FEDERAL AID FINAL RESEARCH PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
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PROJECT TITLE: Effects of snowshoe hare population cycles on demography of Dall sheep and their predators

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FEDERAL AID GRANT PROGRAM: Wildlife Restoration

GRANT AND SEGMENT NO.: W-33-10

PROJECT NO.: 6.14

WORK LOCATION: Unit 20A, Central Alaska Range

PERIOD: 1 July 2003–30 June 2012

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

Dall sheep (*Ovis dalli*) are found throughout mountainous areas of Alaska and are valued for both consumptive and nonconsumptive uses. From 1984–1994, more than 3,000 people hunted Dall sheep in the central Alaska Range (CAR; ADF&G unpublished data), and sheep hunters contribute significantly to the economy of the state (Watson 1986). Sheep populations in the CAR declined by an estimated 60% from 1984–1994 (Dale 1996), a period when the snowshoe hare population reached a peak and then declined. Causes of the decline in sheep numbers are unknown, but lamb abundance during midsummer averaged only 12 lambs per 100 ewes from 1991 through 1993, suggesting that reduced lamb production or survival may have been an important contributing factor. Recent studies indicated that coyotes (*Canis latrans*) and golden eagles (*Aquila chrysaetos*) were major predators of Dall sheep lambs in the CAR (Scotton 1997). However, little is known about population levels of coyotes and eagles in the area or how these may change in response to changes in abundance of the snowshoe hare, which is their major prey species. Thus, increased understanding of factors that influence populations of Dall sheep and their predators will benefit a variety of management programs.

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

Dall sheep populations have been surveyed at irregular intervals in many parts of Alaska for several decades, although precise estimates of population size are not available for most areas. Spring or summer surveys to assess lamb production and survival were conducted annually from 1993 through 1997 in the CAR. Surveys during the 1990s indicated that sheep abundance in this area was below levels that occurred during the 1970s and 1980s (Whitten 1997). Scotton (1997) found that coyote predation was an important source of mortality for lambs in the CAR, and previous authors (e.g., Murie 1944, Heimer and Stephenson 1982) suggested that wolf (*Canis lupus*) predation on adult sheep might be important to some sheep populations. Wolf numbers in the CAR were reduced by a control program during 1993 and 1994. Greatly varying opinions have been published regarding the effects of predator control on sheep populations. Heimer and

Stephenson (1982) suggested sheep populations responded positively to predator reductions in the late 1970s, while Gasaway et al. (1983) and Hayes et al. (2003) concluded that sheep did not respond to predator reduction. Studies elsewhere have suggested that competition with resident wolves can restrict coyote distribution (Thurber et al. 1992) and that coyote populations fluctuate in response to changes in abundance of snowshoe hares (Todd et al. 1981, O'Donoghue et al. 1997). However, little is known about how changes in populations of predators and other prey species may affect sheep populations.

At northern latitudes, snowshoe hares are an important prey of coyotes, at least when hare populations are abundant. In the CAR, hares were the most common prey species in the diet of coyotes during a peak in the hare population (Prugh 2005). However, coyotes also eat a variety of other mammals and birds, and fluctuations in hare populations may affect populations of alternate prey by altering the amount of predation that occurs (O'Donoghue et al. 1997, Prugh 2005). A decline in hare abundance may have either positive or negative effects on alternate prey, depending on the degree to which predators respond functionally (by switching among prey species) or numerically (through reduced fecundity and increased dispersal and mortality).

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

This study is a continuation of federal aid project 6.13, which took place during 1999–2002. Data collected during the previous period as well as during this study (2003–2007) will be used to estimate effects of changes in snowshoe hare abundance on levels of predation on Dall sheep.

OBJECTIVE 1: Estimate home range size and reproductive success of resident coyote pairs. Coyotes that were radiocollared during project 6.13 were monitored through August 2005 to assess movements, home ranges, and habitat use patterns.

OBJECTIVE 2: Estimate annual survival and cause-specific mortality of Dall sheep lambs. During May in 2003 and 2004, 24 Dall sheep lambs were located from a helicopter and then captured by hand and radiocollared within 2 days of birth. Radiocollared lambs were located at least twice per week during May and early June, and monthly during the rest of the year to determine survival. Lamb mortalities were investigated to determine probable cause of death.

OBJECTIVE 3: Estimate survival and natality of Dall sheep ewes.
During 2003 and 2004, 20 Dall sheep ewes that were previously equipped with radio collars were located by aerial radiotracking several times per week during late May and at 2-week intervals during the other months to estimate natality and survival.

OBJECTIVE 4: Estimate size and age/sex composition of the Dall sheep population each year. During late June 2003–2011, sheep populations and recruitment rates were estimated by intensive helicopter surveys, wherein sheep were counted and classified as lambs, yearlings, ewes, or rams. Funding for these surveys was provided by the Dall sheep survey and inventory project (Young 2008; Hollis 2011 [*In prep*]).

OBJECTIVE 5: Data analysis and report writing.
Data on coyote diets; changes in abundance of coyotes, hares, and sheep; and survival and mortality causes of sheep were analyzed. Results of this work were described in a doctoral dissertation by L. Prugh and in a series of articles published in professional journals (see list of publications below). A summary of those results is provided in the following section.

IV. MANAGEMENT IMPLICATIONS

Abundance of snowshoe hares peaked in 1999, declined through 2002, then increased during 2004–2007 (Arthur and Prugh 2010). Coyote abundance peaked during January 2001 and declined through March 2002 (Prugh et al. 2005). Coyotes did not increase predation on lambs when hares became scarce, although predation on voles and porcupines did increase (Prugh 2005). Thus, the intensity of predation on lambs varied in proportion to coyote abundance. Annual survival of lambs ranged from 0.15 during 2001 to 0.63 during 2003, and survival was highest when abundance of hares and coyotes was lowest (Arthur and Prugh 2010). Predation accounted for 93% of lamb deaths (n = 80 lambs for which cause of death was determined). Coyotes and golden eagles were the most common predators of lambs, accounting for 45 and 34%, respectively, of 65 lamb predation events where a specific predator could be identified (Arthur and Prugh 2010). Lamb survival during periods of high hare abundance was not sufficient to maintain the sheep population, despite relatively high natality and survival of adult ewes. However, sheep numbers increased during periods of increased lamb survival when hares were scarce, resulting in a stable cycle of sheep abundance. Thus, changes in abundance of snowshoe hares appeared to have strong effects on coyote abundance, and thereby affected recruitment and abundance of Dall sheep. Furthermore, these changes were reflected in harvest levels of rams. From 1983–2007, changes in harvests of rams in the CAR closely matched changes in hare abundance, with peaks in ram harvests preceding peaks in hare abundance by approximately 1 year (Arthur and Prugh 2010). In this area, sheep hunting was restricted to mature rams (≥8 years old or with full-curl or larger horns), and most rams were harvested at the age of 8–10 years. Thus, harvests reflected recruitment of ram cohorts born 8–10 years previously, which approximates the period of the hare cycle. Interactions among different predator species, particularly the potential for negative effects of wolves on coyotes, suggest that multiple indirect interactions among predators and their prey can greatly complicate management of complex predator–prey communities (Arthur and Prugh 2010). Managing large predators to enhance sheep populations requires an understanding of the effects of alternate prey and of age-specific differences in predation rates on ungulate population dynamics.

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

JOB/ACTIVITY 5: Data analysis, report writing, and travel.
A final report was produced.

VI. PUBLICATIONS

ARTHUR, S. M, AND L. R. PRUGH. 2010. Predator-mediated indirect effects of snowshoe hares on Dall's sheep in Alaska. Journal of Wildlife Management 74:1709–1721.

PRUGH, L. R. 2004. Foraging ecology of coyotes in the Alaska range. Ph.D. dissertation, University of Alaska Fairbanks, Alaska.

PRUGH, L. R. 2005. Coyote prey selection and community stability during a decline in food supply. Oikos 110:253–264.
PRUGH, L. R., S. M. ARTHUR, AND C. E. RITLAND. 2008. The use of fecal genotyping to determine individual diet. Wildlife Biology 14:318–330.
PRUGH, L. R., AND C. J. KREBS. 2004. Snowshoe hare pellet-decay rates and aging in different habitats. Wildlife Society Bulletin 32(2):386–393.
PRUGH, L. R., AND C. E. RITLAND. 2004. Molecular testing of observer identification of carnivore feces in the field. Wildlife Society Bulletin 33(1):189–194.
PRUGH, L. R., C. E. RITLAND, S. M. ARTHUR, AND C. J. KREBS. 2005. Monitoring coyote population dynamics by genotyping feces. Molecular Ecology 14:1585–1596.

VII. LITERATURE CITED

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HOLLIS, A. L. 2011 (*In prep*). Unit 20A Dall sheep. *In* P. Harper, editor. Dall sheep management report of survey and inventory activities 1 July 2007–30 June 2010. Alaska Department of Fish and Game, Project 6.0, Juneau, Alaska.
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O'DONOGHUE, M., S. BOUTIN, C. J. KREBS, AND E. J. HOFER. 1997. Numerical responses of coyotes and lynx to the snowshoe hare cycle. Oikos 80:150–162.
SCOTTON, B. D. 1997. Estimating rates and causes of neonatal lamb mortality of Dall sheep in the central Alaska Range. Alaska Department of Fish and Game, Federal Aid in Wildlife Restoration, Research Final Report, Grants W-24-4 and W-24-5, Study 6.12, Juneau, Alaska.
THURBER, J. M., R. O. PETERSON, J. D. WOOLINGTON, AND J. A. VUCETICH. 1992. Coyote coexistence with wolves on the Kenai Peninsula, Alaska. Canadian Journal of Zoology 70:2494–2498.
TODD, A. W., L. B. KEITH, AND C. A. FISCHER. 1981. Population ecology of coyotes during a fluctuation of snowshoe hares. Journal of Wildlife Management 45:629–640.
WATSON, S. M. 1986. Dall sheep hunting in Alaska: What is it worth? Proceedings of the Biennial Symposium of the Northern Wild Sheep and Goat Council 5:129–148.
WHITTEN, K. R. 1997. Estimating population size and composition of Dall sheep in Alaska: Assessment of previously used methods and experimental implementation of new techniques. Alaska Department of Fish and Game, Federal Aid in Wildlife Restoration, Research Final Report, Grants W-24-3 through W-24-5, Study 6.11, Juneau, Alaska.

YOUNG, D.D. 2008. Unit 20A Dall sheep. Pages 114–122 *in* P. Harper, editor. Dall sheep management report of survey and inventory activities 1 July 2004–30 June 2007. Alaska Department of Fish and Game. Project 6.0. Juneau, Alaska.

VIII. APPENDICES

The following publications were submitted in pdf form as appendices to this final report:

APPENDIX A. ARTHUR, S. M., AND L. R. PRUGH. Predator-mediated indirect effects of snowshoe hares on Dall's sheep in Alaska. Journal of Wildlife Management 74:1709–1721.

APPENDIX B. PRUGH, L. R. 2005. Coyote prey selection and community stability during a decline in food supply. Oikos 110:253–264.

APPENDIX C. PRUGH, L. R., S. M. ARTHUR, AND C. E. RITLAND. 2008. Use of faecal genotyping to determine individual diet. Wildlife Biology 14:318–330.

APPENDIX D. PRUGH, L. R., AND C. J. KREBS. 2004. Snowshoe hare pellet-decay rates and aging in different habitats. Wildlife Society Bulletin 32(2)386–393.

APPENDIX E. PRUGH, L. R., AND C. E. RITLAND. 2005. Molecular testing of observer identification of carnivore feces in the field. Wildlife Society Bulletin 33(1):189–194.

APPENDIX F. PRUGH, L. R., C. E. RITLAND, S. M. ARTHUR, AND C. J. KREBS. Monitoring coyote population dynamics by genotyping faeces. Molecular Ecology 14:1585–1596.