folwell Avenue, St. Paul, MN 55108. Research on the unmanipulated wolf and ungulate prey community of Denali National Park and Preserve (Denali) has continued unabated since 1986. In cooperation with National Park Service personnel, we are currently studying the population dynamics and predator-prey relationships of gray wolves (*Canius lupus*) and caribou (*Rangifer tarandus*), and are beginning new studies of moose (*Alces alces*) in 1998. Our research has provided new information on the population dynamics, predation behavior, social structure, and genetic relationships of wolves; population dynamics, reproductive performance, and calf survival patterns for caribou; and the influence of weather and landscape use patterns on wolf-caribou relationships. During our studies, the late-winter Denali wolf population increased from about 54 wolves in March 1987 to 135 wolves by 1990 with the onset of a six-year period of above average snowfall. Caribou numbers increased from 1986 to 1989, reaching about 3,200 animals. By 1993, the caribou population declined precipitously to around 2,000 animals as a result of high losses of caribou calves to predation. This predation was primarily by wolves and grizzly bears (*Ursus arctos*) following the severe winters and increased mortality of adults during the severe winters. Since 1993, the wolf population in Denali has declined to about 95 animals in late-winter with the decline in caribou and a return to near average snowfall. At the same time, caribou numbers have stabilized at 2,000. Although surveys have been sporadic, the moose population in Denali remained relatively stable through our study period. In 1997, we documented further declines in the wolf population to the lowest fall numbers (approximately 100 wolves which is 25% below the previous fall estimate) since 1987. The decline resulted from lower than average pup production, increases in the occurrence of wolves being killed by other wolves, and probably increased dispersal of young wolves.

Listening to the Past: Oral Histories of Denali Park Area Elders. J. Bryant, Research & Resource Preservation, Denali National Park & Preserve, P.O. Box 9, Denali Park, AK 99755. Oral histories are invaluable in preserving the first-person historical perspective, previously unrecorded historic events and personal life stories. During 1997 there were 4 oral history interviews recorded. In April 1997 a one hour interview with Beatrice Herning was recorded. Beatrice's father, Frank Fox, was a CCC supervisor at McKinley Park in 1938 and 1939, where Beatrice met and later married Harold Herning, a 1938 - 40's park ranger. This couple later held mining claims on Mt. Eielson and built the Herning Cabin, visible today. In June 1997 Mary Tallman Lee visited the area with her daughter. During the drive to the Summit FAA site in Broad Pass, Mary recalled her experiences there as a CAA radio operator during 1941-1944. There is a 45 minute audio recording of this interview. In August 1997 Ted Lachelt shared some of his recollections at the Eagle's Nest, Kantishna. Ted built the Eagle's Nest in 1950, was an early 50's seasonal park ranger, laborer and the first seasonal ranger naturalist in 1954, conducted a snowshoe wolverine study in 1953 and returned in 1959 as the NPS civil engineer overseeing the building of Eielson Visitor Center. This 30 minute audio tape includes memories of Ted's winter visits with Johnny Busia in Kantishna. An interview was conducted with Jim King in Juneau, AK in October 1997. Jim was a seasonal park ranger in 1950 and worked for Chief Ranger, John Rumohr. Jim's recollections of seasonal park ranger duties and activities are recorded on 90 minutes of audio tape. During December 1997, Paul Atkinson transcribed these audio tapes. Informant review of the transcripts is now in progress. Tapes and some transcripts of these interviews and other oral history recordings are available from the Denali National

Park Museum or from Jane Bryant at Park Headquarters.

Evaluating New Techniques to Estimate Wolf Density in Denali National Park, Alaska. John Burch, National Park Service, 201 1st. Ave., Fairbanks, AK 99701. Visitors to National Park areas frequently ask "how many animals exist in a population?" The size of wolf (*Canis lupus*) populations are often estimated using data collected by radio telemetry studies and are expressed as a density (i.e., wolves/km^2). This density extrapolated over the area in question results in an estimate of annual wolf numbers. At first, calculating this estimate of density seems rather simple, but there is an underlying problem. Counting the number of wolves is pretty straight forward. However, estimating the area the wolves use is difficult. For instance, the more radio-locations you collect per year the larger the estimate of the area used by the wolves. Some studies use up to 150 locations to fully described a wolf territory. However, most studies can only afford to gather 30 to 40 independent locations per year. This results in inflated density estimates. One solution to this problem is to treat an aggregate of 12 to 15 wolf packs as a single wolf home range. This technique utilizes the territorial nature of wolves to automatically 'spread out' the locations over a large area. Therefore, fewer locations per pack are needed to describe a large percentage of the total population area. This technique helps, but does not alleviate the problem completely. A second technique involves the use of nonlinear regression to fit an equation to the plot of area versus number of locations. In this equation, area continues to rise up to some asymptote. The asymptote, estimated in the regression equation, is the total area used by the wolves. The details of this technique are still being analyzed and tested. If this technique is validated we will be able to calculate much more consistent wolf density estimates between years and between geographic locations with estimates of precision and confidence limits.

Ancient Volcanism in Denali National Park, Alaska. R.B. Cole, Department of Geology, Allegheny College, Meadville, PA 16335. Early Eocene rocks (about 58-55 million years old) of the Cantwell Formation preserve a rich volcanic and tectonic history in Denali National Park. The Cantwell volcanic rocks are about 3000 meters thick and include roughly 70% lavas (mostly basalt and rhyolite) and 30% volcaniclastic deposits. Results of this study reveal that stratovolcanoes erupted in the vicinity of the McKinley fault zone (along the southern boundary of Denali) and shed lavas and ash northward into the pre-existing Cantwell basin. These volcanic rocks are exposed at Double Mt., Igloo Mt., and Cathedral Mt., and form the bright colors along Polychrome Pass and Polychrome glacier areas. Cantwell volcanism began with basaltic lava flows and small-volume pyroclastic eruptions that poured ash northward across the Cantwell basin. Thin coal seams and abundant plant and tree fossils are present within the lower part of the Cantwell volcanic rocks. These seams and fossils indicate that the Cantwell basin was a wet and swampy environment at the onset of volcanic activity. Volcanic conglomerate and breccia at the base of the Cantwell volcanics at Double Mt. and Igloo Mt. are deposits of high-energy streams and catastrophic debris avalanches. These streams and avalanches cascaded into the basin along the steep leading edge of the new volcanoes. As the volcanic sources grew, their lavas and deposits of hot gas and ash (large volume pyroclastic flows) inundated the rivers, lakes, and swamps of the Cantwell basin. When volcanism waned the Cantwell volcanic rocks experienced deformation that is consistent with right lateral slip along the

McKinley fault (e.g., northeast trending folds and reverse faults and northwest trending normal faults). In addition, other results of this study show that the Cantwell volcanic rocks are the same age and similar in chemical composition as the granitic rocks that form Mt. McKinley. These results allow the hypothesis that McKinley plutons are the uplifted remnant of Cantwell eruptive centers and Mt. McKinley and Cantwell volcanic rocks have been offset by about 40 kilometers along the McKinley fault.

Long-term Studies on the Ecology of Brown Bears in Denali National Park, Alaska. F. C. Dean, Principal Research Associate, Institute of Arctic Biology, University of Alaska-Fairbanks, 211 Irving I, Fairbanks, AK 99775. I began studies on brown bears (*Ursus arctos*) in Denali in 1957. At that time, NPS policy precluded marking bears, so I took advantage of the road access and relatively high visibility afforded by open country to make long-term observations of bears in Denali. These factors, repeated observations, and occasional natural marks and scars helped me to recognize individual bears and groups of bears, especially within a season. Since 1957, we have used intensive, direct observation to collect data on fine-grain habitat use, behavior, and a long sequence of information on the number and age composition of bear families. My studies have concentrated mostly between the Teklanika River and Eielson Visitor Center. I saw a minimum of six bear families during two periods of field work in 1997. My sightings included a pair of distinctively marked, but unreported, spring cubs; four sets of yearlings; and one set of triplet two-year-olds (third summer). I also received a report of a second set of spring cubs, but did not see them. I will add these data to the nearly continuous 40-year run of similar information which is becoming long enough to show patterns. The production of spring cubs seems to drop following poor berry years. Females that do not become pregnant or that loose litters often mate the following spring. These events shift them out of their normal pattern, tending toward synchronous clumping. I was able to add to the extensive habitat use and behavioral data series in 1997. I also photographed a set of stations that I have documented over the 40-year period; these photographs will prove useful for documenting long-term vegetation changes in Denali.

The Relationship Between Berry Production and Brown Bears in Denali National Park, Alaska. R.V. Densmore, U.S.G.S.-Biological Resources Division, Alaska Biological Science Center, 1011 E. Tudor Rd., Anchorage, AK 99503 and J. A. Keay, U.S.G.S.- Biological Resources Division, Alaska Biological Science Center, Denali Field Station, P. O. Box 9, Denali Park, AK 99755. On the north flank of the Alaska Range, the fall nutritional status of female grizzly bears (*Ursus arctos*), which affects cub production and survival, is largely dependent on the availability and quality of berries. The primary berry food sources for grizzlies in Denali are blueberry (*Vaccinium uliginosum*), crowberry (*Empetrum nigrum*), and soapberry (*Shepardia canadensis*). We are evaluating the relationship between berry availability and bear population dynamics as part of a grizzly bear ecosystem research project in Denali in cooperation with National Park Service staff. The study area includes 1,750 km^2 in the western portion of Denali on the north side of the Alaska Range. We are studying distribution of berry plants, yearly variation in berry crops, berry protein content, and the role of nitrogen fixation. We used aerial surveys, ground checks, and information on movements and foraging from radio-tagged bears to assess distribution patterns and to select areas for monitoring berry crops. The study area contains extensive stands of soapberry plants on recent (< 2000 years) glacial moraines and smaller stands on glacial outwash where soapberries are the primary nitrogen-fixers. Blueberry and crowberry plants are abundant throughout the study area, but have small productive patches within a matrix of unproductive bushes. From 1994 through 1997, the soapberry crops were good, the blueberry crop was very poor only in 1996, and the crowberry crop was poor only in 1994.

Soapberries may be very important to nutritional status of bears in autumn in Denali. In 1994, soapberries and blueberries were available, but grizzly bears fed primarily on soapberries from late July until snowfall. Soapberries offer efficient foraging and the pulp from the berries has twice as much protein as pulp from blueberries.

Sedimentology, Age, and Correlation of Silurian and Devonian Metasedimentary Rocks in Denali National Park, Alaska. J.A. Dumoulin and D.C. Bradley, U.S. Geological Survey, Anchorage, AK 99508, and A.G. Harris, U.S. Geological Survey, Reston, VA 20192. Rocks of Silurian and Devonian age (roughly 435-350 million years old) in Denali have been studied by geologists at a reconnaissance level over a span of decades. Different workers have judged these rocks to be the equivalents of rocks found in several tectonic terranes, or distinctive pieces of crust, recognized elsewhere in central Alaska. Various of these terranes have been interpreted as fragments of ancestral Siberia or North America. To test and refine ideas of the nature and origin of the Silurian and Devonian rocks of Denali, we studied their composition, structure, environment of origin, and age, and compared them with similar rocks around Alaska. The rocks in question are mainly limestones and sandstones that have been metamorphosed--that is, altered by exposure to pressure and heat. They originated as sediments deposited in a relatively deep ocean setting. Many of the rocks are turbidites, a special type of sediment deposited by gravity-driven currents. Conodonts (microfossils contained in the sediments) allowed us to date many rock samples with an accuracy not available to previous workers. We found that the Silurian and Devonian rocks of Denali are most similar to rocks of matching age in the Farewell terrane, exposed southwest of Denali in the McGrath quadrangle and adjacent areas. We also found intriguing affinities, however, with rocks of similar age exposed elsewhere in east-central and western Alaska. Our analyses suggest that all deep-water rocks of Silurian age in Alaska formed along or adjacent to the margin of the North American continent, rather than off Siberia. In addition, we found a gradient in the distribution and character of Silurian turbidites. Volcanic material in these turbidites may have come from an arc of volcanic islands in the Alexander terrane, in what is now southeastern Alaska.

Contributing to a Continental Database: Audubon Christmas Bird Count in Denali Park, Alaska. Nan Eagleson, Denali National Park Wilderness Center, P.O. Box 67, Denali Park, AK 99755. The Audubon Christmas Bird Count (CBC) is the oldest and largest survey of birds in North America. The CBC is designed as a series of circular count areas (15 miles in diameter), and birders count birds within these count circles on a selected day within two weeks of 25 December annually. Nationally, over 40,000 birders participate in the CBC annually. The CBC is a valuable supplement to the North American Breeding Bird Survey, in that many wintering species are counted in the CBC but not in the Breeding Bird Survey. Annual variations within the count period are noted over time; these data contribute significantly to the conservation of birds. We celebrated the 98th CBC in the Denali area on 27 December 1997. This was the fifth year that area residents (and a few faithful visitors) made the considerable effort to participate in the Denali CBC. Twenty-four participants took to the hills and valleys to note bird sightings and to enjoy a lovely day of skiing, snowshoeing, dogmushing or simply the beautiful sky of the day. This year's CBC in Denali was exceptional for its number of participants and particularly for the number of bird species observed. Before this year, the highest number of species recorded on the Denali CBC was 11. This year we enjoyed the sightings of 18 species and 629 individual birds. A number of factors, including an increase in the number of participants and very moderate weather on the count day, contributed to the record year. The

mild weather of autumn and early winter and well-tended bird feeders encouraged two Red-breasted Nuthatches to remain in the area. A good seed crop probably contributed to the large numbers of White-winged Crossbills, Pine Grosbeaks, and Common Redpolls in the area. High numbers of raptors including one Northern Hawk Owl, two Great Horned Owls, three Northern Goshawks, one Golden Eagle and one Bald Eagle, probably resulted from high numbers of snowshoe hare and other prey. Many count participants noted abundant numbers of snowshoe hare and Willow Ptarmigan tracks in the count area. We also noted Ruffed Grouse, Spruce Grouse, and Willow Ptarmigan this year. We also noted healthy numbers of Gray Jays, Common Ravens and Black-billed Magpies and two Three-toed Woodpeckers. Let's hope that next year's CBC is as benevolent for the birds and birder's as was 1997's.

Increasing our Knowledge About Butterflies and Moths in Denali National Park, Alaska. C.D. Ferris, Bioengineering Program, University of Wyoming, Laramie, WY 82071. In conjunction with Dr. K. W. Philip (Alaska Lepidoptera Survey), I made two trips to Denali (20-25 June; 16-17 July, 1997) to survey species of butterflies and moths. My study sites were along the Denali Park road between the Toklat River and the Kantishna Airstrip. I sampled 25 species of butterflies and three species of cut-worm moths. Several species of common geometrid moths were noted but not sampled. My interest centered primarily upon the arctic-alpine species: *Parnassius phoebus* (Phoebus' Parnassian), *Colias* species (the Sulphurs); *Erebia* species (the Alpines); and *Oeneis* species (the Arctics). I study habitat associations, geographic distributions, butterfly species that occur together, larval host plants, pattern variations within a given species, and problems of classification (taxonomy). The long spells of cold and wet weather in Denali during the summer of 1997 apparently triggered an unusually large number of aberrantly marked adults of several species. Such aberrations in both color and pattern were found in *Colias canadensis* (Canadian Sulphur), *Erebia theano* (Theano Alpine), and *Erebia youngi* (Young's Alpine). I found *E. youngi* and *E. lafontainei* (LaFontaine's Alpine) flying together at several localities; this is an unusual occurrence. These species typically do not associate in other areas of Alaska and the Yukon. Positive identification of these two species requires dissection to reveal key abdominal structures. This was a one-year research study in which I achieved my research goals. The Alaska Lepidoptera Survey is an on-going project.

A Decade of Studies on Golden Eagle Ecology in Denali National Park, Alaska. C.L. McIntyre-Hander, National Park Service, 201 1st Ave., Fairbanks, AK 99701 and Dept. of Fisheries and Wildlife, Oregon State University, Corvallis, OR, 97331 and M.W. Collopy, U.S.G.S.-Biological Resources Division, Forest and Rangeland Ecosystem Science Center, 3200 SW Jefferson Way, Corvallis, OR 97331. The reproductive characteristics of Golden Eagles (*Aquila chrysaetos*) at northern latitudes in North America are not well-known. For the tenth consecutive year, we collected data to characterize the reproductive ecology of Golden Eagles in Denali. We monitored 72 Golden Eagle nesting areas to determine occupancy rates, the number of pairs that laid eggs and the number of those pairs that raised fledglings. Occupancy rate in 1997 was 88% and showed no significant change from other years. Laying rate was 71% and nesting success, measured as the number of laying pairs raising at least one fledgling, was 73%. Thirty-six successful pairs raised a total of 57 fledglings. Overall population productivity, measured as the number of fledglings raised per territorial pair, was 0.90. This was the second highest year for Golden Eagle productivity in Denali during our study. Productivity of Golden Eagles in Denali is influenced most strongly by the proportion of territorial pairs that lay eggs. Laying rate of Golden Eagles in Denali is influenced by population levels of their cyclic prey, Snowshoe Hare (*Lepus americanus*) and Willow Ptarmigan (*Lagopus lagopus*). Our work has increased our knowledge of the reproductive

ecology of this species at high latitudes in North America. Currently, this is the only long-term program for monitoring Golden Eagle population dynamics in northern North America. In addition to this work we are examining movement patterns and survivorship of immature Golden Eagles using satellite telemetry and examining the relationship between Golden Eagle reproductive success and habitat quality. The later work is funded through the Natural Resources Preservation Program (NRPP). Our research is conducted in cooperation with the U.S.G.S.-Biological Resources Division, Forest and Rangeland Ecosystem Science Center and Alaska Biological Science Center, Oregon State University and Denali National Park and Preserve.

Grizzly Bear Population Ecology and Monitoring in Denali National Park, Alaska.
J. A. Keay, U.S.G.S.-Biological Resources Division, Alaska Biological Science Center, Denali Field Station, P.O. Box 9, Denali Park, AK 99755. Many visitors come to Denali with high hopes of seeing grizzly bears. Potential impacts to bears from efforts to improve visitor access in Denali is a primary concern of park managers. The U.S. Geological Survey and the National Park Service began a project in 1993 to develop noninvasive methods to monitor grizzly bears and identify how nutrition and predation influence bear population dynamics. From 1993 through 1996 we documented bear population characteristics in Denali on the north slope of the Alaska Range, west of Eielson Visitor Center. Females comprised 62% of adults and 36% of subadults in our study area. The female age distribution was bimodal, with 11 bears 16 to 26 years of age and 10 bears three to nine years of age. The male segment of the study population was more continuous. Survival rate of independent females was 98% and for males was 96%. Annual survival rates averaged 36% for cubs, 51% for yearlings, and 82% for two-year-olds. Density was estimated at 37 bears/1000 km^2. We are currently preparing these data for publication. We will use these baseline data to test the accuracy of survey techniques that do not require marking animals. During the same time period, we conducted pilot studies to develop techniques to measure the bias associated with detecting bears from airplanes under different light, snow, and vegetation conditions. By 1996, however, we concluded that we could not obtain meaningful measures. We are currently using methods to minimize visibility bias by shifting survey periods to autumn when bears are more detectable (when they are actively foraging for berries and are using open habitats). In 1997, at the request of Denali Park staff, we delayed development of survey techniques and shifted our focus to identifying the role of nutrition and predation in bear population dynamics in Denali.

Classification of Rivers in Denali National Park, Alaska, for Long Term Monitoring.
Alexander Milner and Sarah Roberts, Institute of Arctic Biology, University of Alaska, Fairbanks, AK 99775. As part of the long term ecosystem monitoring program in Denali, we are developing a method of classifying watersheds and predicting the typical riverine community given no impairment. We used "two-way indicator species analysis" (TWINSPAN) classification of 58 river sites, sampled three times during 1995 for macroinvertebrates, to identify eight groups of distinct rivers. Studies in 1996, of longitudinal variations within 11 rivers from six of these groups, showed that between river variation was greater than within river variation. Discriminate analysis using the physicochemical variables indicated that gradient, nitrate, and channel stability were the most significant variables in the river classification and associated macroinvertebrate community structure. This classification allows an effective choice of sites which may be suitable for long term monitoring and also permits development of ranges of suitable biological metrics for reference sites in each group. This approach can be used to predict the macroinvertebrate community at a site based upon key physicochemical variables. The observed community, or relevant biotic metrics, can then be compared to the predicted and the degree of difference used to indicate if impairment is present. This approach may be

useful in large national parks by first stratifying the types of rivers present and then incorporating a predictive element into the protocol.

Providing Long-Term Data on Landbirds: The North American Breeding Bird Survey in Denali National Park and Preserve, Alaska.
P.A. Owen, Division of Research and Resource Preservation, Denali National Park and Preserve, Denali Park, AK 99755. The North American Breeding Bird Survey (BBS) is the most widespread program for monitoring breeding bird populations on the continent. The BBS program was initiated in 1966 and currently includes nearly 3,700 roadside routes, of which 2,900 are surveyed annually by experienced birders across North America. The main purpose of the BBS is to estimate change of songbird populations on a continental scale. We send the data collected in Denali to the U.S.G.S.- Biological Resources Division, who store and analyze the data. Data from BBS routes have been instrumental in identifying population declines of many species of North American landbirds. BBS routes usually run along roadsides; hence, fewer BBS routes are run in Alaska and other northern areas than in the lower 48. With strong encouragement from Boreal Partner's In Flight, the number of BBS routes run in Alaska has increased dramatically. In Denali, we run two BBS routes along the Denali Park road. The Savage BBS route runs from the Savage River bridge to Sable Pass. The Toklat BBS route runs from the Toklat ranger station to mile 79 on the Denali Park road. Each route is 24.5 miles long and contains 50 stops (each 0.5 miles apart). Each route is run on one day annually between 13 and 22 June. We start our routes just before sunrise (about 3:30 a.m.) and record all birds seen or heard at each of 50 stops. Typically, we record between 20 and 30 species on the Denali BBS routes. The most commonly recorded species in Denali are Wilson's Warbler, Orange-crowned Warbler, White-crowned Sparrow and Savannah Sparrow. Of particular interest are high numbers of Arctic Warblers in the Igloo Canyon area. In 1997, we recorded 290 individuals of 23 different species along the Savage BBS route and 294 individuals of 28 different species on the Toklat BBS route. Noteworthy observations in 1997 included two Barrow's Goldeneyes in a tree near Teklanika flats, two Hawk Owls near Sanctuary River, and an Upland Sandpiper near Sable Pass.

Effect of Vehicle Traffic on Dall Sheep Migration in Denali National Park, Alaska.
J.A. Putera and J.A. Keay, U.S.G.S.- Biological Resources Division, Alaska Biological Science Center, Denali Field Station, P.O. Box 9, Denali Park, AK 99755. We studied the effect of vehicle traffic on the seasonal migration of Dall sheep (*Ovis dalli*) in Denali from 1995 to 1997. Dall sheep leave escape terrain and travel up to 10 km through valleys to reach seasonal ranges. Sections of the park road intersect sheep migration corridors and unsuccessful attempts by sheep to cross the road have been reported. We studied the extent and timing of Dall sheep migration, and whether unsuccessful attempts to cross the Denali Park road occur often enough to alter migration patterns. We used weekly aerial surveys, daily observations, infrared triggered cameras and time-lapse cameras to document sheep migration. We also recorded sheep-vehicle interactions along the Denali Park road. Spring migration from Mt. Wright and Primrose Ridge occurred as early as May 10 and as late as July 7. Group size ranged from one to 62 individuals. Composition of migrating groups included ewes with or without lambs or adult rams and ram groups. Ewe groups without lambs migrated in May and early June. Ewe groups with lambs initiated migration attempts in mid-June. Sixty-seven percent of migration attempts resulted in sheep approaching the road between 10 a.m. and 8 p.m. As many as 159 sheep, of which 75% were ewe-likes and lambs, attempted to migrate from these two ranges in 1997. Unsuccessful attempts by sheep to cross the road were observed each spring, but in most cases sheep were successful during later attempts. Aerial surveys indicate that all ewe-like sheep and lambs attempt to migrate from Mt. Wright and Primrose Ridge. Fall migration occurred as early as August 23 and as late as mid-October. Group size ranged from one to 28 individuals. Ewe and

ram groups migrated separately. Seventy-four percent of groups approached the road between 1 p.m. and 9 p.m. No unsuccessful attempts to cross the road were observed, although ram groups were delayed by the road for up to 7.5 hours due to traffic.

Estimating Abundance of Small Mammals in Denali National Park, Alaska. Eric Rexstad, Institute of Arctic Biology, University of Alaska Fairbanks, Fairbanks, AK 99775. In the sixth year of studying small mammals in Denali, my crew and I caught nearly 2,000 shrews and voles in four watersheds near Park headquarters during the summer of 1997. We captured animals with live traps that allowed us to release animals unharmed after we placed an electronic marker under their skin to recognize them if we subsequently recaptured them. From 1992 to 1996, we worked exclusively in the Rock Creek watershed directly north of Park headquarters. In 1997, we expanded our effort to determine if patterns in small mammal abundance we had recorded in Rock Creek were indicative of patterns at a larger spatial scale. Our results were of the proverbial "good news/bad news" variety. The good news was that abundances of the northern red-backed vole (*Clethrionomys rutilus*), tundra vole (*Microtus oeconomus*) and singing vole (*Microtus miurus*) were similar among all watersheds. This indicated that, at least in 1997, the Rock Creek watershed was representative of the small mammal dynamics occurring at a larger landscape level. The bad news was the abundance of northern red-backed voles in 1997 was the lowest during our six-year study. In 1997, our estimated abundance of northern red-backs was roughly 10 per hectare on one of our Rock Creek study plots, where they were as abundant as 80 per hectare in 1993, 1995, and 1996. In contrast, the Microtus species remained at roughly 20-40 per hectare, effectively unchanged from previous years. The explanation for this difference in the interannual variability between *Clethrionomys* and *Microtus* is unclear. However, the shortage of berries in 1996, an important food for *Clethrionomys* but not for *Microtus*, may have led to poor overwinter survival of Clethrionomys prior to the 1997 field season.

Answering Questions about Population Status of Neotropical Migratory Birds: Monitoring Landbirds in Denali National Park, Alaska. S.K. Springer, Field Biologist, Alaska Bird Observatory, P.O. Box 80505, Fairbanks, AK 99708. Many species of birds breeding in Alaska migrate from the contiguous United States, Canada, Central and South America, Asia, Australia and the South Pacific Islands. Recent documentation of declines in neotropical bird populations has made monitoring their populations an international concern. In 1992 the National Park Service contracted the Alaska Bird Observatory to systematically inventory and monitor breeding landbirds in Denali National Park. The long-term goal of our project is to quantify annual variation in the relative abundance of landbirds found in the park. The specific aim of the monitoring program is to have a 90% probability of detecting a cumulative 50% decline in a species over a 25-year period. From 1992 to 1997, our field work had two primary objectives. The first was to quantify inter-annual variation in the abundance of landbirds along the Denali road corridor using on-road point counts. The second was to quantify intra-annual variation in the detection probabilities of breeding landbirds in spruce forests utilizing off-road point counts. Point counts are specific sites where an observer counts every bird heard or seen for a specific amount of time. The on-road point counts consist of four census routes with 50 point counts each. We survey on-road point counts at least twice a season. The nine off-road transects contain 12 point count stations each and are surveyed once a season. Biologists throughout Alaska are using these same standardized techniques to monitor landbirds. Standardized techniques are vital for long-term comparative studies. Preliminary results of our data suggest that most species of landbirds in Denali are showing relatively stable population trends. Little information exists on the ecology and life histories of many species of landbirds in Alaska,

thus revealing another important component of our research in Denali.

Identifying Spawning Areas of Anadromous Fish in Denali National Park, Alaska. K.E. Stahlnecker, Division of Research and Resource Preservation, Denali National Park and Preserve, P.O. Box 9, Denali Park, AK 99755. Many of the rivers and streams in Denali are glacially fed and have low biotic productivity. The diversity and abundance of fish species in Denali is relatively low compared to other regions of Alaska. Investigators conducting biological studies in Denali recently raised questions about the significance of this fishery. These researchers felt the importance of anadromous fish as a food source for predators and scavengers is underestimated in Denali. Unfortunately, no comprehensive inventory of this fishery exists. Likewise, no evaluation of its importance is available. In Autumn 1995, we set out to address these shortcomings by initiating aerial surveys to identify spawning areas of anadromous fish in and adjacent to Denali. The objectives of these surveys were to identify relative abundance, species composition, and distribution of anadromous fish in Denali. Teams consisting of an experienced pilot and observer conducted surveys using Piper Supercub aircraft. Pilots flew over water bodies at an altitude conducive to observing fish given lighting, streamside vegetation, and wind conditions. Observers identified fish species, counted fish, recorded latitude and longitude for fish locations, and mapped these locations on maps. Since 1995, we conducted 22 aerial surveys over waters in and adjacent to Denali. Waters that appeared to be of particular significance for anadromous fish include Toklat River, McKinley River, Chulitna River, Moose Creek, Hult Creek, and Lake Creek. Predominate species observed in these waters included Chum Salmon (*Oncoryhnchus keta*), Coho Salmon (*O. kisutch*), Chinook Salmon (*O. tshawytscha*), and Sockeye Salmon (*O. nerka*). While considerable work remains, our early results are encouraging. We intend to continue systematic surveys and to develop linkages with ongoing studies to better understand the role the Denali fishery plays in the local environment.

Growth of the Alaska Range as Recorded by the Nenana Gravel Formation. E. Thoms and J. Beget, Dept. of Geology and Geophysics, University of Alaska, Fairbanks, AK 99775. About 8.5 million years ago, rocks began to be uplifted in the Alaska Range and deposition of the Nenana Gravel Formation began. Gravel and coarse sand were shed north into a basin that extended from Mt. McKinley in the west and nearly to Tok, Alaska, in the east. The stratigraphy within the Nenana Gravel is a record of the order in which different rock types were, through faulting and folding, brought to the surface within the Alaska Range. Field work in 1997 in Denali National Park and near Healy, Alaska, involved revisiting Nenana Gravel sites first described over 40 years ago by U.S. Geological Survey geologist Clyde Wahrhaftig. Wahrhaftig was concerned primarily with describing changes in rock types. We hoped to add detailed descriptions of the textural changes (which could be attributable to different rates of uplift) to Wahrhaftig's original work. In the thickest exposures, we found four sets of three to four slack water deposits of silt and mud separated by only 10's of meters of gravel. We believe that the slack water sets indicate times when mountain building was occurring relatively slowly. We also found evidence for an early glaciation, perhaps as old as 2.5 million years, in the form of beds of large, strongly faceted and striated boulders which are characteristic of glacial till. The fact that, in some places, over 1300 meters of Nenana Gravel are now exposed is evidence that the Alaska Range continues to rise and that the limit of affected rocks is moving northward.

Eighteen Years of Studies on the Ecology of Moose in Denali National Park, Alaska. V. Van Ballenberghe, U.S. Forest Service, Pacific Northwest Research Station, 3301 C Street, Suite 200, Anchorage, AK 99503. Our 18-year study has included an element on population dynamics of the naturally regulated moose (*Alces alces*) population at the east end of Denali. Observations going back to 1922 indicate that

moose were scarce in the Savage River drainage initially but increased from 1925 to 1970 in a classic ungulate eruption sequence, reaching densities exceeding one moose per square kilometer. This increase occurred in the presence of both wolves and brown bears that were known to prey upon moose. These predators, however, did not limit moose numbers. After 1970, moose numbers declined, reaching a density of 0.4 moose per square kilometer by 1993. This decline was accompanied by poor calf survival caused by bear predation and severe winter weather in the early 1990s. During 1990-1994, 53% of calves born to radio-tagged moose cows were killed by bears and 6% were killed by wolves. Predators killed 95% of calves with known causes of death. Only 11% of calves born survived to autumn. Clearly, predation was a major limiting factor for this moose population. Interpretation of the general pattern of growth of this moose population followed by decline suggests that the 70-year fluctuation can be traced to market hunting prior to 1925 that reduced moose to very low densities. After five decades of population increase, as moose reached high densities and provided a large potential biomass of prey, bears evidently changed their behavior, and predation became a major limiting factor. Moose densities are currently lower than ecological carrying capacity, and are apparently fluctuating around a low-density equilibrium, limited primarily by predation but occasionally by food shortages in deep snow winters. If this interpretation is correct, it indicates that during 1925-1995, moose at Denali displayed the same pattern of fluctuations as moose populations outside the park, where human hunting of moose and predators results in extreme variation of population size. It also suggests that it has taken decades for natural regulation to reoccur, and underscores the need for long-term protection of places like Denali to truly understand ecological relationships in sub-arctic ecosystems.

Viewshed Monitoring for Wildlife in Denali National Park, Alaska. A.C. Yost, Department of Wildlife, University of Idaho and R. G. Wright, Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, ID 83844. This study was initiated by the National Park Service and is administered by the U.S.Geological Survey, Biological Resources Division. Our goal is to explore alternative methods to effectively monitor wildlife along the Denali National Park road corridor. Results of our studies will also be used to help identify any impacts road traffic may be having on wildlife. We established 20 viewsheds, observable from close elevated locations, within the road corridor between park headquarters and Wonder Lake in 1996. Using spotting scopes and binoculars we systematically observed each viewshed 11 times for a two-hour period between May and August in 1996 and 1997.

In 1997, we established nine backcountry viewsheds; two north of Primrose Ridge, four south of Sable Pass and three on Stony Creek. Backcountry viewsheds are visually separated from the road corridor. Using spotting scopes and binoculars we systematically observed each of these viewsheds seven times between May and August. We recorded data for each group sighting of either caribou (*Rangifer tarandus*), grizzly bear (*Ursus arctos*) or moose (*Alces alces*). We transferred field data to a Geographical Information System database to facilitate spatial analyses such as the distribution of each species in the study area in relationship to road traffic densities, visibility from the road corridor and habitat characteristics. As an index to population size within the study area, we will calculate density estimates for each species using measures of distances that animals were first sighted from each observation point.

Send Comments to:

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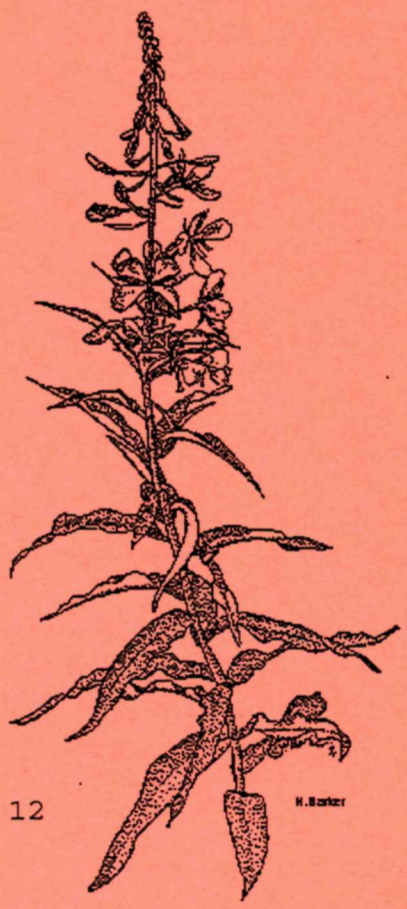

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