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Division of Wildlife Conservation
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Predation on Moose and Caribou by a Regulated Wolf Population

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FEDERAL AID
FINAL RESEARCH PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
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PROJECT TITLE: Predation on moose and caribou by a regulated wolf population

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COOPERATORS: None

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I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

Management of wolf predation on ungulate populations in Alaska requires estimates of predation rates and knowledge of how those rates are affected by management actions. Predation rates by wolves on moose and caribou in Interior Alaska have been estimated during winter using aircraft to track wolves in snow, but continuous daily monitoring of wolf packs throughout the winter period (Oct–Apr) is prohibitively expensive and impractical because of variable weather and personnel availability. Therefore estimates of predation rates for an entire winter are commonly extrapolated from seasonal estimates derived during late winter. However, seasonal estimates, particularly those from late winter, may be biased because of increased prey vulnerability during late winter when snow is deep and prey energy reserves are low. Wolf pack cohesiveness also changes during the late winter breeding and dispersal period, likely affecting short-term predation rates. We sought to develop an affordable method to estimate predation rates by wolves during winter that would identify seasonal variation and avoid seasonal bias.

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS

Previous estimates of wolf predation rates in Alaska and Canada relied upon monitoring radiocollared wolf packs each day for a specified time period during early or late winter (Ballard et al. 1987; Valkenburg 1992; Dale et al. 1995; Hayes et al. 2000). Extrapolation of late winter kill rates were then used to model effects of wolf predation on ungulates for entire winters (Ballard et al. 1997; Hayes et al. 2000). Kill rates have been positively correlated with prey density (Messier and Crete 1985; Fuller 1989) and reported kill rates among various predator–prey systems in North America have ranged from 2.0 kg/wolf/day in a Minnesota deer–wolf (Fuller 1989) system to 8.7 kg/wolf/day in a Yukon wolf–moose–caribou system (Hayes et al. 2000). In most studies kill rates vary by pack size, larger packs kill more prey, but per capita kill rates are higher in small packs (Ballard et al. 1997, Fig 7). Although overall kill rates averaged 8.7 kg/wolf/day for the population of wolves monitored by Hayes et al. (2000) the mean kill rate among pairs of wolves was 19.9 kg/wolf/day. Therefore, because the number of packs within a population is a strong determinant of predation rates (Walters et al. 1981; Hayes et al. 2000), light to moderately exploited wolf populations that are regulated below naturally occurring population levels with low average pack sizes could conceivably have predation rates similar to larger, unexploited populations.

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

OBJECTIVE 1: Develop an unbiased aerial survey method to estimate predation rates on moose and caribou by a wolf population that is regulated by ground-based hunting and trapping.

We conducted computer simulations of different periodic sampling designs with a goal to estimate winter wolf predation on moose and caribou with acceptable accuracy and precision using no more than 45 total survey days. The simulations suggested that 11, 4-day sampling periods would yield unbiased estimates with a 90% confidence interval of ±23% of the mean kill rate. We applied the sampling design during winters 1998–1999 and 2000–2001 within Game Management Unit 20A. During each winter we divided the period from late October to mid-April into 12 consecutive 2-week periods. Within each 2-week period we picked a random day and assigned that day as a starting day for sampling period x_i, $i = 1, 2, \ldots, 12$. Weather precluded us from completing only one sampling period. We surveyed 38 days in 10 periods during 1998 and 43 days in 12 periods in 2000.

On the first day of each period we located wolf packs, but none of the kills detected on day 1 were used in estimating kill rates. Fresh ungulate kills detected on days 2–4 were used to calculate estimated kill per pack per day using the ratio estimator $\hat{R} = \frac{\sum k_i}{\sum d_i}$; where k = kills and d = packdays in period i. The variance was calculated as

$$\hat{V}(\hat{R}) = \frac{1}{\sum \bar{d}^2} \times \frac{\sum k_i^2 - 2\hat{R}\sum k_i d_i + \hat{R}^2 \sum d_i^2}{n(n-1)}$$

where n = number of sample periods (Cochran 1977).

During 1998 we monitored an average of 8.2 packs per sample period and in 2000 we monitored an average of 7.75 packs per sample period. Packs sizes averaged 5.9 wolves per pack in 1998 and 6.9 wolves per pack in 2000. The study packs killed an estimated 168 ungulates during the 172-day winter period in 1998 and 223 ungulates in 2000. Ninety percent confidence limits were ±32% in 1998 and ±25% in 2000, similar to those predicted by the presurvey computer simulations. Based on biomass estimates of different prey items wolves killed 5.0 kg/wolf/day in 1998 and 6.9 kg/wolf/day in 2000. Those values are similar to those reported in other kill rate studies within moose–caribou–wolf and predator–prey systems (Fuller 1989).

OBJECTIVE 2: Identify predation-rate characteristics associated with packs of different size and social structure.

Ballard et al. (1997) compiled data from 4 kill rate studies in Alaska and Yukon and showed that per capita kill rate (i.e., biomass killed per wolf per day) increased as pack size declined, but that overall larger packs killed more prey biomass than smaller packs. We also found that larger packs killed more prey biomass than smaller packs (1998: $r = 0.86$, $p = 0.12$; 2000 $r = 0.70$, $p = 0.03$), but found only a weak negative correlation between pack size and per capita kill rate in 2000 ($r = -0.53$, $n = 10$, $p = 0.12$) and a strong positive correlation between pack size and kill rate ($r = 0.91$, $n = 7$, $p = 0.006$) in 1998. We hypothesized that per capita kill rate is strongly influenced by seasonal variation in prey distribution and vulnerability and that the highest per capita kill rates for small packs should be expected during late winter when prey energy reserves are depleted and snow depths are greatest. Mean per capita kill rate was significantly higher in late vs. early winter among small packs in 2000, but not in 1998 (Pack size 2–6, *t*-test: 2000 $p = 0.05$; 1998 $p = 0.53$).

We hypothesized that newly formed packs consisting of a pair and the current year's offspring would exhibit lower kill rates than packs of similar size that contained more than 2 adults or multiple generations of offspring. We compared mean pack kill rate and mean per wolf kill rate from 2 packs that consisted of only a pair and their current year pups (class 2 packs) with 2 other packs that contained more than 2 adults plus current year pups (class 3 packs). Each pack class contained 1 pack from 1998 and 1 pack from 2000. Mean traveling pack sizes were similar (5.9 vs. 5.1). Although calculated mean per pack and per wolf kill rates were approximately twice as high in the class 3 vs. class 2, the variance associated with the periodic sampling method was high and the difference between mean estimates was not statistically significant (*t*-test, per pack kill rate $p = 0.23$, per wolf kill rate = 0.16). Larger samples sizes are needed to detect those differences if they exist.

OBJECTIVE 3: Integrate those findings with results of a previous study on wolf population responses to hunting and trapping.

Following wolf control in 1993 and 1994, wolves within our study area increased but were regulated below precontrol levels by hunting and trapping between 1998 and 2000 (McNay 2002). Although population size was regulated, the number of packs during 1998–2000 exceeded precontrol pack numbers and mean size declined from 12.1 wolves per pack during 1995–1997 to 7.7 wolves per pack during 1998–2000.

Using data from their Yukon study, Hayes et al. (2000) modeled the effects of increased per capita kill rate in small packs and demonstrated predation rate on moose can be more a function of the number of packs within a wolf population than the number of wolves. Those findings are consistent with a review of 4 northern predation rate studies by (Ballard et al. 1997) that found higher per capita kill rates among wolves in small packs vs. large packs. However in contrast to those studies, we found no overall correlation between pack size and per capita kill rate (pooled 1998–2000 data $r = 0.009$, $p = 0.99$), but instead found evidence that during some years per capita kill rates among small packs were higher and during other years lower compared to larger packs. That result may in part have been a function of the few packs within each size category that we monitored during our study or may have reflected year differences in prey vulnerability that we did not measure.

IV. MANAGEMENT IMPLICATIONS

Data from this current study (Project 14.19) and from previous published studies (Ballard et al. 1997) suggest that both pack size and pack social structure may be important covariates related to overall predation rates. Although data from this study does not clearly define the effects of social class, it is clear that focusing on the numerical response associated with reducing or regulating wolf populations is too simplistic to define predation rate effects. The results to date (Projects 14.17 and 14.19) suggest that predation rates are a function of changes in pack social structure and pack size as well as changes in wolf population size. Further research is needed to identify those effects so that managers can realistically evaluate the efficacy of management strategies to reduce or regulate wolf predation on ungulates.

V. SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN FOR LAST SEGMENT PERIOD ONLY (if not reported in previous performance report)

JOB 8 Complete data analysis and write reports integrating information on the effects of human harvest on wolves with information on predation rates on moose and caribou by wolves.

During the last segment period we compiled and analyzed data on relationships between a) pack size and per capita kill rates and on b) overall population kill rates. The principal investigator spent time developing figures, graphics, and text for oral presentations and for this report.

JOB 9 The principal investigator will present the results of this study at agency workshops, agency meetings or scientific conferences related to the management of northern wolf–prey systems.

The principal investigator traveled to Montana during April 2003 and presented results from Project 14.19 at the 15th North American Interagency Wolf Conference. The presentation was entitled, "Use of Periodic Sampling to Estimate Wolf Predation Rates During Winter."

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

None.

VIII. RESEARCH EVALUATION AND RECOMMENDATIONS

Periodic sampling was successfully applied in the field and results were similar to those predicted in computer simulations for precision of overall kill rates by wolves on moose and caribou. However, because small packs have longer intervals between kills, it is necessary to have longer sampling periods for smaller vs. larger packs to precisely estimate kill rates for small packs. Revisions in the sampling scheme that increase the days per sampling period as pack size goes down should be considered. The current sampling method tends to obtain more precise estimates for kill rates among larger packs, but an important aspect of predator–prey dynamics for the manager is related to kill rates of numerous small packs that result from harvest of wolf populations.

IX. PROJECT COSTS FROM LAST SEGMENT PERIOD ONLY

FEDERAL AID SHARE $62.4 + STATE SHARE $20.8 = TOTAL $83.2

X. APPENDIX

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