

## CONSIDERATION OF A BIOLOGICAL APPROACH TO MANAGEMENT OF SUBSISTENCE SHEEP HUNTING THROUGH ADJUSTMENT OF BAG LIMIT

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*[Author's note: This paper was originally accepted for the Council's 1994 symposium, but the Alaska Department of Fish and Game (for which I worked at the time) insisted on "pulling the paper" because it had placed a moratorium on subsistence-related papers which might be interpretable as critical of subsistence. I failed to grasp how discussing a sheep management situation with professional colleagues in Cranbrook B.C. could threaten Alaskan management policy. I considered it a positive effort to gather input from other specialists in the field. Nevertheless, I was prohibited from formal presentation of the paper. In an effort to satisfy the politically nervous in Alaska, and still gather input from participants at the Council Symposium, I presented the content of the paper as my personal opinion during a suspension of the symposium program. No formal paper had been given and none was published. When I returned, the circumstances surrounding our informal discussion (including the "brown bag incident") were investigated, and my compromise ruled sufficiently unacceptable that I was threatened with termination in an official reprimand. Aside from this personnel matter, there was no negative fallout from our informal discussion at the symposium. Having already received the "glory" for presenting this paper, and because its prediction that management which set aside biological limitations to satisfy social demands would be problematic has been validated, it is now appropriate to publish this account. I shall first present the paper as drafted in 1994, and then offer an update on the consequences as an appendix. WHJ]*

**Abstract:** Both state and federal laws provide priority for subsistence harvest of Dall sheep (*Ovis dalli dalli*) in Alaska, and both laws mandate exclusion of other competing non-subsistence uses (e.g. nonresident guided hunting) when the harvestable surplus from Dall sheep populations cannot provide reasonable opportunity for identified subsistence users to attain past levels of subsistence harvest. Interpretation of these subsistence laws through litigation so politicized subsistence management of Dall sheep that biology became a minor consideration. Present liberal subsistence seasons and bag limits are based on aboriginal traditions (specifically ewe harvests) rather than the biological capacities of Dall sheep to support harvest, and may threaten sheep populations subject to subsistence harvest. By limiting subsistence sheep harvest to the biologically sustainable surplus, mature rams, management could be greatly simplified, and the longer-term stability of subsistence-impacted sheep populations enhanced. At the same time, the social and broader legal impacts of subsistence sheep harvest management would be lessened. Calculations suggest the biomass of sheep harvested would not decrease, but subsistence sheep hunters would have to adjust harvest patterns through increased effort.

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## INTRODUCTION

Development of a legally-mandated priority for subsistence use of fish and wildlife in Alaska followed discovery of the Prudhoe Bay oil fields (Heimer 1978a, 1980, 1982, 1986). Subsistence hunting for Dall sheep was formally institutionalized in state harvest regulations in 1980. At that time, the following conditions existed:

The number of subsistence hunters was relatively small, limited to recognized users in small communities inaccessible by surface transportation.

Subsistence harvest of Dall sheep was limited to areas where sheep were abundant.

It was assumed that subsistence sheep hunting had been traditionally practiced over the long term without detrimental effects to sheep populations.

Little was known about the magnitude, distribution, or composition of subsistence sheep harvests, and it was assumed that "legalizing" the practice through issuing permits for permissive use would provide data upon which future subsistence management programs for sheep could be built.

Because of these circumstances and the state's lack of prior experience in managing for legally mandated subsistence sheep harvests, the population biology of Dall sheep was not a major factor in deciding how to provide for subsistence use. That is, management of Dall sheep for traditional subsistence uses was an untested experimental enterprise (see appendix for details).

## METHODS

### Immediately Relevant History

Based on these assumptions, the State of Alaska established liberal regulations unprecedented in modern sheep management. These regulations were specifically designed to allow the state to implement its subsistence priority law as interpreted by the courts. This law prescribed priority for subsistence users, and defined subsistence as customary and traditional use (of sheep in this case) primarily for personal use or family consumption. Beginning October 1, 1980, the subsistence sheep seasons ran for seven months (Through April 30). The bag limit was three sheep of any age or sex. Requirements for participation included an Alaska hunting license and an "on demand" subsistence registration permit issued at a village in the harvest area. The first subsistence permits were issued in the coastal village of Kaktovik, which is near the remote northeast corner of the Brooks Range. The use of aircraft for transportation to the hunt area, harvest, or transportation of meat or gear from the area was prohibited. Mandatory (but voluntary) harvest reporting was a condition of receiving the permit to participate.

One goal of this program was documentation of sheep subsistence use in the village of Kaktovik, a community which had maintained a tradition of unregulated winter harvest of both sexes of Dall sheep in modern times despite restrictive, conservation-based regulations dating from 1926 (see Heimer, this symposium). The Alaska Department of Fish and Game (ADF&G) needed to

know the magnitude, sex and age composition, location, and chronology of the harvest to implement the state's subsistence law (see appendix). In addition, the Department's Division of Subsistence was interested in other questions of social, political and cultural significance associated with subsistence uses of sheep.

Still, the main thrust of the subsistence management program was provision for subsistence use of Dall sheep consistent with state and federal subsistence laws. Both laws recognize subsistence as the highest priority consumptive use and require that other uses be restricted as necessary to protect reasonable opportunity for subsistence users. According to state law, if a sheep population is unable to provide reasonable opportunity for all users to meet their defined needs, use by guided nonresident hunters must be eliminated first. Should this not make enough sheep available for subsistence uses, non-local Alaskans without a history of past use of the affected population would also be excluded. If further restrictions are necessary, local users are to receive priority based on dependence and past use. Only when the population can no longer support any harvest would subsistence uses be curtailed. Implementing the federal preference was less specific than the state's procedure, providing for a "rural" (undefined in federal law) priority with selection among rural users by the same criteria as the state law. As long as a harvestable surplus exists, both state and federal laws mandate allocation of the surplus for subsistence uses.

The biological consequences of this priority among consumptive uses of Dall sheep, especially when coupled with liberal harvest regimes which may not have been biologically sustainable, were not major considerations when subsistence hunting for sheep was first institutionalized. As stated above, there were relatively few qualifying subsistence sheep hunters in relation to the perceived abundance of sheep in the specific areas where sheep subsistence hunts were to take place. Also, there was but one set of subsistence regulations at that time because the federal government had not yet pre-empted state regulations to provide for rural preference on federal lands (Heimer 1993a, b, c).

### **Ancillary History**

Subsistence harvest programs: In an effort to comply with federal interpretation of the federal Alaska National Interest Lands Conservation Act (ANILCA) subsistence provision (Title VIII), Alaska initially attempted to limit subsistence use to "rural residents." This was not simple because there is no definition of "rural residents" in the federal law.

Alaska's first effort to conform to the federal ANILCA interpretation was to define rural residents through administrative action, i.e. through state regulations. A court challenge of this approach resulted in the Alaska Supreme Court ruling that administrative linkage of rural residence and preference was illegal (see Heimer 1986 for a discussion of the Madison case). Faced with being federally designated as "out of compliance with ANILCA," the Alaska legislature amended its existing subsistence law to define subsistence users according to the federal law (which included residence location as an identifying criterion). This residence criterion was subsequently challenged in court by a citizen named McDowell, and found to be inconsistent with the Alaska Constitution (Holland 1989). By extension from the McDowell

case, all Alaskan residents were defined as subsistence users under the Alaska Constitution. This increased the number of potential subsistence hunters tremendously.

## RESULTS AND DISCUSSION

In the intervening years (between 1980 and the McDowell ruling in 1989), subsistence hunting had proliferated far beyond the experimental Kaktovik program (see appendix). Unfortunately, these efforts to gather subsistence use data failed; few villagers participated in the "mandatory but voluntary" harvest reporting system. Consequently, harvest size and locations remained undocumented and harvest could not be associated with population trend. There was no reason to believe the limited information gathered from the Northeastern Brooks Range was reliable or applicable to other sheep subsistence scenarios. At the end of the proliferation cycle, the Dall sheep subsistence season ran for seven months with a three-sheep bag limit throughout the Northeast, Southeast, Central and Western portions of the Brooks Range. In the Western Brooks Range subsistence hunting was limited to local residents by specific state regulations. The season was open to any Alaskan in both the Eastern and Central portions of the Brooks Range where a typically liberal season had been unintentionally created in areas readily accessible from the oil pipeline haul road (the Dalton Highway). Once state-recognized subsistence hunters discovered they could reach these sheep from the Dalton Highway, the season adjacent to the road was closed.

In addition, subsistence seasons had been defined for readily accessible sheep populations on state lands adjacent to the Wrangell Mountains as well as within Wrangell St.-Elias National Park and Park preserve. Following the McDowell decision in 1989, any Alaskan with a hunting license and free harvest ticket could hunt sheep populations covered by state regulations. This included state lands, federal wildlife refuges, and national Park Preserves. Except in the Brooks Range, these seasons were limited to 42 days (the traditional Aug. 10-Sept. 20 fall hunt period for what is now recognized as non-subsistence hunting). The subsistence bag limit for the sheep-poor Western Brooks Range and the south and west portion of the Wrangell Mountains was one sheep.

### Management Justifications for Harvesting Ewes

Population control: These liberal seasons, bag limits, numbers of potential hunters, and relatively easy access to sheep populations raised the possibility that subsistence harvest of Dall ewes would result in population declines caused by decreased population productivity and growth (Heimer 1978b). In practice this had already been purposefully implemented in Alaska (Nichols 1978) and for bighorn sheep (see Jorgensen et al. 1993 for a summary paper). Throughout the managed bighorn herds of North America, harvest of ewes is not uncommon. However, it should be emphasized that wherever this management practice is employed, the stated objective is limiting population growth or decreasing sheep numbers. Bighorn sheep living in temperate climates where natural predators are greatly reduced or absent encounter insufficient environmental resistance to keep them in equilibrium with their food supply necessitating population stabilization or periodic reduction by ewe hunting or transplant (Jorgensen et al. 1993).

Disease control: An additional factor which dictates maintaining bighorn populations at low densities is their history of population-decimating disease epidemics resulting from contact with domestic livestock (Heimer et al. 1992). Even if food is sufficient to maintain dense bighorn populations, most managers prefer to hold them at lower densities in efforts to prevent disease-related mass mortality.

I have argued this is not the case for Dall sheep in intact ecosystems (Heimer 1992). Dall sheep in undisturbed Alaskan environments do not face the problems common to bighorn populations; disease-related die-offs are unknown in Alaskan Dall sheep (Heimer et al. 1992). Natural predators exist at pristine levels. Consequently, Alaskan sheep populations have been reduced by hunting associated with ewe harvests in both historic and modern times.

### **Historic accounts of subsistence harvest decimating Dall sheep populations**

It is impossible to know with certainty what happened in the unrecorded past. However, Campbell (1974) suggested aboriginal overharvest resulted in the reported paucity of Dall sheep throughout the Brooks Range early in this century. He proposed a similar explanation for extirpation of muskoxen (another "extreme k-selected" species) in Alaska. Similarly, Pruitt (1966) wrote that old hunters reported having hunted Dall sheep in the Lisburne Hills and Cape Thompson cliffs at the extreme Western Brooks Range limit of sheep distribution. Also, Bailey and Hendee (1926) recorded occurrences of Dall sheep at Cape Lisburne and Cape Beaufort. Dall sheep are not known to occur in these areas at the present time. If Campbell (1974) were correct in his hypothesis, it would be reasonable to conclude that subsistence sheep harvests, even using the comparatively primitive transportation and hunting technologies of the early 20<sup>th</sup> century, contributed to local extirpation of sheep in these areas.

### **Modern Alaskan examples of population declines associated with ewe hunting**

Alaskan experience with ewe harvests on the Kenai Peninsula (Nichols 1978) indicates harvest of Dall ewes will lower the absolute productivity of Dall sheep populations and reduce population size. In that experimental population reduction, ewe hunting of an isolated ewe population on the Kenai Peninsula resulted in the planned population decline, but all of the missing ewe sheep could not be accounted for by reported human harvest. It is presumed the missing ewes were either killed by hunters who did not report their harvest (Heimer 1978a) or had abandoned their range as a result of disturbance (Nichols 1978). Population decimation by natural predators in this instance was not considered a rational explanation. Few large predators (wolves) were present on the Kenai Peninsula at that time, and aerial counts before and after the hunt showed the planned population decline took place during the hunting season.

An unplanned example of ewe overharvest took place in the Tok Management area of the eastern Alaska Range during the late 1970s. In this instance, a band of 20 ewes was reduced to two ewes in the course of one afternoon's hunting by a large party of moose hunters with permits to

take ewe sheep (R. A. Matthews, ewe hunt participant, Tok pers. commun.). Recovery of this ewe band has not been documented. Ewe harvests were curtailed in this area 19 years ago.

Alaska Department of Fish and Game managers have also justified ewe-driven population reductions and alleged population and hunter benefits resulting from limited ewe harvests in the Chugach Mountains (Bos 1996). These claimed benefits were chronologically impossible to attribute to ewe population reductions. Nevertheless, this ADF&G testimony to the Alaska Board of Game serves to document the population reduction rationale which has underlain every ewe harvest ever proposed by ADF&G.

An ongoing limited permit hunt for ewes on Round Mountain, Kenai Peninsula was also justified as a necessary population reduction because of lower lambs:100 ewes ratios on this mountain compared with the surrounding area. This examples further demonstrates the ADF&G position that even very limited harvests of ewes are expected to reduce population densities.

These examples show the purposeful harvest of ewe sheep in modern times has been judged to reduce sheep populations even under harvest conditions which were greatly more restrictive than the ewe harvest regulations associated with subsistence hunting in the in the Brooks Range. These modern examples also show that the principle justification for planned harvesting of ewe sheep is to cause a decrease in population size. It appears that Assumption #3 (above) is inconsistent with this thinking.

#### **The Western Brooks Range: a case study/example**

A situation *analogous* to ewe overharvest has been developing in the Western Brooks Range since 1990. In contrast to other ADF&G managers, Western Brooks Range managers maintain it is unlikely this decline involved relatively modest subsistence harvest of ewe sheep. In the Baird Mountains, populations of ewes, yearlings, and young rams counted from aircraft declined dramatically in 1990. I suggest this population is *analogous* to a decline caused by overharvest because a serious population decline required immediate management action (curtailing ewe harvests) to protect the resource.

According to Ayers (1996), the average annual harvest for the five years preceding the decline was 15 ewes per year from a population averaging 466 "ewes." "Ewes" are sheep which look like ewes from survey aircraft (ewes, yearlings, and young rams). This reported mean ewe harvest calculates to a minimum (because of non-ewe sheep among the 466 "ewe" sheep used for the calculation) three percent mortality due to subsistence harvest. If this mortality is additive, it would approximately double the measured natural ewe mortality in Dall sheep populations where ewe hunting is prohibited (Watson and Heimer 1984).

Nevertheless, unfavorable weather is listed as a more likely cause of the decline (J. Dau, Alaska Dep. Fish and Game area biologist, Kotzebue pers. commun). Regardless of the proximal cause, the population decline is still analogous in a management sense. The population of "ewe" sheep had declined to the point it was clear a harvestable surplus of ewes no longer existed. Management action to reduce ewe mortality was clearly necessary.

Still, mature rams continued to be a biological surplus. Harsh weather may virtually eliminate lamb production in any given year, or sequence of years, without severely affecting the survival of adults in their prime (Watson and Heimer 1984). Experience (Heimer 1990) shows mature rams are indeed, a sustainable biological surplus because one ram will breed many ewes. Survey data (Ayers 1995) show the availability of mature rams in the Western Brooks Range had not decreased when "ewe" numbers crashed. Hence, there was a biological surplus of mature rams, just not one of ewes. Ram harvest was biologically permissible, but ewe harvest was not.

In the judgment of managers on the scene, it was unlikely subsistence users would understand why guided or non-local resident ram harvests (viewed unfavorably as "trophy hunting" by local residents) could continue while local residents could not harvest ewes for food (J. Dau, Alaska Dep. Fish and Game pers. commun.). As a result of this judgment by managers in the field, all hunting was curtailed even though a biological surplus of mature rams remained clearly available. In this case, biological and legal management considerations were secondary to local political realities which had their basis in the cultural relevance of subsistence harvest practices and the ADF&G need for harmonious relationships with local residents.

As a result, subsistence hunters (as well as non-subsistence hunters) were deprived of using the relatively abundant biological surplus of mature rams. When, if ever, the population recovers and ewe harvests are restored, and a future decline eventually occurs (whatever its cause), this cycle is likely to be repeated unless a differing view of subsistence sheep hunting management develops. Management is, however, more than biology, and other factors should also be considered.

### **Legal concerns**

The Alaska Constitution (Article 8) establishes the policy of the state with respect to natural resources as, encouraging the "development of its resources by making them available for maximum use consistent with public interest." Title 16 of the Alaska Statutes implements this policy by establishing the Alaska Department of Fish and Game through the duties and powers of the Commissioner of Fish and Game. Duties of the commissioner include management, protection, maintenance, and enhancement of the fish game in the interest of THE ECONOMY and GENERAL WELL BEING of the state (emphasis added).

*"In the interest of the economy:"* Here I shall offer some projections which are so simple they may be considered inappropriate in rigorous economic terms. Still, I offer them as illustrative of potential economic costs associated with socially based decisions relating to the subsistence priority.

Based solely on 1983's hunter expenditures, the non-subsistence sheep harvest of about 1,000 rams grossed about \$7 million dollars in Alaska (Watson 1990). Hence, the simple average expenditure (not necessarily the worth) for each ram harvested in 1983 was \$7,000. Estimates published in 1994 placed the dollar value of non-subsistence ram hunting at about \$12 million (McCollum and Miller 1994) for the harvest of about 900 rams (an average of \$13,000 per ram

taken). Arbitrarily deriving an economic estimate of ram harvest worth by averaging these two data points (separated by 10 years, and with the 1983 figure being only expenditures while the 1993 data estimated value) gives a rough cash worth of \$10,000 per ram. Applying this per-ram worth to foregone harvest from the Western Brooks Range is revealing.

When both subsistence and non-subsistence hunts were offered in the Western Brooks Range, the average non-subsistence ram harvest was 30 rams per year. Simple multiplication (30 rams times \$10,000 per ram) projects a potential loss of \$300,000 per year in economic benefit to the Alaskan economy if the ram season were closed unnecessarily. Unnecessary closure is a rational possibility considering ram stocks were not depleted when the population of sheep which look like ewes from an airplane declined by 44 percent, and the fact it takes at least five years for a young ram which looks like a ewe from an airplane to reach harvestable maturity in the Brooks Range. If ram hunting were unnecessarily closed for 5 years the potential loss would have come to five times \$300,000 or \$1.5 million dollars.

With non-subsistence use excluded from the area, and with the sheep population at half of what it formerly was, the potential economic loss to the state from not harvesting 15 rams would calculate at \$150,000 annually using this simplistic model. Again, I use these projections to illustrate the fact that values other than the cash costs of subsistence foods are attached to Alaska's wildlife. Similarly, I speak of these economic losses as "potential" because it is possible that hunters who would have hunted in the Western Brooks Range could have hunted elsewhere. However, the statewide declines in Dall sheep populations, resulting in a significant downward trend in Dall ram harvests increasingly limit this possibility. It might inform decision makers if they balance the economic loss associated with total closure against the calculated cash value of subsistence foods produced by the same populations.

*"n the interest of general well-being:"* While expenditure values may define the more-or-less direct contribution to the economy of the state, they are not considered adequate measures of value. Contingent valuation methods are better suited to defining value (Watson 1990).

Watson's estimates of net benefit to non-subsistence sheep hunters using contingent valuation methodology ranged from \$30 million for one year's hunting opportunity (\$30,000 per ram harvested) to about \$28 billion for all future opportunities in Alaska (for just the 2,800 hunters surveyed in 1983). If, as Watson supposed, this high dollar value (\$28 billion) represents a "cash expression" of the emotional/spiritual attachment non-subsistence sheep hunters have to Dall sheep hunting opportunity, these sums may represent a measure of the importance of sheep hunting opportunity to the "general well-being" of non-subsistence sheep hunters. The "general well-being" of subsistence hunters has not been estimated. Economic benefits of subsistence hunting are typically expressed as food replacement costs.

The question of whether maintaining subsistence hunting opportunities which are basically inimical to conservation serves the "general well-being" of the state should be considered. How should the feeling of local well-being (which ADF&G says derives from the assurance of potential future subsistence uses to subsistence hunters) be balanced against the measured value of general well-being for non-subsistence hunters?



*State and Federal Subsistence Laws:* In spite of the economic consequences, both state and federal subsistence laws (passed prior to development of wildlife economic valuation) mandate a priority for subsistence uses. The state law was passed in an effort to pre-empt the federal subsistence preference in ANILCA; the federal law resulted from an anti-pipeline alliance between preservationist and Alaska Native interest advocates (Heimer 1982).

Both laws define a procedure for providing subsistence preference: impacted populations must be identified, the harvestable surplus from these populations determined, and the subsistence need defined. Once the harvestable surplus and subsistence need are known, subsistence need is to be subtracted from harvestable surplus. If any of the harvestable surplus remains, or if subsistence users do not take all the harvestable surplus, the remaining animals are to be allocated to non-subsistence users. This process was followed by the state when sheep were relatively abundant in the Western Brooks Range, but not after the weather-related population decline. That is, these laws were set aside by local managers for social reasons. Few observers noticed.

#### **Summary of the present situation and recent history**

The biology of Dall sheep and common management practices coupled with recorded and anecdotal histories of ewe harvests strongly suggest the harvest of ewes should not be considered biologically sustainable under normal conditions in Alaska. Subsistence management of Dall sheep is based on allowing ewe harvests because they were historic aboriginal practices. A case study of subsistence sheep management attending a major population reduction suggests that managing on the basis of human cultural bias is inconsistent with provisions of the Alaska Constitution. Failure to allocate the harvestable surplus of mature rams in the Western Brooks Range served neither the economy or general well-being of the state, and was a violation of both state and federal subsistence laws. Unproductive results such as these, should drive the search for a viable alternative.

#### **AN ALTERNATIVE FOR CONSIDERATION**

The biological side of the management equation seems adequately understood for management of consumptive uses. Demonstration that higher lamb production, greater ram survival and ultimately increased ram harvests occur under a management program designed to stay within the constraints of Dall sheep behavioral ecology (Heimer and Watson 1990) indicated Heimer's (1988) working hypothesis of Dall sheep hunting management predicts correctly. Management failures have come on the human side of the equation. Hence, I suggest that managing within the biological constraints imposed by Dall sheep biology, and meeting human needs and desires within these constraints would mitigate problems such as those detailed in the Western Brooks Range case study (see appendix). If the bag limits for subsistence management of Dall sheep were limited to mature rams (the known biological surplus from sheep populations), problems would be greatly reduced, if not eliminated.

## **Biological Considerations**

Several components of the cumulative data base relating to mountain sheep in general, and Dall sheep in particular, indicate the harvestable surplus produced by Dall sheep populations in intact ecosystems (those with unmanaged predator populations and without exotic diseases) is limited to mature rams. Faced with relatively high environmental resistance, Dall sheep populations typically show slow rates of increase. They are "k-selected" in the extreme. Dall sheep adaptations to their environment do not include multiple births, no matter how good their food. Neither do Dall sheep adaptation options include early ovulation by females as a result of superior nutrition. Apparently, all Dall ewes ovulate in the wild (as do their well-fed zoo counterparts) at the age of 18 months, regardless of sheep densities (Heimer and Watson 1986a). Still, Dall ewes don't normally reproduce until the age of three or four years (Heimer and Watson 1986a), and rams are not consistently involved in reproduction until social dominance is achieved (Geist 1971). For most Dall rams this requires eight years, but in the Brooks Range, ten years is the norm (Heimer and Smith 1975). Rams which are not socially dominant are spared the mortality costs of rutting, and survive at high rates (Heimer and Watson 1986b). Heimer and Watson (1990) demonstrated that sustainable harvests from Dall sheep populations are practically and efficiently maximized by limiting harvest to (i.e. defining the biological surplus as) mature rams. Hence, a biologically sustainable subsistence harvest program would logically limit harvest to mature rams.

## **Social Considerations**

Management of subsistence harvests on the basis of biological capacity appears to be politically impractical at this time. This is because subsistence use of wildlife has evolved a meaning which is much broader than simple sustenance. If harvest of sheep for food were the main consideration, limiting subsistence harvest to mature rams would not pose a significant problem. Mature Dall rams are typically 1.5 to two times as large as mature ewes. Consequently, biomass needs of subsistence users could be supplied by significantly fewer rams than ewes. Using estimates of sheep biomass harvested by subsistence hunters from Kaktovik Village suggested mature rams were sufficiently abundant in the Kaktovik subsistence harvest area to more than satisfy the estimated need in the village and still leave enough mature rams to more than match past non-subsistence ram harvests.

However, hunting selectively for mature rams would require subsistence hunters to expend greater effort to harvest the equivalent biomass as mature rams. This decreased efficiency may not be culturally acceptable. Customary and traditional practices as they relate to maintenance of Alaska Native culture presently represent the political "high ground" in the subsistence debate. Common sense predicts that ancient harvest patterns were driven by economy of effort in obtaining food. If this were true, historic harvest traditions, which centered on ewe harvests, evolved because ewes were the most readily available sheep. Ewes would also have been slightly more abundant because of the natural tendency of sex ratios in Dall sheep to favor ewes in pristine conditions. Still, harvest of ewes could have continued indefinitely if at a low enough level (less than two percent of any band estimated by Heimer (1988)), or if rotated between several ewe populations, particularly given low yield harvest technologies. Campbell (1974)

argued primitive technologies for Dall sheep were highly successful. Nevertheless, primitive harvest techniques were certainly less efficient than modern show machine (or aircraft) transport and flat-shooting rifles with telescopic sights.

Subsistence users are seemingly loath to forsake modern technology in gathering subsistence harvests, but cling tenaciously to the cultural values associated with harvesting wildlife for food. Consequently, there may be little hope of extracting subsistence sheep management from the over-exploitation/complete closure cycle predictable from the Western Brooks Range case study. Over the longer term, this cycle works against sustained subsistence use of Dall sheep populations by focusing on a harvest which does not appear biologically sustainable. If this is realized, it may be possible to eliminate the prospect of this cycle through changes in harvest selection by subsistence users.

Throughout the first 75 years of the 20<sup>th</sup> century, the dominant Western European culture was willing to coerce harvest selection among Alaska Native subsistence users in the name of conservation. However, as evidenced by the legal institutionalization of subsistence uses, those days have passed. The political and cultural mood of today appears to value human cultural diversity more highly than long-term wildlife conservation of the resources on which that diversity is based. This means the only hope for putting Dall sheep subsistence management on a biologically sustainable basis is a trade-off in cultural values within the Alaska Native community. If sustainable subsistence use is of sufficiently high value, Native societies where subsistence use of sheep is anticipated over the long term may find it adaptive (in the light of increased human population sizes and use of advanced harvest technologies) to consider restricting their harvests to those which are biologically sustainable. Even the tolerance of cultural diversity advocates (which favor subsistence uses of sheep as currently practiced) is likely to erode if the dire consequences illustrated by the weather-related events in the Western Brooks Range become associated with documented overharvest by subsistence users.

### **A Rather Encouraging Example**

In 1992, the U.S. Fish and Wildlife Service (USFWS), acting in concert with the Interior Region of the Alaska Department of Fish and Game, took a biologically progressive step in adjusting the subsistence bag limit for Dall sheep in the Southeast Brooks Range. In this case, local residents (of Arctic Village) had complained that their subsistence hunting success was declining. They assigned this decline to sheep disturbance by non-subsistence hunters during the fall season (which effectively ended about a month before the opening of the subsistence season). Faced with this demand, the USFWS committed itself to a multifaceted approach to the problem.

First, the intensity of non-subsistence use was documented in cooperation with ADF&G. Results of this work suggested the level of non-subsistence harvest and its associated aircraft support were insufficient to produce the disturbance and redistribution of Dall sheep alleged by subsistence users.

Next, the USFWS flew intensive distribution and abundance surveys throughout the traditional subsistence use area where subsistence harvest success had allegedly declined. Surveys were also flown in the better sheep habitats adjacent to the subsistence use area. Data gathered on these surveys revealed Dall sheep were scarce in the core subsistence use area, but reasonably abundant in the adjacent better habitats.

Finally, USFWS and ADF&G biologists captured and radiomarked sheep in both the subsistence use area and the adjacent habitats. Subsequent relocations of these marked animals did not reveal movement into or out of the low-density subsistence use zone between the non-subsistence and subsistence seasons. That is, there were no data suggesting non-subsistence use affected subsistence harvest success in the area.

Nevertheless, the federal Subsistence Board (Heimer 1993a,b,c) responded to a request on the part of local residents to exclude all non-subsistence hunting from federal lands in the low-density subsistence use area (the Arctic Village Management Area). This was exactly what the local residents had requested. In this zone, only federally recognized subsistence users (Arctic Village residents and residents of tribally related villages with alleged histories of sheep use from this area) were allowed to hunt for Dall sheep during the "standard" seven-month season.

Most significantly, ADF&G and the USFWS jointly recommended an apparent bag limit reduction from three sheep of either six or any age to two rams.

*[Author's note: Here it is important to note that while ADF&G and USFWS cooperated to effect a more biologically rational regulatory compromise than the three-sheep bag limit, both agencies failed to follow the legally mandated procedure for allocating resources where a subsistence preference is operative. Neither agency determined the harvestable surplus or the subsistence need prior to making subsistence use allocations restricting non-subsistence uses. Having failed to quantitatively define these parameters, it was impossible to subtract the "need" from the "surplus" to see how many sheep, if any, remained for allocation to non-subsistence uses. WHJ]*

Departure from the established "three-sheep" bag limit was not strictly based on agency recognition that "any ram" is part of the biological surplus (which has been demonstrably limited to mature rams where harvest pressure is high). Rationale for the "any ram" harvest was to allow subsistence users maximum selectivity and opportunity for success within a biologically conservative harvest regime. This rationale was based on projections (based on anecdotal accounts of past harvest from the Arctic Village Sheep Management Area) that the ram harvest would be biologically insignificant. The biomass arguments presented above were also a factor.

The USFWS bag limit recommendations were accepted by the Federal Subsistence Board, and became federal subsistence regulations. In the surrounding areas (where sheep were not so scarce) the three-sheep seven-month season was still available to these subsistence users, and non-subsistence harvests of full-curl rams during the fall season continued.

The affected rural residents are now (as of 1994) dissatisfied with this arrangement. They are currently pressing not only for expansion of the subsistence management area, but also for re-instituting ewe harvests and elimination of individual bag limits in order to increase efficiency of sheep harvests for Arctic Village. Allowing the better sheep hunters to take sheep (presumably in the most efficient manner) for the entire community would not only provide greater harvests, it would be consistent with historic aboriginal hunting, harvest, and sharing patterns.

*[Author's note: After this paper was drafted in 1994, residents of Arctic Village were partially successful with proposals to the Federal Subsistence Board. The Arctic Village Sheep Management Area has been expanded to, and non-subsistence hunting excluded from, the higher density sheep populations on the upper east side of the East Fork of the Chandalar River. However, the bag limit has not been expanded from two rams to three sheep. Paradoxically, the result has been an actual lowering of the bag limit from three sheep to two rams in the expanded exclusive use subsistence area. Anecdotal accounts of subsistence effort and harvest from this exclusive use area suggest minimal use of Dall sheep by the federally-recognized users (F. Mauer USFWS, Fairbanks pers. commun.). WH]*

## SUMMARY

Subsistence management of Dall sheep is still evolving, and thus far must be considered an experiment. To date, the experiment can not be considered a success. Little has been learned of subsistence harvest magnitude or distribution during the 14 years of subsistence harvest permit systems. As a result of this continuing dearth of knowledge and the closed-season example from the Western Brooks Range, an optimistic outlook for resolution of the resource-based problems discussed here is naïve.

Further skepticism is warranted by the apparent fact that in the Northeast Brooks Range, federally recognized subsistence users opted for a reduced bag limit (two rams instead of three sheep) in order to exclude biologically insignificant and sustainable ram harvest by non-subsistence users from an area which they use but little. That is, Arctic Village residents sacrificed their customary and traditional harvest patterns (which were earlier justified on economy of effort), and apparently accepted a more restrictive bag limit in order to exclude ram harvests by non-local residents.

*[Author's note: Federal Subsistence Board Action in this case appears inconsistent with the Bureau of Indian Affairs solicitor's opinion that the Federal Subsistence Board cannot accept a proposal which is counter to subsistence (see appendix). WH]*

Descent into this management morass was not sudden. In fact, it has been nearly imperceptible. Failure to recognize this problem for so many years may account for some perceptions of this paper's content as alarmist or anti-subsistence. However, I think an actual and solvable problem

exists, and that basing management on biological constraints before planning allocation of harvests to humans is the key to its solution.

At the outset, subsistence management for Dall sheep was limited enough that consideration of its biological impacts was secondary to its human, political, and experimental justifications. Focus on the human and political components of the system has led us into a complex legal maze which surely isn't the result envisioned by the well-meaning authors of the subsistence priority. The present situation may also be at variance with the state constitution and statutes dealing with natural resources.

Still, it may be possible to provide for subsistence use within a biological framework. If we accept (or test) the working management hypothesis for Dall sheep (that mature rams are the only harvestable surplus produced by mountain sheep populations in intact ecosystems) and provide for subsistence preference through increased opportunity for all hunters to take mature rams instead of excluding non-subsistence hunters for social reasons, the gloomy outlook for the future of sheep management for all uses could be much brighter. For these changes to occur, the adjustment will have to be voluntary, and on the part of the subsistence community. This presents managers with a formidable educational challenge.

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