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TOWARD A WORKING HYPOTHESIS FOR MOUNTAIN SHEEP MANAGEMENT

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Abstract: Working models of species biology (working hypotheses) are the basis of management decisions, and should form the basis for management planning. Unfortunately, working hypotheses have seldom been articulated The purpose of this paper is to demonstrate one method for developing a working hypothesis by giving an example for Dall sheep (*Ovis dalli dalli*). Components of the ecology of Dall sheep were identified. These included population biology, range resource limitation, habitat component importance, predation, weather, and disease influences, and management of hunting and disturbance. The data base about each component was reviewed, and simple predictive statements with qualification were prepared. Some discussion of the benefits of working hypotheses to researchers, planners, and managers is included.

It is unusual for sheep managers to have large, situation-specific data bases upon which to make management decisions. Consequently, most sheep management responses are based on limited data tempered by the manager's impression of what is appropriate at each opportunity. Working management hypotheses (data-based predictions of how sheep are likely to react to the spectrum of possible uses or abuses) have seldom been articulated, and are not generally available to managers and planners unless they also happen to be specialists in sheep ecology. Published working hypotheses predicting probable sheep responses to specific ecological situations should provide a basis for setting sheep management policy, improve management planning efforts, and aid sheep managers in identifying first-response management options. Working hypotheses should also improve research planning by defining management-relevant questions.

DEFINITION

For purposes of this discussion, a working hypothesis is a data-based working model of species biology which is relevant to possible species uses or abuses. It should be predictive statement which integrates the available biological knowledge with management experience and summarizes the known aspects of species biology, management experience, and probable reaction to specific potential management actions or concerns. It should not be thought of as a definitive statement of the natural history of the managed species, and all involved persons should be continually reminded that the hypothesis requires constant testing, re-examination, and modification as management and research proceed. That is, it is just our best guess about how any species will respond to management options.

METHODS

Components of mountain sheep ecology which have been found to be, or are anticipated to be, important in wild sheep management were identified. These included population biology, nutritional range limitation, habitat components, predation effects, weather influences, disease influences, and disturbance effects.

Once these aspects of sheep ecology were identified, documented knowledge produced by research over the years, management experience, anecdotal information, evolutionary relevance, behavioral theory, and personal insights were factored into summary statements about species adaptations, and anticipated population responses.

RESULTS

A review of the material relating to the biology and management of thinhorn sheep in general and Alaskan Dall sheep in particular was conducted. I judged the following points to be reasonably enough established that they could safely be used as the beginning of a working hypothesis for Dall sheep management in Alaska.

1. The number of Dall sheep in Alaska has been minimally established with acceptable accuracy (Heimer 1984).

2. Most Dall sheep populations exist on continental ranges and exhibit normal population size variations up to 20% of their long-term means over time. Densities vary from range to range (Hoefs and Cowan 1979, Heimer 1979, Heimer and Watson 1986).

3. The tendency of sheep populations to be predictably loyal to seasonal ranges has been established (Nichols 1976; Heimer 1973; Watson and Heimer 1984; Ayers 1986; Durtsche, pers. commun.).

4. Examples of effect of heavy winter snowfall on adult Dall sheep survival on continental ranges have been reported to affect older sheep more than prime age sheep (Burles and Hoefs 1984, Watson and Heimer 1984).

5. Examples of disturbances which Dall sheep tolerate have been reported (Heimer 1979, Heimer et al. 1980). These include road, bridge, and pipeline construction work as well as observations at Usibelli coal mine, Cooper Landing and Sheep Mountain Closed Areas, Seward Highway near Girdwood, and Denali Park.

6. The horn growth patterns and capabilities (potential for trophy management) of Dall sheep in Alaska have been described by area (Heimer and Smith 1975).

7. It has been shown that moderate harvest of mature (full curl) rams has little effect on viability of Dall sheep populations (Heimer and Watson 1986).

8. Removal of virtually all Class III and Class IV rams (all rams

above 3/4 curl) in various areas of Alaska was associated with low harvest rates (Heimer 1980a) and increased mortality among remaining young rams (Heimer et al. 1984).

9. Removal of most Class III and Class IV rams was associated with compromised lamb production (Nichols 1978; Heimer and Watson 1982, 1986).

10. Differences in population quality and performance are not likely to be functions of nutrition (Heimer 1980b, 1983; Heimer and Watson 1986).

11. Dall sheep in the eastern Alaska Range are generally free from diseases associated with domestic livestock (Heimer et al. 1982; Foreyt et al. 1983; R. Zarnke, pers. commun.). Disease is not a major component of Dall sheep ecology.

12. Parasite loads are minor factors in Dall sheep ecology (Nielsen and Neiland 1974).

13. Wolf predation can control and depress sheep populations (Murie 1944, Heimer and Stephenson 1982).

The basic tenets of the Dall sheep working hypothesis for Alaska are detailed below:

1. POPULATION BIOLOGY: Dall sheep are a climax habitat species adapted to relatively stable environments throughout most of their range. As such, we do not expect them to show explosive population growth, and we anticipate (in presence of normal predation) population stability OVER THE LONG HAUL.

Population size may vary considerably from year to year depending on a variety of factors; our experience indicates abrupt, weather-related changes of plus or minus 20% in ewe population size may occur from 1 year to the next. Favorable weather occasionally causes transiently high numbers of ewes when given cohorts of ewes experience higher survival for a year or so longer than expected due to mild winters. When weather "catches up" with these populations, the old ewes usually die, but few prime age ewes succumb. Temporary accumulation of (or removal of) entire cohorts of old ewes does not materially affect long-term, numerical lamb production in the population except in a positive way--the ewes may produce 1 or 2 "extra" lambs in their lifetime given an extra season or 2 of mild winter weather. These changes do not affect production by prime age ewes.

Slow population growth is expected. Population growth may occur under favorable conditions (mild winters and depressed predator populations), but these conditions are usually transient, and increasing populations will be stabilized by difficult weather or increased predation before habitat quality declines enough to cause reductions in the population.

2. RANGE LIMITATION: It seems reasonable that the quality of forage on winter ranges limits Dall sheep population performance. However, the

limitation is typically one resulting from poor food quality rather than insufficient quantity of forage.

We do not expect sheep populations to reach sufficiently high densities that concern about density-related nutritional stress is warranted. Nutritional stress my occur in unusual circumstances, but normal circumstances do not lead to this problem. Comparisons of nutrient quality of winter range plants selected by sheep, the summer nutrient quality of these food plants, and the body condition of ewes during rut and in late winter revealed no caloric advantage for a low-density population when compared with a high-density population. Still, population performance was strikingly different between the two; the low-density population had better performance. Nutritional stress or run-away population growth should not be primary management concerns.

3. HABITAT COMPONENTS: All components of Dall sheep habitat are considered critical to population welfare.

Dall sheep habitat consists, most simply, of winter and summer ranges. Specific life functions such as rutting, lambing, geophagy (mineral licking), and migration may involve specific habitats. However, our present understanding is inadequate to define whether any given habitat-centered activity is not essential to population survival. Certainly, mineral licks are the most clearly identifiable of the habitat components. We cannot say whether this makes them the most important or critical. A major concern of management should be habitat preservation; at this point, we should not relinquish any Dall sheep habitat components in the belief that little or no harm will result.

4. PREDATORS: Predators can limit and depress Dall sheep populations.

Predators, particularly wolves, and possibly coyotes and eagles, can depress sheep populations. Our data suggest wolves have little if any effect on lamb survival in Alaska. If prey selection occurs, mature rams are most probably preferred. Also, our data indicate wolves generally use sheep as alternate prey, perhaps relying on them most during summer months when larger animals like moose and caribou are difficult to capture. We found little evidence of sheep in the late-winter diets of wolves killed adjacent to sheep habitat in the GMU 20A wolf reduction program. Still, sheep population trajectory changed from decline to stability with wolf removal. Coyote predation may be important in some areas. In recent years, the observed incidence of eagle predation on lambs has increased dramatically. Eagles may be a significant predator on Dall sheep, particularly in areas where eagles are abundant and sheep population sizes are small.

5. WEATHER INFLUENCES: Dall sheep distribution is determined by climate. Wind action, snow depth, and hardness appear to be limiting factors in determination of suitable habitat. Prevailing winds are required to reliably remove snow from winter food.

The effects of severe winter weather act primarily on older animals from sheep populations. Weather severity influences survival of lambs to yearling age and the production of lambs. Severe weather may reduce lamb production if it is operative during gestation or parturition. It may also lower lamb survival to yearling age while not depressing lamb production. We have never documented an all-age winter die-off. Such die-offs are alleged to have occurred historically, but data have always been gathered long enough after the fact that such die-off explanations are suspect. In modern times, the only well-documented all-age die-offs have been caused by disease.

6. DISEASE: Dall sheep are not expected to tolerate introduction of exotic diseases. Bulk losses will probably result from introduction of virulent, new diseases to Alaska's sheep ranges. While Dall sheep, at least in the Alaska Range, apparently live with contagious ecthyma, lumpy jaw, and a fairly spectacular array of parasites, they are free from other diseases known to have lethal effects on other species of wild mountain sheep. Most investigators think the major cause of bighorn sheep decimation in the western United States was introduction of diseases common to domestic grazers, most notably domestic sheep. We have done little experimental work, but suspect Dall sheep will be unable to adjust to new diseases without extensive selection through mortality of susceptible individuals.

7. HUNTING: Hunting of Dall sheep can produce marked depressive effects on populations. Ewe hunting at less than 2% per year can limit growth in a vigorous population with nominal wolf and eagle predation. Ram hunting has less impact on population performance, but the effects are significant. Maximum harvest of rams at 3/4 curl is associated with breeding by younger rams and immature ewes, extended lactation, and lowered rates of ovulation and lambing. It is also associated with reduced survival of young rams. Hunting 7/8-curl rams seems to fix the problems associated with lamb production, but the effect on survival of young rams is unknown. It is probable that the sustainable harvest of rams is higher when the social structure is not disrupted by removal of most or all of the socially mature rams.

8. DISTURBANCE: Dall sheep may be considered disturbance-tolerant species.

Dall sheep are so bound to their home ranges it is difficult to make them leave. This is reflected in a behavioral syndrome that may be construed as tolerant of disturbance. Whether they are stubbornly committed to home ranges or tolerant of disturbance doesn't really matter. The result is that they will put up with an amazing amount of disturbance in their environment (coal mining, pipeline construction, intense human contact by viewers, heavy hunting, heavy automobile and air traffic, scientific study, etc.) without leaving. They apparently require some time to habituate to "new" environmental components, but they do adapt with SEEMINGLY few problems as long as they are not killed and their range remains habitable.

DISCUSSION

I have identified 3 specific management consequences which may occur because of the lack of a working hypothesis of species biology. The first, and most serious, problem is improper response to management opportunity or challenge. Our first response to any management opportunity or challenge is dependent on the depth of our understanding of species biology. An incomplete, inaccurate, or poorly informed perception may lead to unproductive, expensive, and possibly disastrous management reactions to challenges and opportunities.

The second consequence of an inadequate model of species biology is inefficient and unproductive use of limited research resources. In designing species-specific research, we rely heavily on our mental model (a working hypothesis which has not usually been articulated) of species biology. As a consequence, assumptions often get more attention in the discussion sections of reports than in research planning.

Articulating assumptions in a working hypothesis for research proposal reviewers should raise the level of project review as well as define areas of inadequate information (Heimer 1987). This should increase the chances of making major contributions toward better management. Of course, it should be recognized that some aspects of species biology are time and area specific. This emphasizes the importance of stressing the hypothetical nature of the working model as well as the hazards of overgeneralizing.

The third undesirable consequence of poorly expressed or supported hypotheses of species biology is controversy. When a working model of species biology is not widely understood and accepted, management actions consistent with the working hypothesis may not be understood or accepted by peripherally involved biologists or managers. This can lead to confusion and disagreement over appropriate management activities. It also leads to unhealthy emphasis on legitimate differences of opinion and may compromise the productivity of management programs.

For optimum progress to occur, information used to produce a working hypotheses need not be absolute truth. It is probably little more likely we will ever "prove" a working hypothesis of species biology than that we will "prove' organic evolution. Working hypotheses will, of necessity, be syntheses of gathered data, empirical observation, behavioral and evolutionary theory, and ecological principles. They will require adjustment for specific circumstances, new knowledge, and the failure of broad principles to predict accurately in all cases. I think it is the responsibility of research and management biologists to prepare working hypotheses as well as participate more actively in the planning process.

LITERATURE CITED

Ayers, L. 1986. The movement patterns and foraging ecology of Dall sheep in the Noatak National Preserve, Alaska. M.S. Thesis. Univ. California, Berkeley. 94 pp.

Burles, D., and M. Hoefs. 1984. Winter mortality of Dall sheep, Ovis dalli dalli, in Kluane National Park, Yukon. Can. Field Nat. 98:479-484.

Foreyt, W. J., T. C. Smith, F. F. Evermann, and W. E. Heimer. 1983. Hematologic, serum chemistry, and serologic values of Dall's sheep (Ovis dalli dalli) in Alaska. J. Wildl. Dis. 19:136-139.

Heimer, W. E. 1973. Dall sheep movements and mineral lick use. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-17-2, W-17-3, W-17-4, and W-17-5. Job 6.1R. Juneau. 35 pp.

________. 1974. The importance of mineral licks to Dall sheep in Interior Alaska and its significance to sheep management. Pp. 49-63 in K. Constan and W. Mitchell (Eds.), Proc. Bienn. Symp. North. Wild Sheep Counc., Great Falls, MT.

________. 1979. Dall sheep responses to human activity. Alaska Dep. Fish and Game. Fed. Aid In Wildl. Rest. Final Rep. Proj. W-17-10. Job 6.13R. Juneau. 5 pp.

________. 1980a. A summary of Dall sheep management in Alaska during 1979 (or how to cope with a monumental disaster). Proc. Bienn. Symp. North. Wild Sheep and Goat Counc. 2:355-380.

________. 1980b. Can population quality be related to population density through nutrition? Proc. Bienn. Symp. North. Wild Sheep and Goat Counc. 2:288-310.

________. 1983. Dall sheep body condition and nutritional profile. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-17-8 through W-21-1. Job 6.12R. Juneau. 52 pp.

________. 1984. Population status and management of Dall sheep in Alaska, 1984. Pp. 1-15 in M. Hoefs (Ed.), Wild sheep, distribution, abundance, management and conservation of the sheep of the world and closely related mountain ungulates. Spec. Rpt., North. Wild Sheep and Goat Counc., Yukon Wildl. Branch, Whitehorse. 218 pp.

________. 1987. Publication of Dall sheep findings and development of future research direction. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-22-5. Job 6.10R. Juneau. 33 pp.

________, and A. C. Smith, III. 1975. Dall ram horn growth and population quality and their significance to Dall sheep management in Alaska. Alaska Dep. Fish and Game. Tech. Bull. 5. 41 pp.

________, and R. O. Stephenson. 1982. Responses of Dall sheep populations to wolf control in interior Alaska. Proc. Bienn. Symp. North. Wild Sheep and Goat Counc. 3:320-330.

________, and S. M. Watson. 1982a. Interior sheep studies. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Prog. Rep. Proj. W-22-1. Job 6.9R. Juneau. 31 pp.

________, and ________. 1982b. Differing reproductive patterns in Dall sheep: Population strategy or management artifact? Bienn. Symp. North. Wild Sheep and Goat Counc. 3:330-338.

________, and ________. 1982b. Comparative dynamics of dissimilar Dall sheep populations. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-22-1 through W-22-4. Job 6.9R. Juneau. 101 pp.

________, S. D. DuBois, and D. G. Kelleyhouse. 1980. The usefulness of rocket nets for Dall sheep capture compared with other capture methods. Bienn. Symp. North. Wild Sheep and Goat Counc. 2:601-614.

________, S. M. Watson, and T. C. Smith, III. 1984. Excess ram mortality in a heavily hunted Dall sheep population. Proc. Bienn. Symp. North. Wild Sheep and Goat Counc. 4:425-433.

________, R. L. Zarnke, and D. J. Preston. 1982. Disease surveys in Dall sheep in Alaska (preparing for domestic grazing). Bienn. Symp. North. Wild Sheep and Goat Counc. 3:188-198.

Hoefs, M., and I. McT. Cowan. 1979. Ecological investigation of a population of Dall sheep. Syesis 12:81 pp.

Nielsen, C. A., and K. A. Neiland. 1974. Sheep disease report. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-17-5. and W-17-6. Job 6.6R. Juneau. 111 pp.

Murie, A. 1944. The wolves of Mt. McKinley. U.S. Dep. Int., Nat. Park Serv., Fauna Ser. 5. 282 pp.

Nichols, L. 1976. An experiment in Dall sheep management, progress report. Trans. North Am. Sheep Conf., Colorado State Univ., Ft. Collins. 2:16-34.

________. 1978. Dall sheep reproduction. J. Wildl. Manage. 42:570-580.

Watson, S. M., and W. E. Heimer. 1984. An age-specific winter die-off in Dall sheep in Alaska. Bienn. Symp. North. Wild Sheep and Goat Counc. 4:61-67.