Alaska Department of Fish and Game
Division of Wildlife Conservation
September 2008

Population ecology and spatial dynamics of wolves relative to prey availability and human activity in the Nelchina Basin, Alaska

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Research Final Performance Report
1 July 2006–30 June 2008
Federal Aid in Wildlife Restoration
W-33-6
Study 14.24

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ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
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PROJECT TITLE: Population ecology and spatial dynamics of wolves relative to prey availability and human activity in the Nelchina Basin, Alaska

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FEDERAL AID GRANT PROGRAM: Wildlife Restoration

GRANT AND SEGMENT NO. W-33-6

PROJECT NO. 14.24

WORK LOCATION: Southcentral Unit 13A and northcentral Unit 13D (61.7° N to 62.5° N, -147.7° W to –145.9° W). The area encompasses roughly 4,400 km^2 and is bisected by the Glenn Highway.

STATE: Alaska

PERIOD:

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

This project was revised and cut short in May 2006 because wolf control in Unit 13 compromised the study. Radiocollared wolves necessary for the project were killed during predator control efforts and the field portion of the project could not continue. Year 3 (FY 2008) was devoted to data analysis and report writing.

During the 1970s and early 1980s, moose and caribou populations in Unit 13 were just beginning to rebound from a widespread and significant decline, and wolf and brown bear populations had been reduced during a predator control effort (Ballard et al. 1987, Ballard et al. 1990, Ballard et al. 1991). In the mid 1990s, estimates indicated populations of all 4 of these species are relatively high (Ballard et al. 1987, Ballard et al. 1990, Ballard et al. 1991, Testa et al. 2000a, b, Golden 2004, Testa 2004a, b). Wolf densities were 2.5–3 times higher than they were during the early 1980s. Historically, these species have received significant harvest from humans who have made Unit 13 one of Alaska's most popular hunting areas. Concerns by subsistence and sport hunting interests about declining moose populations in Unit 13 and other game management units in the state during the last 10 years as well as concerns that predation was the most important factor in these declines, prompted Alaska's legislature to enact a law requiring intensive management of prey and predators. The intensive management strategy specifies that certain ungulate prey populations must be managed actively, including through control of predation, to allow for high levels of harvest by humans.

To enable this mandate, a wolf predation control plan was implemented beginning in January 2004, having been approved several years earlier by the Board of Game. Implementation of this plan designated Units 13A, B, and E for land-based trapping and aerially-based land-and-shoot hunting of wolves as population control measures. Those control activities were successful in greatly reducing the wolf population in much of the control area, including all wolves radiocollared as part of Project Number 14.21 (the preceding study to the current project reported here). This wolf control plan, the intensive management strategy, and the large and growing pressure by hunters to harvest big game resources in the area continue to necessitate an in-depth understanding of prey and predator population dynamics to meet management objectives.

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS ON THE PROBLEM OR NEED

Project Number 14.21 was terminated on 30 June 2005, which was its scheduled date for completion. Due to the initiation of active wolf control through land-and-shoot permits and intensive ground-based trapping, most of the objectives of that project could not be met. However, the need to address several objectives of that study still existed, especially with the implementation of intensive management actions. Therefore, we continued to address those objectives with a new study but in an adjacent area. We also examined the potential effects of human activity in winter, through the establishment and use of snowmobile trails, on the spatial dynamics of wolves relative to those trails and to moose, their major prey.

Snowmobiles and the alterations made to the landscape from their activity can have profound impacts on wolf-prey dynamics. Wolves are regarded as habitat generalists that use areas of highest prey density (availability) and diversity (Mech 1970, Mladenoff et al. 1995, Ciucci et al. 2003) and must travel efficiently over large areas to increase the likelihood of encountering and killing prey (Lima 2002, Ciucci et al. 2003). The presence and noise from snowmobiles could displace and disrupt daily activity and movement patterns (Soom et al. 1972, Bollinger and Rongstad 1973, Dorrance et al. 1975, Freddy et al. 1986, Colescott and Gillingham 1998); while the creation of trails could allow energy-efficient travel (James and Stuart-Smith 2000) and increase the likelihood of encountering and successfully capturing prey (Bergerud et al. 1984, Ciucci et al. 2003, Crête and Larivière 2003). High hunting and trapping pressure could exacerbate these effects, particularly during critical periods such as late winter when animals are most stressed and anthropogenic activity is greatest. The Nelchina River basin of southcentral Alaska and the intensive management program presented a unique opportunity to examine the above interactions and their effects. To address the ecological consequences of snowmobile activity on predator-prey interactions, a quantitative assessment of the spatial and temporal relationships of wolves, human activity, and prey resources, snow characteristics, and predation events needed to be made.

III. APPROACHES USED AND FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

The overall objective of this project was to investigate the population and spatial ecology of wolves in the Nelchina River basin of Unit 13 (Figure 1) to improve our ability to model their interactions with prey and human activity to develop appropriate management strategies. This ability is critical to the responsive management required under the intensive management strategy. This study was facilitated by data from previous work on wolves, moose, and caribou in Unit 13 (Ballard et al. 1987, Ballard et al. 1990, Ballard et al. 1991, Testa et al. 2000a, b, Golden 2004, Testa 2004a, b).

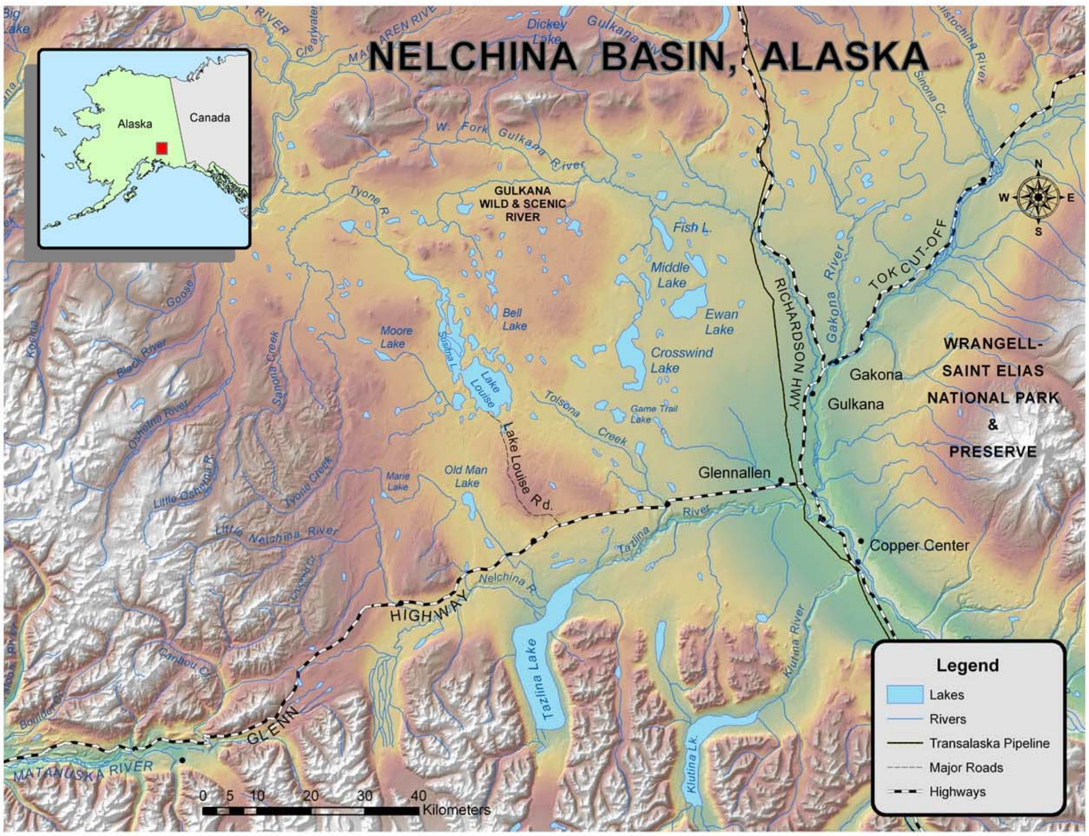

Figure 1. Location of wolf study area in the Nelchina River basin.

This project was directed by Howard Golden as the PI, however Objectives 2 and 3 were conducted primarily by Todd Rinaldi (WBI) as part of his requirements for his Master of Science degree through the University of Northern British Columbia. Todd focused mainly on the effects that human activity, through the establishment and use of snowmobile trails, may have on wolf spatial dynamics and use of prey. All animal capture activities followed the protocols established in the ADF&G Division of Wildlife Conservation “Animal Welfare Policy” and its wildlife capture and restraint manual.

OBJECTIVE 1: Determine the year-round prey selection patterns of wolf packs relative to varying abundance and distribution of prey, primarily moose and caribou.

Using standard helicopter capture techniques for wolves, we deployed GPS and VHF radiocollars on 13 individual wolves from 7 packs using GPS telemetry. Two to three animals in each pack were fitted with GPS collars. We took standard weight and body measurements on each wolf. Blood, hair, vibrissae, and earplugs were collected. Captures took place in February, March, April, and October. We attempted to remove all radiocollars on study animals during the final field year (FY 2006) of this project. Collars that malfunctioned in the field or were not locatable at the end of the project were later returned by predator control agents and trappers.

We used wolf location data retrieved remotely from GPS collars to backtrack wolves from the air and to document their use of prey during the previous 5 days. We attempted to track the wolves biweekly using airplanes as funding and weather conditions allowed. The design was to use these downloaded data to track pack movements and to collect prey encounter and kill information. We found that this approach did not work well within our time and budget constraints due to frequent poor snow conditions and local fog in winter and heavy brush in summer. Our inconsistent observations indicated wolves often visited old kill sites but we found few new kills using this method. Due to the minimal number of observations, we abandoned this job as unproductive in FY07.

Insufficient funding and inclement weather prevented aerial surveys to estimate kill rates of wolves; therefore, on April 30, 2007 the Project Statement was revised and Job/Activity 1c was eliminated.

OBJECTIVE 2: Quantify the spatial and temporal distribution of snowmobile-based human activity in the Nelchina Basin.

We mapped the network of oversnow vehicle (OSV) trails occurring in the Nelchina River basin via snowmachine over the course of 2 winters using a Leica GS-20 surveyor’s grade GPS (Figure 2). Ephemeral, secondary trails, and seismic lines that were not mapped via snowmachine were digitally extracted from aerial photography and a 2.5 m pan-chromatic SPOT satellite image using image-processing software. During the course of this mapping, we placed 12 radio-beam people counters throughout the trail system to quantify the spatial and temporal distribution of OSV-based human activity.

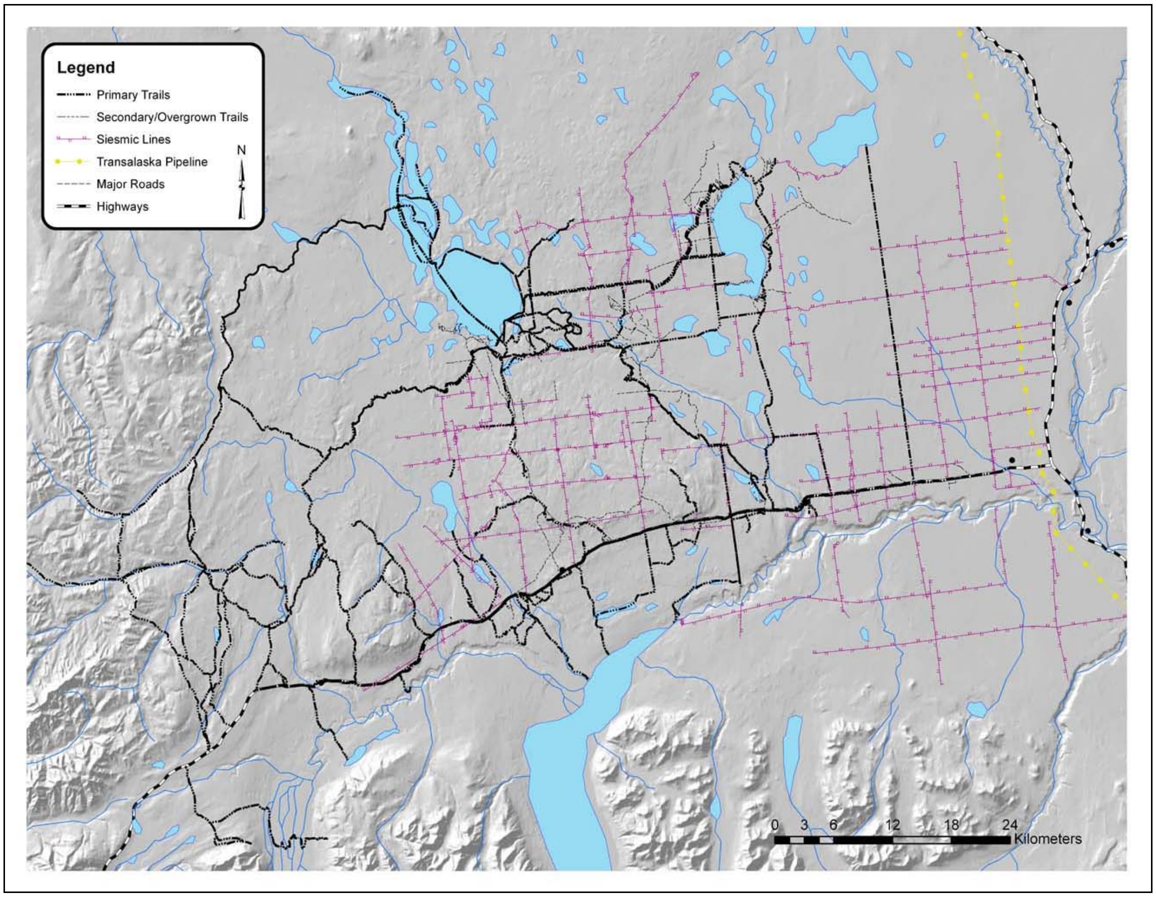

Figure 2. Network of oversnow vehicle (OSV) trails mapped in the Nelchina River basin.

We had planned to incorporate a variety of remote sensing techniques to document the progression of trails throughout the winter. One technique to describe the seasonal expansion of the trail system was to conduct 2 bimonthly aerial videography flights over the study area between February and April 2006 using a Sony VX-1000 digital video camera and a Kodak Pro DSC digital SLR mounted to the open floor of a small fixed-winged aircraft (Anthony et al. 1995). This technique would have allowed for rapid data collection that could have been critically reviewed later in a non-field setting. However, after some trial flights we found the study area to be too large for this technique and, as a result, we acquired a pan-chromatic SPOT satellite image (Spot Image Corporation, Toulouse, France) with a 2.5 m spatial resolution (Figure 3). The image, acquired in mid-March, was corrected and analyzed using ERDAS IMAGINE (Leica Geosystems, Atlanta, Georgia) and PCI Works (PCI Geomatics Inc., Ontario, Canada). Additionally, we supplemented the trail data extracted from the SPOT image with information from a series of aerial photographs. We assumed that the established ATV trails and snow-groomed trails are the first to be used by OSVs and, as the season progresses and more snow accumulates, ephemeral trails are then utilized. We defined trails in ArcGIS 9.3 for Windows (ESRI, Redlands, California) as primary trails, secondary and overgrown trails, and seismic lines. All layers were imported into ArcGIS for final analysis.

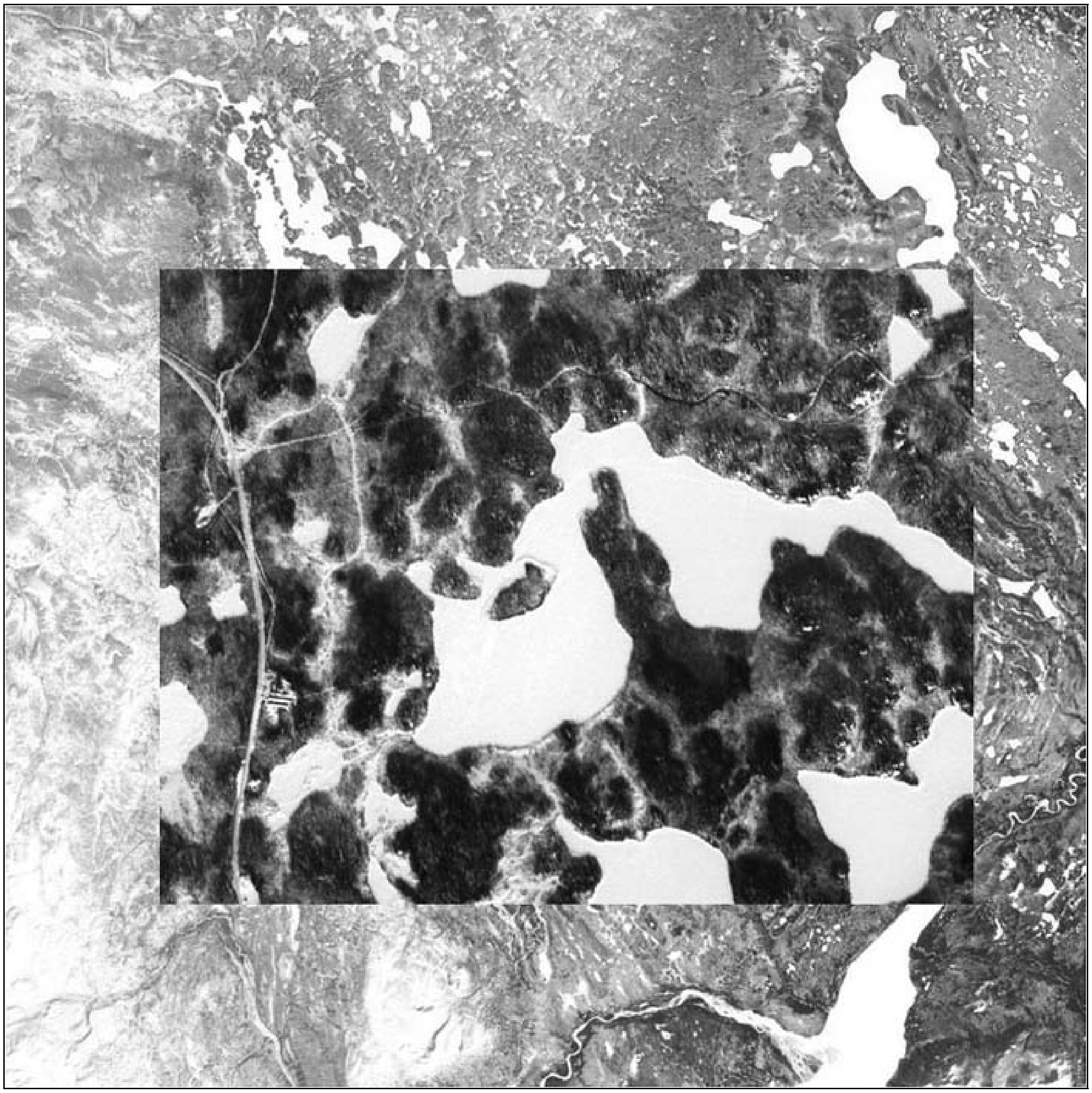

Figure 3. Pan-chromatic SPOT satellite image with a 2.5 m spatial resolution showing OSV trail in winter in the Nelchina River basin.

RBX2003 radio beam counters (Chambers Electronics, Inverness, Scotland) were deployed to enumerate snowmobile activity throughout the NSA because of their advantages over alternative technologies (e.g., TrailMaster, Lenexa, KS). These 12 radio beam counters are cold-tested to -30^{o} C, can operate > 100 days using alkaline batteries (> 200 days with lithium batteries), and will continue to collect data under a layer of snow. The sensor has an adjustable beam that can discriminate between individuals in a group such as multiple snowmobiles passing at high speeds. A microprocessor-based data logger was attached to the receiver box to record the number of snowmobiles passing within pre-set time intervals. Data were uploaded to a PC laptop computer. We selected the locations of the counters along the trail system from *a priori* knowledge of human-use trends and existing ATV trails. Radio beam counters were downloaded every two weeks via snowmobile, coinciding with snow depth and density measurements. This is the first time winter recreation activity has been quantified in the Nelchina River basin. As predicted, the trend in human activity followed diurnal patterns that increased on the weekends, holidays, and as the season progressed due to increasing daylight and snowfall. We will make these data available to interested state and federal land management agencies.

OBJECTIVE 3: Quantify wolf movements and spatial relationships with the availability of prey resources (primarily moose), snowmobile trails, and snow characteristics**.**

To relate prey distribution to wolf movement throughout the trail system, we conducted 2 prey surveys focused primarily on moose. We used 3 fixed-wing aircraft to fly a survey grid that encompassed the entire study area. Our search intensity (SI) for each of the approximately 600 9-km^2 quadrats was approximately 7 minutes/quadrat (1.28 km^2/min). For analysis, each was categorized as having high (≥3) or low (≤2) relative moose abundance. The first survey flight was flown in mid December 2005 to provide an estimate of early season distribution and the late winter survey was flown in mid March 2006. GIS plots of moose relative abundance indicated higher densities in the Oshetna River, Little Oshetna River, and upper Tyone River in December 2005 (Figure 4), but little concentration of moose abundance was indicated in March 2006 (Figure 5).

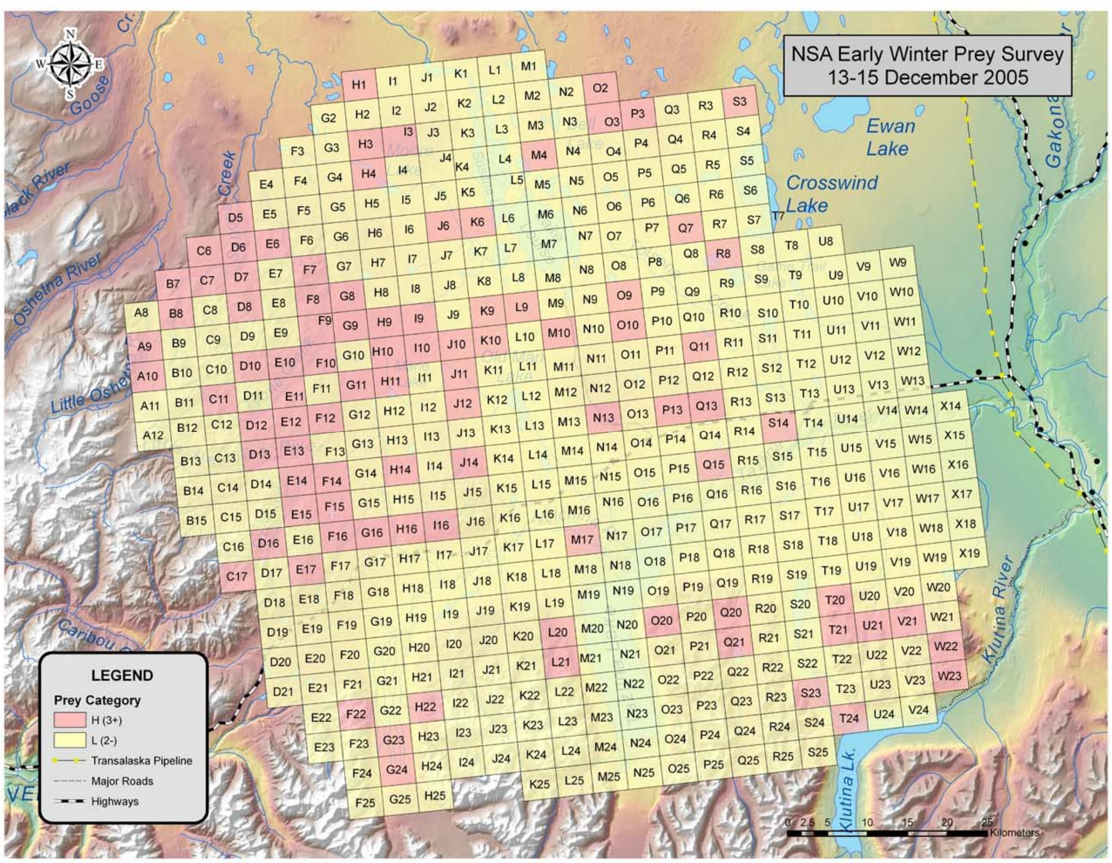

Figure 4. Relative abundance distribution of moose in the wolf study area during December 2005.

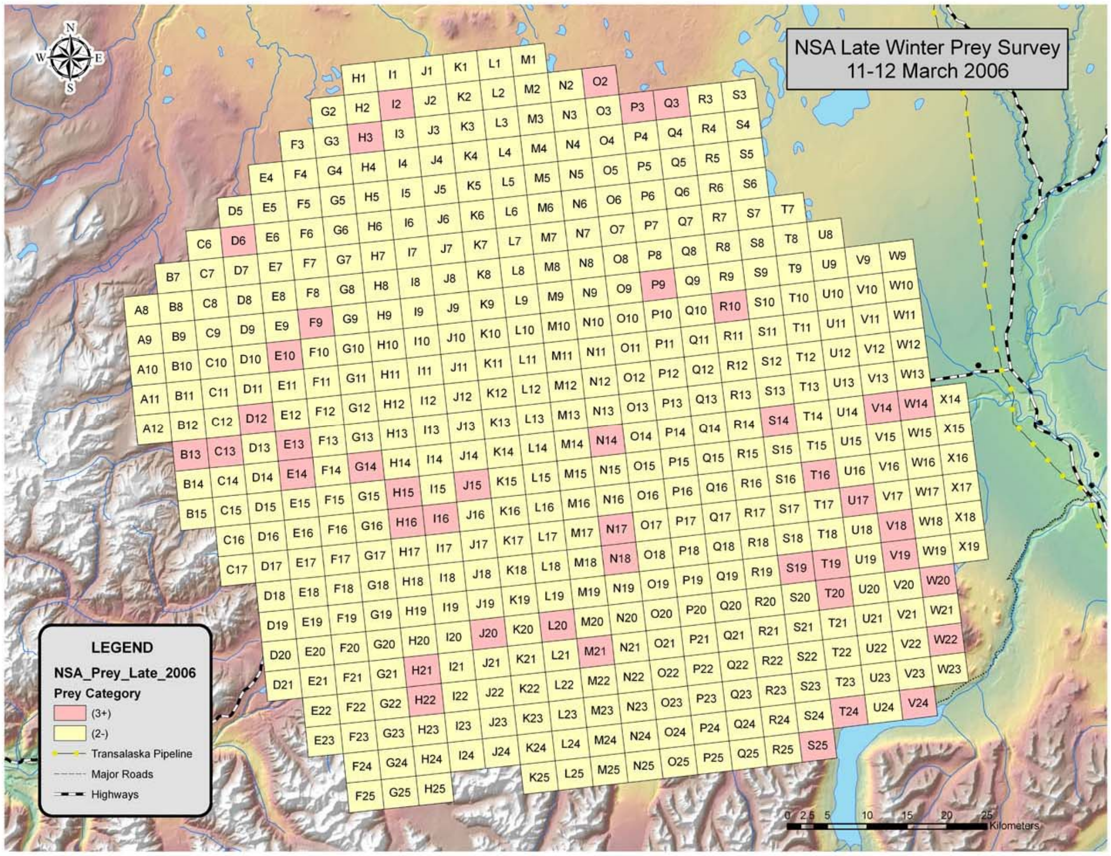

Figure 5. Relative abundance distribution of moose in the wolf study area during March 2006.

We collected snow depth, density, and hardness data biweekly throughout the Nelchina River basin at sites on and off of OSV trails. From these data we created 3 regressions that are presently being used outside the GIS environment to analyze wolf movement data. We used snow data obtained from existing snow stations in the study area. Throughout the Nelchina River basin, the United States Department of Agriculture's Natural Resources Conservation Service (USDA-NRCS) has established a snow course consisting of 12 snow survey sites to monitor snowfall. Each survey site has a depth marker from which snow depth can be determined aerially. The depth markers consist of a series of wide cross members 61 cm (24 in) apart with narrower members interspersed 30.5 cm (12 in) apart. These sites were reached via the road system or flown by small fixed-wing aircraft on or near the first of each month between November and April. The NRCS also monitors these sites to determine snow depth and density using a Federal snow sampler (Carpenter Machine Works, Seattle, WA) to obtain snow core samples. More detail on this methodology is available in the Snow Survey Sampling Guide (U.S. Department of Agriculture 1984). The surveyed snow data was then used to create and validate regressions used to predict snow parameters between snow collection dates and sites. This analysis is incomplete and will continue under another funding source. Completed results will be published as part of Todd Rinaldi's Master's thesis and amended to this report at a later time.

We used location data obtained from GPS radiocollars set to record locations at 15-minute intervals and from VHF radio telemetry flights to measure wolf movements relative to prey abundance and availability and to test the correlation of wolf movements with the availability of trails and OSV use (Figure 6). Because of the widespread failure of the moose GPS collars we used, we were unable to include moose movements in this analysis. Analysis of location and GIS data was done using ArcGIS spatial analyst software and S+ spatial statistics. All location data were screened for errors and integrated with the snow, trail, and human-use layers in ArcGIS 9.3 for Windows. Data were queried using Model Builder in ArcGIS and exported out of the GIS environment into regression models developed in STATA 9 (StataCorp, College Station, Texas). The model outputs will provide the values to identify the relationships between wolves and OSV trails. This analysis is incomplete and will continue under another funding source. Completed results will be published as part of Todd Rinaldi's Master's thesis and amended to this report at a later time.

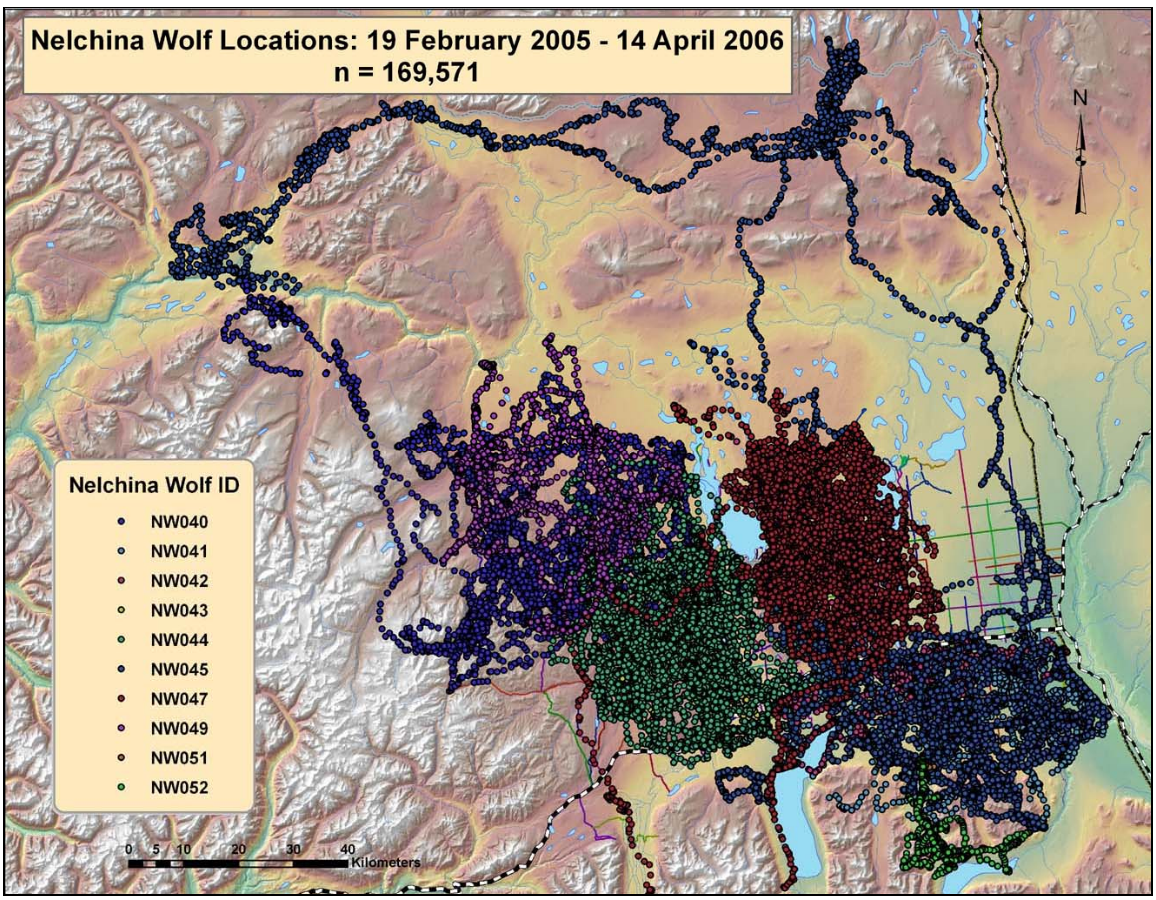

Figure 6. Location data for wolves radiocollared in the Nelchina River basin, 19 February 2005 – 14 April 2006.

OBJECTIVE 4: Evaluate diet of wolves relative to prey availability.

We sampled blood, hair, vibrissae, and subcutaneous fat from wolves during each capture period (March and October). We also collected muscle tissue samples from potential prey for wolves obtained by hunters and trappers and through other department capture efforts.

We used two separate techniques, stable isotope analysis and quantitative fatty acid analysis, to process specimens and to compare results. For the stable isotope analysis, we dehydrated, ground, and weighed tissue samples in the ADF&G lab to prepare them for gas chromatography analysis at Colorado State University. This analysis measured levels of carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), and sometimes sulfur ($\delta^{34}S$) to create isotopic signatures specific for moose, caribou, and other potential prey and relate the levels of those isotopes to levels found in blood and hair of wolves. For the fatty acid analysis, we sampled subcutaneous rump fat on wolves using 4-mm Miltex biopsy punches and preserved them in chloroform BHT. We sent the samples to the University of Wisconsin for processing to determine the specific lipid signatures for individuals. Similar fat samples from moose and caribou, collected during another ADF&G study in the Nelchina River basin, were also processed. The stable isotope and fatty acid analyses were scheduled to be completed during the FY 2008 performance period. However, delays in lab time and personnel prevented us from meeting that schedule. We will continue analyzing all lab results as soon as possible under other funding sources. Completed results will be published and amended to this report at a later time.

OBJECTIVE 5: Estimate wolf population levels relative to varying prey levels.

A sample unit probability estimator (SUPE) was conducted in the study area in 2002 that resulted in a density estimate of 7.4 (SE = 1.1) wolves/1000 km^2. Since that survey was completed, intensive management of the wolf population resulted in a marked reduction in the wolf population through hunting and trapping activities. Unfortunately, funding was inadequate subsequent to that reduction to determine the current population density. Due to funding constraints, we did not attempt to estimate moose and caribou populations beyond the effort to estimate the relative abundance of moose in the study area as described under Objective 3, Job/Activity a.

OBJECTIVE 6: Estimate production, survival, and recruitment of wolves relative to varying prey densities.

Due to the high loss rates and turnover of pack members resulting from the intensive management program in and near the study area, we were not able to obtain adequate sample sizes to estimate these population parameters. Therefore, no progress could be made in meeting this objective.

IV. MANAGEMENT IMPLICATIONS

This wolf research project was designed to help managers meet their population management objectives by improving our understanding of the population and spatial relationships of wolves to varying densities and distributions of prey and to the effects of human activity through the availability of snowmobile trails. We built upon previous predator-prey studies in and near the Nelchina River basin. New techniques and technology (e.g., stable isotope analysis, GPS radiocollars, and radio-beam activity counters) allowed us to explore aspects of wolf ecology that were not possible even a few years ago. The greatest challenge of this project was the loss of study animals resulting from intense hunting and trapping efforts as part of the predator management program in the Nelchina River basin. Lack of funding also was a limiting factor in determining the objectives that could be pursued. However, despite these difficulties, we were able to conduct effective research on wolf movements relative to man-made trails and their use by OSVs and on wolf diet analysis. We used new and innovative analysis techniques that will be useful for future studies and management activities.

V. SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN FOR LAST SEGMENT PERIOD ONLY

Job/Activity 7a: Data analysis and report and publication preparation.

We continued to make progress on compiling and organizing databases for final analyses using ArcGIS 9.3 for Windows and through regression models developed in STATA 9. Four to five papers are being prepared for publication and will be amended to this report at a later time.

VI. ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THE LAST SEGMENT PERIOD, IF NOT REPORTED PREVIOUSLY

None.

VII. PUBLICATIONS

Poster presented at The Wildlife Society Annual Conference, Tucson, Arizona, 2007: Winter movement strategies of wolves in relation to human activity and resource abundance by T. A. Rinaldi, K. L. Parker, H. N. Golden, and M. P. Gillingham; Alaska Department of Fish and Game and the University of Northern British Columbia.

Abstract: The ecological effects of snowmobile activity on wildlife are increasingly a concern for resource managers and planners. Yet relatively little is understood about the implications for predators, particularly wolves (*Canis lupus*), and the dynamic role that OSV (over-snow vehicle) trails can have on predator-prey interactions. In 2003, there were more than 2.4 million snowmobiles registered in North America, 34,000 of which were in Alaska. The production of lightweight, fuel-efficient snowmobiles in the mid-1990s has expanded snowmobile activity into areas where little or no activity previously occurred. OSVs and the alterations made to the landscape from their activity can have profound impacts on wolf-prey dynamics. The presence and noise from OSVs can displace and disrupt animal activity and movement patterns; and the creation of trails enables energy-efficient travel, thereby increasing the likelihood of encountering and successfully capturing prey. High hunting and trapping pressure exacerbate these effects, particularly during critical late winter periods when animals are most stressed and anthropogenic activity is greatest. In October 2004, the Alaska Department of Fish and Game and the University of Northern British Columbia, in cooperation with the Bureau of Land Management, began addressing the ecological implications of OSV activity on predator-prey interactions in the Nelchina basin of south-central Alaska. With its dense network of trails, the Basin presented a unique opportunity to quantitatively assess the spatial and temporal relationships among wolves, human activity, prey resources, and snow characteristics. We monitored the movements of GPS-telemetered wolves, quantified snowmobile activity using remote cameras to delineate categories of human

use, defined relative moose abundance using aerial surveys, and routinely recorded snow depth, hardness, and snow-water equivalents. Our findings provide a baseline for future investigations into the energetic implications associated with winter anthropogenic activity.

VIII. RESEARCH EVALUATION AND RECOMMENDATIONS

None.

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